Promoting Environmentally Sustainable Commercial Aquaculture Project in Uganda

MINISTRY OF AGRICULTURE ANIMAL INDUSTRY AND FISHERIES

Aquatic Animal Health Monitoring Control and Surveillance in Uganda-Gap Analysis

Final report

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PREPARATION OF THIS DOCUMENT

This report is the outcome of desk work and findings from field investigations and analysis related to the development of a monitoring, surveillance and control (MCS) system for Aquaculture production in Uganda under the Promoting Environmentally Sustainable Commercial Aquaculture Project in Uganda that is being funded by the EU. The project falls under the National Authorizing Officer (NAO) in the Ministry of Finance, Planning and Economic Development (MoFPED), and has as the Supervising Authority the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). A Technical Assistance Team (TAT) (provided by Agrotec SpA) was hired through the EU to support the overall implementation of the Project. The work leading to this document was funded through a direct contract with AGT SpA under an agreement contract between AGT SpA and the European Union Delegation (EUD) in Kampala. The project was under the overall management of Mr. Patrick Seruyange, European Union Delegation, Kampala, with technical oversight by Mr Dave Russell, PESCA TAT. International consultant, Dr Nihad Fejzic, contributed the framework for development of the monitoring, control and surveillance system for aquaculture production in Uganda and prepared the report based on a review of pertinent literature and information supplied by the TAT. The local consultant, Dr Isyagi-Levine, undertook the stakeholder consultations around Uganda and gap analysis, the output of which was inclusion in the aquaculture MCS guidelines. For details on the recommended components of the MCS, the authors have consulted international literature, standards, practices, and guidance from documents and approaches used by FAO and OIE for the development of aquatic disease monitoring, surveillance and control in other countries and results from previous activity conducted on aquatic disease surveillance in Uganda.

Executive Summary

Fish is an important dietary component and commodity of trade for Uganda. Currently the currently grappling to meet fish food and nutritional needs of its rapidly growing population and at the same time effectively harness the economic opportunities of its existing local, regional and international markets to support national socio-economic development. The country must produce additional 1,000,000 mt of fish per annum above the 750,000 mt of fish currently being produced from both the fisheries and aquaculture to realize its National objectives for the sectors.

Environmentally sustainable commercial aquaculture has been identified as the most feasible option for sustainably an additional 1,000,000 mt of fish per annum. However, this objective cannot be comprehensively achieved without addressing threats to the aquaculture development arising from biosecurity and biosafety control, ecosystem health and climate-change. The loss of production, access to markets and negative impacts on public health and environmental sustainability that may accrue unless the fore-mentioned are addressed will negate growth that has been realized from the public and private sector investments that have so far been made into the sector. Establishing an aquaculture Monitoring, Surveillance and Control helps address these concerns by generating data and information to facilitate evidence-based decision making for aquatic animal disease control, environmental management, and public health and on national zoo-sanitary status to assure markets.

This report discusses the status and opportunities for aquatic animal disease surveillance and control in Uganda. The prospects and gaps for establishing a One Health aquatic animal health MCS system within the country are evaluated in lieu of the World Organization of Animal Health (OIE), Food and Agriculture Organization (FAO) and East African Community (EAC) regional standards and guidelines for aquatic animal biosecurity control and safe-trade following the FAO 12 Point Checklist. Recommendations for the surveillance of OIE notifiable and endemic aquatic animal pathogens were consequently proposed and the institutional, human resource and infrastructural requirements for implementing aquaculture MCS to support environmentally sustainable commercial aquaculture discussed.

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The authors also acknowledge the contributions of consultants for two parallel running projects that are closely connected to MCS work: Development of a national biosecurity and biosafety system for aquaculture in Uganda Dr David Huchzermeyer and Dr John Walakira and Harmonization of the Licenses & Permits for Aquaculture Production, Mr Etienne Hinrichsen and Dr John Balirwa.

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Acronyms

AMR	Antimicrobial Resistance
ARDC	Aquaculture Research and Development Centre
ATWG	Aquaculture Technical Working Group
CA	Competent Authority for Aquaculture and designated national OIE Aquatic Focal Point
CAH	Commissioner Animal Health
CAMD	Commissioner of Aquaculture Management & Development
CoNAS	Colleges of Natural Sciences
CoVAB	College of Veterinary Medicine, Animal Resources and Bio-security
DAMD	Department of Aquaculture Management and Development
DAR	Directorate of Animal Resources
DiFR	Directorate of Fisheries Resources
DFO	District Fisheries Officer
DFCRQA	Department of Fisheries Control, Regulation and Quality Assurance
DRC	Democratic Republic Congo
DVO	District Veterinary Officer
EUS	Epizootic Ulcerative Syndrome
EVMLU	Essential Veterinary Medicines List for Uganda
FAO	Food and Agriculture Organisation of the United Nations
FCR	Feed Conversion Ratio
FO	Fisheries Officer
FTI	Fisheries Training Institute
GDP	Gross Domestic Product
IGAD	Intergovernmental Authority on Development
IHN	Infectious Haematopoietic Necrosis
HVLD	High Volume Low Density cages
LG	Local Government
LVFO	Lake Victoria Fisheries Organisation
LVHD	Low Volume High Density cages
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MAK	Makerere University
MDA	Ministries, Departments and Agencies
MOH	Ministry of Health
NaFIRRI	National Fisheries Resources Research Institute
NARO	National Agriculture Research Organisation
NDA	National Drug Authority
OIE	World Animal Health Organisation
SDG	Sustainable Development Goals
SPS	World Trade Organisation - Sanitary and Phyto-Sanitary measures
SVCV	Spring Viraemia of Carp
TiLV	Tilapia Lake Virus
UNBS	Uganda National Bureau of Standards
URA	Uganda Revenue Authority
WAHIS	World Animal Health Information System
WHO	World Health Organisation
VHS	Viral Haemorrhagic Septicaemia

Terminology and definition used

- **Aquatic Disease Monitoring** is defined as all activities aimed to detect changes in the epidemiological parameters of a specified disease
- **Aquatic Disease Surveillance** is defined as all regular activities aimed to ascertain the health status of a given population with the aim of early detection and control of animal diseases of importance to national economies, food security and trade.
- **Aquatic disease Control** is set of actions aimed to prevent introduction of disease (when it doesnt exist) or to reduce/eliminate disease event (if exist)
- ***Commodity -*** means *aquatic animals*, *aquatic animal products*, *biological products* and *pathological material*.
- ***Compartment -*** means one or more *aquaculture establishments* under a common biosecurity management system containing an *aquatic animal* population with a distinct health status with respect to a specific *disease* or *diseases* for which required *surveillance* and control measures are applied and *basic biosecurity conditions* are met for the purpose of *international trade*. Such *compartments* must be clearly documented by the *Competent Authority(ies)*.
- ***Competent Authority -*** means the *Veterinary Authority* or other Governmental Authority of a Member Country having the responsibility and competence for ensuring or supervising the implementation of *aquatic animal* health and welfare measures, international health certification and other standards and recommendations in the *Aquatic Code* in the whole territory.
- ***Emerging disease -*** means a newly recognized *infection* resulting from the evolution or change of an existing *pathogenic agent*, a known *infection* spreading to a new geographic area or population, or a previously unrecognized *pathogenic agent* or a *disease* diagnosed for the first time and which has a significant impact on *aquatic animal* or public health.
- ***Epidemiological unit -*** means a group of animals that share approximately the same *risk* of exposure to a *pathogenic agent* with a defined location. This may be because they share a common aquatic environment (e.g. fish in a pond, caged fish in a lake), or because management practices make it likely that a *pathogenic agent* in one group of animals would quickly spread to other animals (e.g. all the ponds on a farm, all the ponds in a village system).
- ***Fish health*** certificate means an official document issued by competent authority for the purpose of attesting the quality and safety of fish and fishery products and conditions under which they were produced. (source Law Insider https://www.lawinsider.com/dictionary/fish-health-certificate)
- ***Veterinary epidemiology*** provides the tools to investigate disease outbreaks, identify risk factors for disease, investigate diseases of unknown etiology, undertake disease surveillance and monitoring, implement herd health programs, and develop and implement biosecurity measures; hence, this discipline is an essential component of disease control, eradication, and prevention.
- ***Veterinary Public Health*** aims to prevent negative impacts on human health by reducing exposure to hazards arising from animals, animal products, and their environment. Examples of these hazards include zoonoses, vector borne infections and other communicable diseases, chemicals and drugs used in animals (AMR), envenomations, and injuries from exposure to animals.

1. Background

Uganda's ability to sustainably produce enough fish to meet the fish food and nutritional needs of its growing population solely from the fisheries has become a challenge. National total annual fish production is estimated to be 750,000 mt, yet the National Fisheries and Aquaculture Policy (NFAP) estimates the annual domestic fish demand to be 1,750,000 mt. Aquaculture contributes about 100,000 mt to the current national annual fish production. The deficit in production is worrisome. Fish consumption rates are 50% of the global average of 20 kg/capita/year but the country's population of 40 million is growing at the rate 3.4% per annum. Further to this, the sector contributes 2.5% to National GDP and is among the country's major forex earners. The fisheries and aquaculture sector needs to expand by 1,000,000 mt to address national food and nutritional concerns and sustain the socio-economic contribution of the sector (MAAIF, 2017).

The NFAP consequently advocates environmentally sustainable commercial aquaculture development as the most feasible option for simultaneously increasing fish production to address growing food and nutritional security, employment, and socio-economic needs. It supports the National Development Sector Plan III and Agriculture Sector Strategic Plan. As such, the objectives, and expected outcomes from the development of sustainable commercial aquaculture seek to transform the sector into a major source of fish for domestic consumption and Uganda's external markets for fish products. Productivity, value-addition, quality assurance and access to markets are key elements for accomplishing the objectives and enhancing the competitiveness of Uganda's aquaculture products. Safeguarding the sector from threats of disease, fish-food safety and facilitating safe fish trade are among the pillars set in the NFAP strategy to build resilience and secure the expansion and sustainable growth of the aquaculture sub-sector (MAAIF, 2016, NPA, 2020, OIE, 2019).

It is against this background that the Government of Uganda (GoU) sought the support of the European Union (EU) for Promoting Environmentally Sustainable Commercial Aquaculture (PESCA) development in Uganda. Ugandan fishery products have access to EU markets. The opportunity exists for Uganda's aquaculture products to access regional, EU and other international markets. Ugandan farmed fish products are currently traded within Eastern Africa. However, the quality assurance of its value-chain and its capability for meeting regional and international standards remains a hindrance for accessing new emerging markets. The PESCA project was consequently developed *to support the development of a competitive, job-intensive, environmentally sustainable, and climate-resilient aquaculture value chain in a comprehensive manner* (EU/MAAIF, 2017, LVFO, 2016, OIE, 2019).

1.1. Justification and scope of the assignment

Aquaculture in Uganda is a regulated sub-sector where licenses and permits are required to facilitate aquaculture environmental management. However, the rapid expansion of the sector amidst environmental challenges, has brought to the forefront the need for better health management, aquatic disease surveillance, aquatic disease reporting and biosecurity control strategies before the capacity for these was fully developed. The need for an aquaculture monitoring, control and surveillance (MCS) system to facilitate the development of appropriate interventions for disease prevention, mitigation and biosecurity control, as well as for the certification of aquaculture establishments and products in compliance to regional and international standards cannot be understated. Implementation of MCS will

support country efforts in establishing farm certification, zoning and compartmentalization (OIE, 2019). The nascent status of the industry and limited national capacity for aquaculture biosecurity and biosafety control means that the most feasible and sustainable MCS system is likely to be one that encourages self-compliance among stakeholders rather than one that demands enforcement. The establishment of a supportive framework with appropriate implementation guidelines validated by the MCS system to strengthen the capacity of stakeholders to implement in this regard, will be crucial.

1.2. Objectives and Expected Outcome of the Assignment

The objective of this assignment is therefore, to develop an aquaculture MCS system for Uganda that is practical, feasible, cost-effective, and beneficial for all stakeholders at each level value-chain in order to encourage self-compliance.

It is envisaged that the output of the assignment will contribute to **Result 1.4.1.1.** of the PESCA project on improving and strengthening the capacity for implementation of policy and regulatory frameworks that would affect the operations of an environmentally sustainable commercial aquaculture industry (Fig. 1).

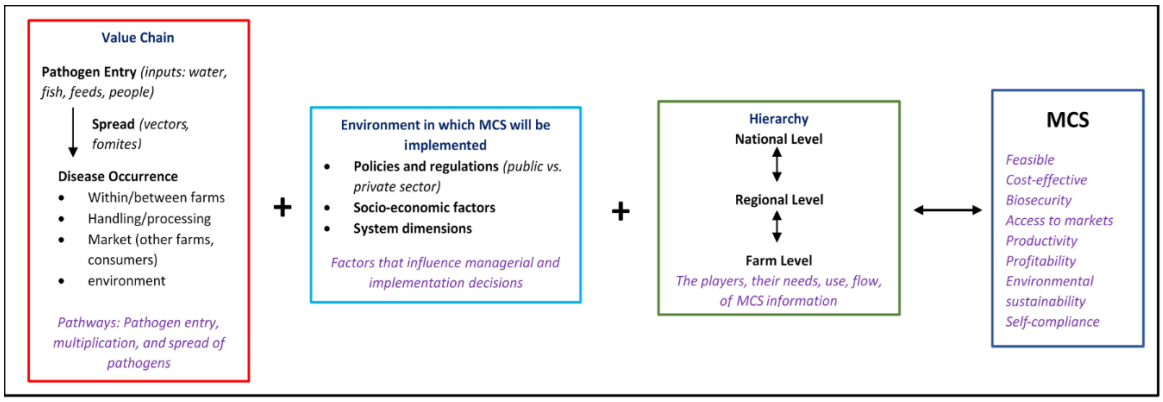


Figure 1. Expectations of the aquaculture MCS Terms of Reference

2. Methodology

The methodology used is described below.

2.1 Approach

A three-step approach has been used for this assignment (figure 2):

(i) ***Step 1*** *– Identify and assess the presence and potential risk of introduction of aquatic animal health hazards and impacts of fish diseases present in Uganda's aquaculture production systems with the aim of developing a national pathogen list.* A value-chain approach was used to establish likely entry points and pathways for the spread of priority pathogens in order to identify potential control points against spread across the value-chain. The outcome of this step provided an indication of possible aquatic animal health concerns for Ugandan aquaculture, MCS priorities, quality assurance and certification requirements' for the sector within the context of regional and international biosecurity control and market standards. Emphasis was therefore on the country's capacity to comply with the provisions of the World Trade Organization's (WTO) Sanitary and Phytosanitary agreement, the OIE Aquatic Animal Health Code, FAO'S guidelines on aquatic

animal health and trade and the East African Community guidelines for regional fish trade (FAO, 2004, OIE, 2019 and LVFO, 2019).

(ii) ***Step 2*** *– Assessing the capacity for fish disease surveillance, monitoring and control (i.e. inspection and sampling procedures, laboratory diagnostic, interpretation and dissemination of surveillance results) among producers, governmental services and other key stakeholders in the aquaculture industry, animal health and environmental management sectors*. A SWOT analysis was done to assess the status of aquatic animal disease diagnostics and aquaculture MCS in the country. It included a stakeholder analysis to ascertain stakeholder's currently roles and capacity needs to enable them contribute more effectively towards a robust national MCS system. Options to support a self-compliant aquaculture MCS under current the socio-economic, technical, and policy and regulatory environment were consequently be proposed.

(iii) ***Step 3*** *– Develop an aquaculture MCS system in Uganda that is tailored to the needs of the industry and in line with policy expectations*. Account was taken of data collection and management, reporting, stakeholder participation, policy and regulatory requirements and capacity needs following national, regional and international policy guidelines on aquatic animal biosecurity control and access to markets within the context of One Health and climate-change.

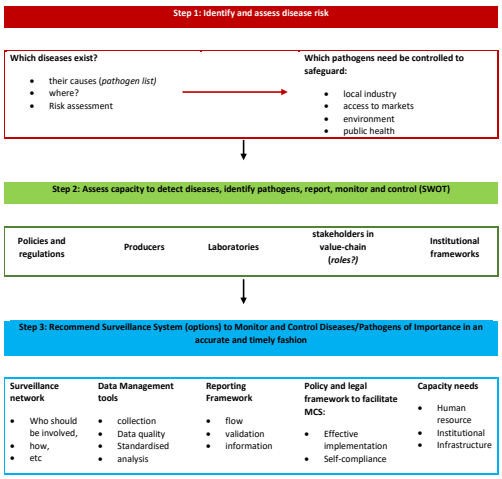


Figure 2. Methodology

2.2 Data Collection

2.2.1. Desk Review

A detailed review of secondary data was undertaken to evaluate data and information on the status of the aquaculture sub-sector, potential threat to the sector from fish diseases, capacity to detect, diagnose and implement MCS principles and tools. The review included an in depth analysis of national, regional and international policies, regulations, guidelines and institutional frameworks for the diagnosis, monitoring, control, and surveillance of aquatic animal diseases in aquaculture. These were used to assess capacity needs and opportunities for establishing a self-compliant aquaculture MCS system in Uganda.

The following is a list of documents shared with consultants by the client at the beginning of the consultancy:

(i) Agriculture Sector Strategic Plan
(ii) Aquaculture Rules 29 July 2020 draft currently with the Solicitor General
(iii) Aquaculture permit list 7 Jan 2021 compiled by Business Summit Africa who are developing the internet based One-Stop-Shop for the PESCA project
(iv) National Aquaculture Development Strategic Action Plan Draft January 2021
(v) Aquaculture Codes of Practice draft
(vi) National Fisheries and Aquaculture Policy Uganda 2017
(vii) National Development Plan III 2020-25
(viii) Uganda Extension Services MAAIF Aquaculture Manual.

2.2.2. Key stakeholder interviews

The objective of the stakeholder interviews was to identify key stakeholders for aquaculture MCS in Uganda (in addition to producers and fisheries personnel), introduce the concept and intended objectives of aquaculture MCS to the stakeholders, identify their specific interests, roles, and capacities in/for MCS, identify how best to engage the various stakeholders for MCS. The most important part of MCS development at this phase was to asses and secure involvement of industry and farmers obtaining their views and expectations from an aquaculture surveillance program.

The stakeholders interviewed included: the MAAIF departments of Fisheries Resources (FRD) and Animal Health, national aquaculture research and training institutions, farms and suppliers of veterinary inputs among others has been drawn (Appendix 2). The interviews additionally enabled stakeholder mapping and analysis for current and prospective roles for aquaculture MCS.

2.2.3 Field Survey

Semi-structured questionnaire appropriate to each node in the aquaculture value chain was developed and administered to primary stakeholders. They include farmers, feed manufacturers and suppliers, laboratories (veterinary, fisheries, water quality and food-safety) and fish processors and traders.

The objectives of questionnaires were to obtain quantitative and qualitative data to assess the status on:

- The occurrence and/or prevalence of aquatic disease events that may have occurred in recent past, pathogens that have been detected and laboratory confirmed, their risk determinants and impacts (where such information existed from previous or current survey and surveillance program, either passive or active to permit this);
- Methods used for the detection and diagnosis of diseases (Level I diagnostic), samples calculation and sample collection, laboratory diagnostic (Level II and III), role of the national animal health diagnostic and reference laboratories, record keeping, reporting, biosecurity control and distribution of aquaculture inputs and products at all levels (i.e. from farm to national level; local, regional, international);
- Existing Animal Health Laboratory Information Management Systems (LIMS), and integration of aquatic disease data in system.
- Resources availability and technical and institutional capacities for disease detection, diagnosis, data management and reporting at all levels;

- Factors affecting the provision of and access to diagnostic services and information at all levels, specific interests and needs for MCS at various segments of the value-chain;
- Policies and regulations applied at all levels for aquatic animal disease control, the implications, and impacts;
- Status of knowledge, attitudes, and practice

Administration of questionnaires and data collection in order to describe and determine aquaculture population characteristics and current health status

The major aquaculture production systems in Uganda include cage culture, earthen ponds, tanks and some recirculating systems. In descending order of importance, the country's commercial aquaculture species include tilapia *(Oreochromis niloticus)*, African catfish *(Clarias gariepinus)*, Mirror Carp *(Cyrpinus carpio)*, ornamental species (both exotic and indigenous species such as Gold fish, Koi carp and Haplochromines) and pockets of Chinese carps and Rainbow trout (*Oncorhynchus mykiss*) in the highlands (MAAIF, 2020).

The specific management practices employed within these systems are adapted to suit the entrepreneur's investment capabilities, environmental constraints within specific water bodies and agro-ecological zones and targeted markets (MAAIF, 2018, MAAIF,2020). Additionally, there's importation and trans-boundary trade of aquaculture inputs and products, respectively. Uganda is also a transit route for the aquaculture inputs and products its landlocked neighbors import. The likelihood for disease occurrence and spread therefore differs across the country even for the same production systems.

(i) Data collection from sample of aquaculture establishments

Purposive sampling of aquaculture establishments was done with the aim of comprehensively covering all segments of the value chain, production systems used and markets for farmed fish. Thus the following criteria were applied as much as was effectively possible given the resource and time frames availed for the study:

- Location of the aquaculture facility (land/water based, agro-ecological zone and proximity to Ports of Entry)
- Type of culture system (hatchery/grow-out; cage, tank, ponds, or RAS)
- Scale of business (small scale versus large scale commercial enterprises)
- Targeted market (local or regional)
- During the MCS visits, the emphasis was on observation of potential pathways for aquatic disease entry, infection and transmission.

Additionally:

- Process of issuing operating permits and license.
- The number of aquaculture establishment permits issued.
- National estimates and regional distribution of total number of aquaculture farms.

Secondary literature, specifically FRD and district fisheries records were used to evaluate population size, and thus location and number of aquaculture establishments to visit.

(ii) Data collection from sample of laboratories

There are several laboratories within the country. Therefore, purposive visits were done to cover the public regional and national reference animal (terrestrial and fish) health diagnostic laboratories, fisheries, water quality and food-safety laboratories bearing in mind their strategic location in relation to agro-ecological zones, water catchments, Ports of Entry, and concentration of aquaculture production.

Additionally, it was envisaged that the assessment of private sector laboratories operated by veterinary clinicians and district laboratories where they have existed within selected study areas would be visited; however, this was not the case. The scope for the provision of Level I, II and III diagnostic services within fish farming communities was consequently assessed.

(iii) Processors and traders of aquaculture inputs (seed, feed and veterinary products) and products (fingerlings, fresh and processed fish)

Purposive sampling was done of aquaculture businesses oriented towards supplying local and/or regional markets. Data generated from these augmented and helped validate the information required to develop a national pathogen list, status of fish diseases, and policy and regulatory requirements to enable aquaculture MCS facilitate the adoption of biosecurity control, safe fish trade and food-safety standards and self-compliance.

Appendix 3 gives a summary of the data collection tools used.

2.2.4. Data Management, Analysis and Research Conduct

The assignment has been conducted in line with the principles of ethical conduct as indicated in the ToR. In addition, participants' identities were not disclosed and their consent will be obtained before data collection tools are administered to them.

Table 1. Stakeholders Consulted

1. **Secondary information**
    - *National, regional and international policies and guidelines on AAH*
    - *Status of the aquaculture sector*
    - *Laboratory diagnostic reports*
    - *Aquatic animal disease status in the region*
2. **Key stakeholder interviews with checklist**
    - *National managers MAAIF – Com Animal health, Ass Com. Disease Control, Director – DiFR, NDA* (5)
    - *District Officers – fisheries, veterinary, entomology, border inspectors, (20)*
    - *Research and training institutions MAK, - CoVAB, NaFFIRI – Jinja & Kajjansi (12)*
    - *Farmers association – WAFICOS Chair & Commercial Fish Farmers (3)*
    - *LVFO Secretariat & TrueFish team (6)*
    - *NADDEC – (1)*
3. **Semi-structured questionnaires**
    - *Animal (&aquatic) health diagnostic laboratories – district, regional, research, training, NADDEC (17)*
    - *Farmers (6)*
    - *Traders (5)*

See appendix 2 for more details

2.3. Data Analysis

Description of the situation

2.3.1. Prioritisation of pathogens

The decision criteria matrix used was adapted from the methodology previously applied to develop a national aquatic pathogen list for the Federated States of Micronesia (MacKinnon B. *et al.,* 2020).

2.3.2. SWOT Analysis of the Current Situation

A SWOT was done based on OIE/FAO practices with objective of assessment of institutional capacity and socio-economic and technical factors likely to affect sustainability and ability to meet desired standards.

2.3.3. GAP Analysis

The gap analysis focussed on capacity to actually implement standards for surveillance – based on the technical gaps raised during the situation analysis following the FAO surveillance 12-pont checklist approach and OIE guidelines (figure 3).

The approach that has consequently been used in drafting *MCS system* for aquatic animal disease is based on the Progressive Management Pathway (PMP) recommended by FAO for both livestock and aquatic animal disease control. Uganda fortunately has experience with its implementation for livestock and is implementing PMP in the surveillance and control of Foot and Mouth Disease (FMD) in cattle. The 12 step approach in drafting and evaluation of aquatic diseases surveillance has been already piloted in Uganda for surveillance of TiLV (FAO project) and was recommended as practical and efficient solution for developing countries were surveillance activities were implemented by interdisciplinary teams.

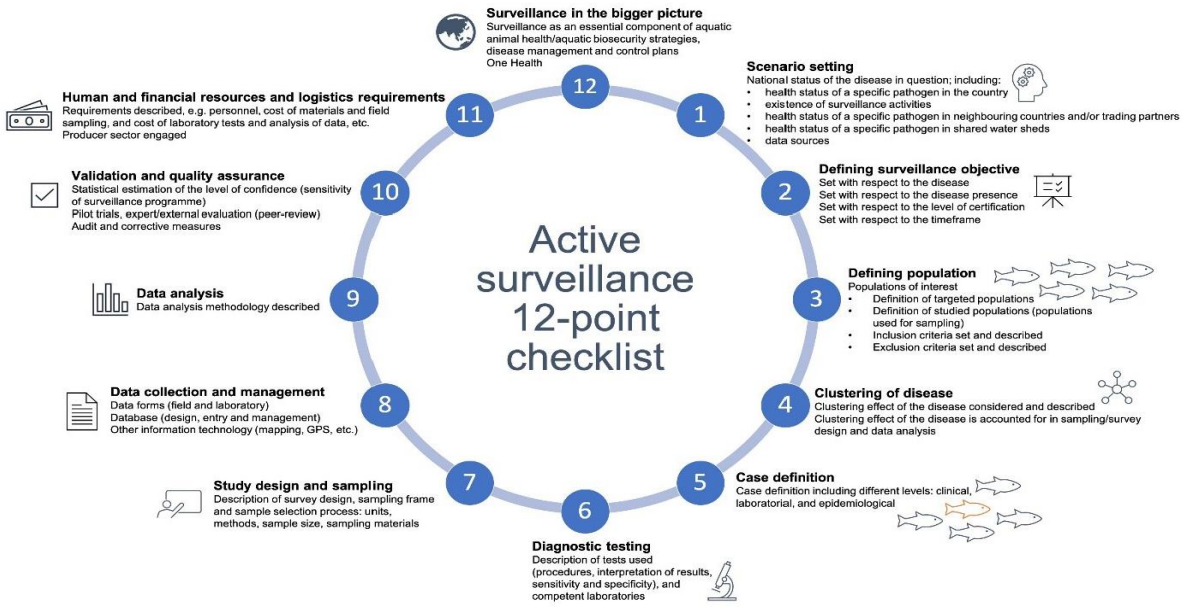


Figure 3. The 12-Point Checklist (Bondad-Reantaso *et al*., 2021)

The findings are discussed based on a descriptive narrative of current practices and status, SWOT, and GAP analysis.

3. Current Status

3.1. Step 1: Scenario Setting

The overall objective of any animal health surveillance program is to monitor disease occurrence and trends, to facilitate the control of infection or infestation, to provide data for use in risk analysis for animal or public health purposes, to substantiate the rationale for sanitary measures and to provide transparency and confidence to trading partners.

Over the last twenty years, Uganda's aquaculture sector has transformed from a rural smallholder activity whose primary objective was to address rural livelihoods and household food and nutrition security. It is now becoming a market-oriented agricultural sub-sector that supplies fish to major urban and regional markets, generates employment and contributes to national socio-economic development. In 2019, Uganda produced 102,000 mt of fish worth USD 241,463,000 from aquaculture. This equated to 15% of the 706,167 mt total national fish production that year (FAO, 2021). See figure 4.

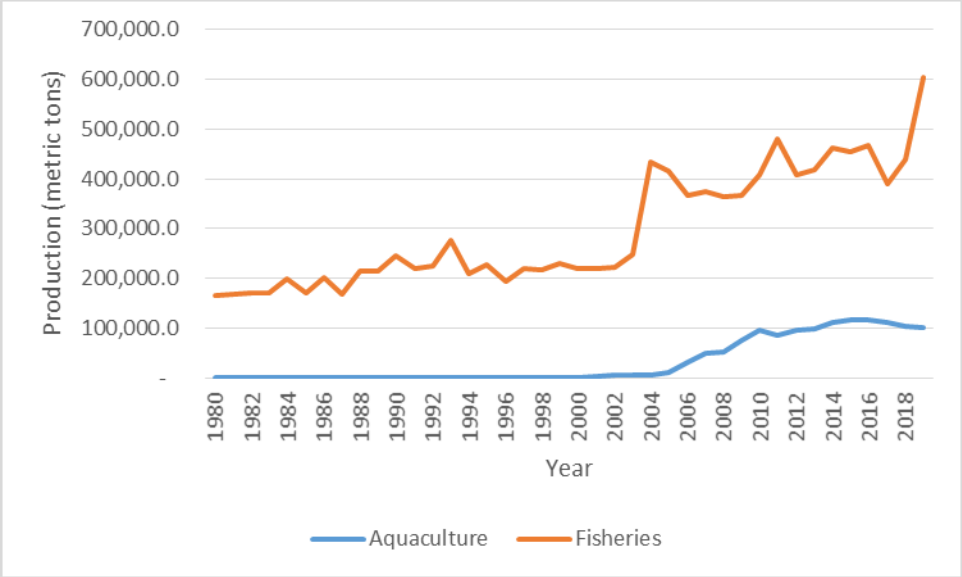


Figure 4: Trends in National Fisheries and Aquaculture Production

The transformation observed has been driven by the increased demand for fish arising from rapid population growth, improved incomes, urbanization *vis-à-vis* the limited capacity of the fisheries to expand production above sustainable fishery yields. The country's sustainable fishery production was estimated to be 500,000 metric tons, yet the country's current population 41.6 million is growing at the rate of 3.0% per annum (UBOS, 2020). As a result, the National Fisheries and Aquaculture Policy (NFAP) estimated a deficit in supply of one million tons of fish that was set to progressively increase unless an alternative sustainable source fish supply was identified (MAAIF, 2017). The factors and trends associated with the widening of the gap between fish supply and demand in Uganda, also depict the status quo within the Eastern Africa region.

To address this challenge, environmentally sustainable commercial aquaculture development is being promoted in Uganda and East Africa as a whole. Sustainable commercial aquaculture is seen as the most feasible method for sustainably expanding fish production in tandem with growing demand. In addition it offers an opportunity for creating employment for the youth, expanding the country's local and regional

markets for fish and contributing to national earnings (MAAIF, 2017; LVFO, 2016; MAAIF, 2016). The fisheries sector contributes 2.6% to GDP (UBOS, 2020).

3.1.1. Policy and Institutional Set-Up

(a) International Level

Uganda ascribes to international, continental and regional guidelines for sustainable commercial aquaculture development, trade and aquatic animal health *in lieu* of the United Nations global Sustainable Development Goals (SDG's). As a member of the World Trade Organisation (WTO) it ascribes to the principles of accessing markets by ensuring its agricultural products are safe for human consumptions and would not have any negative impact on the health of humans, plants or animals at the destination of products. Thus, it's a signatory to the WTO's Sanitary and Phytosanitary Measures (SPS) that sets out the basic requirements for food safety, animal and plant health in order to address non-tariff barriers to trade. The country follows the guidelines of the OIE, FAO and World Health Organisation's (WHO) *Codex Alimentarius* for the certification of its fish and fisheries products (i.e. locally referred to Fish Health Certificates).

The World Organisation of Animal Health (OIE) sets international standards on animal (terrestrial and aquatic) health to facilitate safe trade in support to implement provisions of WTO SPS agreement. The country consequently seeks to establish its aquaculture biosecurity control measures in accordance to the recommendations of the OIE's Aquatic Animal Health Code which include fulfilling its aquatic animal disease reporting obligations on the World Animal Health Information System (WAHIS). To facilitate the implementation of OIE Aquatic Code, Uganda's designated OIE National Delegate, the Commissioner Animal Health (CAH) nominated the Commissioner of Aquaculture Management & Development (CAMD) as the country's OIE Aquatic Animal Focal Point. The CAMD is the country's Competent Authority (CA) for all matters pertaining to Aquaculture Management and Development.

Similarly, the country ascribes for FAO's technical fisheries and aquaculture guidelines that also foster the implementation of the WTO SPS agreement. FAO's Code of Conduct for Responsible Fisheries and Ecosystem Approach to Aquaculture provide the foundation for all recommended practices for environmentally sustainable commercial aquaculture development. Aquatic animal disease biosecurity control is a key component of these guidelines that facilitate compliance to the WTO SPS agreement, the tripartite One Health approach, Convention on Biological Diversity and global climate-change mitigation strategies. Impacts arising from the emergence of animal disease negatively affect the social, economic, political and environmental interfaces of society and life simultaneously. The complexity this presents requires robust Monitoring, Control and Surveillance systems for effective biosecurity control to safe-guard food value chains, especially for those linked to regional and global markets (FAO, and OIE, 2019).

(b) Continental Level

Africa's continental policies provide a bridge between the international, regional and national policies. Uganda's environmentally sustainable commercial aquaculture policy has therefore been harmonised to the African Union's Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) (AUC-NEPAD, 2014). To strengthen the capacity for compliance to international standards of African Union Member States, the aquatic biosecurity concerns highlighted in the PFRS are expounded in the African Union's Ten Years Aquaculture Action Plan for Africa 2016 – 2025, Guidelines to Support the Implementation of the Regional Frameworks on Environmental Management for Sustainable Aquaculture Development in Africa, Animal Health Strategy for Africa (2020-2035) and Animal Welfare Strategy for

Africa. The continental policies provide a framework for regional co-operation in the management trans-boundary aquatic resources, control of emerging trans-boundary aquatic animal diseases and equitable safe regional and intra-regional trade (AU-IBAR/NEPAD, 2016, AU-IBAR, 2019[a], AU-IBAR, 2019[b]). For example, Uganda's aquaculture occurs within Nile River Basin. Uganda therefore has an obligation to conscientiously utilise the aquatic resources within its jurisdiction so as not to comprise the aquatic ecosystem benefits derived by the countries downstream (AU-IBAR, 2019[c]).

(c) Regional Level

The East African Community Protocol on Sanitary and Phytosanitary (SPS) Measures guides the development and implementation of SPS measures at regional level (EAC, 2013).

Most of East Africa's aquaculture (Uganda inclusive) is undertaken in the Equatorial Nile whose hydrological system constitutes the Lake Victoria sub-basin, Albert Nile Sub-basin and Victoria Nile Sub-basin. The former are trans-boundary and drain through Uganda to the Sudan. Potential risks consequently exist for aquatic animal pathogen entry and spread across the country through this hydrological system. The Lake Victoria Fisheries Organization (LVFO) was established by the East African member states to jointly address issues that could affect the sustainable management and utilization of the transboundary fishery resources of Lake Victoria. The LVFO Strategic Plan (2016 – 2020) and Fisheries Management Plan III provide overall guidance for aquaculture development within the region. Environmentally sustainable commercial aquaculture is being promoted to stem threats to the industry arising from unsustainable management practices, environmental degradation and climate change and their implications for the biosecurity and bio-safety. A regional Aquaculture Technical Working Group (ATWG) is in place that has so far, developed regional Guidelines for Cage Culture in the basin. In addition, the LVFO is implementing the TrueFish Project with support from the European Union to strengthen capacity within the region for environmentally sustainable commercial aquaculture. A key result areas of this project, is the establishment of a regional aquatic animal biosecurity strategy.

The institutional linkages between LVFO links and the CAMD are illustrated in Appendix 4.

(d) National Level

The Terms of Reference for this assignment emphasise the expectations of the NFAP, National Development Sector Plan III and Agriculture Sector Strategic Plan for the aquaculture sector. The key parameters against which the aquaculture sector is subsequently expected to perform are environmental sustainability, growth, productivity, value-addition, quality assurance, access to markets and market competitiveness. Safeguarding the sector from threats of disease, fish-food safety and facilitating safe fish trade are consequently key attributes an aquaculture MCS system would have to address. As such, the national policy and institutional frameworks that provide anchorage for the establishment of an aquaculture MCS are those that govern fisheries and aquaculture production, SPS controls and environmental management.

- Aquaculture Development and Management

Aquaculture Management and Development in Uganda is guided by the NFAP following the National Development Plan III and National Agriculture Policy and Agriculture Sector Strategic Plan as the overarching national and agricultural sector development policies. The regulations that support aquaculture development fall under *The Fish Act (Cap.197) of 1951* to which Statutory Instruments for aquaculture have been appended, the *Fish (Aquaculture) Rules 2003*. The *Fish (Aquaculture) Rules 20*03

are currently under revision and a new bill, the *Fisheries and Aquaculture Bill* that will more comprehensively address the needs of environmentally sustainable commercial aquaculture development, has been tabled for approval to the Parliament of Uganda.

The Department of Aquaculture Management and Development (DAMD), headed by Commissioner of Aquaculture who is also the Competent Authority for Aquaculture (CA), is housed within the Directorate of Fisheries Resources (DiFR) of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The CA is supported by District Fisheries Officers (DFO's) and Fisheries Officers (FO's) employed under the Local Government (LG) structure. The Fisheries Officer's report to the CA through their respective District Local Governments. Cross-border movement and trade of aquaculture produce and products is supervised by the Department of Fisheries Control, Regulation and Quality Assurance (DFCRQA) and Uganda Revenue Authority (URA).

The National Agriculture Research Organisation (NARO), an agency of MAAIF, is responsible for public research in aquaculture, including aquatic animal health. The Aquaculture Research and Development Centre (ARDC) of the National Fisheries Resources Research Institute (NaFIRRI) houses the designated National Aquatic Animal Health Reference Laboratory. The major tertiary training institutions that offer training in aquaculture production are the Fisheries Training Institute (FTI), Colleges of Natural Sciences (CoNAS) and Veterinary Medicine, Animal Resources and Bio-security (COVAB) of Makerere University (MAK) and Busoga University. Post-graduate training occurs more broadly in the various Universities within the country in more specialized topic areas. Training of the laboratory technicians who work within the country's animal health laboratories is done by the Mbale School of Health Sciences, CoVAB – MAK and the Faculty of Medicine, Mbarara University. Fisheries and aquaculture production technicians are trained at FTI (Appendix 5).

- SPS based Controls in Uganda

The SPS based controls system in Uganda is organized into the three distinct functions of animal health, food safety, and plant health as required under the WTO SPS Agreement (LOL, 2020). The policies that support SPS measures applicable to the aquaculture value chain include the NFAP, Food and Nutrition Policy of 2003, the Animal Feeds Policy of 2005, the National Trade Policy of 2008, the National Industrial Policy 2008, the National Health Policy of 2009, the National Drug Policy and Act 1993 in addition to the National Development Plan III and National Agriculture Policy and Agriculture Sector Strategic Plan. The National SPS Policy for Uganda *(draft)* has not yet been approved. According to the SPS control system, the line Ministries, Departments and Agencies (MDAs) for SPS controls on animal health is the Department of Animal Health (MAAIF) which is the National Enquiry Point on Animal Health, the Ministry of Health (MOH) is the *Codex Alimentarius Commission's* focal point and thus the National Enquiry Point on Food Safety, and the Uganda National Bureau of Standards (UNBS) is the SPS National Notification Authority for the FAO/WHO *Codex Alimentarius Commission* international Food Standards and the National Enquiry Point for the WTO TBT agreement.

The UNBS is a member of the International organization for Standardization (ISO); the African Regional Organization for Standardization (ARSO) and the East African Standards Committee (EASC).

Animal Health: Animal health controls in Uganda are overseen by the Commissioner of Animal Health (CAH) who heads the Department of Animal Health in the Directorate of Animal Resources (DAR), MAAIF. The other two department in DAR are Animal Production and Entomology. The Directorate's mandate is to provide technical guidance for the formulation, review, and implementation of policies, legislation,

standards, plans and strategies in the areas of animal production, animal health, veterinary regulation, inspection, and enforcement. The Directorate implements and enforces the *Animal Diseases Act 2000*, the *Veterinary Surgeons Act 1958*, *National Drug Policy and Authority Act 1993*, *Animal Breeding Act 2001*, *Dairy Industry Act 1998*, *Fish Act Cap 197, Fish (Aquaculture) Rules 2003*, and *Cattle Traders Act 1945* (LOL, 2020). The Essential Veterinary Medicines List for Uganda (EVMLU) specifies which veterinary drugs are licensed for use in Uganda, including for fish (MAAIF, 2020).

Food Safety: The national food control system in Uganda is made up of several MDAs with regulatory powers over different products and production points. For fish, they are:

(a) MoH under the *Public Health Act 1935* and *Food and Drugs Act 1959*,
(b) UNBS under the *Uganda National Bureau of Standards Act*,
(c) DiFR, MAAIF following the *Fish (Quality Assurance) Rules, 2008 (S.I. No. 12 of 2008).*

A National Codex Committee, chaired by the Director of Health Services coordinates the various MDAs involved in food safety controls, namely: NARO, UNBS, and the MAAIF Directorates. Proposals on the table are the National Food Safety Policy to harmonize and coordinate the roles of the different MDAs in food safety control and the National Food and Drugs Authority Bill for the regulation of local and imported manufactured food stuffs. The control of food safety for food produce traded on local markets is currently under MAAIF (LOL, 2020).

UNBS is a member of the International organization for Standardization (ISO); the African Regional Organization for Standardization (ARSO) and the East African Standards Committee (EASC). UNBS is also the National Contact point for the FAO/WHO *Codex Alimentarius Commission* international Food Standards and the National Enquiry Point for the WTO TBT agreement (UNBS).

- Environmental Management

The Ministry of Water and Environment (MWE) is the line ministry concerning water resource management and utilisation, environmental management and climate change. The policies under MWE that impact on aquaculture MCS for environmentally sustainable commercial aquaculture development the 1995 Water Policy, the 1996 National Wetlands Management Policy, Environment And Social Safeguards(ESS) Policy, National Environment Management Policy (1994), Uganda National Wetlands Policy and Uganda National Climate Change Policy. A Climate Change Vulnerability Assessment, an Adaptation Strategy and an Action Plan for the Water Resources Sector in Uganda are already in place. Likewise, there is a framework for Integrated Catchment- Based Water Resources Management that encourages conservational and ecologically compatible agricultural systems to increase resilience to the impacts climate change. The Wildlife Policy (1996), Forestry Policy (2001) and the NFAP (2017) are strongly linked to the country's environmental policies.

The environmental legal framework under the *1995 Constitution* constitute the *National Environment Act (Cap 53), Water Act, Land Act, National Forestry and Tree Planting Act, Wildlife Act, Fisheries Act and Environment Impact Assessment Regulation* (Akello, 2007).

3.1.2. Stakeholders and their Roles

The current NFAP and institutional arrangements place the ADAM and Local Government (Fisheries Officers) as having the responsibility for aquatic animal disease control. However, considering a value-chain approach, when the National SPS control system and OIE standards are put into context, aquatic

animal health (AAH) and biosecurity control are roles designated to the CA by the CAH. The CAH as the National OIE Focal Point therefore remains accountable for the compliance of AAH and biosecurity control policies strategies to national and OIE standards (Appendix 6). The National SPS control system and *Codex Alimentarius* guidelines on the other hand, delegate the responsibility for fish-safety entirely DiFR.

Table 2 lists and describes the current roles of stakeholders involved in aquatic animal disease control in Uganda.

Table 2. Stakeholders currently involved in aquatic animal disease control

Activity	Major stakeholders Involved	Stakeholder Roles
Disease detection	• Farmers • Fisheries Officers • Community	• Observe changes in behaviour or abnormalities
Disease identification	• Farmers • Fisheries Officers • NARO (ARDC, ZARDI's) • MAK (CoVAB, CoNAS)	• Farmers may seek advice from fellow farmers, fisheries officers • Referrals and in some cases to ARDC and MAK • Regional AHL, ZARDI's and VO sometimes consulted
Disease control	• Farmers • Fisheries Officer	• Farmer implements control measures on-farm
Disease reporting	• Fisheries Officer (FOs)	• FOs report to CA-ADAM (MAAIF) • ARDC research and activity reports to DG-NARO • MAK remain as research reports
Disease surveillance	• ADAM (CA) • CAH (OIE Delegate)	• On-going TiLV Surveillance program supported by FAO, under supervision of CA
Inputs currently used for disease control	• Agro-vet suppliers • National Drug Authority (NDA)	• Most agro-vet input stores are managed by veterinarians/animal husbandry officers • NDA quality control of veterinary inputs
Permits for the movement, export/import of fish **Fish sanitary certificate**	• Farmer • DFO • ADAM • DFQA • URA	• Farmers obtain movement permits for inland travel from DFO • Fish sanitary certificate for fish and fish products and export/import of fish issued by ADAM and DFQA • URA verify products crossing border and collate national data on volumes of export/imports

3.1.3. Description of Uganda's Aquaculture Sector

Warm fresh water culture is practiced in the country. The Nile tilapia (*Orechromis niloticus*) and African catfish (*Clarias gariepinus*) are the dominant commercial aquaculture species. They are reared mainly in cage and pond based production systems. About sixty percent of the country's farmers are smallholder farmers with fish ponds (NARO-KARDC, 2020). However, the bulk of the country's production comes from tilapia cage culture. In 2016, total aquaculture production constituted 74,654 mt of tilapia (61%) and 431,187 mt of catfish (39%) (Bolman *et al, 2018)*. This trend has not changed much.

(a) Establishment of fish farms

Permits are required to establish medium and large scale fish farms. An *Aquaculture Establishment Permit* is required in all cases with additional specific permits for establishing and operating fish breeding facilities, hatcheries and cages. Environmental approval is also required before any medium or large scale aquaculture operation is established.

(b) Water sources for aquaculture

Surface waters constitute the major source of water for fish farms in the country. These comprise streams, rivers, dams and lakes. A few land-based fish farms obtain their water for aquaculture production directly from underground springs or wells. It is not uncommon therefore to find wild fish (including of the farmed species) within the water channels on fish-farms and sometimes within production units, even where screening of inlets and outlets is done. To avoid this, intensive commercial catfish hatcheries construct boreholes to supply the hatching and early rearing phases of production.

(c)Production Systems

Uganda's commercial aquaculture producers have been categorized into four broad groups based on their annual production and management practices by Bolman *et al.,* 2018. See Table 3 below.

Table 3. Categories of Commercial Aquaculture Producers

Farmer Category	Production (tonnes)	Production systems	Construction ponds/cages	Production intensity	Species produced	Production cycles and Food Conversion Ratio (FCR)
I	1 - 5	Small earthen ponds (average 600 m^2) and square Low Volume High Density (LVHD) cages	*Ponds:* constructed with family labour *Cages:* locally fabricated cages from bamboo, or metal bar frames	Extensive	Nile tilapia, African catfish and in the high altitude parts of the country Mirror Carp (*Cyprinus carpio*) Some do polyculture	*Tilapia:* 1.3 cycles per annum, 8-9 month to grow to 400-500 grams, average FCR is 2– 2.5. *Catfish:* 1.3-1.5 cycles per annum, 8-9 months to grow to 1 kg, average FCR is 2.0-2.2. Mostly use family made feeds
II	6 - 40	Larger earthen ponds (average 1,000 m^2) and square LVHD cages	*Ponds:* constructed with hired labour *Cages:* locally fabricated/imported from China	Extensive to semi-intensive	Nile tilapia and African catfish	*Tilapia:* 1.3-2.0 cycles per annum, 6-8 months to grow to 400-500 grams, average FCR is 1.9-2.0 *Catfish*: 1.5-2.0 cycles per annum, 6-7 months to grow to 1 kg, average FCR is 1.7-2.0 Mostly use locally made feeds but a few of them use imported feeds
III	41 - 50	Larger square and circular LVHD cags	*Square cages*: self-made from metal/imported from China, made from metal *Circular cage*: self- made from PVC and barrels	Semi-intensive	Nile tilapia	*Tilapia*: 2 cycles per annum, 6 months to grow to 400-500 grams, average FCR is 1.4-1.5 Use manufactured feeds local or imported
IV	+100	Large scale commercial cage-culture farms Circular High Volume Low Density (HVLD) cages	Imported cages with frames made from HDPE pipes	Semi-intensive	Nile tilapia	*Tilapia*: 2 cycles per annum, 6 months to grow to 400-500 grams, average FCR is 1.4-1.5 Imported floating fish feeds

Adapted from Bolman *et al.,* 2018.

Lake Victoria and Lake Albert are the major water bodies where cage culture is practiced. Smaller cage culture operations exist in inland lakes and dams, the River Nile and Lake Kyoga. Pond culture on the other hand, is more widely distributed across the country (figure 5). There are an estimated 20,000 fish ponds in the country averaging 500 m^2 (FAO, 2017). Both tilapia and the catfish are raised in ponds using a variety of feeds.

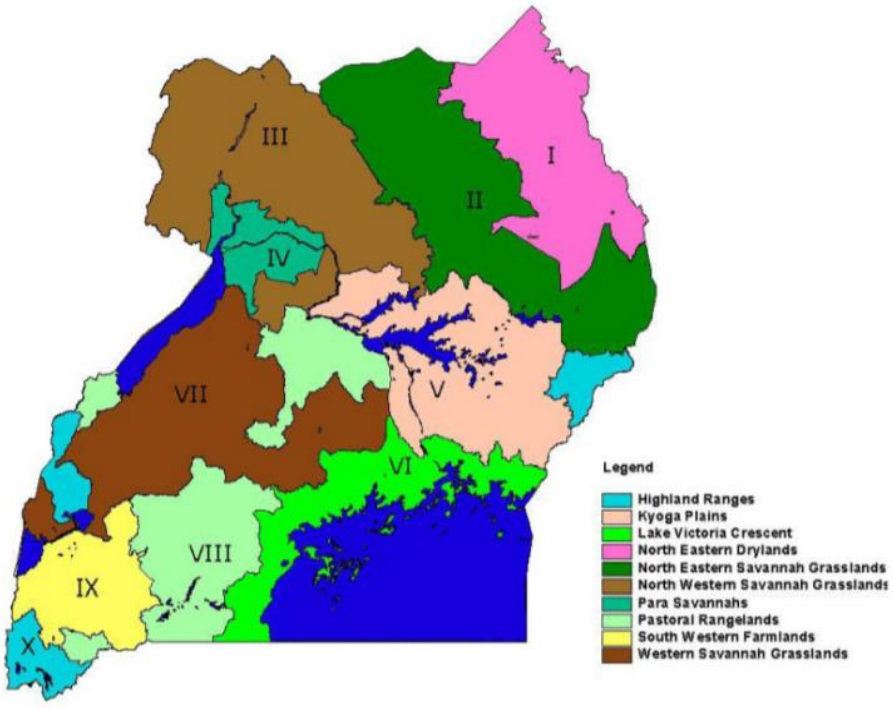


Figure 5. Distribution of major aquaculture production systems in Uganda in relation to the country's agro-ecological zones (Bolman *et. al*, 2018)

Key to figure 2 above: Dominant aquaculture production systems in given AEZs		
Agro-ecological zone		**Aquaculture Activities**
I.	Eastern dry lands	Very little aquaculture. Dominated by cattle production
II.	North eastern savannah grasslands	Dominated by Nile tilapia raised in ponds
III.	North western savannah grasslands	Dominated by African catfish raised in ponds
IV.	Para Savannahs	Dominated by African catfish raised in ponds
V.	Kyoga plains	Dominated by Nile tilapia raised in ponds
VI.	Lake Victoria Crescent	Dominated by Nile tilapia raised in cages (Lake Victoria)
VII.	Western Savannah grasslands	Nile tilapia in ponds, Nile tilapia raised in cages (Lake Albert)
VIII.	Pastoral Rangelands	African catfish, Nile tilapia raised in ponds
IX.	South Western Farmlands	Mirror carp raised in ponds
X.	Highland Ranges	Dominated by Nile tilapia raised in ponds

(d) Production Inputs

Fish Seed

There are about 100 fish hatcheries across the country that produce tilapia, catfish, mirror carp and some ornamental species in decreasing order (Bolman *et al.*, 2018). The bulk of this production comes from certified commercial hatcheries in the southern part of the country. Some of the commercial hatcheries are integrated as a component of large-scale commercial cage culture operations.

The parent stock for most tilapia and catfish hatcheries comes directly from the country's major lakes. A hatchery is required to apply for and obtain a *Fish Transfer Permit* when collecting brood-stock for stocking from the local District Fisheries Officer (GoU, 2003). The stock upon arrival to the designated hatchery are sorted to select out brood-stock for seed production. Selection is visual for typical phenotypic species characteristics, body condition and apparent health status. To prevent in-breeding, the general practice is to replace a proportion of the breeding stock regularly with new stock from the wild or other fish farms. Thus, the tilapia and catfish farmed, are close relatives to wild populations.

Tilapia seed production is largely done in semi-intensively managed earthen ponds. Both mixed sex and sex-reversed all-male tilapia fry and fingerlings are produced. Sex reversal is done in hapas within ponds. A couple of the large commercial hatcheries spawn tilapia in hapas to collect fertilised eggs for incubation in hatchery jars. Thereafter, on-growing from fry to fingerlings is done semi-intensively managed earthen ponds with artificial feeding and pond fertilisation or, continued in hapas. The latter, is used by large-commercial cage culture farms whose operational set-up comprises an integrated hatchery-grow-out system that transits from land-based hapas for early rearing to off-shore nursery and grow-out cages. This is done as a strategy to raise the fish from fry to adults under relatively similar conditions to reduce stress when juveniles are transferred and stocked into large grow-out cages further out off-shore.

Catfish seed on the other hand, is produced in intensive tanks-based hatchery systems with aeration. Artemia and imported commercial hatchery diets are fed to juveniles. The brood-stock are managed in out-door earthen ponds.

The variability in quality of seed between different hatcheries was among the challenges cited by small and medium pond and cage farmers who were interviewed. Such farmers relied on seed from hatcheries to stock their farms. As a result of variability and/or inconsistencies in quality of seed from fish hatcheries, grow-out fish farmers often ended up stocking from distant hatcheries and/or delaying re-stocking if they wanted seed that met 'good quality' standards. Assessment of seed quality was visual and largely subjective based on the cohort's uniformity in size, physical appearance, vigour of individual fish and presence of gross lesions or deformities. All hatcheries were required to have a valid *Fish Seed Production Certificate* to operate, in addition to the aquaculture establishment permit. The certification of fish seed producers was done by the Department of Aquaculture Development and Management (DADM) located in Entebbe.

Fish Feed

Imported and locally manufactured fish feeds are used for production. Most cage culture producers and catfish hatchery operators rely on imported nutritionally complete diets. The presence of outlets through which farmers can locally procure both imported and locally manufactured feeds has improved the options for smallholder rural farmers. With these options available, some small and medium scale fish

farmers use a combination of different feeds within one production cycle to reduce feeding costs. The feeding strategy used by such farmers constitutes pond fertilisation and higher quality imported feeds for the initial months after stocking to improve survival and growth rates. As the fish approach table market size, they change to locally manufactured feeds that may be supplemented with other agricultural by-products whose cost and feed performance is generally lower than the imported feeds. Examples of supplementary feed inputs used towards market included freshwater crustaceans caught as by-catch and poultry-offals. These adaptations have resulted into higher and more reliable pond yields even for rural smallholders and fish supply from ponds into rural markets.

Inconsistencies in feed quality were among the major challenges cited by the Fisheries and Veterinary Officers concerning feeds locally made by smallholder feed manufacturers and on-farm. Poor handling, packaging and storage of feed ingredients and the consequent contamination, insect infestation, moulding and common presence of rodents in feed premises was linked to reduced performance in poultry and livestock fed such feeds. Animal feed ingredients are commonly stored and made in semi-permanent structures by smallholder feed manufacturers. Ventilation, humidity control and entry of pests are difficult to control in such structures (figure 6). When animal feedstuffs are stored under such conditions for long, significant changes in quality occur. Adulteration of local feed ingredients was also rather common. Issues of feed-safety associated with aflatoxins and other contaminants in feed comprised a potential health risk. Smallholder fish farmers obtained their fish feed ingredients from the same stores smallholder livestock and poultry producers got their ingredients to make on-farm feed. Whenever such fish farmers had access to better quality feeds (be they locally manufactured or imported) they reportedly observed an improvement in growth. Veterinary officers found it a challenge enforcing good practice among local animal feed ingredient traders and manufacturers because though the Animal Feed Bill had been approved in 2019, no public guidelines had been developed yet for smallholder animal feed producers and feedstuff traders. There are, however, Uganda National Bureau of Standards for specific aspects regarding processing of animal feedstuffs and manufacture of animal feeds, including fish feeds as listed in table 7 (UNBS, 2015, UPPC, 2009).

Figure 6. Structures typically used to store animal feed ingredients by smallholder feed manufacturers and animal feeds on-farm

Fertilizers

Both organic and inorganic fertilizers are used to fertilize ponds. Cow dung from cattle kraals or zero-grazing dairy units and poultry droppings from birds raised under the dip-litter system are the commonest organic manures used. Inorganic fertilizers used are granular composite fertilizers containing Nitrogen, Phosphorus and Potassium commonly used for crop production. Organic fertilizers are preferred for nursery ponds because of the zooplankton production they also stimulate.

3.1.4. Distribution and Trade of Aquaculture Produce and Products

The local and regional markets for Uganda's aquaculture products have expanded across the country and within the region. The country's major regional markets for both fingerlings and table fish are Kenya, the Democratic Republic of Congo, South Sudan and Burundi.

(a) Fingerlings

Fish fry and fingerlings are transported overland by road packaged in oxygenated bags or open tanks with or without aeration. For long distance haulage, transportation in tanks as a rule, is done with aeration. Farms located on islands within Victoria transport fish seed and other inputs from the mainland by boat. Middlemen are also involved in the distribution and supply of fingerlings both locally and regionally. Local and regional aquaculture support programs run by NGO's, local and regional governments are the major bulk buyers for Uganda's fish seed. They purchase large consignments through suppliers (middlemen) for programs to support rural livelihoods among smallholder, stimulate commercial aquaculture in new areas or for stock enhancement programs.

The recommended practice is to acclimatise fry or fingerlings prior to packaging for live fish transportation. However, FO and farmers reported that acclimatisation was not always adequately done by some hatcheries. The water used to package live fish was ordinarily sourced from the hatchery supplying the fish seed. When faced with water quality challenges en-route however (more commonly so when non-aerated open tanks were used), transporters partially exchanged water in fish transport containers with water fetched from streams or wetlands by the road-side. Fish seed was otherwise transported straight to the final destination. A *Fish Transfer Permit* issued by the District Fisheries Officer from the district of origin was required for any consignment delivered off the farm. A *Fish Import/Export Permit* was required whenever fish seed was to be exported (GoU, 2003). The transportation of live fish

When bulk consignments had been procured for several farmers at a go under an aquaculture support program, the onus was on the supplier to deliver the required amount to the various beneficiaries. Such consignments were visually inspected by the resident fisheries officer or other official to assess the quality (including health status) and verify quantities upon arrival to head offices and to individual farms. Counting in such cases would normally be done manually while stocking simultaneously. Tools and equipment to minimise fish stress during such long and laborious processes were lacking. As a result, it was not uncommon that ponds got stocked after sunset well into the night because there were no temporary live fish holding facilities at districts. Districts did not have designated facilities for temporarily holding live fish for inspection fish prior to re-distribution to farms.

Clients who obtained seed from commercial hatcheries, were generally given an invoice and/or delivery note as proof of purchase and source at the time of collection from the hatchery (Appendix 6). The standard delivery note captured information of the species, size and quantity of fish and clients name and/or address. Invoices and receipts tended to capture the value of the total consignment, and not

necessarily the specifications of the fish sold. Live fish could also be imported into the country for fish farming. However, this was not encouraged and special permission was required as specified in the *Aquaculture Rules (2003)*. A *Certificate for the Importation of Live Fish into Uganda* issued under these rules, only permitted fish from sources free of Infectious Haematopoietic Necrosis (IHN), Viral Haemorrhagic Septicaemia (VHS) and Spring Viraemia of Carp (SVCV) into the country (GoU, 2003).

The *UNBS US EAS 829:2015* prescribes as a Code of Practice, the conditions for the handling and transportation of live fish seed for aquaculture purposes. However, none of the stakeholders interviewed (farmers and district officials) referred to this standard.

(b) Table Fish

The major markets for farmed table fish were urban centres and regional markets. Farmed fish was distributed as whole fresh or whole chilled straight from the farm to point of sale. Some large-commercial farms had set-up fish outlets within Kampala and Jinja selling chilled or frozen tilapia. There were fish traders who also purchased fish in bulk directly from cage farms and supplied local and regional markets. Such traders transported the fish in refrigerated trucks. There was also a small niche market for live tilapia in Kampala that was sourced from cage farms.

Rural smallholder farmers disposed of their fish largely through pond-side sales within the local community or to local markets. There were also regional traders who collected and bulked fish from different land-based fish farms in refrigerated trucks. Once they accumulated the quantities they required, the fish was transported to designated regional or major rural fish markets. It could take such a trader up to five days to fill a truck.

Minor farmed fish products included deep fried tilapia, smoked catfish and catfish sausages. Deep frying was done at local markets. Smoking was done to add-value and preserve farmed fish in areas where access to ice or cold storage facilities was difficult. Smoking was done by the farmer or by fish traders. In the case of the latter, the smoking of fish was a specialised business that was sometimes done on the farmers' farm or some other designated place.

(c) Fish Feed

Uganda has a number of factories which combined produce between 20,000 to 30,000 tonnes per annum of factory fish feeds. The main local fish feed manufacturing companies are Ugachick, Novel feeds and Sabra and Sons Ltd. There are a number of other smaller feed mills, including, the Government of Uganda / Chinese supported feed mill at Kajjansi, and privately owned mills that have been set up to support the owners own fish farming enterprises. Examples of feed mills owned and operated independently without a fish farm attached, include Premier Millers and JODAR Services. Commercial fish feeds manufactured within Uganda are reportedly also distributed to Kenya, South Sudan, the DRC, Burundi and Rwanda (Aura et al, 2017).

Commercial fish feeds are imported into the country from Zambia, Mauritius, Brazil, Egypt and Israel.

(d) Standards

There are some UNBS standards that apply to the aquaculture sector (UNBS). These focus on the safety of products and not necessarily on aquaculture produce which as mentioned in section 3.1.1. lies within the domain of DiFR (table 4).

Table 4. UNBS Food and Agriculture Standards that Apply to Aquaculture

Standard	Description	Compulsory (C) or voluntary (V)
Aquaculture Production		
US 1802:2017	*Code of practice for establishment and operation of cage fish farming* - guidelines for the establishment and operation of cage fish farming and aquaculture parks	V
US ARS/AES 05:2018	*Aquaculture - African catfish - Sustainability and eco-labelling – Requirements.* Principles, criteria, indicators and measurable performance levels for responsible African catfish (*Clarias spp*.) aquaculture with regard to economic, social and environmental sustainability.	**V**
Aquaculture Inputs		
US EAS 97:1999	*Specifications for fishmeal* used in compounding livestock feeds	**C**
US EAS 973:2019	*Specifications for compounded fish feeds* used in aquaculture. Applies to tilapia and catfish feeds	**C**
US EAS 829:2015	*Code of practice for the transportation of live fish seeds for aquaculture purposes*	**V**
US EAS 230:2001	*Specifications for maize bran as livestock feed* -	**C**
US ISO 17375:2006	*Animal feeding stuffs - Determination of aflatoxin B1*	**V**
Aquaculture Products		
US EAS 827:2015	*Specification for fresh and frozen whole fin fish*	**C**
US CODEX STAN 36:1981	*Standard for quick frozen finfish, eviscerated or un-eviscerated*	**C**
US EAS 831:2015	*Specification for frozen fish fillets* - Intended for human consumption	**C**
US EAS 828:2017	*Specification for dried and salted-dried fish* **-** various types of dried and dried-salted fish intended for human consumption. Does not apply to dried silver cyprinid (mukene) and dried smoked fish	**C**
Processing and Marketing Guidelines		
US EAS 832:2015	*Fish industry - Operational cleanliness and hygiene - Guidelines*	**C**
US 129:1999	*Code of Practice for the handling, processing, storage, and placing on the market of fish and fishery products* for human consumption	**V**
US EAS 833:2015	*Code of practice for processing and handling of dried fish and fish products* - intended for human consumption.	**V**
US EAS 871:2017	*Specification for fish sausages* – for fresh fish sausage, smoked fish sausage, dried fish sausage and fermented fish sausages intended human consumption.	**C**

Standard	Description	Compulsory (C) or voluntary (V)
US EAS 876:2017	*Specifications for smoked fish, smoke-flavored fish and smoke-dried fish* - intended for human consumption covering all fish species.	**C**
US EAS 828:2017	*Specification for dried and salted-dried fish* - intended for human consumption covering all fish species except *Rastrineobola argentea*.	**C**
US EAS 896:2017	*Specifications for fried fish* - of all species, which may be whole or portions intended for human consumption or fried fish	**C**
US EAS 898:2017	*Code of practice for processing and handling of smoked fish, smoke-flavored fish, smoke-dried fish and smoked fish products* **-** intended for human consumption all fish species. (V)	**V**
US EAS 834:2015	*Code of practice processing and handling of salted fish and fish products* **–** for human consumption	**V**

The microbiological and nutritional testing of animal feedstuffs is voluntary, including for bacterial loads of Coliforms, *Vibrio parahaemolyticus* and *Vibrio cholera* known to cause gastrointestinal infections in animals.

3.1.5. Case Study: The Significance of Farmed Fish in Local and Regional Trade (Busia, District)

Farmed tilapia is now becoming more prominent in Uganda's major urban center's and key local fish markets. Busia market is one of the major fish markets in the Eastern Region and is also major source of fish for fish traders in Kenya (figure 7) Busia Fishery statistics for example, indicate that about 60% for the fresh tilapia sold in Busia main market was farmed fish from cages. A similar trend was observed whereby most of the fresh catfish sold in the market was from fish ponds (figures 8 and 9, and table 5).

Figure 7. East African Ports of Entry used in regional fish trade

There's is a growing preference for cage cultured fish because for fish traders, the guarantee of obtaining full truck load for each cage harvested; makes it more cost effective than waiting several hours or a couple days at a landing site. Traders transport the fish to market chilled in refrigerated trucks. The farmed fish which is brought into Busia market comes from various districts within the Lake Victoria Basin, including from the districts of Lira and Arua in Northern Uganda. Specific traders ply the northern route bulking fish (both tilapia and catfish) from different farms after which it is delivered to Busia Market.

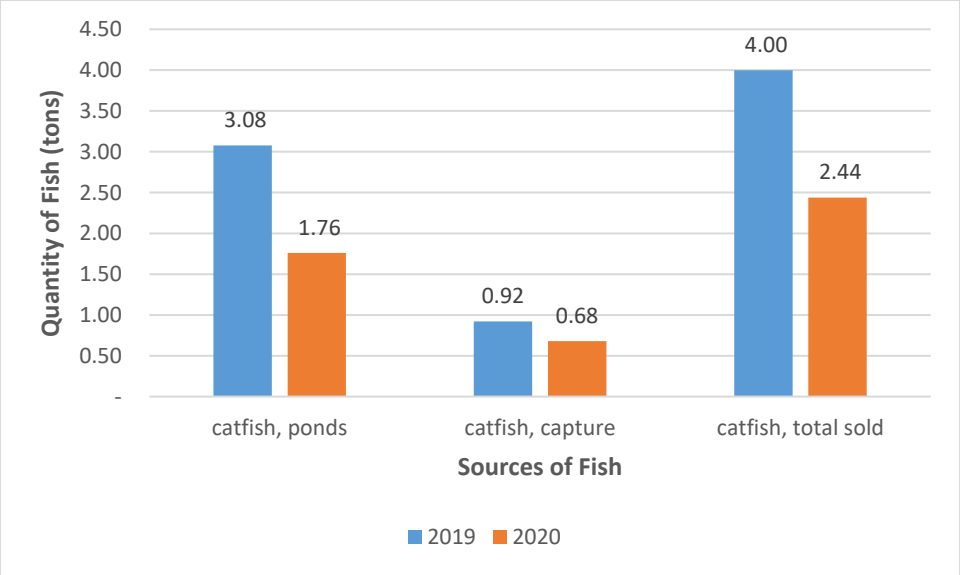


Figure 8. Major sources of fresh catfish (*C. gariepinus*) sold in Busia Main Market. Source District Fisheries Statistics, Busia District Local Government.

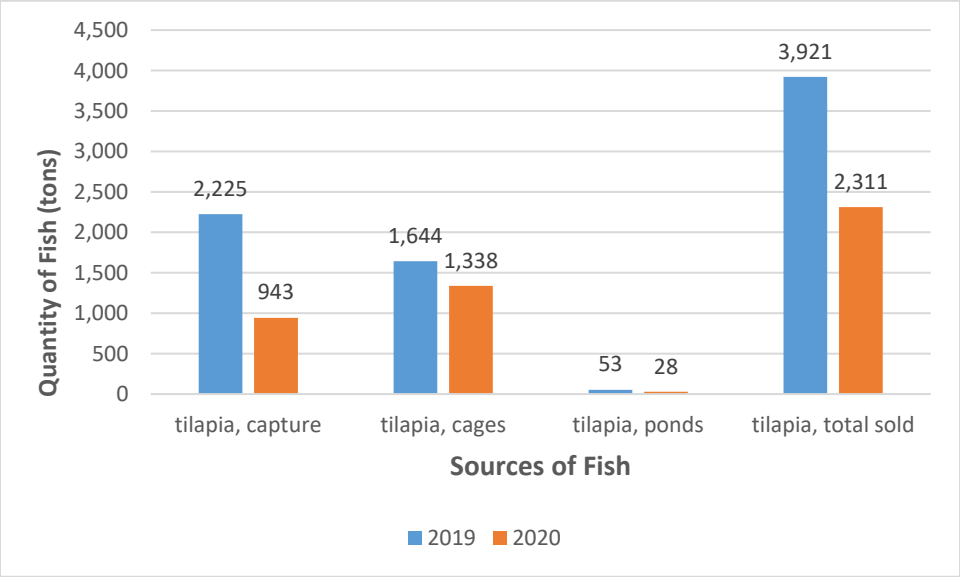


Figure 9. Major sources of fresh tilapia (*O. niloticus*) sold in Busia Main Market. Source District Fisheries Statistics, Busia District Local Government.

Table 5. Value of Farmed Fish Sold in Busia Main Market

Species and Source	Value (USD) 2019	Value (USD) 2020
Tilapia, capture	5,970,765	2,274,981
Tilapia, cages	4,231,943	3,226,385
Tilapia, pond	134,178	67,607
Tilapia, total	**10,336,886**	**5,568,974**
Catfish, capture	1,639	1,252
Catfish, pond	5,674	3,745
Catfish, total	**7,314**	**4,997**

Markets for Farmed Tilapia Fish Sold in Busia market

The DFO Busia estimated that about 80% of the farmed fish traded through Busia Market eventually ends up in Kenya where it proceeds to Nairobi, Kakamega, and Busia (on the Kenyan side). The rest was consumed locally.

A Fish Import/Export permit was required for the export of fingerlings and table fish. The Fish Export Permit could only be obtained from DiFR in Entebbe. A Fish Health Certificate was additionally required for the export of table fish. The farmer normally obtained the permits for any consignment to be exported on behalf of their clients, so that when clients came to collect their consignments for export, all the supporting documentation required from the Ugandan side was ready. The information captured by both these documents described the species, volumes, product characteristics, source and destination of the fish (see Appendix 6).

It was noted though, that not all of the farmed table fish was formally exported. Some of it, especially in the former case, was informally traded across border towns.

3.1.6. Status of Aquatic Animal Disease Control in the Country

The actual status and impacts of aquatic animal diseases in Uganda have yet to be ascertained. The levels of awareness are low and farmers' personal experiences with fish diseases, especially among small and medium scale grow-out pond farmers was reportedly low. Similar observations were made during a study to assess the antimicrobial resistance in farmed fish (Wamala S *pers comm*). Commercial hatchery and cage-culture producers had more experiences with incidences of fish disease on farm.

Based on their experiences, farmers related the observations listed in table 6 to the presence of fish disease.

Table 6. Observations farmers associated with fish disease

Observations	Examples	Production System
Changes in behavior	• Fish isolated	Catfish hatcheries
Changes in physical appearance	• fungal growth around eyes • wounds and/or patches on body • swollen bellies sometimes with signs of bleeding • spongy like growth on bruised parts of fish (usually observed after fish transfer)	Cages Cages, hatcheries Hatchery ponds Pond, tanks
Mortality patterns	• sudden large number of fish deaths	Cages, ponds, hatcheries
Changes in movement	• fish swimming on their side or upside down • suspended vertical position	Cages Catfish hatcheries
Reduced feeding	• Reduced feed intake	Cages, hatcheries
Environmental changes (weather)	• Kaliro and high waves	cages
Changes in water quality	• Reading from water quality kits, changes in temperature,	Cages, hatcheries
Parasites	• Parasites attached on body of fish or underneath scales • Parasites inside intestines	Ponds, cages Old heavily silted fish ponds

The farmers noticed abnormalities in their fish during fish handling, soon after transferring fish to different production units and in cages, soon after storms and/or periods when the lake had been rough. They mentioned that they did not report cases of disease when they occurred as a rule to the FO unless mortalities were extremely high. And even in cases of high mortality, reporting was not necessarily deliberate but depended on when the FO could be met/the information relayed directly or indirectly.

The FO's confirmed that they tended to be informed inadvertently of any disease incidents, often several days later. Farmers relied more on advice from other farmers when they had cases of disease or unknown mortality. Consequently, farmers did diagnose and treat diseases themselves without ever reporting to FO or VO. According to FO's, incidences of high mortality tended to be caused by poor water quality arising from poor management among pond farmers or as a sequel to stress after stocking in cages and ponds. Their presumptive diagnosis was based on farmer's verbal reports and where they had been able to follow-up reports of incidents with field evaluations.

The veterinarians (i.e. those who had been consulted by FO for a second opinion) also believed that cases of mortality were additionally compounded by poor nutrition which compromised the ability of fish to overcome stress arising from routine handling among farmers who used on-farm feeds. Their basis was the aflatoxins commonly present in feed ingredients and the presentation of some symptoms such as lesions, whose characteristics they assumed were due to secondary infections. However, both FO and VO reiterated that without water quality equipment, the FO could not verify water quality parameters, hence preventive measures to address mortality from poor water quality could not be addressed in time. The lack of basic equipment at the District also had a negative impact on disease reporting because farmers

realised that there was nothing the FO nor VO for that matter, could do other than give assumptions about disease causes and their personal opinions on resolving disease issues. It was therefore more cost-effective to consult another farmer who had experienced a similar incident. There were no aides such as posters, at the districts to help guide farmers or extension personnel on the identification of fish diseases once they occurred.

Large commercial farmers tended to seek help directly from DiFR, ARDC-Kajjansi or CoVAB at Makerere University.

(a) On-going Surveillance Programs

Some farmers in the districts that were part of the on-going TiLV surveillance had had water quality and fish samples taken from their farms. However, no results have been communicated as yet to the districts or farmers involved, on the status of health of farms involved in project. The unofficial results of this project have so far found no case of TiLV on participating farms.

(b) Farm Biosecurity Measures

Disease entry and occurrence was prevented by stocking apparently healthy looking fish from known sources (preferably hatcheries certified by DiFR), screening ponds, fencing, ensuring ponds and tanks filled and drained independently, washing nets and other fish handling tools after use, drying and disinfecting ponds and tanks prior to stocking, ensure water quality and proper feeding.

Dead or 'sick' fish however, were disposed off on-farm by throwing into garbage, bush or fed to other animals (pets) on the farm.

Wild fish were observed to be present in the main channels supplying farms, birds were observed on ponds and on-top of cages, tadpoles and frogs as well as snails in vegetation along channels. These are potential vectors for aquatic animal diseases. One of the DVO's enquired about the likelihood of Ranaviruses (*Iridoviridae*) in fish farms in Uganda because frogs and tadpoles were among the commonly present *'wild life'* on fish farms. This was in view of the fact that ranaviruses were reportedly increasingly being associated with mortality events in amphibians, wild fish, and reptiles in the America's.

The siting of cage farms and determination of optimum carrying capacity of designated areas for cage culture, from the point of view of farm production management, currently largely depends on the farmers' experiences, i.e. trial and error. MAAIF provides guidelines that prospective farmers need to comply with in order to obtain the necessary permits to establish and operate cage farms (GoU, 2003 and MAAIF, 2020). Farmers who have experienced diseases on their farms however, noted that they had observed from experience that relocating cages, spreading independent cages from each other, the proximity to certain features in the lake and seasonal factors helps reduce the magnitude and occurrence of fish diseases in cage farms. This is a process that can take a cage farmer up to five years to determine for a given farm in relation to their management practices and seasonal hydrological, hydrodynamic and water quality changes. The farmers' did not have data on this but when prompted on why they did certain things that were peculiar to their farms were done, they were able to elucidate these factors.

Potential hotspots for the amplification and spread of parasites into cage farms consequently came to light. However, according to both the DVO and District Entomologist (DE) (the latter position falls under Directorate of Animal Health), the status of vectors and fish parasites in the environment or on fish for that matter were not routinely monitored like those known to affect public and livestock health. It was

apparent from discussions with farmers, DVO, DFO and DE that the current status quo whereby there was no comprehensive zonation to guide the establishment cage culture was something that needed to be prioritized urgently for aquaculture biosecurity control before it became too late. Zonation and biosecurity control management practices would need to be additionally tailored to the independent needs of clustered smallholder farms *versus* individual farms for a given zone or locality.

The DVO's also brought to light the fact that there was no requirement for 'fish inspection' for public health as there was for other food products of animal origin as a potential biosecurity and food-safety hazard. Thus, there was also no obligation for veterinary public health nor fish processors to report parasites or abnormalities observed at points of slaughter or sale. According to the DFO's, the latter was only required for fish destined to export-oriented fish processing plants and even then, no data other than average weight and species was recorded from fish rejects. Fish rejects found their way into domestic and regional (especially DRC) food markets, was fed to domestic animals or thrown into bush or back into the lake.

Another observation made was the potential risk from the movement of fishing and cargo boats across the lakes. The licensing of boats has improved the ability to trace boats and fish consignments transported across the lake. This would support aquaculture MCS and biosecurity control.

Potential environmental risks for aquaculture biosecurity and biosafety observed at various farm's during the field survey

a) Wetland vegetation where snails and aquatic animals seek refuge or dwell

b) Snails – common vectors for metacercaria of fish parasites and other aquatic pathogens

b) Tadpoles in newly filled pond. A common site in most fish ponds. Amphibians are potential vectors

d) By-Catch as supplementary feed (e.g. crustaceans). Processed and fed without consideration to potential feed-safety risks.

d) Human activity upstream. Potential source of contamination.

e) No clear guidelines for minimum distances between cages and cage-farms. When too close increased likelihood for transmission of diseases and parasites between production units.

(c) Fish Health Records

Farmers: The status of record keeping among fish farmers varied and was more consistent among large commercial farmers. Farmers kept records of inputs, feeding and sales. For small holder farmers, previous receipts served as records of inputs. Health records were not specifically kept but only of mortality. The reason given by farmers for this was that they did not know how to identify fish diseases. Hence, it was difficult to assess the status of fish diseases on farms.

Fisheries Officers: Only reported in their general monthly reporting to the District if an incident occurred. However, it was not obligatory to report health incidents. Based on the explanations given above, uncertainity was a factor affecting their confidence to state they had been disease incidents.

Animal Health Services: There was more systematic data capture, recording and relay on information on health indicators among the animal health services. However, fish diseases diagnosed in AHL remained in the laboratory log books and was not captured in the DVO's monthly reporting to MAAIF. This was DVO's (as did the DFO's) believed that they were not obliged to report fish diseases. Furthermore, the DFO's did not think the AHL were supposed/allowed to diagnose fish diseases.

3.1.7. Status of Aquatic Animal Disease Risks among Aquaculture Trading Partners and in Shared Water Bodies

(a) Emerging Trans-boundary Aquatic Animal Diseases

The presence of Epizootic Ulcerative Syndrome (EUS) (*Aphanomyces invadans*) and Tilapia Lake Virus (TiLV) (*Orthomyxoviridae*) has been confirmed within the Great Lakes region of Eastern and Southern Africa (figures 10 and 11). EUS has been isolated from fish with clinical symptoms in the Congo River Basin of the Democratic Republic Congo (DRC). TiLV has been isolated from apparently healthy fish that showed no clinical signs in Lake Victoria Uganda and Tanzania.

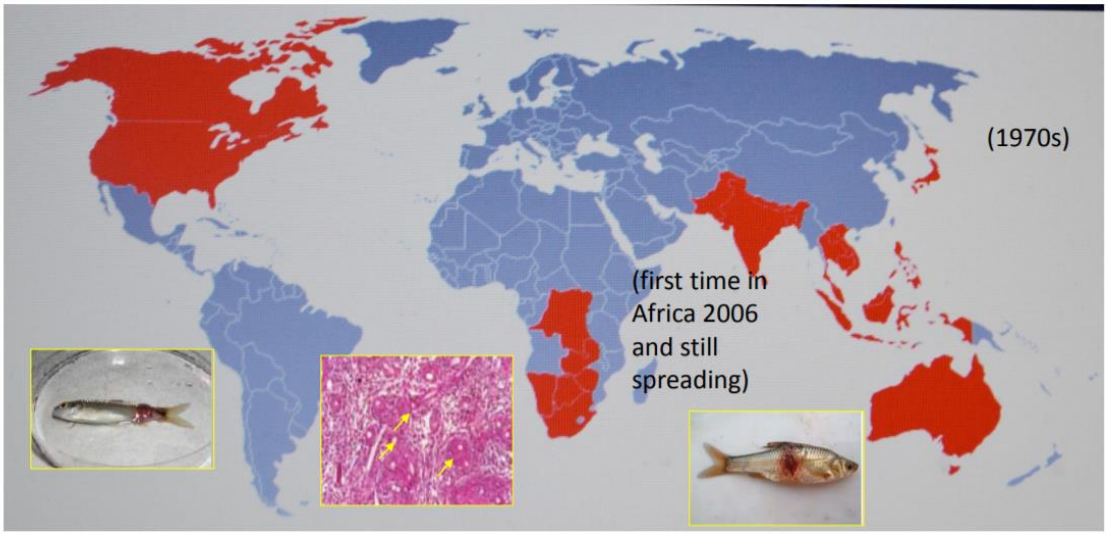


Figure 10. Geographical Distribution of EUS (FAO, 20

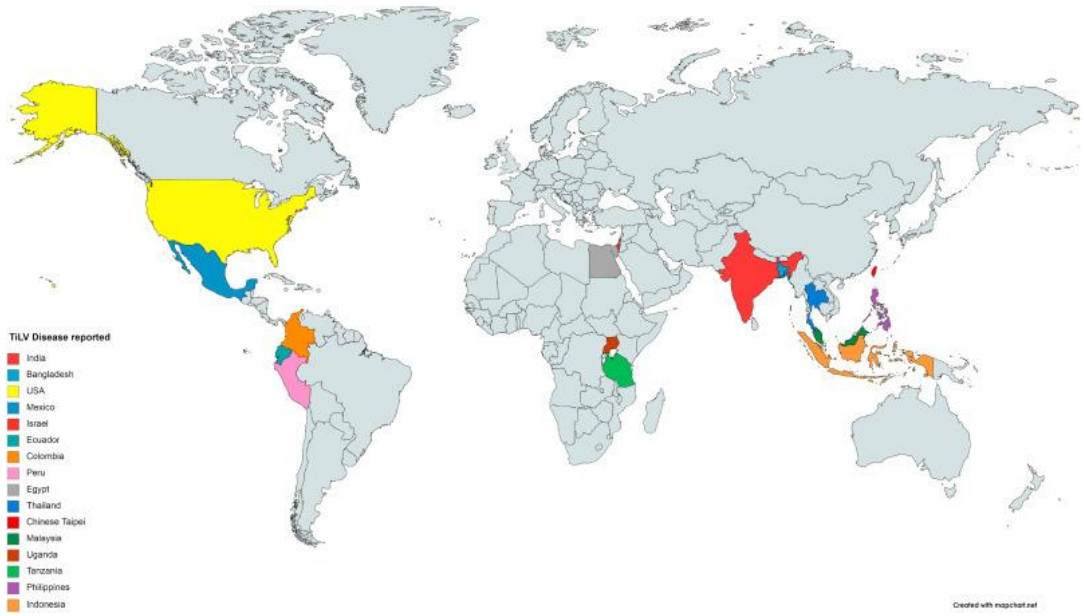


Figure 11. Geographical Distribution of TiLV (Aich N., 2021)

(b) Environmental Risk Factors

The most economically important freshwater species within East Africa are the Nile perch, tilapia, small pelagics and African catfish. They are indigenous to the region and constitute the most traded fish species locally and regionally. The major lakes that support these fisheries (Lakes Victoria and Albert in Uganda's case) are also, the dominant lakes where cage culture is practiced and whose drainage basins support land-based fish farms. These two lakes, currently pose a real threat for the incursion TiLV and EUS into Uganda's fishery and aquaculture systems given that their causative agents have been isolated in fish from the respective lake and river basins. The environmental and anthropogenic factors likely to affect the pathogenicity of these infectious agents that are known to spread through contact, have yet to be determined for Uganda's aquaculture. The current situation whereby the number and sizes of fish farms in the country is increasing rapidly, as are the volumes of farmed tilapia and catfish traded from these establishments without factoring in the system dynamics and ecosystem health, presents a precarious situation for the sustainability of commercial aquaculture in Uganda.

Unless there is been evidence of eradication, the assumption that these infectious pathogens (especially TiLV that has been isolated from tilapia within the country) are currently in the process of adapting to survive in Uganda's aquatic ecosystems is not unfounded. The attributes this evolution process will infer to the pathogens in order to confer a status of endemicity, will determine the most appropriate measures for controlling the prevalence these diseases. Hence, the impacts of pollution and climate change as potential fish stressors and factors that influence ecosystem dynamics should also be integrated into aquaculture MCS especially for trans-boundary aquaculture systems where the factor of magnitude by virtue of the size of trans-boundary water bodies pre-empts the potential scale in case of an adverse event.

(c) Endemic Aquatic Animal Diseases

Similar aquatic animal parasites and managemental diseases are reportedly found on land-based and water-based fish farms in Kenya, Uganda and Tanzania, including those located within the same trans-

boundary water bodies. This situation, coupled with environmental degradation and the increased proximity and number of fish farms within water-bodies and catchments raising larger volumes of fish, substantiates the need for strengthening biosecurity controls to ensure the zoo-sanitary status of aquaculture facilities, hence public and ecosystem health. Under the circumstances, it can no longer be taken for granted that commensal aquatic pathogens have exited without detrimental impacts for the fisheries and aquaculture. This is because fertile grounds for the multiplication and transmission of commensal pathogens are simultaneously being created through the expansion of aquaculture as the pathogen's hosts are no longer sparsely distributed and have become exposed to continuous and intractable environmental stressors. The case of the sea lice (*Lepeophtheirus salmonis*) and its impacts for salmon farming in the North Sea provide a scenario that simulates the current risk for commercial cage culture in Uganda which is expanding without paying due diligence to environmental and biosecurity concerns. The stocking of fry whose health status has not been established from different hatcheries across the country is a risk factor that can lead to the North Sea situation. Should such a situation ever occur, then the market attributes of the country's fishery and farmed fish such as for 'labelling' may decline depending on what control measures might be necessary at the time.

Figure 12 illustrates how the issues raised above are actually unfolding into a real risk for Masese Fish Famers Cooperative Society, one of the fish farms visited during this assessment. It qualifies the MCS expectations fish farmers listed in 3.1.8.2. It also re-affirms the need for establishing an aquaculture MCS system that addresses risk analysis based on One Health and climate-change risks.

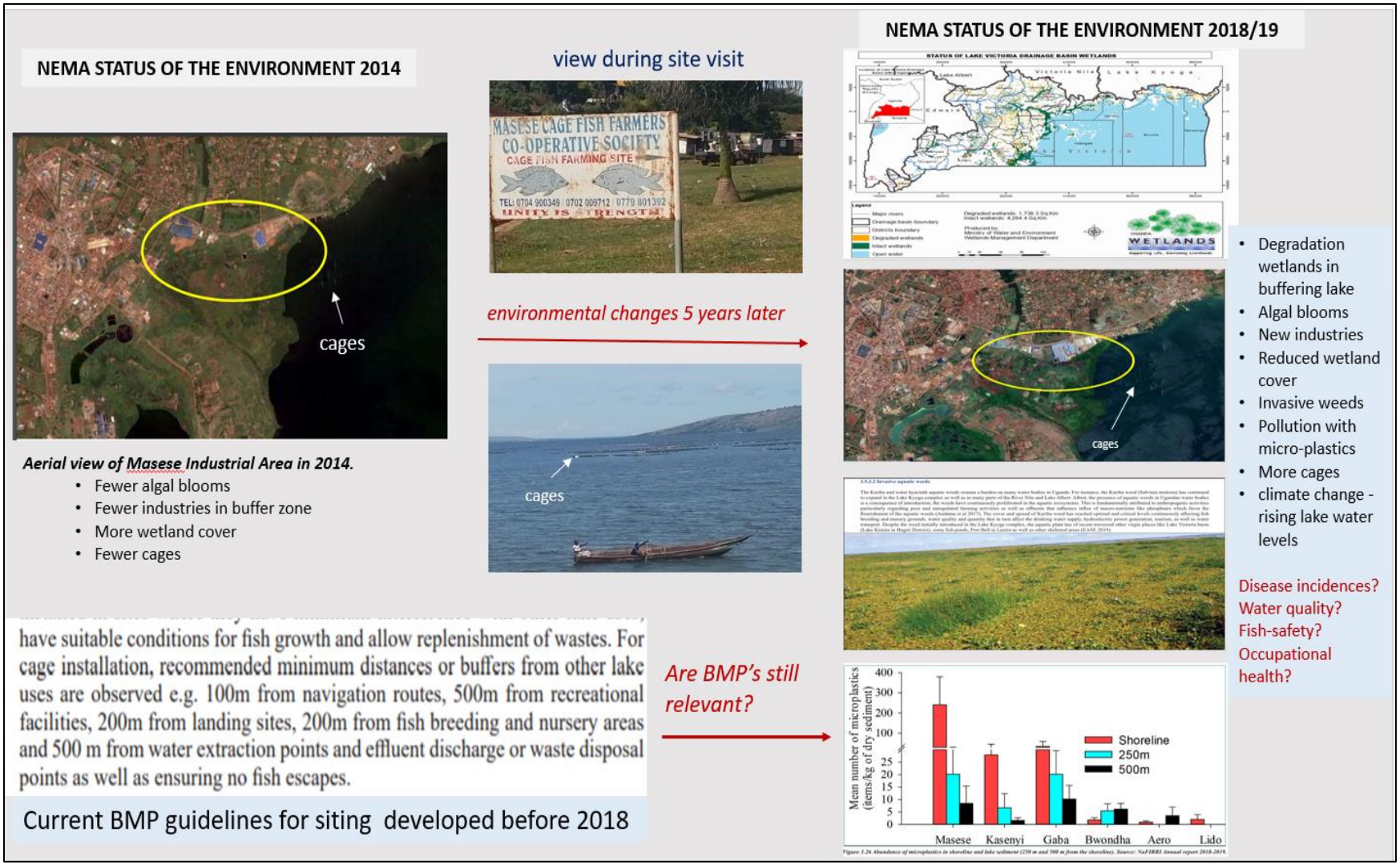


Figure 12. Environmental Changes that have occurred over 5 years that pose a risk for aquatic biosecurity, farm productivity, bio-safety and public health (adapted from NEMA, 2019).

3.1.8. National and Farmers Expectations from Aquatic Animal Disease MCS

3.1.8.1. National Perspective

The national objectives for assuring the sanitary status of Uganda's aquaculture industry focus at protecting the industry from disease threats to safeguard its sustainable growth and obtain access to markets. he country seeks to achieve its national objectives concurrently with its international obligations to the Convention of Biological Diversity, the FAO Codes of Conduct for Responsible Fisheries, OIE and SDG's (UN, 1992; FAO, 2011; OIE 2020; UNDP, 2015).

(a) Safe Trade - Traceability and Certification of Aquaculture Products

The movement and trade live aquatic animals poses a threat for the entry and spread of both notifiable and endemic aquatic animal diseases across the country and region. The major mode of transmission for the infectious aquatic pathogens of importance listed is horizontal via water involving contact with fish/aquatic organisms, fomites and fresh affected farmed/wild fish products.

Zoo-sanitary measures should therefore be implemented in support of aquaculture biosecurity and trade guidelines. The issuance of permits and certificates facilitates monitoring and surveillance for safe trade, public and environmental health.

(b) Inland Movement of Live Fish

The provisions in the *Aquaculture Rules (2003)* endeavour to ensure that only healthy fish are permitted for transfer within the country by requesting evidence of adherence to quarantines in the Ninth Schedule. However, the *Aquaculture Rules (2003)* do not define what is referred to as 'quarantine' nor the evidence that would be required to prove 'adherence to quarantine' guidelines as is clarified in the *Animal Diseases Act (Cap 38)*. Guidelines for infection prevention and control during transit and on arrival at the destination in the *Aquaculture Rules (2003)* are not explicitly addressed as they are in the *Animal Diseases Act*.

The *Animal Diseases Act* provides for a three-tier approach for disease control whereby the movement of animals is restricted at inter sub-county, inter-district and international level. Only healthy animals are permitted to move between sub-counties and districts. Healthy animals are not permitted to travel through an infected area or go to an infected area as the final destination. In addition, a letter of no objection is required from the destination (be it another farm) and movement at night is not permitted to enable the verification stock and their health status upon arrival. Animal movement permits and health certificates under this Act facilitate health monitoring and traceability to source in the event an animal is found to have an infectious condition upon arrival (appendix 6).

There are also no obligatory guidelines for live fish seed traders and/or transporters compared to the *Cattle Traders Act* that licences cattle traders and obliges them to abide to the *Animal Disease Act* when transporting live animals internally or for export.

(c) Trans-boundary Movement of Live Fish

The certificates and permits required for the import-export of live fish to the country are the Certificate of Importation for Live Fish, Fish Import/Export Permit guided by the List of Species that can be traded live as stipulated in the Sixth, Seventh and Eight Schedules of the *Aquaculture Rules (2003)* respectively (appendix 8). There is no explicit requirement for zoo-sanitary certification in any of these permits in

compliance to OIE requirements nor any equivalence to Articles 8 – 19 of *Animal Disease Act* (38-4) (Appendix 8 and 9).

Ports of Entry, were found to be limited in their capacity to verify the health status of fish imported. Consignments officially being imported would have the required documentation. However, the fish inspector could only visually verify the content based on documentation given due to lack of live fish holding facilities and basic equipment for ascertaining indicators of fish health stated on fish import documents. Cereals and grains are checked because they can be held for checking without resulting into undue loss for the owners as opposed to live animals.

Agricultural inspectors at Ports of Entry stated that technically, they could not confirm that no live fish (especially juveniles) entered the country without having been declared. The country has several porous entry points along its borders through which goods and people cross into the country.. Secondly unless one openly declares what they have, it is easy to hide fish fry shipped in oxygenated bags because packages are not bulky. A small bag with hundreds of fry can be placed under or within other cargo for which entry is permitted. There were no facilities to scan all vehicles/cargo entering the country by road. The number of fish health inspectors was inadequate (one per region yet there is more the one border post per region). This is in the process of being addressed by proposed new recruitments for each Port of Entry.

Further to this, the level of awareness on the manifestation of aquatic animal diseases was low among agricultural inspectors (fisheries, veterinary and crop border inspectors) and the public was low. The border posts did not have public awareness posters that showed how specific aquatic animal diseases of concern might present as compared to the crop and livestock health posters displayed at Ports of Entry. The public could not therefore cooperate because they had no basic knowledge of fish diseases nor of what biosecurity control or sanitary measures should be applied in compliance to aquaculture and live fish trade regulations.

(d) Regional Trade

The demand for freshwater fish within Eastern and Southern Africa has created a good intra-regional market for Uganda's fish (figure 8).

The Harmonized EAC Guidelines for Trade in Fish, Fishery and Aquaculture Products and Inputs in Regional and International Trade provide guidance for the export/importation of live fish among East African member States and internationally (LVFO, 2019). These guidelines provide guidance on clearance procedures at Ports of Entry and the roles and responsibilities CA that included aquatic animal disease outbreak reporting and issuing of licenses, permits and/or certificates for the export-import of fish, fishery and aquaculture products and inputs. These guidelines however addressed the *Codex Alimentarius* which also mentions disease control within the context of diseases being a likely risk for food-safety rather than from the perspective of establishing zoo-sanitary measures to safeguard animal health as per the OIE standards (Box 1).

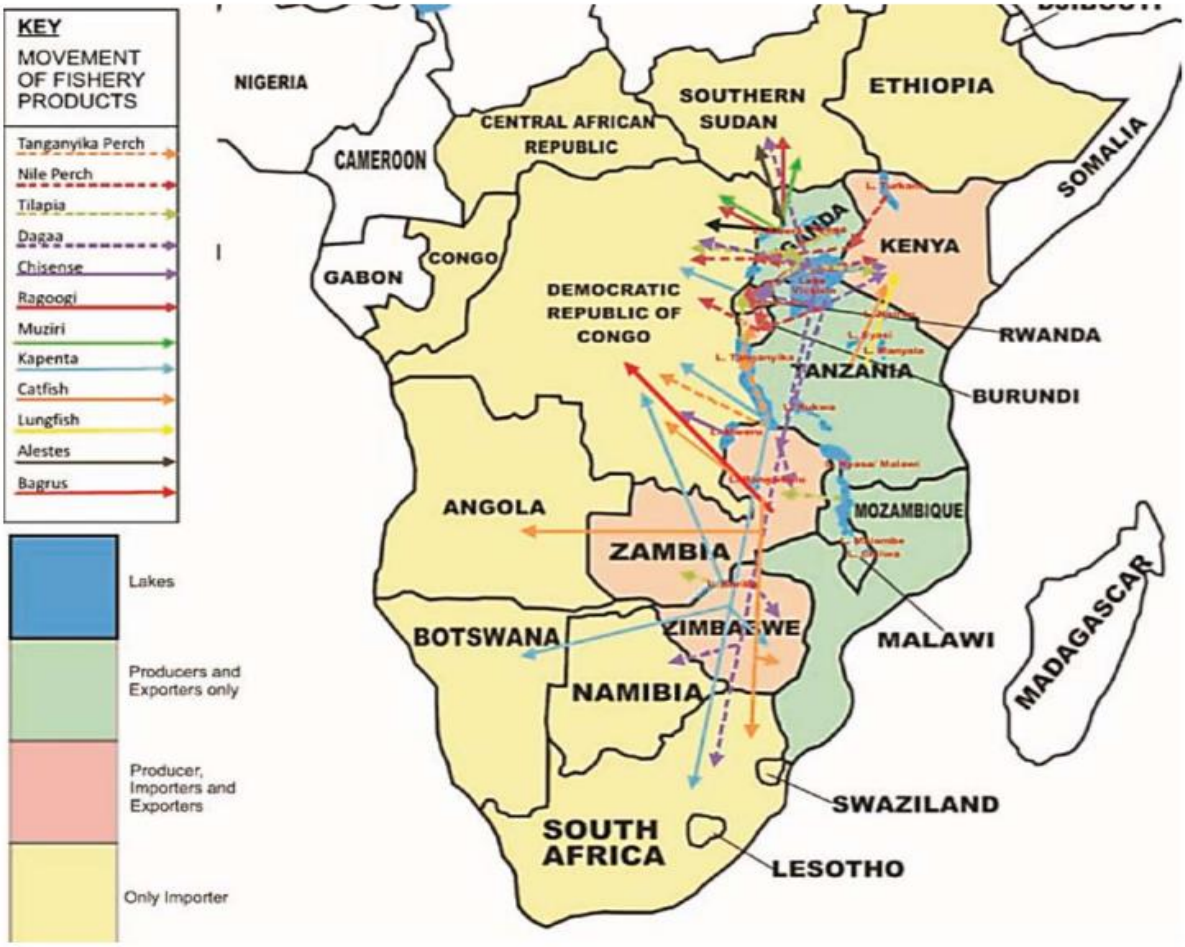


Figure 13. Intra-regional Fish Flows (FA0, …)

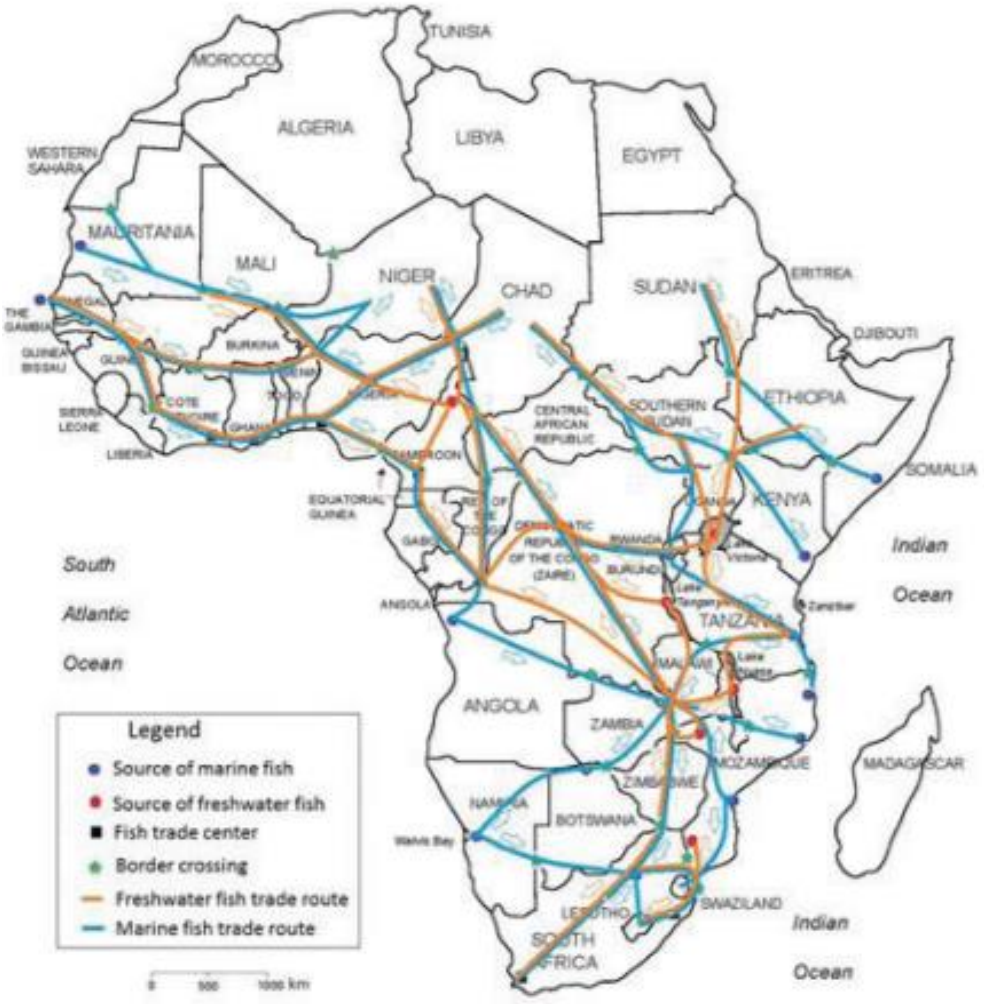


Figure 14. Fish Trade Routes in Africa (fresh and marine) (AU-IBAR, 2018)

The EAC One-Stop Border clearance system sends information on agricultural goods crossing to the respective regulatory authority on Fisheries Inspection, Bureau of Standards, Crop Inspection, Veterinary Inspection and Port Health for subsequent actions. The actions include joint inspection and document verification. After verification, the relevant regulatory authorities can clear, query or deny entry online. Cleared goods are given an exit note and cargo manifest online. The exit note is printed and stamped and presented at the exit gate to enter the destined country. For export of fish, fishery and aquaculture products or inputs, consignment should be accompanied by Health Certificates, export permit, invoices, cargo manifest/packing list and authorization from importing country (where applicable). The Fish Health Certificates detail the requirements for health certification according to *Codex Alimentarius* but not the OIE Aquatic Code. It is only the Republic of Kenya, which stipulates in its regulations and provides International Veterinary Certificates for live aquatic animals under the auspices of the Directorate of Veterinary Services (figure 15 and appendix 8).

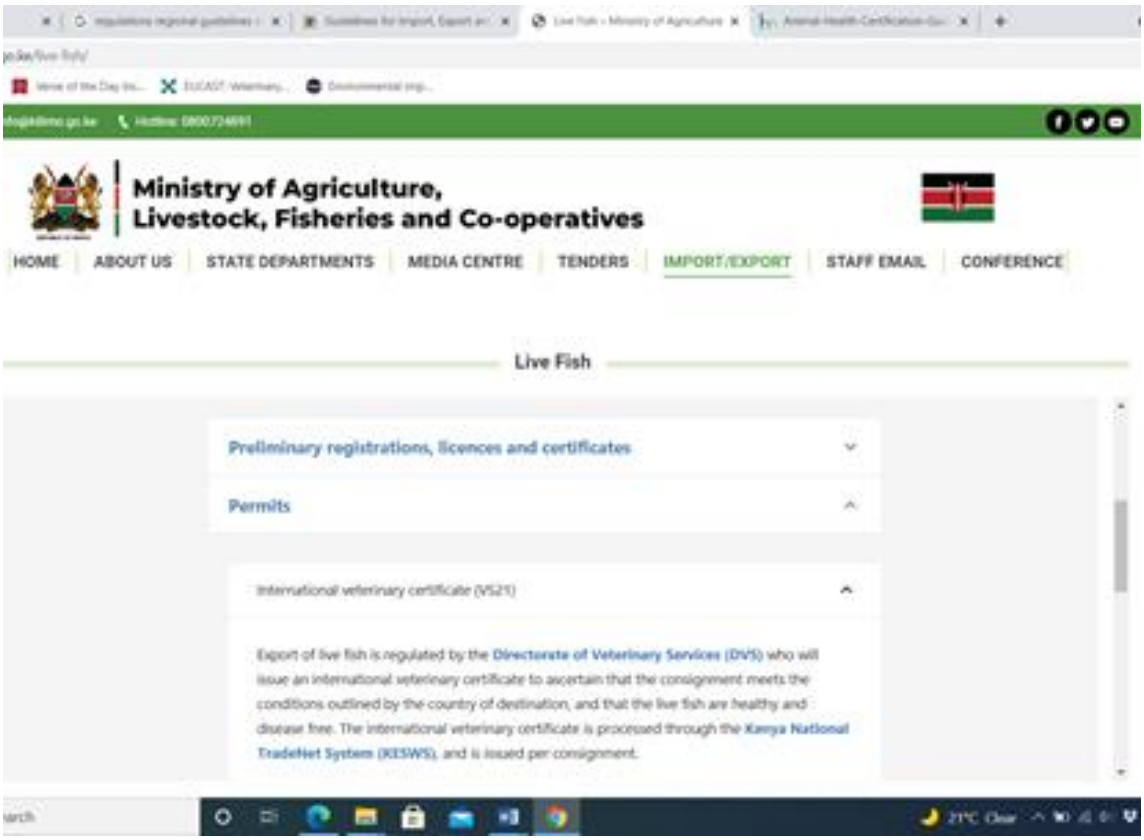


Figure 15. Export of Live Fish, Kenya

In addition to the above, there is a Harmonized Fisheries and Aquaculture Border Inspection Manual for East African Community (LVFO, *not dated*). The purpose of the latter is to guide Border Fisheries Inspectors implement their Terms of Reference, and in so doing it shows the extent to which the lack of appropriate infrastructure for live fish inspection at Ports of Entry is currently affecting SPS measures (Box 1.). With respect to the quarantine of live fish, the manual states '*the Government Institution responsible for aquaculture should inspect and quarantine fish being imported into their countries in accordance with the legislation governing movement of live animals and necessary Health Certificate confirmed by both sides*'. The quarantine of fish feeds, fish, fishery products and capture fisheries gears are additionally tied to the origin of a consignment and subject consignments from high risk areas, *such as where a cholera outbreak has occurred* to inspection under the Quarantine Law of that Partner State. Aquatic animal disease issues are not *fully* aligned to Article 5 of the Animal Health East African Community Protocol on Sanitary and Phytosanitary (SPS) Measures (EAC, 2013).

Box 1. Guidelines for EAC Border Fisheries Inspectors (LVFO, *not dated*)

1. Live Fish For traceability, live fish (ornamental fish, fish fry, fingerlings or brood stock) should be from facilities certified by a Competent Authority.
2. Each consignment of live fish for export should be accompanied by a health certificate issued by the Competent Authority responsible for fish health in the respective Partner State.
3. Health certificate/movement permit should indicate the following;
   - fish species (common and scientific name),
   - destination, number, intended purpose for exportation,
   - Health attestation, and
   - Source (wild or farmed).
4. Conditions for transportation include;
   i. The water temperature should be maintained as per fish species requirements;
   ii. There should be provision for ensuring adequate oxygen;
   iii. There should be no clinical signs and symptoms of diseases;
   iv. Containers used should be easy to clean and disinfect;
   v. Inner surfaces of a container should not injure or cause damage to the fish; and
   vi. The container should not be made of material that offer any undesirable attributes to or change the wholesomeness of the contents.
   vii. If live fish has been treated, it should be indicated in the relevant document accompanying the consignment

The Intergovernmental Authority on Development (IGAD) SPS guidelines more comprehensively address the OIE on zoo-sanitary aspects but refer only to livestock as opposed to the EAC whose SPS animal health guidelines are broad and can therefore be adapted to address the weaknesses for aquatic animal health SPS raised above (IGAD, 2016).

Currently, since Uganda does not have a national database demonstrating its sanitary status, the country cannot fully comply with regional or international standards for safe trade in live aquatic animals or aquaculture produce and products.

3.1.8.2. Farmers' Perspective

The initiative to establish and aquatic animal disease MCS system in Uganda was welcomed by most farmers, who generally felt the initiative was long overdue (see figure 12). According to the farmers, establishing a MCS system in Uganda would require training of farmers, personnel and equipping of laboratories and extension workers with appropriate diagnostic tools. They noted that farmers were likely to be visited by local extension for disease monitoring more often on fish health status and in this process farmers will improve fish health management on-farm, diseases will be detected, reported and controlled earlier and in the event of an incident, farmers will know whom to contact.

The following are the benefits farmers expected from the aquatic animal diseases MCS:

(i) It should improve ability of farmers to obtain certification for export
(ii) It should positively impact on profitability and
(iii) It should result into the development and adoption of better production standards which in turn would help reduce current production risks that cause failure and financial loss.

(iv) Improved communication between farmers, stakeholders and sector managers as there will be more evidence of the cause and effect of management practices.

Thus, farmers would support the implementation of MCS system depending on its effectiveness and the benefits that would accrue to their enterprises.

3.2. Step 2: Definition the surveillance objective with respect to the disease/pathogen

Animal health surveillance is a tool to monitor disease trends, to facilitate the control of infection or infestation, to provide data for use in risk analysis, for animal or public health purposes, to substantiate the rationale for sanitary measures and for providing assurances to trading partners (OIE, 2019).

The prioritization of pathogens and/or diseases in MCS depends on their relative importance for the sustainability of the aquaculture sector, economic importance (local and regional trade), environmental sustainability and fish-food safety.

3.2.1. Listing of Pathogens

3.2.1.1. OIE Notifiable Pathogens

It is obligatory to report OIE notifiable pathogens as they are typically highly infectious pathogens characterised by their devastating impacts on fish populations. Based on the national aquatic disease status described above, the OIE notifiable pathogens considered to be of importance to Uganda's aquaculture industry are listed in table 7 below.

Table 7. Decision Matrix used to list OIE notifiable pathogens of importance to Uganda's commercial aquaculture industry.

Criteria/Pathogen	**Epizootic ulcerative syndrome (EUS)**	**Koi Herpes Virus (KHV)**	**infectious spleen and kidney necrosis virus (ISKNV)**	**Tilapia Lake Virus (TiLV)**	**Infectious Haematopeotic Necrosis (IHN)**	**Viral Haemorrahgic Scepticiemia**	**Spring Viraemia of Carp Virus (SVCV)**
1. Category of Disease	OIE	OIE	OIE	emerging	OIE	OIE	OIE
2. Presence in Uganda	?	?	?	Suspected	?	?	?
3. Significant economic, sociological or environmental impacts?	+	+	+	+	+	+	+
4. Infectious agent and is transmitted vertically or horizontally?	+	+	+	+	+	+	+
5. Affects tropical species and has potential to establish in national territory?	+	±	+	+	+	+	+
6. Needs to provide assurance of disease status for trade purposes	+	+	+	+	-	-	-
7, financial impact or threat posed by the different diseases	+	+	+	+	-	-	-
8. Are major commercial aquaculture species in the country affected	+	±	+	+	-	-	-
9. Regional presence and importance	+	-	-	+	-	-	-
10. Importance of an industry-wide disease control program within a country or region	+	-	+	+	-	-	-
11. Additional Remarks	catfish	carp	tilapia, Ghana	tilapia	*Aq Rules (2003*), cold water species, N. Hemisphere		
Score *(decreasing order of importance)**	**1**	**2**	**2**	**1**	**3**	**3**	**3**

Ranking* - **1 -** is the most important and **3 -** least considered to be less of a threat

3.2.2. Endemic Pathogens

The exact prevalence, economic and environmental impact of endemic aquatic animal pathogens to aquaculture and the fisheries are unknown. A number of pathogens have however, been isolated from clinically affected fish on-farms. Several studies have been done to profile parasites found in fish for scientific. The majority of these studies sampled apparently healthy fish; they did not aim to determine causes of disease but rather were done for scientific interest (AU-IBAR, 2017).

Reported cases of aquatic animal disease have increased over time associated with aquaculture. The presumption of disease has largely been based on the symptoms and mortalities farmers observe. Such reports have been associated more frequently with hatcheries and cage culture. Where clinical diagnoses confirmed with laboratory confirmation of disease causing, indications are that disease occurrences on fish farms tend to be associated with endemic pathogens that have also been isolated from wild fish or contaminated environments. Non-infectious diseases arising from water quality changes and nutritional deficiencies have also been identified. Similar diseases have also been reported on fish farms in Kenya (Opiyo et al., 2018, Kundu, 2017).

Currently, the economic significance of endemic aquatic animal diseases is of greater concern for fish farmers compared to the apparent threat from notifiable diseases. Farmer's description of case histories and laboratory confirmation of causative agents linked to symptomatic signs of disease and mortality on-farm suggest the likely presence of subclinical conditions that rapidly progressed into clinical cases with high mortality sometimes when fish were exposed to sudden stressors. Hatcheries and cage culture were more predisposed to physical stressors due to the routine harvesting and crowding of fish that occurred during grading, sampling and transfer to on-growing units. The fact that most farmers did not have knowledge on how to generically detect symptoms of stress nor on how to identify such diseases, meant that when disease incidences or mortality occurred it was a haphazard process of trial and error to control them. By the time farmers' worked out what the risk factors for common aquatic animal health conditions were likely to be, often they would have lost entire batches or administered a concoction of treatments to no avail. Thus, the more immediate concern for sustainable sectoral growth and performance is the identification and reduction of production risks causing inconsistencies in batch performance and financial loss for farmers.

Addressing the above challenges with the support of a MCS system, will result into standardised aquaculture production and disease control protocols that shall facilitate quality assurance and traceability across the aquaculture value-chain. Currently, every farmer is doing their own thing albeit in a few cases with independent guidance from other farmers, the internet, extension workers, ARDC, CoVAB and/or external experts. Recommendations given are not standardised and the trial and error process increases the risk for environmental, public health (including antimicrobial resistance (AMR)) and food-safety concerns arising from inappropriate disposal of contaminated effluent or dead fish, use of non-approved drugs and non-supervised treatment regimens. Adherence to sector standards and opportunities for certification becomes impossible even for regional markets under such circumstances where additionally the quality, fish health and feed-safety status are unknowns for several fish farmers (section 3.1.3).

The current situation where there are many unknowns regarding the determinants for disease among the different aquaculture production systems, value chain sanitary risks, bearing in mind farmers MCS expectations and the presence of susceptible wild fish populations and implications for public health, it is

recommended that the MCS approach for endemic pathogens and/or aquatic animal diseases be two pronged. It should aim at:

(i) Aquatic animal pathogen/disease (biosecurity) control
(ii) Quality assurance of the aquaculture value chain

(a) Surveillance objectives for aquatic animal pathogen/disease (biosecurity) control

The MCS approach against the occurrence of endemic diseases in Uganda's aquaculture production systems need focus at minimising the risk of pathogen transmission, build-up of pathogen densities to infective thresholds and mitigating against factors that enhance pathogen infectivity and virulence.

The dynamics of infectious disease within aquatic environments differ from those on land because there are fewer barriers between the movement of host and pathogen in aquatic environments. Fish migrations and water currents can rapidly carry both the hosts and pathogens over long distances and the unique behavior of some fish species such as shoaling and congregating in breeding grounds increases the likelihood for the build-up of host and pathogen densities (Krkošek, 2017). Where fish farming occurs within the same wild aquatic environment (i.e. cage culture), the above factors constitute a disease risk factor for the sector. Similarly, fish farms present a similar disease risk for wild populations in the respective aquatic habitats and vice versa. Therefore, the location of fish farms, their proximity to each other, concentration in a designated area and management practices are likely to influence disease dynamics among both farmed and wild fish populations because of the predilection of physical hydrodynamic and ecosystem factors in the spread pathogens. The anticipated climate change risks for Uganda include increased air temperature, changes in rainfall patterns, and an increase in extreme weather events. These changes are expected to result in changes in fish population, parasite and aquatic ecosystem dynamics (MAAIF, 2018[1] and MAAIF, 2018[2]). In lieu of the above, it will be important that the aquaculture MCS system envisaged additionally monitors pathogens and evaluate their risk based on spatiotemporal analysis associated with impacts on farm location, hydrologic connectivity between farms and water bodies, wild fisheries, aquaculture management and trade practices, changes in land-use patterns, aquatic ecosystem and climate change variables.

The outcomes of the aquaculture MCS system should inform policy and practice on appropriate One Health (OH) disease control measures, zonation, Good Aquaculture Practices (GAP), licensing of farms, certification, biosecurity and biosafety control, fisheries and environmental management as well as climate change adaptation.

- Ranking of Pathogens/MCS Approach

All the identified endemic pathogens associated with aquaculture have had significant negative impacts for farmers, and potentially can have negative impacts on wild populations especially if farms are located close to ecologically sensitive areas such as fish breeding grounds. Because of the lack of epidemiological data on the prevalence of these diseases and the nature of their impacts, it is challenging to establish a targeted MCS system based on specific pathogens. Given the status of the aquaculture sector, the stakeholder objectives for MCS and based on the fact that endemic pathogens are commensal organisms that will tend to cause disease as a result of management or environmental factors, it would be prudent, in this instance to establish endemic disease MCS system that evaluates the relative importance of the different pathogens and appropriate control measures thereof, based on the risk of transmission and spread between and within farms with implications for the One Health and climate change (see table 8

and 9 below). Progressively, the outcome of this approach would be a prioritised list of endemic pathogens. Such a system can be aligned with that recommended for the notifiable diseases (3.2.1.1. above) hinged on passive risk-based surveillance.

Table 8 Fish Pathogens of Potential Economic Importance that have Isolated in Lab

Pathogen	Common Name	Impacts
Bacteria		
Aeromonas hydrophila, A. sobria and C. carviea	**Motile aeromonas septicemia (MAS disease)**	- acute or chronic sceptecemia - has public health significance: [1]
Aeromonas salmonicida		
Aeromonas spp	Bacterial gill disease rot	
Bacillus subtilis		
Flavobacterium spp Flavobacterium columnare *1*	Columnaris disease	- Mortalities among juveniles tilapia and catfish hatcheries - Ponds [1]
Edwardseilla tarda	Edwardsiellosis	- Associated with mass mortalities in tilapia - More prevalent in tanks compared to ponds - Public health significance
Edwardseilla ictaluri		
Edwardsilla hostinae		
Escheria coli		
Mycobacterium fortuitum [1]		- Kenya in ponds
Staphylococcus aureus		-
Staphylococcus epidermis		
Streptococcus agalactiae , Streptococcus sp. Streptococcus iniae[1] (in ponds)	Streptococcal disease	- Affects both farmed and wild populations - Worldwide problem estimated to causes losses worth $150 million annually to the tilapia farming industry - Public health significance
Klebsiella pneumoniae		
Klebsiella spp.		
Pseudomonas spp. (in Kenya *P. fluorescens* and *aeruginosa* disease in ponds)[1]	Bacterial scepticemia	- Bacterial scepticemias - Ponds[1]
Lactococcus garviae		
Fungal Diseases		
Saprolegnia	Saprolgeniasis	- Mass mortalities in stress and/or injured fish soon after handling or transfer - Hatcheries[1]

Pathogen	Common Name	Impacts
Aspergillus flavus and A. parasiticus a	Aspergillomycosis	- mycotoxin producing fungi, - and common contaminants of fish feed - infection occur via feeds that have been stored in warm (greater than 27N C), humid (more than 62%) conditions that promote the growth of mycotoxin producing fungi, mainly if moisture content in the feed is more than 14%
Parasitic Diseases		-
Ichthyophthirius multifiliis	Ichthyophthiriasis (white spot disease, Ich)	- Idenfied farmed tilapia, catfish [1,2] and aquaria - High morbidity rates often associated with high mortality rates on farms (ponds, tanks)
Trichodina spp.	Trichodiniosis:	- Affects cultured and wild fish - High mortalities especially in hatcheries
Chilodonella pisicola	Chilodonellosis	• High mortalities especially in hatcheries
Monogenic trematodes Dactylogyridae (Gill Flukes), Gyrodactylides (Skin Flukes).	encysted metacercaria in the subcutaneous tissue, gills, eye or internal organs1	• feed on the epithelial cells and blood and can cause massive damage to fish skin and gills • mortalities especially among juveniles in hatcheries
Digenetic trematodes		• metacercaria in tissues which reduces market table value of fish
Lernaea spp.		• External parasite • characterized by high morbidity • reduced growth and fish value

Pathogen	Common Name	Impacts
Argulus spp.	Argulosis (fish lice	• obligate ectoparasites • site for secondary attacking by bacteria and fungi • can lead to mass mortalities in young fish. • they may transmit some trypanosomes through blood sucking. • Grow-out tilapia, bagrus sp. and catfish in ponds [1,2]
Environmental Diseases		•
Pollution		•
Climatic changes		•

Table 9. Risk factors and pathway for Endemic Aquatic Animal Pathogens

Risk Factors	Risk Pathway		
	Transmission	Spread	One Health
• Fish species • Pathogen • Land vs. water based farms • Farmed vs. wild fish • Fish products?	• Vertical/horizontal • Reservoirs, vectors, fomites • Hydrologic connectivity • Live fish movements • Water temperatures and seasonal changes • Production systems (hatchery, cages, ponds, tanks) • Geographical location • Water sources • Linear distance to known regions/areas • Production and biosecurity measures in place	• Reservoirs, vectors, fomites • Hydrologic connectivity • Live fish movements • Water temperatures (water quality), quality and seasonal changes • Production systems (hatchery, cages, ponds, tanks) • Geographical location • Proximity of farms • Water sources • Linear distance to known regions/areas • Production and biosecurity practices • Effluent discharge, including from fish processing • Trade and marketing practices • Socio-economic impacts	• Environmental impacts • Public health • Wild species • Reservoirs and vectors • Climate change impacts

(b) Surveillance objectives for quality assurance to the aquaculture value chain

The overall purpose of MCS from this perspective is to assure the safety of the aquaculture value chain. Thus MCS would target pathogens of public health significance and residual monitoring. A Hazard Analysis Critical Control Point (HACCP) and residual monitoring plan for the sector would need to be established in lieu of market standards and in the case of the latter, additionally, environmental impacts. It would be important to distinguish hazards that accrue due to the production process and as a result of contamination to the production environment, post-harvesting handling, processing, transportation and marketing. Table 10 outlines the potential safety hazards for Uganda's aquaculture value chain (Bagumire et al., 2008).

Table 10. Potential Safety Hazards for Commercial Aquaculture in Uganda (Bagumire et al., 2009)

Production step	Hazard	Preventive/control measures	Critical limits	Monitoring procedure	Corrective action
Site selection	Harmful chemical contaminants	Site history, land-based activities, review of soil data, implement pollution monitoring plans	Water quality standards, soil limitation rating	Soil and water analyses, survey of pollution sources	Water treatment, isolate batches of affected fish, relocate fish farm
Water source	Chemical contamination, parasites, bacteria and viruses (latter in rarer cases)	Water supply section, water treatment, water analysis (water source), vector control	Conforming to national and international guidelines, absence of trematodes and intermediate hosts	Laboratory analysis or certification of water supply, visual inspection for snails and other vectors, fish affected with parasites	Alternative sources of water, isolate batches of infested fish, water treatment, remove parasites, re-condition ponds
Receiving of fish fry and fingerlings (fish seed)	GMO, diseases, usually no chemical hazards	Approved source, inspect fish seed for disease	Meet national guidelines for transfer, stock fish seed only form certified sources, fry free from diseases and parasites	All see procedures certified, fry inspected before transfer	Infected and affected batch quarantined
Feed	Physical, biological and chemical contaminants, uncontrolled use of veterinary drugs	Procure feeds from reputable suppliers, proper feed storage, Selection of components of feeds prepared on-farm, supervised use of veterinary drugs according to manufacturer's guidelines	National and international guidelines, quantities used according to manufacturer's codes or regulatory limits	Certificates of quality from manufacturers, laboratory testing, supervision of quantities used, withdrawal periods observed	Reject un-certified feed, isolate batches of fish, extend purification periods
Production/grow-out	Agro-chemical residues, veterinary drugs, food borne pathogens	Use only approved chemicals, use according to manufacturers' instructions, Prevent contamination of farms	Follow limits recommended in international cods of practice and national regulations	Supervision of type and use of agrochemicals and veterinary drugs, monitoring treatments times and conditions, observance of withdrawal periods, preventing animals and humans from trespassing on the farm	Isolate contaminated batches of fish where unapproved chemicals have been used or drugs misused; extend depuration times, construct fences around the farm and restrict entry of animals and un-authorized persons
Fertilizers	Parasites, bacteria, agro-chemical and veterinary drug residues	Do not use manure from animals under treatment, use manures and fertilizers obtained from reputable sources	No parasites in manure, Only manure from animals not treated with drugs used, Only fertilizers from reputable source used	Inspect manure for parasites, establish the history of animals from which fertilizer is used	Suspend application of organic manure

Harvesting	No hazard	NA	NA	NA	NA
Post-harvest handling and processing	Biological, chemical and physical contamination	use cold storage, use approved water and ice, use clean and disinfected fish contact surfaces, protect processing and storage areas for pests and dust	Keep fish at temperature (<4 ^{o}C), use international standards for water (portable water), Microbiological quality of food surface (TPC = 10^{-2})	Monitor temperature, test food surfaces, monitor quality of water and ice used	Change ice and water, clean fish and fish holding containers
Transportation	Biological contamination	use cold storage, use approved water and ice, use clean and disinfected fish contact surfaces, protect processing and storage areas for pests and dust	Keep fish at temperature (<4^{o}C), use international standards for water (portable water), Microbiological quality of food surface (TPC = 10^{-2})	Monitor temperature, test food surfaces, monitor quality of water and ice used	Change ice and water, clean fish and fish holding containers
Marketing	Biological contamination	use cold storage, use approved water and ice, use clean and disinfected fish contact surfaces, protect processing and storage areas for pests and dust	Keep fish at temperature (<4^{o}C), use international standards for water (portable water), Microbiological quality of food surface (TPC = 10^{-2})	Monitor temperature, test food surfaces, monitor quality of water and ice used	Change ice and water, clean fish and fish holding containers

The pathogens isolated from Ugandan aquaculture likely to affect food- safety are also listed in table 12 above.

3.2.3. Surveillance Objectives

The expected outcomes from surveillance are a reduction in the risks of exposure, infection and transmission of listed pathogens to prevent the occurrence and minimise the negative impacts arising from the presence of a disease.

3.2.4. OIE Notifiable Diseases

The following factors were considered when determining the surveillance objective:

(i) Species affected
(ii) Susceptibility of wild populations
(iii) Presence in country
(iv) Presence in neighbouring country, trading partner and shared water body
(v) Risk of transmission
(vi) Likely impact on access to markets for Ugandan fish farmers
(vii) On-going surveillance
(viii) National diagnostic capacity (table 7 above) .

See also figures 16 and 17 below that illustrate the high risk areas for EUS and TiLV.

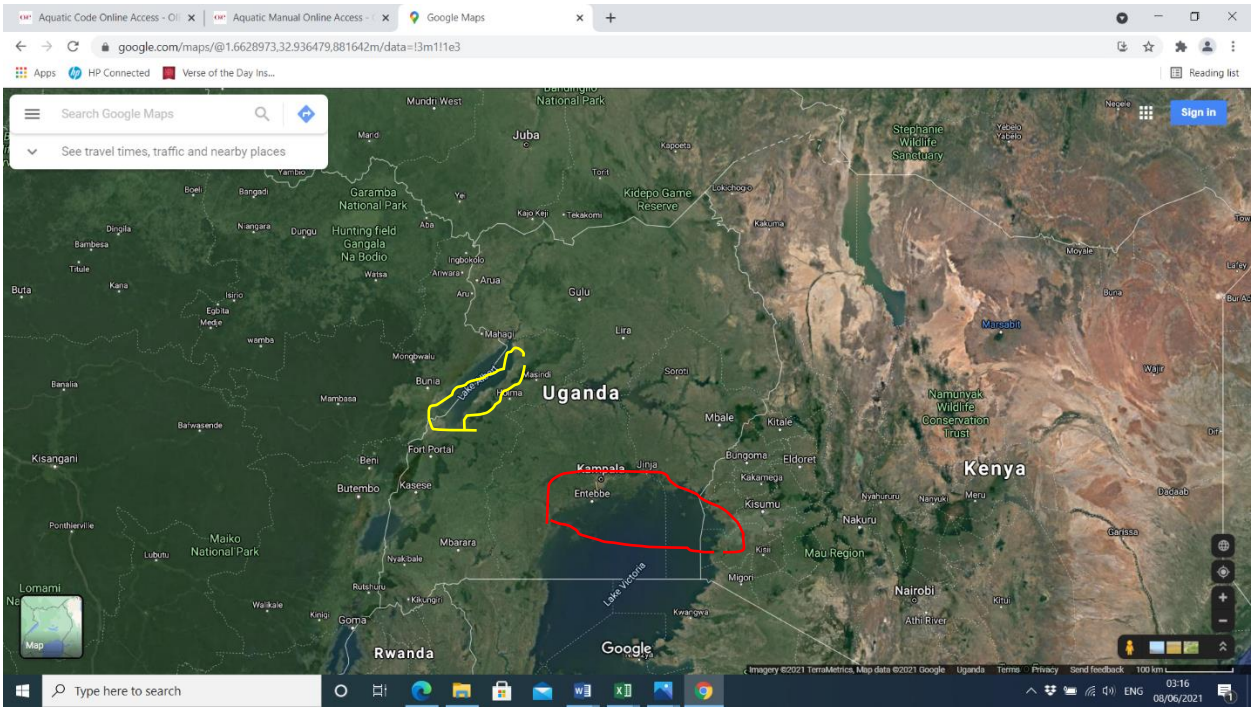


Figure 16. Major Cage culture growing areas relative to areas risk of EUS (yellow circle) and TiLV (red circle) *i.e. locations/neighbouring country where disease has been reported.*

**When you refer to zonation map above, you also find that most of the catfish farming is done in the Northern & North western parts of the country and tilapia farming (including in ponds) in the southern parts. Most tilapia and catfish hatcheries supplying fingerlings across the country and for regional trade*

are located in the southern part of the country. Another risk factor for EUS not mentioned is that African catfish is also farmed for bait used in the Nile perch fishery within Lake Victoria and sometimes L. Albert too.

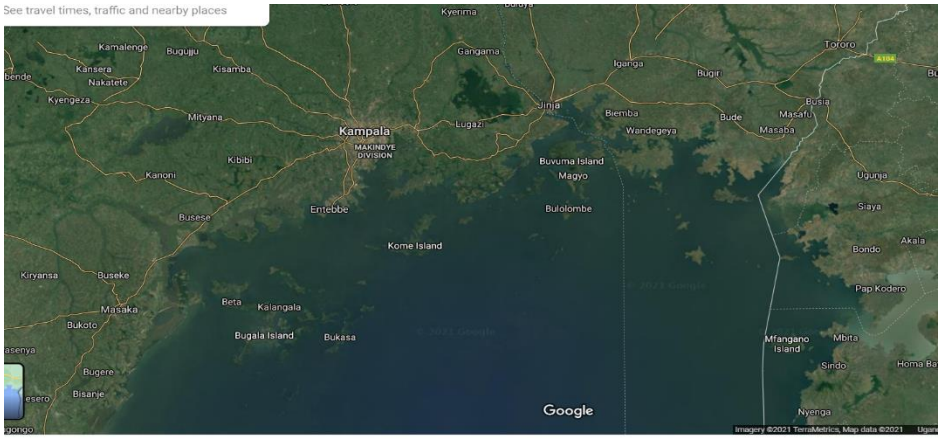


Figure 17. Larger magnification just to show Busia along border. *The bay right next to the border on the Kenyan side has commercial cage culture where similar endemic diseases and same notifiable risks occur as Uganda. This water drains through a river by the border into Uganda where some fish farms are located and of course via lake Victoria to River Nile – hence water movement into Uganda's major tilapia cage culture growing areas*

Therefore the surveillance objectives for the listed aquatic animal notifiable disease are summarised in table 11 below.

Table 11 Surveillance objectives for the Prioritised Notifiable Diseases

Disease or Pathogen	Surveillance Objective(s)
Epizootic ulcerative syndrome (EUS) Fungus *Aphanomyces invadans*	• Prevent entry and spread across country from DRC • Establish measures to contain potential spread from high risk areas through zonation. Zone off high risk areas along DRC border and create buffer zone. L. Albert zoned to safeguard cage-culture on lake; • Compartmentalize aquaculture production areas in N. West Uganda that trade aquaculture fingerlings and other products • Establish country/zonal sanitary status for purposes of regional and international trade • Establishment of early warning system
Koi Herpes Virus (KHV)	• Prevent entry and the establishment of the disease in the country • Develop contingency plans for control &/or eradication in the event of an outbreak

Disease or Pathogen	Surveillance Objective(s)
Infectious spleen and kidney necrosis virus (ISKNV)	• Prevent entry and the establishment of the disease in the country • Protect the aquaculture industry and wild fish populations • Develop contingency plans for control &/or eradication in the event of an outbreak
Tilapia Lake Virus (TiLV)	• Prevent entry and spread across country from Lake Victoria basing • Establish measures to contain potential spread from high risk areas through zonation. Zone off high risk areas Lake Victoria and create buffer zone. Safeguard cage-culture on lake; wild populations and industry in region. • Compartmentalize aquaculture production areas, including tilapia hatcheries located in region to minimize dissemination from these facilities to other parts of the country and region • Establish country/zonal sanitary status for purposes of regional and international trade • Establishment of early warning system • Develop contingency plans for control &/or eradication in the event of an outbreak
Infectious Haematopeotic Necrosis (IHN)	• Prevent entry and the establishment of the disease in the country • Develop contingency measure for control &/or eradication in the event of an outbreak
Viral Haemorrahgic Scepticiemia (VHS)	• Prevent entry and the establishment of the disease in the country • Develop contingency plans for control &/or eradication in the event of an outbreak
Spring Viraemia of Carp Virus (SVCV)	• Prevent entry and the establishment of the disease in the country • Develop contingency plans for control &/or eradication in the event of an outbreak

3.2.5. Non-listed pathogens

Most of these are non-obligatory pathogens that are endemic and can be controlled by adopting Good Aquaculture Management practices.

Objectives for surveillance (level depending on specific pathogen) will be to:

(i) Minimise susceptibility to infection and spread within farm and to other farms (e.g. from hatcheries) in order to safeguard the productivity and profitability of fish farming.

(ii) Minimise infection and spread to wild fish populations within designated farming zones, fish marketing and processing areas.

(iii) Reduce the likelihood for infection and transmission for live fish and fish products during transit
(iv) Minimise the likelihood of occurrence of aquatic animal health disease of public health significance
(v) Promote animal welfare
(vi) Assess and mitigate against climate change impacts (aquaculture, fish health and environmental)

3.3. Step 3: Defining the Population

It is important to establish the appropriate population for surveillance (epidemiological unit) for the given surveillance objectives. This may be based on location, relevance to local and regional trade, susceptibility to infection (e.g. juveniles, vs. adults, species specificity, farmed vs. wild fish, indigenous vs. exotic species, presence of reservoirs, vectors, etc.).

Once the population has been defined, it becomes possible to ascertain the sample size that will give the appropriate confidence interval and design the survey.

3.4. Step 4: Clustering Disease

When a disease incident occurs, it usually happens within a confined area and rather than uniformly across an entire farm to geographical local. This in part may due to environmental conditions in that locality that might have favored disease spread such as temperature. Thus clustering is also related space and time when planning of surveillance activities. Additional factors that influence clustering include the pathogens' attributes that affect its infectivity, the food-safety concerns and certification requirements associated with the presence of a disease that may hinder market access and result in negative environmental impacts. Therefore transboundary aquatic animal diseases (TAADS) (most are also OIE notifiable diseases) tend to be clustered by region (, country or zones.

The clustering of endemic (managemental) diseases on the other hand, would more appropriately be done based on:

(i) the production system and socio-economic impacts, and
(ii) Zones based on the interaction between the country's agro-ecological zones, water management zones and trans-boundary water catchment management.

Clustering influences the design and statistical analysis of data collected in surveys, in this case MCS.

3.5. Step 5: Case Definition

Once a disease case is clearly defined, diagnosis becomes more objective which improves accuracy, repeatability, specificity and depending on the diagnostic tests available, the level of sensitivity and epidemiological analysis. The actual status and impacts of aquatic animal diseases in Uganda has yet to be ascertained.

(a) Farm Level

The levels of awareness on aquatic animal disease and on how specific diseases manifest in production is generally low. Most small and medium scale grow-out pond farmers have had not experienced overt disease on their farms first-hand. Commercial hatchery and cage-culture producers were more familiar with fish diseases.

In either case farmers detected based on symptoms and mortality. Table 12 below describes the observations farmers used to infer the presence disease. They could not tag specific disease conditions, to any of the symptoms they observed.

Table 12. Observations associate with fish disease by farmers

Observations	Examples	Production System
Changes in behavior	• Fish isolated	Catfish hatcheries
Changes in physical appearance	• fungal growth around eyes • wounds and/or patches on body • swollen bellies sometimes with signs of bleeding • spongy like growth on bruised parts of fish (usually observed after fish transfer)	Cages Cages, hatcheries Hatchery ponds Pond, tanks
Mortality patterns	• sudden large number of fish deaths	Cages, ponds, hatcheries
Changes in movement	• fish swimming on their side or upside down • suspended vertical position	Cages Catfish hatcheries
Reduced feeding	• Reduced feed intake	Cages, hatcheries
Environmental changes (weather)	• Kaliro and high waves	cages
Changes in water quality	• Reading from water quality kits, changes in temperature,	Cages, hatcheries
Parasites	• Parasites attached on body of fish or underneath scales • Parasites inside intestines	Ponds, cages Old silty ponds

According to farmers, fish abnormalities got noticed during fish handling, soon after transfer and in cages after storms and periods when the lake was rough.

Farmers and FO interviewed stated that unless mortalities were extremely high, incidences of diseases were not reported. When a case was reported, the FO would visit to assess the situation and advice the farmer. FO's linked most mortalities to poor water quality arising from poor management among pond cases farmers or as a sequel to stress after stocking in cages and ponds. Otherwise, local extension workers tended to be informed inadvertently. Farmers also obtained advice on disease from other farmers.

Farmers tended to diagnoseand treat themselves so cases usually remained unnoticed by District personnel. Large commercial farmers tended to seek help directly from DiFR, ARDC-Kajjansi or to CoVAB at Makerere University.

Some districts were part the on-going TiLV surveillance. According to farmers' and DFO, during surveillance, water quality and fish samples had been taken from farms but to-date, no findings had been communicated yet the districts or farmers involved on fish health status.

There was an Aquaculture Training Manual for Extension Agents in Uganda that provided simple tools to assess health status and symptoms of fish diseases commonly found in Uganda (MAAIF, 2020; Walakira

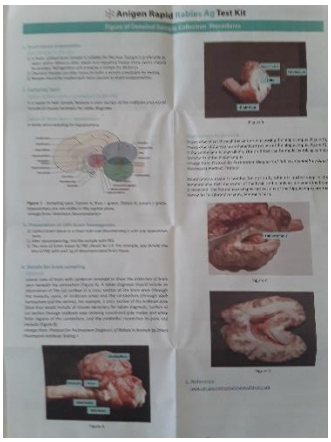
et al. 2014). However, there were no prescribed protocols for the detection of specific diseases on farm and not all extension workers or farmers had access to this information.

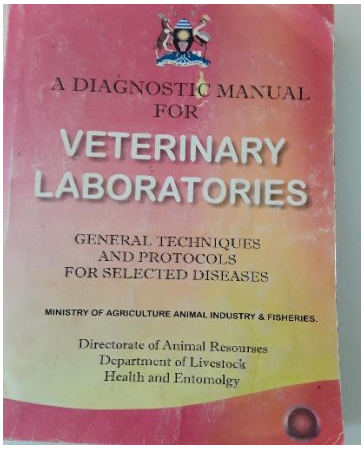
(b) Laboratory Level

At laboratory level diagnosis tended to be general. The case definition for parasitic diseases was better defined. The case definition for most non-parasitic infections in the country is not specifically defined. There was however, an on-going study at CoVAB that sought to link the production environment and symptoms observed to specific pathogen. Findings from such research will improve the specificity of presumptive diagnosis at Level I and Level II.

There are currently no comprehensive Standard Operating Procedures (SOPs) for the laboratory diagnosis of aquatic animal diseases in Uganda similar to those in the livestock sector (figure 18). Without clear laboratory diagnostic guidelines on case definition, laboratory standards cannot be maintained.

a) Pictorial posters targeting farmers and extension





b) Manuals for sample collection and laboratory diagnosis

Figure 18. Examples of tools used in the Veterinary Services to aide detection and diagnosis of diseases in the field and laboratory. *Simple tools like these would improve the capacity of farmers, extension workers and district veterinary laboratories to detect, identify and report aquatic animal diseases.*

(c) Research and Training

Steps are being taken to address the current situation. There is on-going research to improve aquatic animal disease diagnosis in the country (tables 13 and 14.)

Table 13. On-going Research in Aquatic Animal Disease Detection and Diagnosis at Makerere University

Titles	Related Output	Collaborating partners	Funder
Laboratory evaluation of selected phage isolates against prevalent fish bacterial pathogens for development of phage bio-control agents for use in aquaculture in Uganda. (SAFEFISH Project)	Three well characterized phage candidates against each genus, *Aeromonas* spp and *Edwardsiella* spp, for development of cocktails	CoVAB, ARDC	–AU/EU
Mitigating the effects of environmental pollution from aquaculture on Freshwater resources in Lake Victoria basin (MEEP).	Establish baseline water and sediment quality indicators, as well as identify indicator invertebrate species capable of reflecting the short and long term impacts, respectively of aquaculture facilities on freshwater resources	CoNAS, NEMA, NWSC.	MAK - RIF
Strengthening the capacity of small holder fish farmers and extension staff to mitigate the risk of fish diseases in Uganda	Fish disease training manual on detection, prevention and control of fish diseases. Four field trainings in 4 districts to increases farmers knowledge in the detection, prevention and control of fish diseases	CoVAB, ARDC	MAK - RIF
Assessment Of The Status Of Tilapia Lake Virus (TiLV) Infection In Uganda as a Pathway to Vaccine Development.	Awareness and laboratory equipment.		MAK-RIF
One Health approach for the control of fish diseases in Lake Victoria basin	Fish diseases of public importance determined. Environmental drivers for emergence of fish diseases established. Systems-specific management strategies to reduce exposure and spread of pathogens in aquaculture developed.	CoVAB	MAK-RIF
The Uganda National Action Plan on Tilapia Lake Virus Disease: Enhancing capacity/risk reduction of emerging Tilapia Lake Virus (TiLV) to African tilapia aquaculture	Awareness created and capacity built on management of TiLV disease. Infrastructure and human capacity (farmers, fisheries officials and Professionals of knowledge) to management disease built and strengthened. A surveillance system for TiLV established. Disease surveillance undertaken to guide science-based information for policy makers, farmers and professionals. Fish disease management/control programme for effective infection prevention and control developed. A contingency plan for aquatic animal health pathogens for effective infection prevention and control of emergences and re-emergences designed	CoNAS, ARDC	FAO/MAAIF

Table 14. Examples of Recent Local Publications on the Detection and Control of Fish Diseases Commonly Associated with Aquaculture in Uganda

Title of Publication	Author
Detection of tilapia lake virus (TiLV) infection by PCR in farmed and wild Nile tilapia (*Oreochromis niloticus*) from Lake Victoria	Mugimba *et al.,*2018
Multilocus sequence analysis revealed a high genotypic diversity of *Aeromonas hydrophila* infecting fish in Uganda	Wamala et al. 2018
Common fish diseases and parasites affecting wild and farmed Tilapia and catfish in Central and Western Uganda	Walakira et al., 2014
A review of phage mediated antibacterial applications	Ssekatawa K. et al, 2021
Tilapia lake virus downplays innate immune responses during early stage of infection in Nile tilapia (*Oreochromis niloticus*).	Mugimba K. K.et al.,
Gray (*Oreochromis niloticus* x O. aureus) and Red (*Oreochromis* spp.) Tilapia Show Equal Susceptibility and Proinflammatory Cytokine Responses to Experimental Tilapia Lake Virus Infection	Mugimba K. K.et al.,
Current advances on virus discovery and diagnostic role of viral metagenomics in aquatic organisms.	Munang'andu HM, et. al, 2017
Occurrence and antibiotic susceptibility of fish bacteria isolated from *Oreochromis niloticus* (Nile tilapia) and *Clarias gariepinus* (African catfish) in Uganda	Wamala, S.P., et al, 2018.
Molecular Characterization and Antibiotic Susceptibility of *Edwardsiella tarda* isolated from Farmed Nile Tilapia and African Catfish from Wakiso, Uganda	Nantongo M., 2019
Parasite fauna of farmed Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) in Uganda	Akoll P. , et. al, 2012
Infection patterns of Nile tilapia (*Oreochromis niloti*cus L.) by two helminth species with contrasting lifestyles.	Akoll, P. et. al., 2012
Prevalence of columnare disease, fungal infections, ecto-parasites and underlying factors in selected fish farms in Uganda	Tamale A., 2009
Isolation and identification of potential probiotic bacteria on surfaces of *Oreochromis niloticus* and *Clarias gariepinus* from around Kampala, Uganda	Kato C. D., 2016
Antimicrobial resistance of Escherichia coli found in the intestinal tract of *Oreochromis niloticus*.	Kikomeko H., 2016
Identification and characterization of *Flavobacteriaceae* sp. from farmed Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarius gariepinus*) in Uganda	Amono R., 2017
Fish as bio-indicators in aquatic environmental pollution assessment: a case study in Lake Victoria wetlands, Uganda.	Naigaga, et al, 2011.

3.6. Step 6: Diagnostic Testing

3.6.1. Farm Level

Level I diagnosis, based on the observations made by farmers, extension workers or community on changes in fish behaviour, mortality and changes in the physical appearance constitute the indicators currently used in the field to assess fish health status. Disease diagnosis and management at this level was associated with history, previous experiences on the farm or other farms and symptoms. Most cases were not reported to the FO unless mortalities were high. Under such circumstances, the farmer or FO would seek additional advice from other farmers, FO via social media, the internet or ARDC, MAK or DiFR.

The majority of FO interviewed did not have water quality testing equipment, a situation that occurs in most districts of the country. So, much as FO often cited stress arising from poor water quality as a factor in the occurrence of diseases on-farm, they could not confirm that this was actually the case. The majority of smallholder farmers could not afford the cost of submitting samples for laboratory diagnosis to ARDC or MAK. Reports made on fish diseases at District Level were consequently described based on symptoms associated with stress or poor water quality as possible causes of disease as confirmatory diagnosis was out of reach. The larger farmers and fish hatcheries could afford to submit samples to CoVAB or ARDC in Kampala for confirmatory laboratory diagnosis.

3.6.2. Status of Laboratories and Laboratory Diagnosis

3.6.2.1. Description of the National Animal Health Laboratory Services

Uganda's public veterinary laboratory system falls under the Veterinary Diagnostics and Epidemiology Division of the Directorate of Animal Health. The core functions of this division are:

i. Review, update, formulate and implement policies, plans and strategies for veterinary diagnostics and epidemiology
ii. Conduct and disseminate information on field and laboratory investigations of animal diseases and vector outbreaks
iii. Monitor outbreaks and prevalence of animal diseases and vectors in the country including neighboring countries
iv. Conduct surveillance and prompt collection, collation and dissemination of epidemiological data
v. Map out disease occurrence and prevalence in the country
vi. Collaborate with research and other organizations nationally, regionally and internationally on diagnosis and surveillance for animal diseases and vectors.

The national veterinary laboratories that comprise the district and regional veterinary (animal health laboratories) fall within this department (see figure 19).

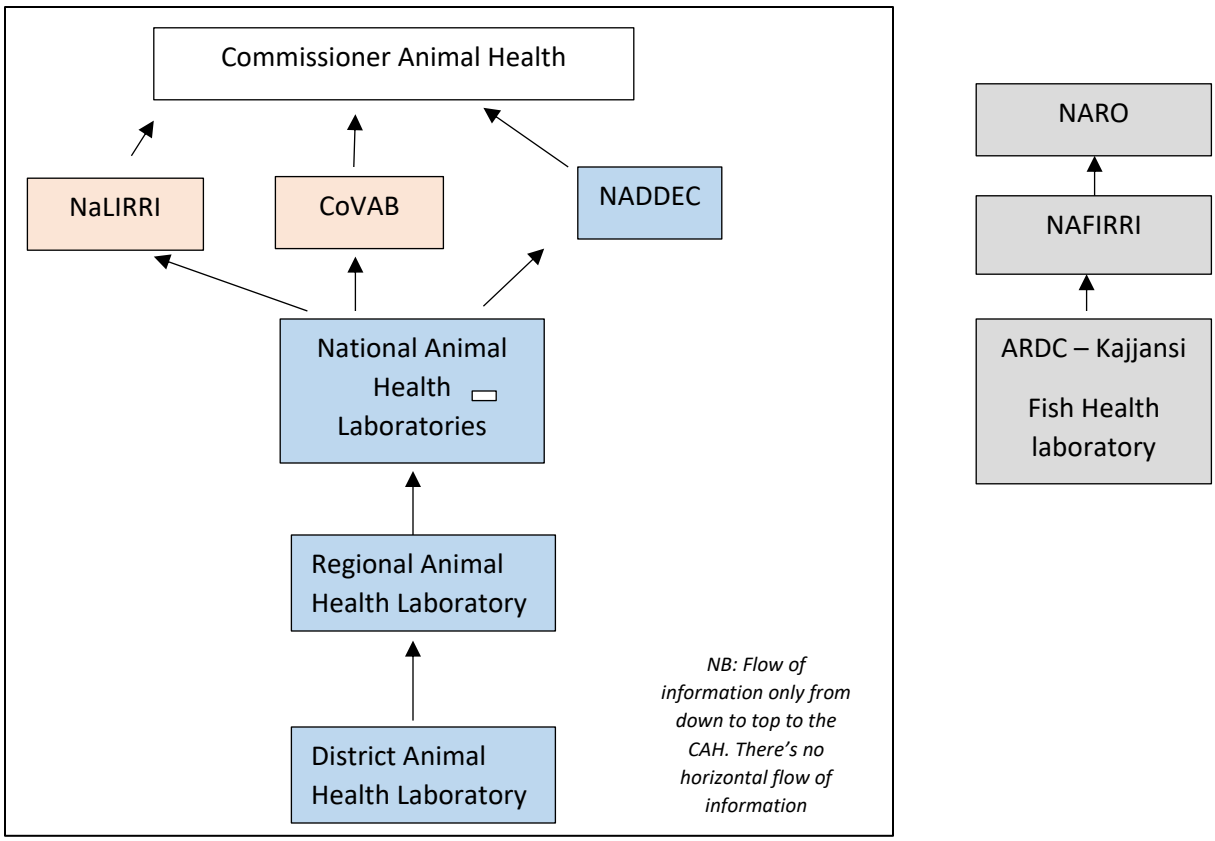


Figure 19. The National Animal Health Laboratory Referral System
(Blue denotes National Veterinary Diagnostic services, Pink – National Research and Training Animal Health Laboratories, Gray – Fish Health Laboratory ARDC-Kajjansi)

The principal role of the district, regional and national laboratory at NADDEC is to diagnose, monitor and control diseases. They form a key component for the early recognition of diseases irrespective of whether they are endemic or notifiable; and serve an important function in MCS. The Central Diagnostic Laboratory located within CoVAB is part of the national veterinary diagnostic services. Theresearch and training laboratories at CoVAB and NALIRRI are not directly linked to the national veterinary diagnostic services. Their principle function is to generate diagnostic and disease control tools, knowledge and support of the national veterinary diagnostic services. The national veterinary diagnostic services also collaborates with the Government Chemist for residual monitoring of pollutants and toxins, and audits. Similar collaborative arrangements existed with the National Virus Research Institute (NVRI), Chemiphar and the Ministry of Health (MOH) for specialist support.

The national Fish Health Laboratory at ARDC – Kajjansi is not integrated officially into the network of national veterinary diagnostic services.

(a) Profile of the AHL visited in the study

A total of 22 laboratories were visited as illustrated in the Figure 12 below. Three of these, were newly constructed One-Stop Border agricultural laboratories that have been established as part of the EAC Protocol on Sanitary and Phytosanitary (SPS) Measures to facilitate safe and efficient regional agricultural

trade. The One-Stop Border agricultural laboratories have not yet been equipped and fall under Uganda Revenue Authority's (URA) Customs & Excise department.

The rest of the AHL were all public laboratories except for the Central Diagnostic Laboratory located at CoVAB that is operated as a Public-Private-Partnership. The range of diagnostic services currently given by these laboratories is illustrated in figure 20 below.

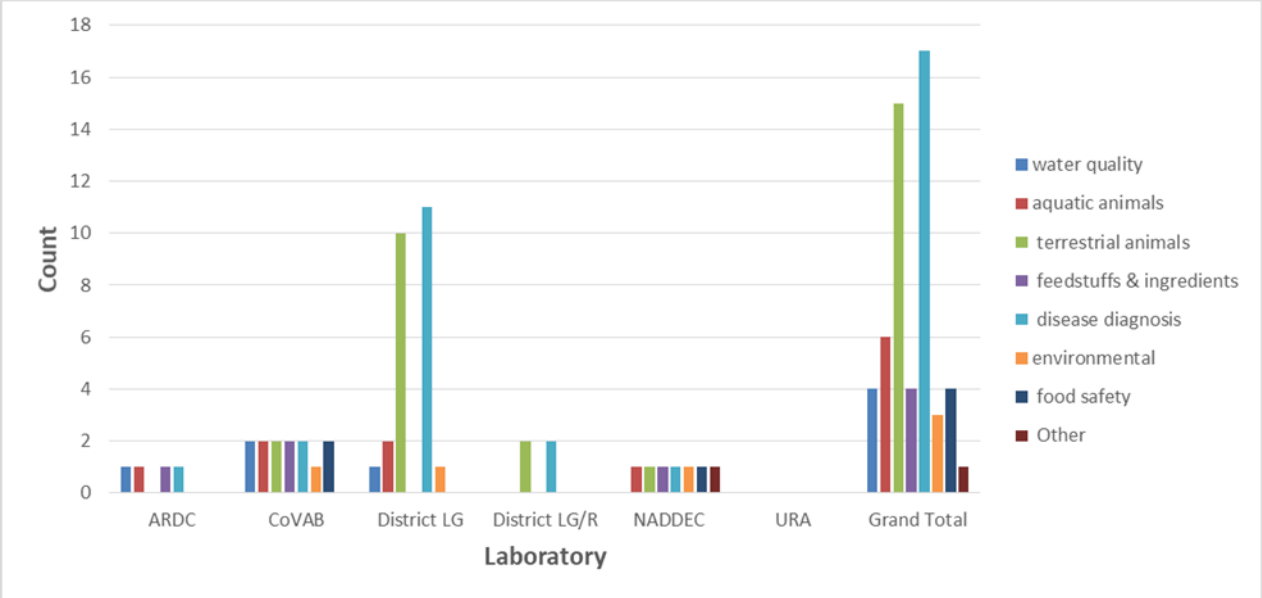


Figure 20. Laboratory diagnostic services offered by the different laboratories visited.

(b) Accountability and Oversight

Where there was a district AHL, the respective District Veterinary Officer (DVO) was accountable and provided oversight for the quality and delivery of diagnostic services as bio-containment, biosecurity, biosafety and animal welfare associated with the operations laboratories. The DVO was responsible for developing strategic and implementation plans and budgets for the laboratory (and animal sector) and collating data to facilitate the monitoring, surveillance and control of animal diseases in the district (MPS, 2011). The DVO was the single authority responsible for the AHL, deputised by a veterinary officer (VO) or laboratory technician depending on the human resources available within his department. This was in line with the recommendations of the OIE on management of veterinary laboratories and core functions of the national veterinary diagnostic services (OIE, 2019).

At ARDC, the Research Officer in-Charge of Fish Health, oversaw the management and operations of the laboratory. The principle objective of the laboratory was research.

3.6.2.2. Infrastructure

(a) Buildings

Of AHL visited, only CoVAB and ARDC had live fish holding systems that were used mainly for research in fish health. According to the EAC SPS protocol, the One-Stop border posts are expected to have infrastructure for temporarily holding both live fish, fish feeds and other fish products for inspection as well as quarantine facilities for live animals, fish inclusive. However, in the design, these features were

not taken into account. Consequently, the One-Stop border agricultural laboratory facilities visited did not have a gazetted area for establishing a quarantine.

The infrastructure among the District AHL varied tremendously from good to inadequate. Some of these laboratories were adequately equipped and had the capacity to deliver basic Level II laboratory diagnosis: notably clinical diagnosis, post-mortems, parasitology, hematology, and collection and submission of samples to referral AHL. Some district AHL could also do basic bacteriology and mycology. Where applicable, some diagnosis was done using serological test kits. Thus, irrespective of the status of the laboratory, most had at least a cool-boxes for cold-chain transportation and at least one functional 4^{o}C fridge for storage of vaccines, reagents and/or samples (figures 21). Similar observations have been made from other assessments on the status of veterinary laboratory services in Uganda (Nakayima J. *et al*., 2016 and NABC, 2011). The findings from these studies prompted the establishment of Regional AHL to build capacity within each Uganda's six regions for animal health surveillance and animal disease diagnostics.

The Regional AHL meet the basic infrastructural standards for veterinary laboratories are equipped to handle Level II laboratory diagnosis following the guidelines for National veterinary laboratory diagnosis (see figure 22 and 23).

A new building is under construction at ARDC for the fish health laboratory. The current laboratory that have a wet lab and diagnostic room shall move into the new unit.

(b)Electricity Supply

A consistent and adequate supply of electricity and water to the laboratory is essential to run the laboratory equipment, process samples and conduct tests. Interruptions affect the ability to conduct tests and the quality of results obtained.

The status of electrical supply to most AHL was generally considered good. However, some of the district AHL districts visited had fair to poor electricity supply (figure 26). Not all district AHL had alternative sources of power for back-up, and even where back-up generators had been installed, they did not have a budget set aside to fuel to the generators when need arose. Section 2.2. of the laboratory assessment questionnaire attached in Appendix 3, provides more details on the criteria used to assess the status of electricity supply to the AHL.

(c)Water supply and laboratory Grade Water

The status of volume and quality of water supplied to the AHL varied. Most were connected to portable water supplied by the National Water & Sewerage Cooperation (NWSC). In areas where supply was not consistent alternative water sources were harnessed to supplement NWSC or opted for where they guaranteed a more consistent supply, such as the sinking of a shallow borehole to specifically supply the Fish Health laboratory at ARDC. Rainwater harvested from roof-tops stored in tanks was another source of water for district AHL not linked to main district water supply or as a back-up source up-country. Otherwise water was fetched from local public boreholes or purchased in jerry-cans for use in the laboratory from water sellers.

The District AHL and ARDC relied on water from these various sources for their laboratory work. If laboratory grade water was required, the District AHL purchased deionised water from local petrol stations (figure 24 and 25).

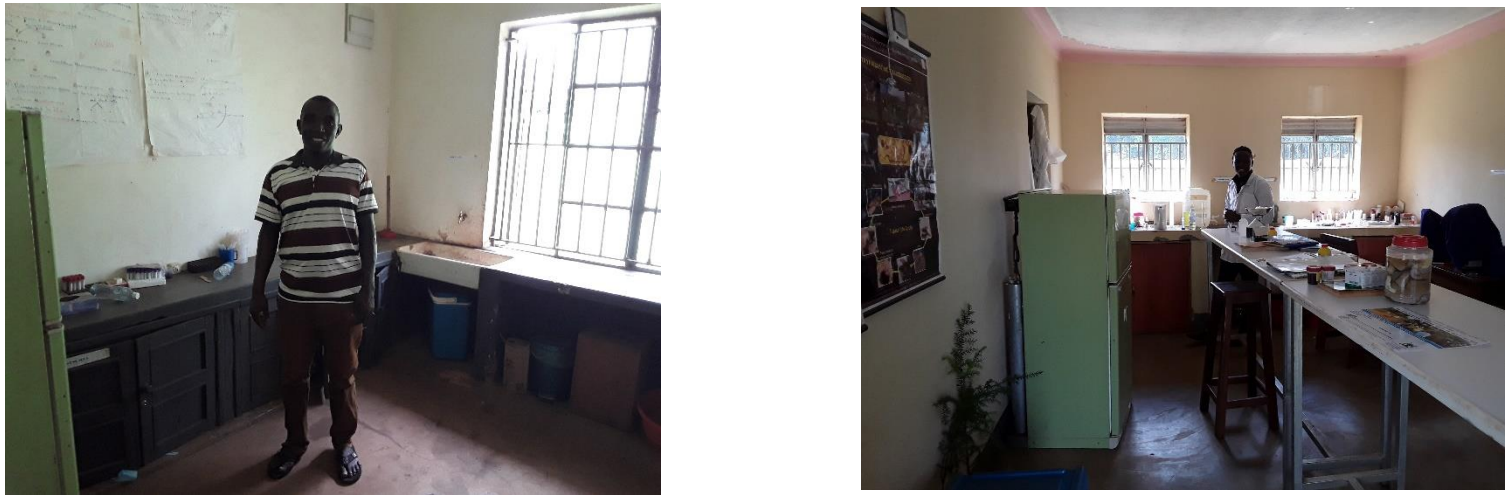


Figure 21. Difference in status of infrastructure and laboratory equipment available at District Veterinary Laboratory. *In the former case therefore, other than postmortems, further diagnosis is referred to the Regional Veterinary Laboratory.*

Figure 22. Snapshot of Mbarara Regional Veterinary Laboratory. *All the six Regional Veterinary Laboratories in the country are similarly equipped.*

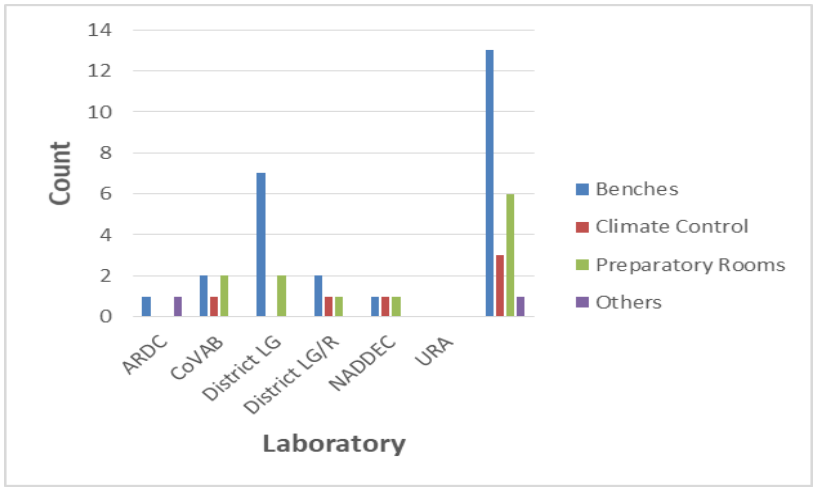


Figure 23. Examples of Laboratory Set-up

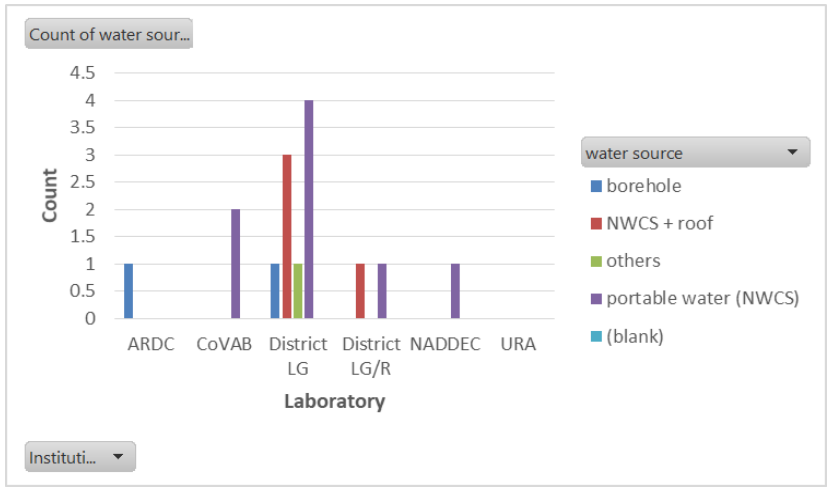


Figure 24. Sources of Water

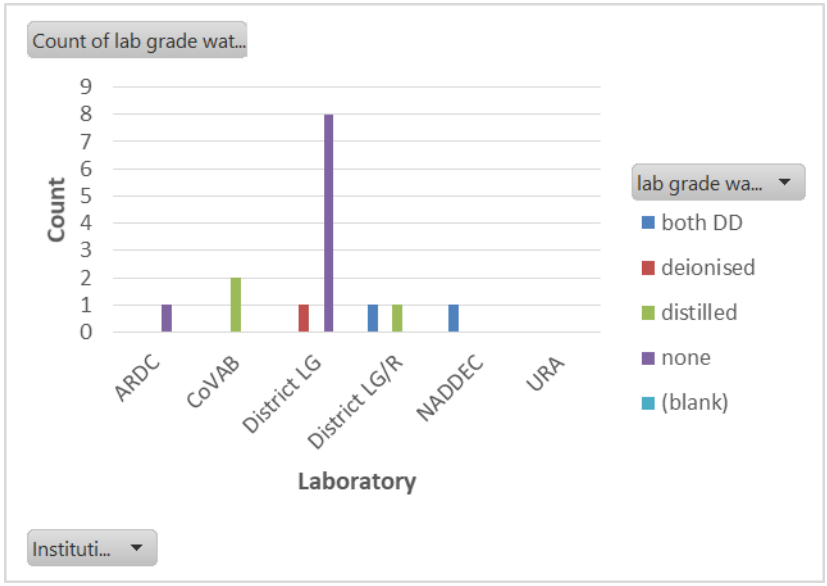


Figure 25. Ability to Produce Laboratory Grade Water

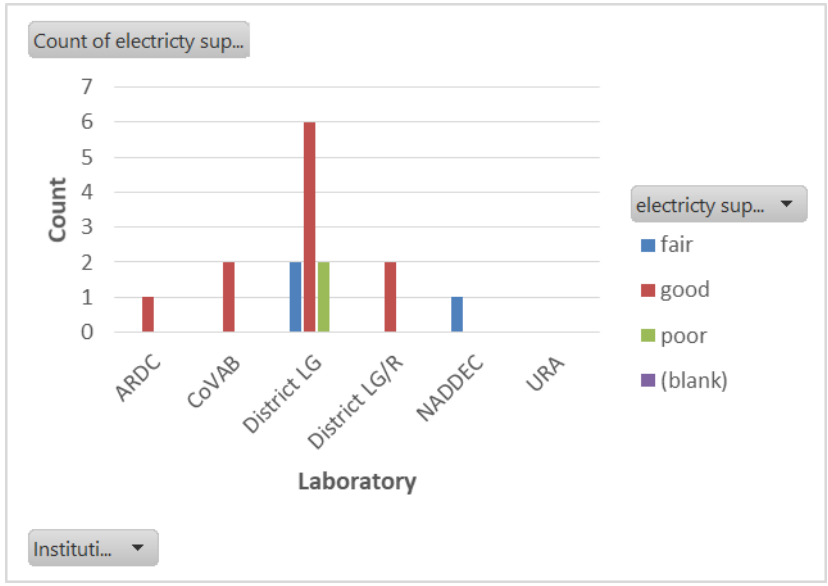


Figure 26. Status of Electricity Supply

(d) Climate Control

The status of climate control to ensure samples, reagents and tests were stored/conducted at optimum temperature varied among laboratories. Each of the AHL had at least a cool-box that was used to transport samples and vaccines. Fridge's (4^{o}C) were also present, though in some laboratories not all the fridges they had were functional. This sometimes resulted in an overload of storage space depending on the number of disease incidents. Such situations affected compliance to national AHL Standard Operating Procedures (SOPs) for biosafety and the prevention of cross-contamination in laboratories with only one functional fridge (table 15).

The cold storage equipment at the national laboratories were adequate for the storage of biological materials and reagents for level III diagnostics and research. NADDEC had -100 ^{o}C (dry ice) for cryopreservation which also supported its role in the shipment of laboratory samples to international AH reference laboratories. Some of the laboratories at CoVAB and NADDEC were furnished with AC units. With this capability, CoVAB and NADDEC maintain pathogen banks given their respective mandates covering epidemiology, diagnostics and research.

Table 15. Cold Storage Status of Animal Health Laboratories

Laboratory	Temperature Range				
	4-8 ^{o}C	**-20/-40 ^{o}C**	**-80 ^{o}C**	**-100 ^{o}C**	**cool boxes ice packs**
ARDC	yes	yes	none	none	yes
CoVAB	yes	yes	yes	none	yes
District LG	- 2/13 had none	- 9/13 had none - 3/13 not functional, - 1/13 had a functional	none	none	- 1/13 had none
District LG/R	- All had fridges. - However some among these not function which was a constraint	none	none	none	yes
NADDEC	yes	yes	yes	yes	yes
URA	N/A	N/A	N/A	N/A	N/A

(e) Laboratory Diagnostic Capabilities

Standard light microscopes and dissecting kits at the minimum were available in most of the AHL (see figure 21 and 22; and table 16).

Table 16. Laboratory Diagnostic Capacity for Notifiable and non- Notifiable Aquatic Animal Diseases

Laboratory Categ	Gross Signs	Light microscopy	histopathology	Isolation in tissue cultur	Antibody-based virus detection assays	*In situ*DNA probes	RT-PCR	Conventional PCR	Sequence analysis	Antibody detection assays (serology)	Transmission EM	IFAT	Biassays (viral isolation	OIE/ISO 17025	ISO: 35001	Accreditation*
Farm Level	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
District Veterinary Laboratories	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	**N (±)**
ARDC - Kajjansi	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Regional Animal h laboratories	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	**N**
CoVAB	+	+	+	+	-	-	+	+	-	+	-	+	-	-	-	**I**
CDL	+	+	+	+	+	+	+	+	+	+	-	+	+	+?	-	**I**
NADDEC	+	+	+	+	+?	-	+	+	+	+	-?	+	+	+	+	**I**

Notes: *Accreditation** ***N -*** national standards based on MAAIF guidelines given the Diagnostic Manual for Veterinary Laboratories in Uganda; ***N(±) –*** some of the laboratories apply these standards, others none; ***I –*** have started implementing measures to obtain accreditation internationally

3.6.2.3. Human Resources

The national, regional and district veterinary laboratory are supervised by a veterinary surgeon. Table 19 summarises the staffing in the AHL visited.

(a) Staffing

Table 17 broadly describes the staffing at AHL.

Table 17. Staffing in Animal Health Laboratories

	Head/In-charge of laboratory	**Laboratory Manager**	**Laboratory Technician**	**Quality Assurance Manager**	**Non-technical Staff**	**Students/Interns**	**Administrator**
ARDC	+	-	+	-	+	-	-
CoVAB	+	+	+	+	+	+	-
District LG	+	±	±	-	+	+	-
District LG/R	+	+	+	-	+	+	-
NADDEC	+	+	+	+	+	+	+
URA	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The national veterinary diagnostic laboratories were all headed by a qualified veterinarian as stipulated by the OIE General Standards on the Management of Veterinary Diagnostic Laboratories (OIE, 2019). The District Veterinary Officers (DVO's) were in-charge of both the district and regional AHL. At ARDC, the person designated to be in-charge of the Fish Health Laboratory is the Research Officer (RO) leading the aquatic animal health research program (AAH) who is required to have a minimum of an undergraduate

degree in any of the related relevant sciences. The currents status quo is that at district level some of the DVO's additionally have post-graduate veterinary training, the RO at ARDC has a MSc. major in Aquatic Animal Health, and CoVAB and NADDEC laboratories are headed by veterinarians with PhDs in the respective fields.

CoVAB, NADDEC and the regional AHL have laboratory managers who may be veterinarians and/or laboratory technicians with additional training and experience in the various fields of veterinary diagnostics and laboratory management. In the case of the former, these may have up to PhD. In some districts, the DVO has assigned a VO to manage the laboratory under their supervision.

The qualifications of laboratory technicians within the national veterinary diagnostic laboratories were either a:

(i) Diploma at the minimum from either the Mbale School of Clinical Officer's or a diploma in Science Laboratory Technology from Mbarara University of Science & Technology

(ii) Bachelor's degree in Medical laboratory Science from Mbarara University of Science & Technology or a Bachelor of Biomedical Laboratory Technology (BLT) from CoVAB.

These laboratory courses at Mbale and Mbarara meet the diagnostic needs for the medical sciences and laboratory management. It was, only BLT that additionally covered veterinary and plant diagnostics. Thus, laboratory technicians recruited from the medical schools, required additional in-house by the DVO/VO on the diagnosis of animal diseases. None of the above courses currently exposed students to diagnostic laboratory protocols for aquatic animal diseases.

At ARDC, the laboratory technicians may have a diploma or degree in Fisheries & Aquaculture or any other related field.

CoVAB, the district and regional AHL and NADDEC regularly had students and/or interns working within their laboratories. These included local and sometimes international students undertaking their field research in any of animal science fields and/or laboratory management.

The laboratories at CoVAB and NADDEC had Quality Assurance managers with under-graduate training at the minimum in laboratory bio-technology.

It is envisaged that the One-Stop Border agricultural laboratory will be used to support the inspection and verification of live fish and other fish products in transit by a Fisheries Inspector from MAAIF. DiFR is in the process of recruiting additional Fisheries Inspectors to man the border posts. The current situation is that there is one Fisheries Inspector per region who cannot be at each of the Ports of Entry simultaneously. Thus when fish crosses into or out of the country, the agricultural or veterinary border inspectors infrequently have to fill in.

(b) Staff Training

There is a system in place whereby newly recruited district veterinary laboratory technicians as well as those who have been in services for a while, become attached to the regional AHL and NADDEC for a least month in each case for in-service training/refresher on diagnostic SOPs and in the event of up-dates. Similarly whenever new diagnostic tools are to be introduced (including at CoVAB and NADDEC), staff were trained prior. CoVAB also provides tailored practical training upon request for the District AHL technicians and ARDC Fish Health personnel.

The laboratory technicians and their managers in all the AHL reiterated the gap and need for short in-service practical skill-based training and laboratory manuals in aquatic animal disease diagnostics to enable them to provide appropriate services to fish farmers in their districts.

3.6.2.4. Biosecurity, Biosafety and Health and Safety

Personnel had basic protective wear for working in the laboratory and when collecting samples in the field.

CoVAB and NADDEC have laboratories that meet Bio safety Level 2 (BSL) and have in place the appropriate infrastructure and SOPs including for disposing of infectious liquid and solid waste. Infectious waste was sterilised by autoclaving and/or chlorinating the waste in the case of liquid waste. Both facilities have incinerators for disposal of solid waste. NADDEC additionally has a BSL 3 facility. NADDEC follows the National standards and ISO 35001 for waste disposal. It has a double chamber incinerator, hence can contain highly infectious waste. Both CoVAB and NADDEC facilities have biosafety cabinets (up to Class II) in the designated laboratories. The cabinets are serviced by biomedical engineers from the Ministry of Health (MOH). Despite having a Class II biosafety cabinet, CDL does not handle zoonotic diseases because the laboratory is also principally a facility for training undergraduate students. To ensure student safety for zoonotic diseases, CDL would require a biosafety cabinet of Class III. Zoonotic disease diagnostics are therefore referred to non-teaching laboratories at NADDEC and Ministry of Health. Table 18 describes the BSL levels.

The district, regional AHL and ARDC AHL meet BSL 1. The methods used by the district and regional AHL to dispose of liquid and solid laboratory waste varied. None of these facilities had incinerators. Solid infectious waste was either buried with/without lime, burnt in a pit and in some instances buried thereafter or outsourced from local companies that disposed of hospital waste. Liquid waste was autoclaved or chlorinated prior to being poured out into drain and/or poured down deep pit specifically dug for such purposes.

At ARDC laboratory waste was disposed of in the bins and liquids poured down the sink.

Table 18. Level of Bio-security and Biosafety Laboratory (BSL) and Guidance Notes to Coloration of Tables 17, 24, 25, 26 and 27

	Agents	Practices
BSL 1	• Not known to consistently cause disease in health adults	• Standard microbiological practices
BSL 2	• Agents associated with human disease • Routes of transmission include percutaneou injury, ingestion, mucous membrane expos	BSL 1 practice plus • Limited access • Biohazard warnings • Sharps precautions • Biosafety manual
BSL 3	• Indigenous or exotic agents that may cause serious or potentially lethal disease through inhalation route	BSL 2 practice plus • Controlled access • Decontamination of all waste • Decontamination of laboratory clothing before launderin
BSL 4	• Dangerous/exotic agents with high risk of aerosol transmitted infections that are frequently fatal and there are no vaccines o treatments	BSL 3 practice plus • Clothing change before entering • Shower on exit • All material decontaminated on exit from facility

3.6.2.5. Quality Assurance

The overall objective of quality assurance in animal disease diagnostic laboratories is to ensure that the diagnostic processes, thus results are robust, reliable and repeatable.

Each of the laboratories, except CDL and the regional laboratories that were part of NADDEC system used different independently developed laboratory forms and report formats.

The district AHL on the whole followed the national guidelines for the diagnosis of animal diseases, with some adaptations depending on the status of laboratory equipment and supplies. The regional AHL strictly followed the protocols stipulated by NADDEC. CoVAB and NADDEC have systems in place for proficiency testing that include their pathogen banks and epidemiological capacity.

ARDC referred to general aquatic animal diagnostic guidelines given in reference books and obtained technical support for their application (i.e. training, laboratory diagnoses) from CoVAB.

A common challenge for BSL 1 laboratories was regular servicing of equipment and calibration. They therefore relied a lot on the regional AHL, CoVAB and NADDEC to verify results and for diagnostic support. The laboratories at CoVAB involved in aquatic animal disease diagnostics as well as NADDEC have embarked on obtaining accreditation from the South African National Accreditation Scheme (SANAS) and the Infectious Disease Institute (IDI) respectively. NADDEC meets ISO 17025 standards.

3.6.2.6. Information Management, Communication and Reporting

None of the laboratories had centralised Laboratory Management Information System (LIMS) except NADDEC. NADDEC, the regional AHL and some of the district AHL had a computer(s) specifically designated to the laboratory solely for data storage and management of laboratory data. NADDEC used *'SILAB for Africa'* (SILABFA) for its LIMS.

Box 2. About SILABFA

SILABFA is a web application developed by FAO as laboratory information management system to support laboratory diagnostic activities and to meet the needs of various African countries. SILABFA is designed to collect and manage all necessary information on samples, tests, and test results. The system involves the entry of sample data on arrival, the tracking of samples through the various sections of the laboratory, and the collection of test results. It automates the generation of test reports and monitors outbreaks through data interrogation functions and eliminates multiple registrations of the same data on paper records. SILABFA has currently been installed in Namibia, Botswana, Zambia, Zimbabwe, Tanzania, Uganda, Kenya, Ethiopia, and Cameroon, and installation in Senegal and Ivory in on-going (Colangeli *et al.,* 2019)

Data was recorded in hard copy laboratory log or case books and/or the computers of individuals working in/managing the respective laboratories. In such cases therefore, there was no centralised retrieval system and a high likelihood for loss of historical data in the event of staff changes.

Laboratory results were communicated to clients in written hard copies. The formats of laboratory reports differed (figure 27). Emails, WhatsApp and mobile phone calls were used to alert clients that results were ready. The client either collected the report from the laboratory or the report was emailed as the case might be.

The district and regional AHL and CDL at CoVAB compiled their laboratory results monthly and relayed them through the DVO to NADDEC. ARDC and the research laboratories at CoVAB were not similarly obliged as their core function was research and training. ARDC Fish Health laboratory made and submitted regular reports as did the other research programs through the Head ARDC to the Director NaFIRRI. These were then compiled into the institute's report for submission to Director General NARO.

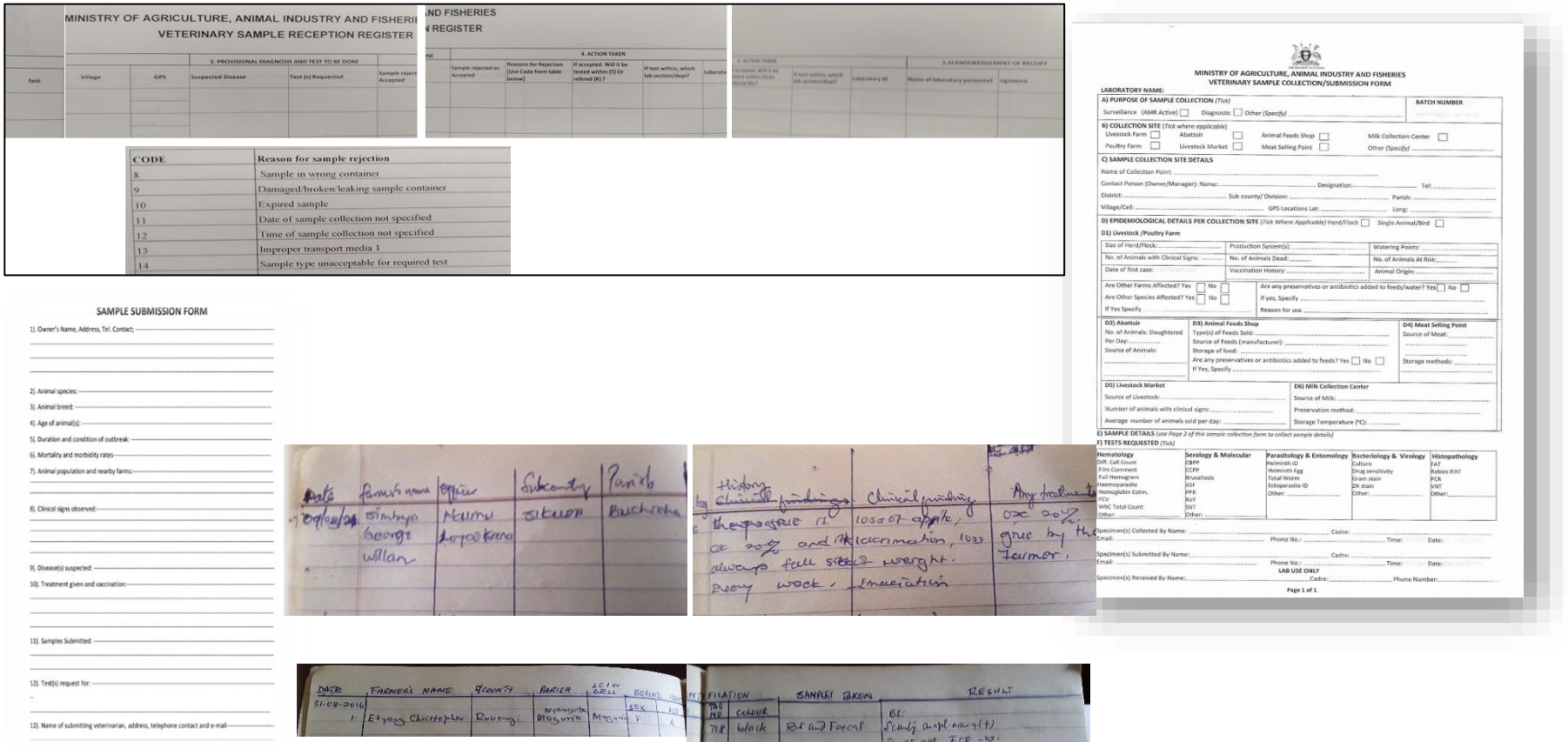


Figure 27. Examples of Laboratory Sample Collection Forms and Log Books. Printed with MAAIF logo are from NADDEC used by Regional AHL and some district AHL; counter books used in District Laboratories and printed form from District Laboratories.

3.6.2.7. On-going AH Surveillance Programs

Most of the AHL laboratories were involved in various AH surveillance programs which reflects their potential capacity to support MCS (table 19). Further to this, NADDEC is implementing the Progressive Management Pathway (PMP) for Foot and Mouth Disease (FMD) control an OIE notifiable disease in livestock. The PMP approach is among FAO's flag-ship strategies to support country's develop comprehensive biosecurity control plans and programs. There are four major components to PMP namely raising awareness, increasing surveillance capacities, developing governance structures and targeted action towards a specific concern. The PMP approach was initially developed for disease control in livestock and has now been adapted by FAO for aquaculture biosecurity and AMR control.

This demonstrates that there is capacity and experience within the country with systems in place to undertake surveillance from District to National level and an initial basis for developing and implementing aquaculture PMP. This provides a strong foundation upon which aquaculture MCS can be built.

Table 19. On-going animal Health Surveillance Programs

Name of Laboratory	Institution	Ditrict	Lab Category	Species	Type of Program	Geographical Scope	Category of Diseases Monitored	Other labs involved
CDL	CoVAB	Kampala	National reference	livestock	surveillance	national	zoonoses	
CDL	CoVAB	Kampala	National reference	livestock	surveillance	national	environmental	
CDL	CoVAB	Kampala	National reference	poultry	surveillance	national	AMR	NADDEC
CDL	CoVAB	Kampala	National reference	poultry	surveillance	national	endemic	
CDL	CoVAB	Kampala	National reference	wildlife	research	regional	zoonoses	UAB
CDL	CoVAB	Kampala	National reference	livestock	research	regional	transboundary	UAB
CDL	CoVAB	Kampala	National reference	livestock	research	regional	environmental	UAB
Tororo	District LG	Tororo	District	livestock	surveillance	national	zoonoses	CoVAB
Busia	District LG	Busia	District	livestock	surveillance	national	endemic	NADDEC, CoVAB
Busia	District LG	Busia	District	livestock	surveillance	regional	transboundary	NADDEC, CoVAB
Busia	District LG	Busia	District	livestock	surveillance	national	zoonoses	Government Chemist
Busia	District LG	Busia	District	livestock	surveillance	national	environmental	Government Chemist
Busia	District LG	Busia	District	poultry	surveillance	national	transboundary	NADDEC
ARDC-NaFIRRI	ARDC	Wakiso	University/research	fish	surveillance	national	transboundary	CoVAB, CEFAS
Jinja	District LG	Jinja	District	livestock	surveillance	national	AMR	Jinja hospital, NADDEC, CoVAB
Kayunga	District LG	Kayunga	District	livestock	surveillance	national	zoonoses	
Kayunga	District LG	Kayunga	District	livestock	surveillance	national	transboundary	
Kasese	District LG	Kasese	District	livestock	surveillance	national	transboundary	NADDEC, UVRI
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	livestock	surveillance	national	AMR	NADDEC, CDL
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	livestock	research	national	AMR	NADDEC, CDL
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	fish	surveillance	national	endemic	ARDC

Name of Laboratory	Institution	Ditrict	Lab Category	Species	Type of Program	Geographical Scope	Category of Diseases Monitored	Other labs involved
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	fish	research	national	zoonoses	ARDC
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	fish	research	national	environmental	ARDC
Vet Microbiology Research Lab	CoVAB	Wakiso	University/research	poultry	surveillance	national	endemic	MOBILA
NADDEC	NADDEC	Wakiso	National reference	livestock	surveillance	national	transboundary	
NADDEC	NADDEC	Wakiso	National reference	livestock	surveillance	national	AMR	

3.6.2.8. Funding Sources

Most of the AHL (except ARDC), had multiple sources of income associated to the provision of services provided to respective clients (figure 28).

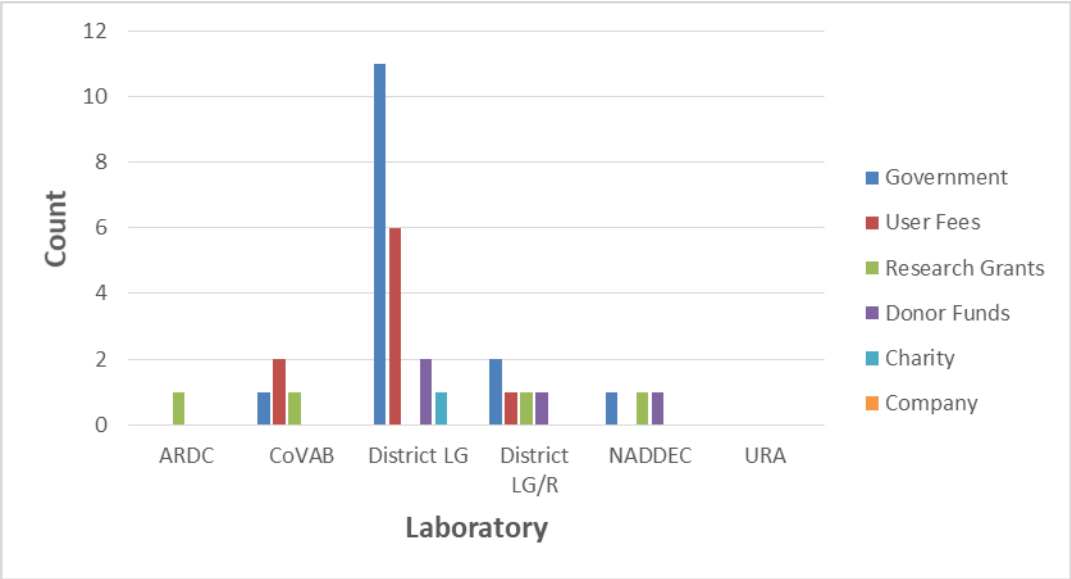


Figure 28. Major Funding Streams for Animal Health Laboratories

The district AHL relied on the District LG to finance them under the DVO's budget. However, the total amount allocated to the DVO fluctuated each year and was usually not adequate for undertaking all planned AH activities (DFO's fisheries and aquaculture budgets were similarly affected). There was no specific budget line for the district AHL which prompted DVO's to charge a minimal fee to farmers requiring diagnostic services so as to cover costs for laboratory reagents. Otherwise some of the district AHL would not have been in position to sustainably provide basic services. The fees farmers paid ranged between 3,000/= to 5,000/= per test with a discount when many animals/samples had to be tested e.g. herd health or flocks of birds. In such situations if samples had to be referred to the Regional AHL, CoVAB or NADDEC, the farmer contributed to the cost of transport and laboratory fees where these applied.

Hence, districts where animal productivity and the viability animal production enterprises was higher, tended to have higher turnover with respect farmers seeking laboratory diagnostic services (table 20 and figure 29.). This also goes to illustrate that where good AH diagnostic services are easily accessible and affordable for producers, farm productivity and profitability improve and District laboratories can generate additional income to support the provision of Level I and essential Level II diagnostic services.

Table 20. Turnover of Animal Health Laboratories

Institution	District	Average number of clients per month	Average number of samples per month	Major Clients	
				producers	advisors
NADDEC	Wakiso			Yes	Yes
CoVAB	Kampala		100	Yes	Yes
District LG	Nakasongola			Yes	
District LG	Hoima			Yes	
District LG	Mukono	80	200	Yes	
District LG/R	Mbale		50	Yes	Yes
District LG	Kasese	63	178	Yes	
District LG	Kazo	10	20	Yes	
District LG	Kayunga	36	401	Yes	
District LG	Ngora				
District LG	Kalangala	100	300	Yes	
District LG	Kabarole	20	50	Yes	
District LG	Jinja	50		Yes	
District LG/R	Mbarara	50	500	Yes	
ARDC	Wakiso	2			
District LG	Busia		30-40	Yes	
URA	Busia				
District LG	Tororo	12	30	Yes	
CoVAB	Kampala	30-50	100-150	Yes	Yes
District LG	Kabale		30-40	Yes	
URA	Kabale				
URA	Tororo				

The Chairperson of WALIMI, who is a fish farmers raised the concern over the long distances farmers had to travel across the country to seek aquatic animal disease diagnostic services. She noted that fish farmers had on several occasions reiterated that they would be willing to pay laboratory fees as was the case in other agricultural enterprises, if these services were brought closer to them. The availability of laboratory services closer to the farms would save farmers from the high mortalities and other health-related losses they are currently going through (which largely remain undocumented). The paragraphs above reiterate these concerns and show the benefits that would accrue to the aquaculture sector if if aquatic diagnostic services were available at the District animal health laboratories.

The national laboratories on the other hand, obtained income to finance their operational costs from research grants, training, Central Government and industry. The District and Regional AHL's on the other hand provided more services to farmers, who constituted their primary client base (figure 29). The diagnostic capacity of the District and Regional AHL therefore had a direct impact on animal health status, farm productivity and profitability, biosecurity control, food-safety and supported environmental management

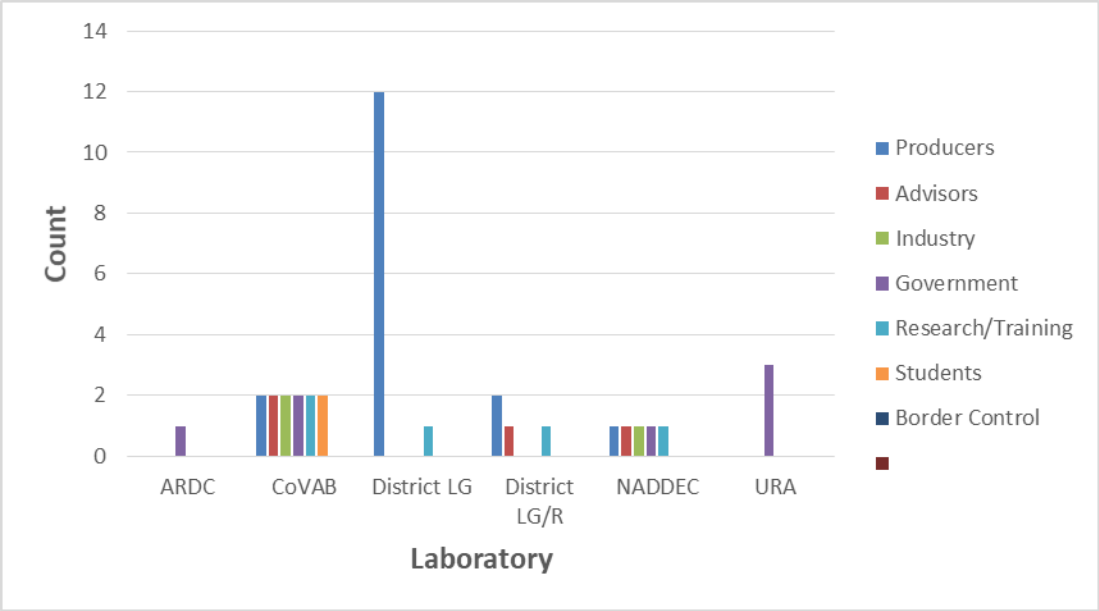


Figure 29. Animal Health Laboratory Funding Sources by Client

3.6.2.9. Other Laboratory Services

The sectoral objectives for establishing an aquatic animal health MCS system fall within the context of environmentally sustainable commercial aquaculture and include assurance of the aquaculture value chain for purposes of certification of the safety of aquaculture products. To achieve this comprehensively, the AHL would similarly need to collaborate with the following specialist laboratories and build capacity to bring some of the essential food-safety and environmental services down to the district level (table 21).

Table 21. Additional Laboratory Services in Support of Food-Safety, One Health and Climate Change

Topic Area	Laboratories	Comments
Water quality and limnology	CoNAS, NAFIRRI-Jinja, Directorate of Water Development (DWD), Government Chemist	Water quality, limnology, toxicology
Fisheries biology and taxonomy	CoNAS, NAFIRRI-Jinja	Fish population dynamics
Botany and Zoology	CoNAS	Classification of 'new' pathogens, establishing life cycles of 'new' endemic pathogens, identification and develop control measures for invasive aquatic plants,
Public Health	National and district veterinary and medical health laboratories, Medical School (*Institute of Public Health*), CoVAB (*Veterinary Public Health Department*) , National Drug Authority	Assess impacts of zoonoses and food-safety concerns in humans

Topic Area	Laboratories	Comments
Environmental management and climate change	CoNAS (*School of Environmental Sciences*), CoVAB (*Departments of Ecosystem health and biosecurity control*), DWD NEMA, Meteorology	Identify and develop environmental indicators and tools for aquatic animal biosecurity control and environmental mitigation strategies, population genetics, climate change, toxicology
Food-safety	NARO – Kawanda (*Food Science and Technology*), College of Agricultural & Environmental Sciences, MAK (*Food Science and Technology)*, MAAIF (Fish Safety Laboratory), CoVAB (- *Veterinary Public Health Department*), MoH, Government Chemist, Chemiphar, National Drug Authority, Uganda Bureau of Standards	Food-safety, residual monitoring and quality assurance for safety of aquaculture products

PS: None of the above laboratories were visited during the study but were referred to by the AHL as collaborators within the context of food-safety, One Health and climate change.

3.7. Step 7: Study Design, sampling frame and sampling

A reputable MCS system requires international recognition. To achieve this, it must be designed based on science and meet international (OIE) standards. Thus all aspects of the surveillance plan, right from the design must be documented to ensure and assure that sound data from a statically representative population is generated in time, analysed and thereafter interpreted. Reliable surveillance results cannot be generated without adequate allocation of financial resources.

Through the aquaculture permitting system described in the *Aquaculture Rules (2003*), a database exists of registered cage farms, fish hatcheries and land-based commercial fish farms in Uganda. The DFO's also maintained database of the fish farmers in their respective districts as recommended by DiFR. However, aquaculture permits were often not renewed at the frequency stipulated in the *Aquaculture Rules (2003)* nor did the DFO's and the FO supporting them have the capacity to annually up-date their aquaculture database due to budget constraints.

The data collected in both the national and district fish farmer's databases included the farm location, size of farm (surface area, number of production units, type of production units), species farmed and production capacity in terms of total number and tonnage of fish produced annually. During the course of the year a number of fish farms do close down and new ones come into operation without the DFO/FO knowledge. In addition, when hatchery producers and grow-out farmers sell, buy and transport fingerlings to stock their farms (cages or ponds), often times the FO are not informed yet a movement permit is required. No data is captured about such fish movements nor of the fish health status. Equally so, neither is data captured of table fish harvested and distributed to inland local markets by SME and/or traders. Poor record keeping among the majority of fish farmers compounds the poor status of data in the country as it creates a situation whereby there are no prospects for retrospectively filling in data gaps. The DFOs/FOs acknowledged that large commercial fish farmers (especially cage and hatcheries)

maintained good records; however in order to safeguard their business interests they were not inclined to share this information.

Bearing in mind that what the major risk-determinants for the occurrence and transmission of the likely OIE aquatic animal diseases for Uganda are *(i.e. geographical location, water body, species, age and fish movement*), the absence of and/or inadequacies in the maintenance of the above-mentioned database(s) present a risk for national aquaculture biosecurity and make it difficult to identify and accurately describe the specific epidemiological units above farm-level that may warrant aquaculture MCS.

Until recently, the only semblance of aquatic animal disease MCS have been research studies to identify pathogens profiles of fish from various aquatic environments or to establish causes of common/recurring incidences of disease associated with specific production systems and/or fish farms. The results of one such study detected the presence of the Tilapia Lake Virus (TiLV) in apparently healthy farmed and wild tilapia (*O. niloticus*) within Lake Victoria (Mugimba *et al.,* 2018). The findings prompted the development of the *'Uganda National Action Plan on Tilapia Lake Virus Disease'* to enhance national capacity for risk reduction against the emergence and spread of TiLV in order to protect the aquaculture sector (MAAIF/CoNAS/FAO, 2018). Consequently, active surveillance to assess prevalence and determinants likely to influence emergence of TiLV among a cross-section of farms representative of the major aquaculture production systems within the Lake Victoria Basin (LVB) is on-going. A couple of farms visited in this study were targets for this surveillance. Farmers raised concern that despite the fact that water, fish and feed samples had been collected from their farms every six months for the last year or so, they had never received any feedback. Among the criteria used internationally to give credibility to an animal health MCS system is the efficiency by which stakeholders receive feedback.

3.8. Step 8: Data, Collection and Management

According the OIE, the success of a surveillance system is dependent on a reliable process for data collection and management (OIE, 2020). The consistency and quality of data collection and event reporting in a format that facilitates analysis, is critical. Factors influencing the quality of collected data include the:

- distribution of, and communication between, those involved in generating and transferring data from the field to a centralised location;
- motivation of the personnel involved in the surveillance system;
- ability of the data processing system to detect missing, inconsistent or inaccurate data, and to address these problems;
- maintenance of disaggregated data rather than the compilation of summary data;
- Minimisation of transcription errors during data processing and communication.

The existing National active TiLV surveillance program has developed its own tools for data collection, management and analysis. However, this is a specific projected being implemented by MAAIF with support from FAO. It therefore has a fixed timespan after which, it is expected that the country should have developed the capacity to continue MCS for the control of TiLV and other notifiable diseases. A good surveillance plan has to achieve the appropriate and acceptable balance between resources needed (not only financial) the resources available and the expected outcomes of the surveillance.

The status of data collection and management on aquatic animal diseases among the sectors stakeholders is as follows:

Farmers - Farmers do keep records of inputs purchased, feeding and sales. The quality, uniformity and management of these varies tremendously ranging from jotted notes on scrap paper, descriptive notes written in exercise books, adopted of record templates from various sources that are photocopied and kept in a file or transcribed into a counter book to the more elaborate record keeping systems comprising both hard copies and ICT applications used by large-scale commercial famers. Among smallholder farmers, previous receipts of inputs purchased often constitute the only most accurate written quantitative record of their aquaculture enterprise.

Health records and incidences of mortality were generally not maintained among smallholders unless there was a drastic event. Small and medium sized commercial farmers kept records of mortality but not necessary about behavioural abnormalities observed other than of poor feeding response.

Large-scale commercial hatcheries and cage farms collected and submitted samples of diseased fish directly to CoVAB and/or ARDC as the need arose. Records of laboratory findings were kept at the laboratory and a report given to the farmer.

Fisheries Officers - Disease events on-farm were generally not reported in time as a rule unless sudden mass mortalities had occurred. The FO would then arrange to visit the farm to assess the situation. Often this would be after the event. Samples were sometimes collected and submitted to ARDC for laboratory diagnosis. District AHL were often not considered for the provision of this service except in a few districts. The DFO passed on results to farmers, sometimes verbally, and reported the disease event in their routine district reports.

Laboratories – Kept records of samples received, clinical history, tests done and laboratory findings in their log books. The research laboratories at ARDC and CoVAB did not have to report beyond giving the client a laboratory report of results.

The AHL laboratories under the national veterinary services, had a standard format for submitting reports of laboratory findings to NADDEC (see figure 19 above). However, this form did not capture fish as among the species for which data was required, at the time of the study. Therefore even when fish diseases were diagnosed within these laboratories, the results were not relayed with other laboratory findings to NADDEC, but remained in laboratory log book.

National Level – Consequently, other than from isolated reports, there was no national database on the status of aquatic animal disease in the country, neither at NADDEC nor at DiFR. Figure 30 below illustrates the existing terrestrial *vs.* aquatic animal disease reporting pathways. It highlights exisitng gaps in the relay of aquatic animal disease data from farmers and AHL through to NADDEC and the Commissioner for Aquaculture Management and Development (*also the OIE Aquatic Focal Point*).

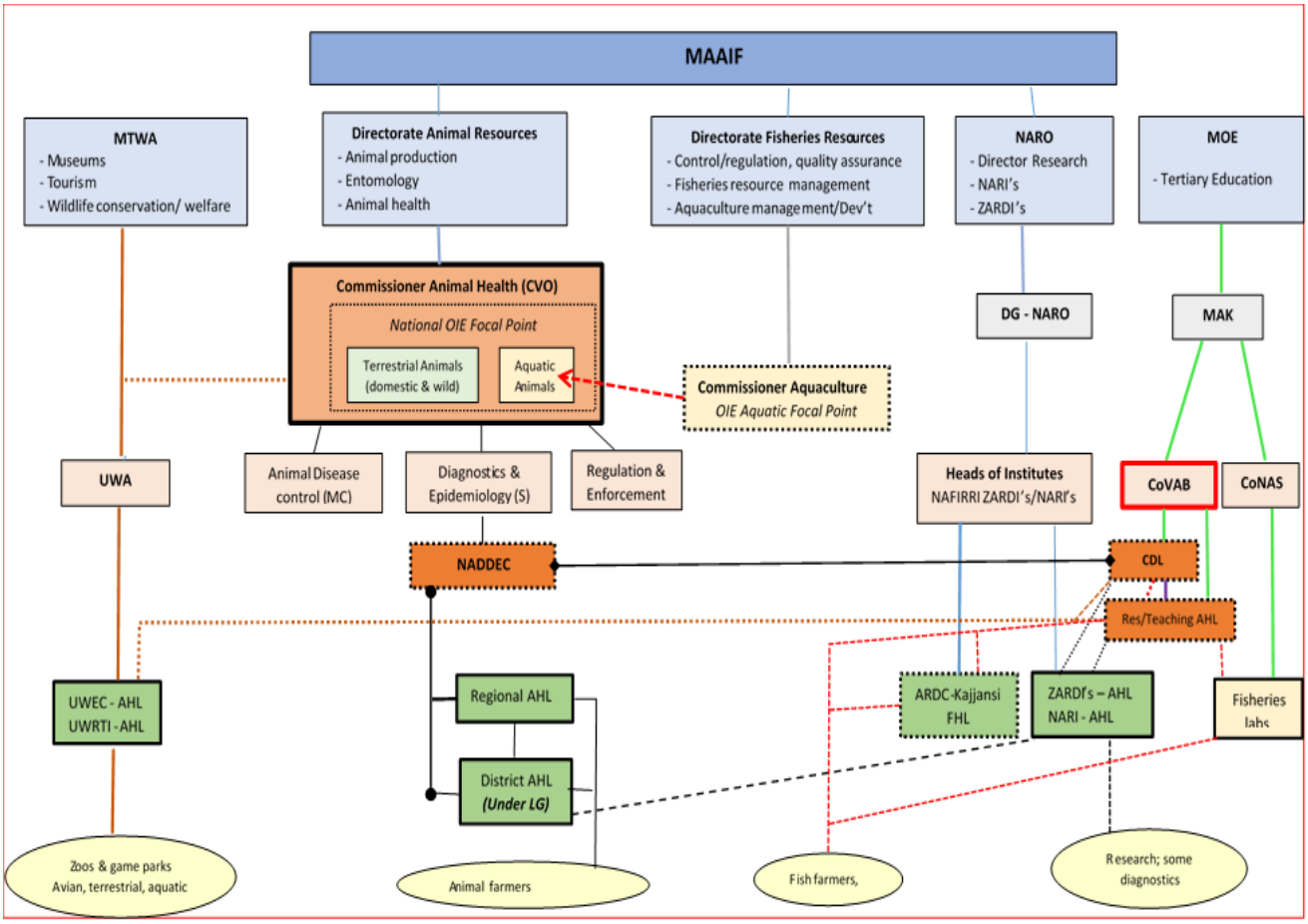


Figure 30. Status of Aquatic Animal Disease Diagnosis and Reporting in Comparison to Animal Disease Reporting

Key to figure 30

- *Red dotted lines* – aquatic animal disease diagnosis (laboratory requests) flow & referrals
- *Black dotted lines* – terrestrial animal (livestock & pets) disease diagnosis (laboratory requests) flow & referrals
- *Brown dotted lines* – wildlife animal disease diagnosis referrals
- *Brown boxes* – Level III animal health diagnostic laboratories
- *Green boxes* – Level II animal health diagnostic laboratories
- *Light blue boxes* – Line departments and agencies (accountable agency to which reports are submitted by respective departments)
- *Solid lines* – disease reporting pathway
- *Green solid lines* – Ministry of Education (Makerere University)
- *Light Blue solid lines* – Director General – NARO
- *Black solid lines* – Commissioner Animal Health
- *Red solid lines* - Commissioner of Aquaculture Management and Development
- *Brown solid lines* – Executive Director, Uganda Wildlife Authority
- *Light pink circles* – major clients/beneficiaries

3.9. Step 9: Data Analysis

According to the OIE (2020) data should be analyzed using appropriate methodologies, and at the appropriate organizational level to facilitate effective decision making, whether it be planning of interventions or demonstrating status. Methodologies for the analysis of surveillance data should be flexible enough to deal with the complexity of real life situations. No single method is applicable in all cases. Different methodologies may be needed to accommodate different host species, pathogenic agents, production systems, surveillance systems, and the types and amounts of data and information available. This is important because the results of surveillance form the basis for aquatic animal health management and reduce the likelihood for wrong decision making. . Credible decisions emanate from the data collected and its analysis and interpretation.

To-date, other than for the data being collected in the on-going TiLV Surveillance program, all other disease data collected on aquatic animal diseases in the country has been analyzed to answer specific research questions rather than national aquatic animal sanitary status. The current aquatic animal disease data collection and management practices whereby the national veterinary laboratory services (NVLS) are not engaged and ARDC exists and operates in isolation as a national Fish Health laboratory without official collaborative linkages the existing NVLS, has created a situation whereby aquatic animal disease information is not collated NADDEC, the National reference animal disease diagnostic and epidemiological center (see figures 11 and 22 above). Thus, aquatic animal diseases are not captured into the national mechanism for the collection, collation, epidemiological analysis and validation of animal disease data that NADDEC is mandated to do. Hence, Uganda cannot officially report on its aquatic animal disease status to the OIE nor confirm its sanitary status to gain access to international markets, unless on bi-lateral terms.

At district level this has created a situation whereby because no laboratory results exist because aquatic animal disease cases not handled at district AHL. Thus, the DVO/VO cannot monitor the prevalence and trends of aquatic animal diseases in the district and in consultation with the DFO develop locally appropriate aquatic animal disease control strategies as is done for the other animal and zoonotic diseases. This is a function that the DVO/VO are mandated to provide given public service Terms of Reference founded on their background training as veterinarians in veterinary epidemiology, preventive medicine and public health. By so-doing, DVO is in position to assess the socio-economic impacts of animal diseases in the district depending on local farming systems and prioritize pathogens of importance which in turn provide useful input for national strategies (see table 13 above). Establishing collaborative linkages in similar respects between the DVO, DFO, District Environment and Health Officers would advance aquatic animal health surveillance to provide One Health benefits in terms of facilitating environmental sustainability, food-safety and safeguarding ecosystem and public health.

Unless there's continuous monitoring and epidemiological analysis of data collected at district level, early warning systems and contingency plans cannot be developed. Consistency in the application of different methodologies and transparency should be encouraged. Uncertainties, assumptions made, and the effect of these on the final conclusions should also be documented to facilitate corrective action.

3.10. Step 10: Validation and Quality Assurance

The validation and quality assurance of an animal health MCS system hinges on the extent to which a disease and/or pathogen can be reliably detected, data captured accurately and relayed consistently in a timely manner using a given set of tools for analysis, interpretation and action. Results from animal

health surveillance systems are subject to one or more potential biases. When assessing the results, care should be taken to identify potential biases that can inadvertently lead to over- or under-estimation of the parameters of interest. Unless data collection at the primary (i.e. farm, market, processing) level is robust, repeatable and reliable the MCS will have flaws. Thus:

Farm level – currently there are no nationally validated nor standardised tools for the early detection disease and presumptive diagnosis of aquatic animal diseases for use at farm level. The majority of fish farmers are not aware and have no practical knowledge to enable them relate symptoms to potential diseases. Extension workers are similarly challenged. When incidents occur the time spent consulting other farmers and attempting to seek appropriate technical support creates a lag phase that can have a significant negative impact on the accuracy, quality and reliability of clinical and laboratory diagnoses. For example, fish samples may be collected when the causative infectious agent is no longer present in the specific tissue(s) of the fish and/or when pathological lesions have become complicated as result of secondary infections. The likelihood for making the wrong diagnosis both on-farm and in the laboratory for such cases is high.

Laboratory Level – There is no national aquatic animal disease laboratory diagnostic manual stipulating recommended aquatic animal laboratory diagnostic protocols whose specificity and sensitivity has been validated within a cross-section of the country's NVLS nor ARDC. At present the laboratories routinely involved in aquatic animal disease diagnostics operate independently and are only accountable for their own institutions, rather than to the CA nor are the linked to the CA via NADDEC. Horizontal disease data transfer among these institutions is the status quo. There is no hierarchal structure in place that permits peer review (external evaluation), audits and the implementation of corrective measures where errors may have occurred at lower level as is the case in the NVLS structure and as is recommended by the OIE (figure 30 above). Thus, other than for the confidence accruing from the track record of these institutions, currently there is no robust documentation of aquatic animal disease diagnostic system in the country that would stand the test of audits. Similarly there is also no peer review system in place to validate and assure the quality of any data collection system and analysis for aquaculture MCS. The validation of data for the on-going TiLV MCS is being done under supervision of Centre for Environment Fisheries and Aquaculture Sciences (CEFAS) one of the International Centres of Excellence for Aquatic Animal Health recognized by the OIE and FAO.

National Level – The absence of a national system for the systematic reporting and collating of aquatic animal disease data centrally at national level is currently a major stumbling block for aquaculture MCS. For the reasons given above, this has created a situation where there's lack of technical oversight and stakeholder accountability on the detection and reporting of aquatic animal diseases. Consequently, there is no sound basis for developing or guiding the implementation national aquatic animal disease control and biosecurity strategies such as zonation, health certification, establishment of quarantines or capacity building. The current absence of a national aquatic animal's disease and/or pathogen list and accredited laboratory(ies) for confirmatory diagnosis is another major hindrance. The country consequently cannot ascertain its aquatic animal sanitary status and thus cannot also report with confidence internationally.

3.11. Step 11: Human and Financial Resources and Logistics

3.11.1. Human Resources

The actors across the entire aquaculture value chain (farmers inclusive), constitute the human resource capacity present for the effective implementation of an aquaculture MCS. Their capacities need to be strengthened to enable them effectively implement their respective roles in each of the steps described above. Fortunately, technical training in the relevant disciplines currently covers some aspects of aquatic animal health. Recruitment and targeted skills training to address identified gaps would improve accessibility to AAH services for producers as well as improve data collection.

3.11.2. Financial Resources and Logistics

The performance and effectiveness of any animal health MCS system depends on its organisational, functional, technical and economic attributes. The sampling frame and quality of diagnostic data collected depend on the ability to provide the necessary human resource, financial and logistical requirements in a timely manner in accordance with the surveillance objectives. Figure 31 illustrates broadly the operational structure of any animal health MCS and the attributes that would need to be qualified under domain.

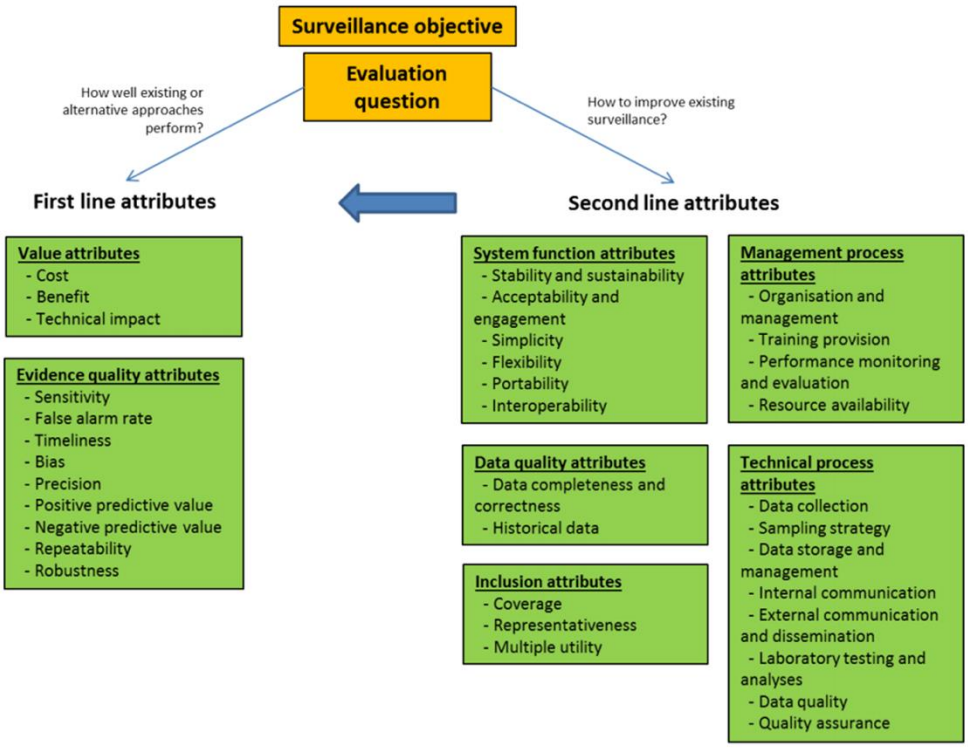


Figure 31. Factors that will need to be considered in resource allocation for the implementation of MCS (after Calba *et al.*, 2013).

3.12. Step 12: Surveillance the Bigger Picture

Broadly speaking, the existing national policies, regulations and sectoral plans create an enabling environment for the establishment an aquaculture MCS that is compliant to regional and international standards. Notable among these are the East African Community (EAC), Intergovernmental Authority for Development (IGAD) and Common Market for Eastern and Southern Africa (COMESA) which constitute the regional blocks where Uganda's aquaculture and fisheries product are traded. The ability to meet OIE

standards expands the opportunities for Uganda's aquaculture sector beyond its regional market while at the same time protecting the aquaculture sector from TAADS. Where there are shortfalls in the fisheries and aquaculture policy, regulations and implementation capacity, a supporting framework exists in the Directorate of Animal Health, the research and training institutions of NARO and Makerere University respectively and affiliate the MDA's (see table 22 above). Further to this, the existing *Fisheries Act* and *Aquaculture Rules (2003)* have been tabled for amendment in consideration of the current NFAP that advances environmentally sustainable commercial aquaculture development in support of the National Development Sector Plan III and Agriculture Sector Strategic Plan.

At implementation level, the establishment of commensurate infrastructure, human resource and institutional capacity (in the public and private sector) to effectively implement MCS within a timeframe and cost-structure that makes economic sense while strengthening the competitive advantage of Uganda's aquaculture sector will be no easy feat. It will require honest and pragmatic approaches that build onto existing animal disease control mechanisms and address the dichotomies that exist between the different departments and institutions. Further to this, the impetus for such an approach, is anchored into One Health and the UN SDGs that form the basis for current international best practice in animal disease control, safe trade, public and ecosystem health and climate change. It is therefore imperative that formal functional linkages and collaborative multi-sectoral working arrangements are established within this context for aquaculture MCS to foster resilience and sustainable aquaculture development.

What this will translate into at farm-level, is the freeing up of already scarce human, financial and institutional resources that would have otherwise been used to establish and expand parallel infrastructure for aquatic animal disease control which if directed into strengthening the detection and control of disease at farm and district AHL would have far reaching results. As indicated in the narrative above, a major constraint hindering the early detection and reporting of aquatic animal diseases is the proximity of AHL to fish farmers. The volume of live fingerlings currently being transported across the country or exported without verification of health status presents a great biosecurity, environmental and economic risk for country. The propensity for the spread of notifiable and endemic diseases under the circumstances is tremendous when one considers that approximately 170,000,000 fingerlings per year are required to produce 100,000 tons of fish annually assuming the average weight at harvest is 600 g. Ascertaining the health status of such a volume of fish before transit cannot be achieved unless laboratory diagnostic services are available at District Level and producers and district personnel have more accurate tools for case definition. Consideration should therefore also be given to licensing/permitting live fish transporters along similar lines as the cattle traders to ensure conformity to live fish movement public guidelines including for data on live fish movements collection.

Strengthening the collaborative working relationship between DiFR and DAH to enable District and Regional AHL provide fully fledged quality aquatic animal diagnostic services should therefore be given priority which will additionally go a long way in promoting sustainable and effective aquaculture MCS and biosecurity control in the other aspects of One Health and climate change. At this level, farmers can afford to cost-share by contributing towards costs of laboratory reagents which advances the objectives of the assignment to establish *'an aquaculture MCS system most feasible and sustainable MCS system is likely to be one that encourages self-compliance among stakeholders'*. As the farmers mentioned (section 3.1.8.2), the establishment of an MCS system that would enable them evaluate the cause and effect of management practices objectively was likely to improve constructive collaboration between them and the authorities and thus promote self-compliance to recommended Best Practices especially if such

practices translated into increased profits. The MCS therefore will need to generate cost and benefit analysis data for recommendations and impacts at farm, zonal and sectoral level. Epidemiological analysis is therefore critical.

Action at District and Regional level is more likely to have direct and more immediate impact on the quality of farm output, farm productivity and returns, and in turn, the increase the turnover and earnings from laboratory fees of district AHL creating an opportunity for of sustainably providing AHL diagnostic services to farmers. Currently most fisheries and aquaculture extension services are provided without basic water quality testing equipment that would otherwise have enabled them detect stressors and thus mitigate against the occurrence of aquatic animal diseases beforehand thus, improving productivity and returns of fish farmers. The capacity of the DFO and FO to monitor and guide farmers implement best management practices will be strengthened additional backup from District AHL . Unless the situation at District and farm level is improved, quality assurance of the value-chain will not be possible through self-compliance as producers and traders will not have the tools at hand to assess and take corrective action early enough before it becomes too costly to address. Well-equipped District AHL will also improve staff morale. At present it it is quite disheartening for the district personnel to live with the realization that among the reasons farmers consult each other or the internet more, is because farmers realize DFO/DVO do not have the capacity to provide technical guidance.

4. SWOT Analysis

The SWOT has been done based on findings of the MCS assignment in lieu of the:

- MAAIF/EU-PESCA overall objective to establish a foundation for an environmentally sustainable commercial aquaculture sector in Uganda that's compliant to international standards and products have access to markets.
- Main objective of the assignment to 'Develop *an aquaculture MCS system for Uganda that is practical, feasible, cost-effective, and beneficial to all stakeholders at each level value-chain to encourage self-compliance'.*
- Hence, the OIE Aquatic Animal Health Code, OIE reporting guidelines, FAO Guidelines, One Health approach, continental and EA regional guidelines have in addition been taken into account in addition to the current National policy guidelines and institutional structure.

The existing reporting system is not efficient to provide confidence and cannot be used neither to calculate disease prevalence figures nor to certify disease freedom.

Specifically:

The Current Public Institutional Set-up as pertains to aquaculture and aquatic animal disease control

1. The OIE set standard for the reporting animal diseases (of which aquatic animal diseases are among) whereby in Uganda's case, the Commissioner Animal Health (CAH) is the designated as *National OIE Delegate*. In this capacity the CAH as the country's CVO, is:
    - The only authorised entity who can report or make notification on the status of animal diseases on behalf of the country
    - Responsible for ensuring (and supervises) that all animal health legislation, national animal disease diagnosis and veterinary services comply with the OIE standards in accordance to the Terrestrial Animal Health Code, the Aquatic Animal Health Code and

WTO/SPS Agreement and that resolutions of the World Assembly of Delegates are applied within the country.

- Ensures the National animal disease diagnostic laboratories remain informed (and is national official link) to the OIE worldwide network of Reference Laboratories and Collaborating Centres to promote scientific and technical cooperation
- Responsible for nominating and designating national focal points to comply with the consequent national obligations and support the *Delegate* in the following fields: animal disease notification, wildlife, aquatic animal diseases, veterinary products, animal production food-safety and animal welfare.
- Has the discretion to give focal point(s) access WAHIS to notify on terrestrial and/or aquatic animal diseases or both.
- The *National Animal Disease Notification Focal Point* is the direct contact point with the OIE Animal Health Information Department in-charge of disease notification and should be the person responsible for *National Epidemiological Unit* (which in Uganda's case is *NADDEC*) through which all animal disease data and information is collated, analysed and verified prior to submission of national reports to the Delegate (including other national focal points)
- The *National Aquatic Animal Disease Focal Point* support the work of *Delegate* by:
    i. Establishes and/or communicates with the exiting national network of aquatic animal health experts for purposes remaining and keeping the *Delegate* up-to-date on status of aquatic animal health in the country
    ii. Establishes dialogue, cooperation and communication with the Competent Authority for aquatic animal health and the relevant authorities and institutions
    iii. Receive reports and conduct the in-country consultation process in lieu of the Aquatic Animal Health Standards Commission
    iv. Prepare comments for the Delegate on relevant meeting reports and proposals for new or revisions to OIE aquatic animal standards

2. In Uganda's case, the *Competent Authority for Aquaculture* (i.e. Commissioner Aquaculture Management and Development) has been designated by the *Delegate*, the National Aquatic Animal Disease Focal Point.
    - According to the National Fisheries and Aquaculture Policy (2017), the Commissioner Aquaculture is responsible to ensuring aquaculture biosecurity.

3. Within the Agricultural Sector:
    - NARO is responsible for public research and is accountable to the DG-NARO. For aquatic animal health research under NARO, NAFIRRI's ARDC – Kajjansi is the national lead institution. The ARDC-Kajjansi has an aquatic animal health laboratory that has been designated a National Reference Lab by (DiFR). ZARDI's can also undertake and/or support ARDC based on the country's regional needs.
    - The National Universities are responsible for training, research and providing technical backstopping to the sector. They are accountable to the Ministry of Education. Currently Makerere University Kampala (MAK) is the only university that teaches aquatic animal health. In this regard:

i. College of Natural Sciences (CoNAS) has a degree in fisheries and aquaculture which focusses on production and has a fish health component. It also offers courses in the basic sciences that would backstop the animal and public health components
ii. College of Veterinary Medicine, Animal Resources and Bio-security (**COVAB**) whose training and research focus is animal (i.e. all animals = wildlife, livestock, aquatic, companion) animal health, veterinary epidemiology and preventive medicine, animal welfare, veterinary public health, ecosystem health and biosecurity control and animal production. It offers a degree in veterinary medicine, biomedical laboratory technology and diploma in animal production.
iii. College of Agricultural & Environmental Sciences – food safety and environmental aspects,
iv. FTI offers diploma in aquaculture and also fisheries
v. Mbarara University and Mbale School of Medical train bio-medical laboratory technicians to degree and diploma level respectively.

4.1. SWOT of Aquatic Animal Disease Situation Analysis

Table 22 below summarise the SWOT of the status quo for MCS

Table 22. SWOT Analysis of Policy and Institutional Set

Strengths	**Weaknesses**
• Institutional framework already exists in compliance to OIE and FAO guidelines • Elaborate network of animal health diagnostic labs and reporting network that cuts across the country including a NADDEC • Collaboration with OIE international reference laboratories exists through NADDEC and CoVAB • Can undertake Level II and Level III laboratory diagnosis and have a national referral system in place. *(NADDEC and CoVAB host the national reference labs and samples from ARDC, CoNAS are also taken/referred to CoVAB for diagnosis)* • Implementing with support from FAO TiLV surveillance • Resource personnel - Research and post-graduate training in various aspects of aquatic animal health and disease control being done at ARDC, CoVAB and CoNAS • Animal Health in syllabi for fisheries, aquaculture and veterinary medicine undergraduate degrees at MAK • Agricultural laboratories have been built at On-Stop border posts and these are designated to cover SPS requirements for cross-border trade • Growing industry • Supporting policies and political good will exist	• Poor functional institutional linkages between relevant departments, notably Departments of Animal Health, Aquaculture Development and Management, CoNAS, CoVAB, ARDC, FTI, and others for purposes of aquatic animal disease MCS and biosecurity control • Extension staff, farmers, district and regional animal laboratory personnel need more training • Low level of public awareness • Currently district and regional animal health diagnostic laboratories don't have water quality testing equipment; nor live fish holding facilities. • Strengthen current guidelines do not capture data relevant for aquatic animal health, biosecurity and bios-safety control
Opportunities	**Challenges**
• Easily build on existing animal disease diagnostic infrastructure to address aquatic animal disease diagnostic and monitoring needs	• No secure budgets for District animal health laboratories and are best positioned for front-line diagnosis and early detection. They depend entirely on district budgets, are often

• A good base exists (labs, resource personnel, programs) upon which functional institutional linkages, collaboration and partnerships can be established to quickly establish an effective and affordable aquaculture MCS system • Brought competence levels of existing field personnel (VO, FO and Animal Health laboratory technicians) can rapidly be brought up to speed by short practical tailored training programs tailored (skills training) as most already have basic knowledge on aquatic animal health and/or laboratory diagnostic procedures	not among district's priorities hence most are not well equipped and/or lack laboratory consumables. • Border agricultural laboratories are not yet fully operational. • Securing adequate financial resources for investment. • The fwk for aquatic animal disease reporting • Strong overlap in roles regarding animal disease control between Animal Health and DiFR departments down to district level which need to be better defined/streamlined down to district level for effective service delivery *(e.g. samples for aquatic animal disease diagnosis are handled in animal health labs which are under supervision of VO at district level. When results come these are not reported in animal health reporting to NADDEC because currently not required to and VO are accountable to CAH, not Commissioner Aquaculture. Results are given to farmer/FO. Similarly ARDC reports to DG-NARO and MAK to MoE*

4.2. SWOT of the Exiting Laboratory Diagnostic Capacity for OIE listed diseases representing the risk for Uganda

The following is a SWOT analysis of the current capacity of the public animal health diagnostic laboratories for the diagnosis of the OIE diseases of likely importance to Ugandan aquaculture. It had been done based on the OIE Aquatic Animal Code and Manual in lieu of the resources available at the various laboratories, their BSL level and quality assurance systems - OIE/ISO 17025 (OIE, 2019 and OIE 2020).

Tables 23 to 26 below summarise the current status of animal health diagnostic laboratories with respect to compliance to the above standards and ability (equipment, human resources and BSL) for diagnosis of the notifiable aquatic animal diseases of concern to Uganda.

Aquaculture safety

According to Bagumire et al., 2009 Uganda's National aquaculture food safety control system meet international requirements Uganda's food laboratories score fairly well for compliance to international standards for food-safety control except for the fact that they are not yet accredited and do not have adequate assured budgets. Invest more resources in maintenance of existing laboratories, especially ensuring that the chemical laboratories that are vital in ensuring controls for aquaculture products achieve international accreditation such that countries as Uganda have adequate testing capacity for other exports and the growing aquaculture sector. Legislation also needs to be reviewed between respective MDAs as there are overlaps and updated to support the current development objectives of the industry. The capacity of the inspection services needs to be built via recruitment and training of adequate numbers of inspectors targeting basic aquaculture and food safety skills. These aspects need be introduced in tertiary curricula

Table 23. Laboratory Diagnostic Capability for EUS

	Category of Diagnosis and Laboratory	Recommended Tests by OIE							Recommended Laboratory	
		Gross Signs	LM – squash smears	Observation of hyphae in tissues	Histopathology	Pathogen isolation & identification by bioassay or PCR	PCR of tissue extracts	Sequence Analysis	Presumptive Diagnosis	Confirmatory Diagnosis
Type Test	Presumptive	**P**	**P**	**P**	**P**					
	Confirmatory		**C**	**C**	**C**	**C**	**C**	**C**		
Capability Assessment	Farm Level	a							**Yes**	**No**
	District Veterinary Laboratories	a,b	b	b					**Yes**	**No**
	Regional Animal health laboratories	a,b	b	b					**Yes**	**No**
	ARDC - Kajjansi	a,c	b	b					**Yes**	**No**
	CoVAB	a,b	b	b	b	b	b	b	**Yes**	**Yes**
	CDL	a,b	b	b	b	b	b	b	**Yes**	**Yes**
	NADDEC	a,b	b	b	b	b	b	b	**Yes**	**Yes**
	*One-Stop Border Post**	*a,b*	*b*	*b*					***Yes***	***No***

Notes

a – Need practical training and field tools to identify symptoms and conditions under disease may manifest

b – Have appropriate equipment, adequately trained/skilled personnel and BSL level for specified test. Need practical skills training, relevant diagnostic manuals and/or reagents.

c – Lack appropriate equipment and appropriate BSL level for the test

d -lack equipment but have adequately trained personnel and BSL level to do test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

P – Presumptive

C – Confirmatory

* *Have not yet been commissioned or equipped.* However. there are designated positions for agricultural inspectors (crops, veterinary and fisheries) at the Ports of Entry

Table 24. Laboratory Diagnostic Capability for KHV

	Category of Diagnosis and Laboratory	Recommended Tests										Recommended Laboratory	
		Gross Signs	Direct LM	Histopathology	Isolation in Cell Culture	Transmission EM	Antibody based viral assay	*In situ* DNA probes	PCR of tissue extracts	Sequence Analysis	Antibody Detection Assays	Presumptive Diagnosis	Confirmatory Diagnosis
Type Test	Presumptive	**P**	**P**	**P**	**P**	**-**	**P**	**-**	**P**	**n/a**	**P**		
	Confirmatory								**C**	**C**			
Capability Assessment	Farm Level	a										**Yes**	**No**
	District Veterinary Laboratories	a,b	b	b							d	**Yes**	**No**
	Regional Animal health laboratories	a,b	b	b							b/d	**Yes**	**No**
	ARDC - Kajjansi	a,b	b	b							d	**Yes**	**No**
	CoVAB	a,b	b	b	b	b			b	b	b	**Yes**	**Yes**
	CDL	a,b	b	b	b	b			b	b	b	**Yes**	**Yes**
	NADDEC	a,b	b	b	b	b			b	b	b	**Yes**	**Yes**
	*One-Stop Border Post**	a,b	b								b	**Yes**	**No**

Notes

a – Need practical training and field tools to identify symptoms and conditions under disease may manifest

b – Have appropriate equipment, adequately trained/skilled personnel, quality assurance systems and BSL level for the specified test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

c – Lack appropriate equipment and appropriate BSL level for the test

d -lack equipment but have adequately trained personnel and BSL level to do test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

P – Presumptive

C – Confirmatory

* *Have not yet been commissioned or equipped.* However there are designated positions for agricultural inspectors (crops, veterinary and fisheries) at the Ports of Entry

Table 25. Laboratory Diagnostic Capability for TiLV

	Category of Diagnosis and Laboratory	Recommended Tests					Recommended Laboratory	
		Gross Signs	Histopathology	Cell Culture	RT-PCR	Sequence Analysis	Presumptive Diagnosis	Confirmatory Diagnosis
Type Test	Presumptive	**P**	**P**	**P**	**-**	**n/a**		
	Confirmatory				**C**	**C**		
Capability Assessment	Farm Level	a					**Yes**	**No**
	District Veterinary Laboratories	a,b					**Yes**	**No**
	Regional Animal health laboratories	a,b					**Yes**	**No**
	ARDC - Kajjansi	a,b					**Yes**	**No**
	CoVAB	a,b	b		b	b	**Yes**	**Yes**
	CDL	a,b	b	b	b	b	**Yes**	**Yes**
	NADDEC	a,b	b	b	b	b	**Yes**	**Yes**
	*One-Stop Border Post**	a,b					**Yes**	**No**

Notes

a – Need practical training and field tools to identify symptoms and conditions under disease may manifest

b – Have appropriate equipment, adequately trained/skilled personnel, quality assurance systems and BSL level for the specified test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

c – Lack appropriate equipment and appropriate BSL level for the test

d -lack equipment but have adequately trained personnel and BSL level to do test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

P – Presumptive

C – Confirmatory

* *Have not yet been commissioned or equipped.* However there are designated positions for agricultural inspectors (crops, veterinary and fisheries) at the Ports of Entry

Table 26. Laboratory Diagnostic Capability for ISKNV

	Category of Diagnosis and Laboratory	Recommended Tests								Recommended Laboratory	
		Gross Signs	Bioassay (virus isolation in cell culture & identification by IFAT or PCR)	Direct LM	Histopathology	EM	IFAT of isolated virus or stamp smear	PCR	Sequence Analysis	Presumptive Diagnosis	Confirmatory Diagnosis
Type Test	Presumptive	**P**	**P**	**P**	**P**		**P**	**P**	**n/a**		
	Confirmatory		**C**				**C**	**C**	**C**		
Capability Assessment	Farm Level	a								**Yes**	**No**
	District Veterinary Laboratories	a,b		b						**Yes**	**No**
	Regional Animal health laboratories	a,b		b						**Yes**	**No**
	ARDC - Kajjansi	a,b		b						**Yes**	**No**
	CoVAB	a,b	b	b	b		b	b	b	**Yes**	**Yes**
	CDL	a,b	b	b	b		b	b	b	**Yes**	**Yes**
	NADDEC	a,b	b	b	b		b	b	b	**Yes**	**Yes**
	*One-Stop Border Post**	a,b		b						**Yes**	**No**

Notes

a – Need practical training and field tools to identify symptoms and conditions under disease may manifest

b – Have appropriate equipment, adequately trained/skilled personnel, quality assurance systems and BSL level for the specified test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

c – Lack appropriate equipment and appropriate BSL level for the test

d -lack equipment but have adequately trained personnel and BSL level to do test. Need practical skills training, relevant diagnostic manuals and/or kits & reagents.

P – Presumptive

C – Confirmatory

* *Have not yet been commissioned or equipped.* However there are designated positions for agricultural inspectors (crops, veterinary and fisheries) at the Ports of Entry

4.3. AQUAMIS

AQUAMIS is a bioinformatics program that has been developed based on the sequencing of microbial genomes to aide in outbreak investigation and surveillance of microorganisms largely affecting human clinical and public health settings, i.e. hospitals, sanitation and food-safety (Denke C. et al, 2021). Subscribers to it would have to pay the costs of sequencing isolated pathogens and costs of obtaining data for use in order identify isolates at level III diagnosis . Considering that the country has pathogen banks and laboratories that can do genetic sequencing of pathogens already this would be and added cost. There are in place globally recognized International standards and guidelines from the OIE, FAO and WHO (including databases) that are accessible to countries at t more affordable cost, have been applied aquaculture settings and enable a country meeting its international reporting obligations. Examples include WAHIS (https://wahis.oie.int/#/home) and WHONET (https://www.whonet.org/software.html). The system of international reference centers can be used to validate microbes isolated. Technical Assistance can be obtained to the establishment of such systems in a country which would later be maintained at a more affordable cost for the country. DiFR would therefore need to critically review what its specific needs are *vis-a-vis* the capacities of local laboratories, reporting requirements, national epidemiological capabilities and costs acquiring and maintaining AQUAMIS services before making the decision to use AQUAMIS as its major database for aquatic animal microbes.

5. Gap Analysis based on OIE/FAO recommendations on surveillance approaches

Technically, the most effective and participatory approach for MCS is to adopt a combination of both passive and active surveillance. Such an approach has shown to be beneficial for disease surveillance in Uganda's livestock sector (Namayanja, J., et al., 2019).

Syndromic surveillance based on clinical history and symptoms for Level I diagnosis will improve the sensitivity at laboratory diagnosis at Level II and III. Where case definition is well defined and consistently applied, passive surveillance can be used to:

(i) rapidly identify introduction of exotic aquatic animal diseases,
(ii) detect new or emerging aquatic animal diseases,
(iii) meet international reporting requirements

The key components of what a passive reporting system would entail in Uganda's aquaculture case include (the list is not exclusive): farmer reports, traders, transporters, local fishery/aquaculture inspection or extension officers, disease report form (outbreak investigation), diagnostic laboratory reports, data management and analysis, reporting and feedback.

Active surveillance would then complete and serve to validate trends observed from passive surveillance whereby laboratory diagnoses would be done to confirm presumptive diagnoses. For active (targeted) surveillance, the specific survey approaches and sample sizes would need to be determined at the time based on epidemiological knowledge and surveillance objectives.

The gap analysis is described in table 27 below.

Table 27. Gap Analysis for development of MCS using FAO 12 point approach

MCS Steps	Status Quo	Technical Gaps	Recommendations
1. Scenario setting (current status of aquatic animal disease management in Uganda)	• NFAP, regional, continental and international guidelines for sustainable commercial aquaculture development and aquatic biosecurity • Rapidly expanding commercial aquaculture sector • Growing acceptance of farmed fish In local and regional markets • Existing regional aquaculture markets and trade • Emerging TAADS threats in the region, including TiLV • Inadequate capacity for aquaculture MCS to ensure biosecurity and enable certification of aquaculture products for trade • Trans-boundary nature of country's major aquaculture producing water-bodies	• No MCS system in place to monitor prevalence and inform actions on control of disease incidences and spread	• Situation analysis to inform establishment of an MCS for aquaculture
2. Surveillance Objective	• No data on the status and economic impact of aquatic animal disease in the country • No national pathogen list • Reported presence of TiLV within the country and of both TiLv and EUS neighbouring countries • Certification of Ugandan aquaculture products for export • Prevent entry &/or contain spread on infectious aquatic animal diseases	• Establish criteria for prioritisation of pathogens • Demonstrating disease status • International reporting • Cost-benefit analyses • Targeted markets • Establish an early warning system(s)	• Conduct baseline prevalence studies • Establish desired outputs needed to support decision making to address gaps • Communication with stakeholders

MCS Steps	Status Quo	Technical Gaps	Recommendations
3. Defining populations	• No comprehensive database of all aquaculture establishment, volumes of aquaculture production and trade • Wild vs. farmed population • Indigenous *vs* exotic species	• Determining spatial distribution and disease frequency • Location of affected or susceptible populations, especially in trans-boundary lakes	• Conduct baseline prevalence studies • Share of population data collected in different governmental departments
4. Clustering of diseases	• OIE notifiable vs. non-notifiable diseases • Inadequate information on the causes, prevalence and impacts of diseases • certification requirements	• Rare studies available of previous surveillance activities • Lack of equipment for monitoring of environmental data poor formal linkages among *all* stakeholders with a role in aquatic animal diseases	• Conduct baseline prevalence and incidence studies • Cost-benefit • Establish functional linkages between all multiple stakeholders
5. Case definition	• Low level of awareness on aquatic animal diseases • Greater reliance on literature and previous experience to diagnose diseases rather than on laboratory diagnosis. • Poor documentation of previous disease incidents especially on-farms	• Determination of causative agents and symptomatic expression of diseases • Geographical distribution, determinants and pathogenesis of diseases in various aquaculture production environments not yet established • Establish most appropriate and cost-effective diagnostic and epidemiological tools • poor formal linkages among *all* stakeholders with a role in aquatic animal diseases	• Laboratory trials to verify causative agents and develop or assess existing tools for efficacy, specificity and sensitivity, cost-benefits • Similarly assess and identify most appropriate epidemiological tools • Establish parameters for monitoring • Establish functional linkages between all multiple stakeholders

MCS Steps	Status Quo	Technical Gaps	Recommendations
6. Diagnostic testing	• Current opportunities and constraints of ARDC and other AHL • Diseases to be monitored • No nationally standardised diagnostic tools • Poor record keeping	• No harmonised tools to enable farmers and extension staff tools detect diseases based on symptoms • Inaccessibility to aquatic animal disease laboratory diagnostic services (especially at district level) • Poor status of practical knowledge and skills • Inadequate equipment and reagents at AHL in country • poor formal linkages among *all* stakeholders with a role in aquatic animal diseases	• Develop and validated national tools for farm level and laboratory diagnosis of disease • Train farmers and personnel • Produce and disseminate aides for famers and national laboratory manuals • Equip laboratories and secure operational budgets • Develop harmonised data collection formats • Officially recognise/put in place measures to promote AHL diagnose and report aquatic animal diseases country-wide • Strategic planning for all AHL and development of business plans to generate resources to sustain operations of district and regional AHL • Establish functional linkages between all multiple stakeholders
7. Study design and sampling	• No accurate data of number of farmers and production; nor disease status or trends • No link with Surveillance objectives • Lack of epidemiological knowledge	• Because of no data, difficult to establish approach survey approaches, sampling frames, sizes, etc. • Currently no tools for syndromic surveillance	• Identify/secure resources and materials required for the survey and sampling • Develop work plans • Training of technical team on use of tools • Strengthen stakeholder capacity for syndromic surveillance

MCS Steps	Status Quo	Technical Gaps	Recommendations
8. Data collection &management	• No standardised data collection tools • Diagnostic data captured in AHL not streamlined into NVLS	• Inability of current tools and reporting arrangements to relay diagnostic results upward to national level • Ease of data capture and transmission • Need to improve status of keeping the relevant records right from producers, post-harvest handlers, extension and professionals and across the different sectors and institutions associated with aquatic biosecurity, biosafety, environmental management and trade	• Review and harmonise all AHL laboratory forms to capture aquatic animal diseases • Link aquatic animal disease data existing NVLS - NADDEC • Raise stakeholder awareness and mobilise stakeholders in accurate and systematic record keeping; and timely reporting • Develop and use apps. • Establish functional linkages between all multiple stakeholders
9. Data analysis	• No systematic aquatic animal disease reporting system and collation of data at national level • No data collated at NADDEC for risk analysis and to support decision making	• Aquatic animal disease data not captured in district/regional AHL or NADDEC	• Linkage into NADDEC for epidemiological risk analysis and development of early warning and contingency plans • Establish functional linkages between all multiple stakeholders to ensure trade, One Health and climate change perspectives are integrated
10. Validation and quality assurance	• Absence of harmonised and systematic tools for data collection right from farm, markets, ports of entry to national level • National laboratories not yet accredited • Horizontal transfer of aquatic animal disease data	• No nationally validated manuals • Inadequate data to support validation processes • No peer review system	MAAIF to actively drive and support accreditation of national AHL • Plot trials to ascertain and validate recommended diagnostic and data tools • Establish technical hierarchy to NADDEC and CA to facilitate peer review, audits and correction actions • Establish functional linkages between all multiple stakeholders

MCS Steps	Status Quo	Technical Gaps	Recommendations
11. Human, financial resources & logistics	• Inadequate resources allocated for aquatic animals disease in support of diagnostics	• Grossly inadequate and inconsistent supply of materials and personnel in support of aquatic animal disease diagnostics and MCS	• Mobilise resources for investments for sustainable MCS •
12. Surveillance the bigger picture (public health, Environmental and Ecosystem Health)	• Implications of national and international policy for establishing a sustainable OH MCS that promotes self-compliance and stakeholder contribution • No disease risk analysis, early warning and contingency planning for aquaculture sector • No quality assurance of aquaculture value chain • No standard veterinary public health services to the aquaculture sector such as for fish inspection for farmed fish produce for purposes of food-safety and controlling zoonotic diseases as compared to the case for livestock products • Border and district laboratories currently not operationalized for aquatic animal disease control, surveillance and no quarantine facilities • Weaknesses in ability of farmers and Local Governments for the detection, surveillance and control of aquatic animal diseases.	• Weak multi-sectoral linkages • Inadequate status of district AHL for both terrestrial and aquatic animal disease diagnostics • No secured budgets for district AHL • Budgets for foods safety, aquatic environmental management (e.g. water quality etc) • No services except for fish destined for export. • Adopt OH comprehensively across the value chain • Zones, compartments and quarantines cannot be established and managed without laboratories at Ports of Entry, district and regional level. • Institutional and stakeholder capacity at district level weak for detecting, data capture and reporting of aquatic animal diseases	• Put in place measures to strengthen functional linkages between different departments and stakeholders • Invest into district and regional AHL to improve their viability and generate income to augment operational budgets thus delivery of quality and reliable diagnostic services. • Sensitise public and district leaders on the value of AHL, OH and food-safety • Provide veterinary public health services for aquaculture value chain at district level • Strengthen collaboration and budgets to food-safety and public health laboratories to provide services and develop simple tools for producers and traders with field indicators for extension and AHL. • Strengthen collaboration with the respective OH departments. • Equip producers, extension workers and district laboratories with the appropriate tools (e.g. posters, manuals) and equipment to detect, collect data and report aquatic animal diseases; as well as create and maintain public awareness

6. General Remarks and Recommendations

Based on described methodology and field findings the following activities are recommended:

Short-Term

1. Establishment of the multi-disciplinary and multi-sectoral National Aquatic Animal Disease Surveillance Unit under supervision of the Commissioner Aquaculture/Aquatic Focal Point following the recommendations of the OIE. Membership to the unit will include among others CAH, NADDEC, farmers and aquaculture industry representatives, NAFFIRI, ARDC, CoNAS, COVAB, representative of district and the 6 regional animal health laboratories, UWA, ADAM, UNBS, MoH, NEMA, etc.
2. Undertake an OIE Performance of Veterinary Services on Aquatic Animal Health Services to comprehensively assess and progressively build Uganda's capacity to deliver aquatic animal health services that meet international standards.
3. As recommended by OIE, the national animal disease diagnostics and reporting is done through NADDEC. Thus the country's the district and regional animal health laboratories supervised by VO all report to and obtain technical backstopping from NADDEC. The regional AHL and Central Diagnostic Laboratory (CDL in CoVAB) are directly under/part of NADDEC play a big role in animal disease MCS. The role, capacity and reporting requirements of these labs should be expanded to cover aquatic animal diseases. Similarly, the ARDC Aquatic Animal Health Lab should be integrated/linked into NADDEC so that all disease data/reports can nationally be collated, analysed (epidemiology/risk analysed) and verified prior to submission to the Commissioner Animal Health and eventually upon her validation to the CAH/Delegate. The modalities of this would include:
    a. All laboratory submission and reporting formats be immediately revised to include provision for aquatic animal diseases.
    b. Skills training and provision of requisite diagnostic tools extension and laboratory personnel (e.g. sample collection, laboratory manuals, etc)
    c. Identify best options for linking ARDC to NADDEC (e.g MOU, etc) with commensurate operational guidelines
    d. Water quality testing equipment and live fish holding to regional AHL and selected key district labs. The FO in the interim would provide technical backstopping to these labs.
    e. Strengthen capacity at District level for aquaculture associated food safety, biosafety, enviornmental and public health monitoring
4. Develop approve standardised national protocols for aquatic animal disease diagnosis (to different levels), passive and active surveillance and aquatic animal health certification.in collaboration with the national surveillance team,
5. Develop TORs, MOU's or other such guidelines better streamline and define the roles and responsibilities to establish functional linkages and working arrangements between the different MDA's, private sector and stakeholders for aquaculture MCS.

Medium to Long Term

1. Review and develop appropriate national curricula within the respective institutions training personnel and providing services to the aquaculture sector to address the national needs.
2. Invest to equip and staff respective national laboratories to build capacity for aquatic animal disease diagnosis and reporting.
3. Expand the staffing of the regional AHL to include position aquatic animal health specialist; and similarly at NADDEC.
4. Training of personnel to further strengthen the capacity of aquatic animal disease MCS.
5. Seek avenues to permanently address challenges associated with the status and operations of District AHL in collaboration with the DiAR so as to develop sustainable mechanisms through PPP with LG and farmers to ensure comprehensive AHL services are available to farmers for purposes of early disease detection, early warning and biosecurity control at farm and regional level (include making it possible to supervise quarantines by DFO's and DVO).
6. Establish national quarantine and aquatic animal health certification system
7. Ensure designated aquatic animal health reference laboratories are upgraded to level III, accredited and staffed with suitably trained specialists.
8. Establish processes and forum (network) to support the Commissioner Aquaculture/Aquatic Focal Point consult and execute the designated tasks, including towards aquaculture MCS, biosecurity control and biosafety.

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Appendices

APPENDIX 1. Terms of Reference

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APPENDIX 3. Data Collection Tools Used

3.1. Disease Status in Aquaculture Establishments

Questionnaire. No.	**Date:** **Time:**	**Interviewers Name:**

The purpose of this survey questionnaire is to collect specific data on the detection, prevalence, control and impacts of fish diseases in aquaculture production systems. The data collected by this questionnaire will be used to:

Identify the diseases of economic importance within Uganda's aquaculture sector,
Develop monitoring, control, and surveillance systems to mitigate against their occurrence and spread in aquaculture establishments.
Develop guidelines to support producers meet phyto-sanitation and market certification requirements for regional and international trade.

It will take about two hours of your time to fill. Thank you for your cooperation.

I agree to take part in the survey and understand that the data collected will only be used for the purpose stated therein and will be kept confidential.

Respondents Name: ……
Respondents contacts: Tel: ……..
Email: ……..
Respondents Signature: …….. **Date:** ……

Location of Establishment

District		**Sub-county**	
Parish		**Village**	
GPS Readings *Indicate units*	**Longitute** *Accuracy*	**Latitude**	**Altitude**

Ownership and Permits.
Name of Farm:
Name of owner *(if different from respondent)*
Gender of *(i)* owner: **M F** *(ii)* farm manager: **M F**
Level of Education *(i)* owner: **N P S T** *(iii)* farm manager: **N P S T**
Have you had any training in fish health?
Owner: **Yes No** *(ii)* farm manager: **Yes No** *(iii)* other farm personnel: **Yes No**
Which permits does the farm/aquaculture business have? **Yes No**

Type Permit	**Y**	**N**	**Type Permit**	**Y**	**N**
Aquaculture establishment permit			If so, aquaculture permit No:		
Business permit			Hatchery producers permit		
EIA certificate			Breeding permit		
Water discharge permit			Building permits		
Water extraction permit					
Borehole permit					

Do you stay up to date with your licensing requirements? **Yes No.**
If yes, which permits, or licenses do you regularly keep up-to date with and why?
……
……
……
If not, why not?
……
……
……..

Description of the Production System

		REMARKS
Setting	Land-based Water-based Lake river man-made dam swamp dry land	
Nature of Farm	Hatchery Grow-out Broodstock (breeder) Research/training facility	
Total fish farm area (please give units used)		
Type, number and size of production units on the farm	Cages Hapas Ponds Tanks RAS	
Species reared	**Commercial species** Tilapia *(Oreochromis niloticus)* African catfish *(Clarias gariepinus)* Mirror carp *(Cyrpinus carpio)* *Koi carp* *Gold Fish (* **Research species** *Bagrus docmac* *Alestes baramose* *Labeo victorianus* *Nile Perch*	
Are there wild fish within your farm	Yes No Tilapias African catfish Others (mention if you know names) Others	

Source of water to farm for fish production	River/stream Lake swamp Spring well Bore-hole. Man-made dam Roof-trapped rainwater Tap water. Irrigation canal Drainage from another farm (circle fish, livestock, industry, residential area) other	

Production

What was the estimated average annual production over the three years.

Species	**Fry (no.)**	**Fingerlings (no.)**	**Table fish (kg)**	**Broodfish (no.)**

Feeds and feeding

Name the feeds you use specifying their source?

Are the feeds used labelled? **Yes No**

How is feed transported to the farm?.....

How is feed stored on the farm?

……

…….

Generally, what is the average turn-over time for each consignment of feed you receive on the farm (i.e. per month)?.....

Do you import fish feed? Yes No. *If so, where from and what brand?*

.....

What feed records or records related to feeding do you routinely maintain on the farm?

Batch number on label

Feed manufacturer and/or supplier

Source of feed

Source of ingredients (if you make your own feed)

Type of feed

Receipts of purchase and/or delivery notes

Date received.

Amounts of feed fed to each production unit daily.

Daily Feeding response for each production unit.

Species being fed.

Age group being fed.
Management in units during production
Water quality
Incidences of feed spoilage

General Management Practices

Age Group	**Production Unit**	**Level of Management**	**Type of Feeds Used**	**Sources of Feed**	**Remarks** *(i.e. brand name, comments on feed quality and availability; slaughter waste – fish, poultry, pigs, cattle, etc.)*
Eggs	Cages Hapas Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Extensive Semi-intensive Intensive Aeration Flow through Static water Water re-use	None Farm residues Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	On-farm Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	
Larvae	Cages Hapas Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Extensive Semi-intensive Intensive Aeration Flow through Static water Water re-use	None Farm residues Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	On-farm Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	
Fry	Cages Hapas Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Extensive Semi-intensive Intensive Aeration Flow through Static water Water re-use	None Farm residues Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	On-farm Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	
Fingerlings	Cages Hapas	Extensive Semi-intensive	None Farm residues	On-farm	

	Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Intensive Aeration Flow through Static water Water re-use	Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	
Table fish	Cages Hapas Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Extensive Semi-intensive Intensive Aeration Flow through Static water Water re-use	None Farm residues Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	On-farm Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	
Broodstock	Cages Hapas Hatchery jars Ponds Tanks RAS *(i.e with biofilter)*	Extensive Semi-intensive Intensive Aeration Flow through Static water Water re-use	None Farm residues Supplementary meals nutritionally complete powder/crumbles cooked dough sinking pellet floating pellets live feeds fresh animal slaughter waste	On-farm Small-scale (unmechanized) Small-scale (mechanized) Industrial manufacturer Imported Locally produced. Trading center Other farmers	

Record Keeping

Which records do you keep?

None

Inputs (their entry and use on farm)

Production management

Feeding

Health

Sales and expenses

Status of record keeping: **rarely done** **routinely done** **irregular but frequent**

If you keep health records, may we take a look and copy of a page of the health records kept.

Methods for and Records Kept on Fish Health Status and Disease Incidences

What makes you notice that your fish may not be feeling well or are sick (have a disease)?

	Explain
Changes in behavior	
Changes in physical appearance	
Mortality patterns	
Changes in movement	
Reduced feeding	
Environmental changes (weather)	
Changes in water quality	
Other	
Other	

Mention the fish diseases have you encountered on your farm and how you identified them?

Name of disease *(indicate fish species affected)*	**Diagnosis**	**Who advised**	**Describe details on diagnosis**	**When did the disease occur/how frequent?**
	Behavior Appearance Mortality Water quality Weather Feeding patterns Laboratory PM Record trends Signs in wild fish Species Age group	Self Another farmer fisherman Extension worker Vet Internet Input supplier other		
	Behavior Appearance Mortality Water quality Weather Feeding patterns Laboratory PM Record trends Signs in wild fish Species Age group	Self Another farmer fisherman Extension worker Vet Internet Input supplier other		
	Behavior Appearance Mortality Water quality Weather Feeding patterns Laboratory PM Record trends Signs in wild fish Species Age group	Self Another farmer fisherman Extension worker Vet Internet Input supplier other		
	Behavior Appearance Mortality Water quality Weather Feeding patterns Laboratory PM Record trends Signs in wild fish Species Age group	Self Another farmer fisherman Extension worker Vet Internet Input supplier other		

	Behavior Appearance Mortality Water quality Weather Feeding patterns Laboratory PM Record trends Signs in wild fish Species Age group	Self Another farmer fisherman Extension worker Vet Internet Input supplier other		

Have you ever had samples of sick fish sent to a lab? **Yes** **No**
If yes, which lab, who took the samples?

Disease symptoms observed *(also indicate fish species affected)*	**Name of lab where diagnosis was done (also indicate location)**	**Which samples were submitted?**	**How were they submitted?**	**Who collected (C) the sample and/or who took (T) the samples to the lab:**			**Did you fill a form at the lab**	**Lab costs if any**
		Live Freshly dead, whole Dead, whole Tissue Water parasites	ambient temperature chilled in kavera chilled in cool-box preservative labelled bus/taxi designated vehicle boda boda	self friend extension worker destination lab specialist/vet	**C**	**T**	yes no received ref. no	
		Live Freshly dead, whole Dead, whole Tissue Water parasites	ambient temperature chilled in kavera chilled in cool-box preservative labelled bus/taxi designated vehicle boda boda	self friend extension worker destination lab specialist/vet	**C**	**T**	yes no received ref. no	
		Live Freshly dead, whole Dead, whole Tissue Water parasites	ambient temperature chilled in kavera chilled in cool-box preservative labelled bus/taxi designated vehicle boda boda	self friend extension worker destination lab specialist/vet	**C**	**T**	yes no received ref. no	
		Live Freshly dead, whole Dead, whole Tissue Water parasites	ambient temperature chilled in kavera chilled in cool-box preservative labelled bus/taxi designated vehicle boda boda	self friend extension worker destination lab specialist/vet	**C**	**T**	yes no received ref. no	

Which are the commonest diseases (or parasites) that have occurred in your establishment? And of these which do you consider the most important *(i.e., the ones you never want to have and if they occur, you think must be controlled or eradicated immediately)*. Please rank in either case.

Commonest disease *(also indicate species of fish affected)*	**Rank**	**Most important disease** *(also indicate species of fish affected)*	**Rank**	**Reason for level of importance**

What information do you collect and record whenever there are indications that fish may be stressed or sick on your farm?

None	Changes in physical appearance
Date	Changes in social behavior
Age group	Changes in movements
Species	Symptoms
Production unit ID	Parasites if any
Water quality changes	Changes in weather
Changes in feed consumption	Mortalities
Predators	Other environmental changes (e.g., floods, wild fish, etc.)
Results from diagnostic tests (e.g. PM, lab results if done)	Name of condition
Control measures used in each case	Other

When there is a disease incidence on your farm, whom do you consult for help and how to you contact them including to obtain feedback?

Whom do you call	Rank order of importance	Explain ranking	Communication Channels used
Self			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Another farmer			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Farmers association (whats app gp)			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Fish traders/fishermen			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Local extension ……			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Fisheries dept (Entebbe)			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
MAK (name specific department)			Go to meet them physically. Phone call Social networks/group online Relay request through second party

			Email
NARO (name specific institute or station)			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email
Others *(please mention)*			Go to meet them physically. Phone call Social networks/group online Relay request through second party Email

Do you share records of disease cases with anyone? *Under what circumstances/why*

……
……
……

Disease Prevention Measures

What do you do to prevent the disease(s) mentioned occurring or recurring on your farm (in general and for the specific ones you have mentioned)?

……
……
……
……

Disease Control Measures

What do you do to control the progression or spread of disease mentioned on the farm or into the environment (in general and for the specific ones you have mentioned)?

……
……
……
……
……

Waste disposal and Management

How do you dispose of dead fish on the farm *(i)* under normal conditions and/or *(ii)* when there's a disease incidence on the farm? *Do you keep records of this?*

……
……
……

How do you dispose of the effluent from production units with sick fish? *Do you keep records of this?*

……
……
……

Marketing of Fish Farm Produce

What transportation methods are used for farm products to market?

Product	**Mode of transport to market**										
	Open container	Closed container or bag (not insulated)	Closed container (insulated)	Walk to market	bicycle	Boda-boda	Truck - ordinary	Refrigerated truck	Boat-ordinary	Well-boat	(other e.g. air)
Live											
Fresh: whole/fillets/chunks											
Chilled on ice: whole/fillet/chunks											
Smoked: whole/fillet/chunks											
salted											
fried											
other											

Do you keep records on fish transportation and if so, what records do you routinely maintain whenever to transport farmed fish or products to market?

Never	Destination
Sometimes	Transport method
Yes I keep records whenever I transport fish to market	Stops/incidences during transportation
Date	Mortalities
Batch no (from production)	Water quality
Copy of delivery/receipts	Refrigeration
Species	Others
Age group	
Number	
Average weight	
Product	
Clients contact	

Is your farmed produce ever inspected once at the market? Did you get a certificate of inspection?

Product *(also indicate species for each category)*	**Market**	**Is it inspected; if so what for?**	**Do you get certificate**	**Are you charged? How much?**
Live	Local food market Another farmer Processing plant Restaurant/hotel Neighbors Export (regional) Export (international) other			
Fresh	Local food market Another farmer Processing plant Restaurant/hotel Neighbors Export (regional) Export (international) other			
Chilled on ice	Local food market Another farmer Processing plant Restaurant/hotel Export (regional) Export (international) Neighbors other			
Smoked	Local food market Another farmer Processing plant Restaurant/hotel Neighbors Export (regional) Export (international) other			
salted	Local food market Another farmer Processing plant Restaurant/hotel			

	Neighbors Export (regional) Export (international) other			
fried	Local food market Another farmer Processing plant Restaurant/hotel Neighbors Export (regional) Export (international) other			

Traceability

Are you able to track each cohort of fish on the farm down to its source, production and health inputs and management practices used for each cohort? **Yes No**

How do you do this?

None

Records kept.

Record batch numbers of inputs from suppliers

Allocate batch numbers to cohorts.

Depend on dates of delivery and supply.

Indicate and maintain initial cohort batch numbers on sales/delivery notes; and all documentation pertaining to the batch.

Allocate new independent batch numbers to sales/delivery notes (different from those used during the production process)

Others *(mention)*

What are your suggestions, from the farmers perspective on?

Quality and access to services for the diagnosis and control of fish diseases?

……

……..

What improvements, if any, would you like to see made?

……

……

Do you think it's a good idea to have a national fish disease monitoring, control and surveillance system in place? **Yes No**

Explain

……

……..

How would you like to benefit (your expectations) from a fish disease surveillance and control program?

……

……

……..

How do you think you (other farmers too) can participate and/or contribute to ensure that a national fish disease reporting and surveillance program runs efficiently and is effective?

……

……

Any other comment/suggestions.

……

……

3.2. Laboratories

Questionnaire. No.	Date: Time:	Interviewers Name:

The purpose of this survey questionnaire is to collect specific data on laboratory diagnosis of fish diseases in order to provide guidelines to establish and/or integrate aquatic animal disease MSC data into the national veterinary epidemiology and animal health LIMS structure. The data collected by this questionnaire will be used to obtain an understanding of:

The basic practices, procedures and laboratory standards that guide sample collection comprehensively for aquatic animal disease diagnosis (water, fish, fish products, environment, etc.) and how the laboratory and farmers/extension/veterinary services interact,
The organization of the laboratory and its capabilities for fish disease diagnosis.
The laboratories capacity to isolate and identify pathogenic agents, especially those of aquaculture importance to Uganda; including antimicrobial sensitivity testing.
Laboratory data – how its obtained, stored, what information can be extracted for MCS and data communication outside the laboratory.
Nature of lab services and current laboratory diagnostic standards used for quality assurance.

It will take about an hour and a half of your time to fill. Thank you for your cooperation.

I agree to take part in the survey and understand that the data collected will only be used for the purpose stated therein and will be kept confidential.

Respondents Name: ……
Respondents Job Title: ……
Respondents contacts: Tel: ……
Email: ……..
Respondents Signature: …… **Date:** ……

Laboratory details

Name of laboratory:	
Contact:	**Official Tel: …….** **Email contact: …….** **Website: …….**
Location	**Town: …….. District:……..**
Contact person	**Name: ……** **Position: …….** **Tel: …….** **Email: ……**

(ii) **Lab category**

Category		**Ownership of the Lab**		**Average monthly no.**	
	General laboratory services rendered	**Private Sector**	**Govern-ment**	**Clients**	**Samples**
Local *(i.e. at district, company, individual levels)* Regional (in-country) AH	Water quality Aquatic animals Terrestrial animals Feedstuffs & /ingredients				

University/research laboratory National reference laboratory Regional reference laboratory *(cross-border eg. EAC, COMESA area)*	Disease diagnosis Environmental Food-safety Other				

Who are the laboratory's clients? *Producers, advisors, industry, government, research/training institutions, etc.*

Collaborations

Does the laboratory participate in any national or regional animal health research or surveillance program? **Yes/No.** *If yes, mention the program(s) are you involved in.*

Animal health Diagnostics	**National Programs**		**Regional Programs**		**Name/details of the monitoring or surveillance program** *(e.g. the disease(s), etc)*	**Diseases the surveillance monitors**				**Name and contact of other labs you work with in these programs**
	research	surveillance	research	surveillance		Endemic	zoonoses	transboundary	environmental	
fish										
livestock										
poultry										
wildlife										
water quality										

Is your laboratory part of a surveillance network? **Yes No** If yes, please describe the surveillance network or laboratory information system?.

Does the laboratory collaborate with other laboratories for the purposes of fish disease diagnosis and surveillance? **Yes No** If so, please list the laboratories you collaborate with.

Name of lab and institutional contact	**Type of collaboration**	**Remarks**

Are there any national or international institutions that have provided support to this laboratory in the last 5 years? **Yes No.** If yes, please describe the nature of support and/or training provided. *Add additional rows if required.*

Name of Institution	
Years	
Support provided.	
Name of Institution	
Years	
Support provided.	
Name of Institution	
Years	
Support provided.	

How is the laboratory funded? **Single source Multiple source** *(if multiple, indicate in each ticked box the relative proportion)*

Government budget	Research grants
Client/user fees	Donor funds
Charity organizations	Company funds
Other	Other

Does the laboratory have official accreditation? **Yes No** *If Yes, from who? and for which aspects?*

……

……

Laboratory Infrastructure

Human Resources

Describe the composition of your staff?

Staff category	**No. of staff**	**Qualifications in each category (***none, certificate, diploma, BSc., Masters, PhD, etc)*	
		Lowest	**Highest**
Laboratory manager			
Laboratory scientists			
Laboratory technicians			
Quality assurance manager			
Administrative support			
IT support			
Non-technical support staff (e.g. cleaners)			
Students (post-grad and interns)			

Others (please specify)			
TOTAL			

What is the scope of diploma/degree laboratory training technician(s) working in your laboratory? *Please tick*
Fisheries/aquaculture production
limnology
Bio-medical
General laboratory
animal production
For your current workload, are you adequately staffed? **Yes No** Please explain.
……
……
Does the facility have HR policies on in-service training? **Yes No** Please Describe
……
……
If not, how are staff kept up-to date on laboratory diagnostic procedures and best practices?
……
……
Infrastructure
Basic infrastructure

Item	**Remarks (e.g. number, status, adequacy, etc.)**
Live fish holding	
Benches	
Climate control/AC units	
Preparatory rooms (e.g. media, stock, etc.)	
others	

Source and quality of water
Major source of water to the facility: **portable water (NWCS) borehole rain water (roof) none other (specify)**
Does the laboratory have the capacity of produce laboratory grade water?
If so, which type? **Distilled, de-ionised**, ……
Electricity supply

Category	**Description**	
Good	Good main grid electricity supply Supply interruptions infrequent and less than 2 hours on average Voltage fluctuations rare	
Fair	Fair main grid electricity supply Interruptions frequent and 2-4 hrs average Voltage fluctuation rare	
Poor	Poor grid supply e.g. on alternate days for 10-12 hours per day Frequent interruptions and for more than 4 hours Voltage fluctuations common	
Very poor	Unreliable grid supply with less than 10 hours per day supply Frequent interruptions and for more than 4 hours each time Voltage fluctuations common	
Backup systems	What back-up system is in place	Generator Solar None
	Is laboratory back-up system separate from institutional back-up system	Yes/No
	Is it reliable	Yes/No
	Is all essential equipment (e.g. incubators, freezers, etc.) connected to back-up systems	Yes/No

Sample storage
Does the lab have:

Storage Equipment	No	Yes		Records to Monitor temperature	
		Not functional	functional	Yes	No
4-8°C storage					
-20°C/-40°C storage					
-80°C storage					
Cool-boxes and ice-packs					

Sample transportation
What procedures are used to collect or send samples for confirmatory testing to other laboratories for fish disease diagnosis?

Do not go get samples from sites	Frozen sample sent on ice
Do not send samples to other labs	Fixed samples
Live fish	Agar slopes/stabs
Chilled on ice	Freeze dried
Other (specify)	(other specify)

Information and communication technology
Does the laboratory have:
A functional computer for entering routine laboratory work and results?
Adequate internet access?
A backup system for data backup?
Biosafety and Biosecurity
What is the biosafety level classification of your laboratory as per CDC/WHO standards?
……..
Does the laboratory need/have an access system (i.e. restricted entry)?
Do you have a biosafety cabinet, and if so which class?
Is the biosafety cabinet:
Regularly certified (BSC). ***Yes No***
Filters replaced regularly. ***Yes No***
Cabinet fumigated? ***Yes No occasionally***
What personal protective equipment are routinely available? **Gloves lab coats safety goggles hand sanitizer**, **first aid kits, fire extinguishers, safety showers,** etc.
What methods are used for disposing of solid infectious waste (please describe and indicate guidelines used (none, local, national, international)?
……..
……..
What methods are used for disposing liquid infectious waste (please describe and indicate guidelines used (none, local, national, international)?
……
……
What is the procedure used for discarding expired reagents?
……
……
Is effluent from the laboratory monitored? **Yes No.** If so, what is monitored and by whom?.....
Do you have an incinerator?
Diagnostic Capabilities
Basic tools and equipment (please list).
benches
microscopes (e.g. oil immersion light, inverted, electron, field light, etc.)
autoclaves – media preparation
autoclave – waste management
incinerator
centrifuge
lab glass washers

electrophoresis equipment
water distillation
water dioniser

Laboratory Capabilities for disease diagnois

Diagnostics	**Assessments/Samples**				**Tests Used**			**Specify test Quality Assurance Standards followed**
	water	**Animal/fish tissues**	**Feeds**	**Environ *(soil, surfaces***	**Field kits**	**routine**	**specialized**	
Clinical examination								
Water quality characteristics								
Algal profiles								
Farm environment								
Gross pathology								
Hematology								
Microbiology								
A**ST**								
Parasitology								
Virology								
Toxicology								
Histopathology								
Mycology								
Immunological/serological tests								
Clinical biochemistry								
Molecular Diagnosis								
Radiography								
Feeds (general profiles – e.g. DM, CP, CF, EE)								
Feeds (aflatoxins)								
Feeds (micronutrients)								
Health assurance testing								

Laboratory Protocols
Does the laboratory have a manual of all protocols used? **Yes No**
If yes, what does it contain?
Sample collection and receiving of samples.
Maintenance and calibration of equipment
Diagnostic procedures used.
Biosafety and biosecurity protocols including for staff.
Record keeping
Information (including data) Management and communication
Lab fees
others.

Data Management

Data collection and storage

Do you have a standard laboratory request form that all clients requesting laboratory services must fill in? **Yes No (***If yes, please share a copy with us. If not, what is normally done?*

……
……

Does the laboratory maintain a logbook of all laboratory requests done, and results found? **Yes No** (*If yes, please share a copy with us. If not, what is normally done?*

……
……

Are all tests done within this laboratory? **Yes No**
If not, where else are samples sent and for what tests outside this laboratory?

……
……

Do you have a laboratory computer(s) to store data and all data management in centrally managed? **Yes No**
If yes, is it centrally managed? *Explain*

……
……..

Which program(s) do you use for data management?

……

How often is data entered into the data system or logbook?
Daily weekly monthly other

Communication and Reporting of Diagnostic Results
How do you communicate results to the client?
Paper report, E-mail, text messages, WhatsApp, verbal only

……
……..

How do you interact, communicate, and provide technical support clients when results come out? *Specify in either case– farmers, field extension/vet,*

……
……
……

What is the interaction between your laboratory and other diagnostic laboratories?

……
……

Data sharing outside the Laboratory
Does the laboratory share data on aquatic diseases to the regional center and/or Ministry? **Yes No**

To whom are results reported	
How are results reported	Via LMS Paper report E-mail Text message WhatsApp

	Phone call/verbal Not reported Formal reporting system
When do you send reports?	As and when results have been obtained. Regular Quarterly or annual reporting Only when find or suspect notifiable conditions? Other *(specify)*
What do you report?	No of laboratory requests only Type of requests made. Results obtained. Tests done. Other *(specify)*
Is there a *liaison person* for supervisory purposes on diagnostics with the LIMS and/or Ministry?	Yes No If so, whom?
What sort of interactions does the lab have with the *liaison person*?	None other than sending the reports mentioned above. Support on interpretation of results Regular supervisory and/or advisory Ad Hoc interactions Workshops/meetings for laboratory personnel (examples)……
Other activities the laboratory is engaged in	Training Research Regular Government surveillance programs

Pathogens

Please list (share) your diagnostic results you have obtained associated with aquaculture production systems and their environment *(pathogens isolated from production units, water sources/effluent to/from farms and farmed fish products).*

Pathogen or parasite	**Rank**	**Tests Used**	**Summary case notes (***eg. season, species, type of farm, age etc, if available)*

General Comments/Remarks

……
……
……
……

3.3. Checklist(s) for Key Stakeholders

The purpose of this survey questionnaire is to collect specific data on the detection, prevalence, control and impacts of fish diseases in aquaculture production systems. The data collected by this questionnaire will be used to:

Identify the diseases of economic importance within Uganda's aquaculture sector,
Develop monitoring, control, and surveillance systems to mitigate against their occurrence and spread in aquaculture establishments.
Develop guidelines to support producers meet phyto-sanitation and market certification requirements for regional and international trade.

It will take about an hour and a half of your time to fill. Thank you for your cooperation.

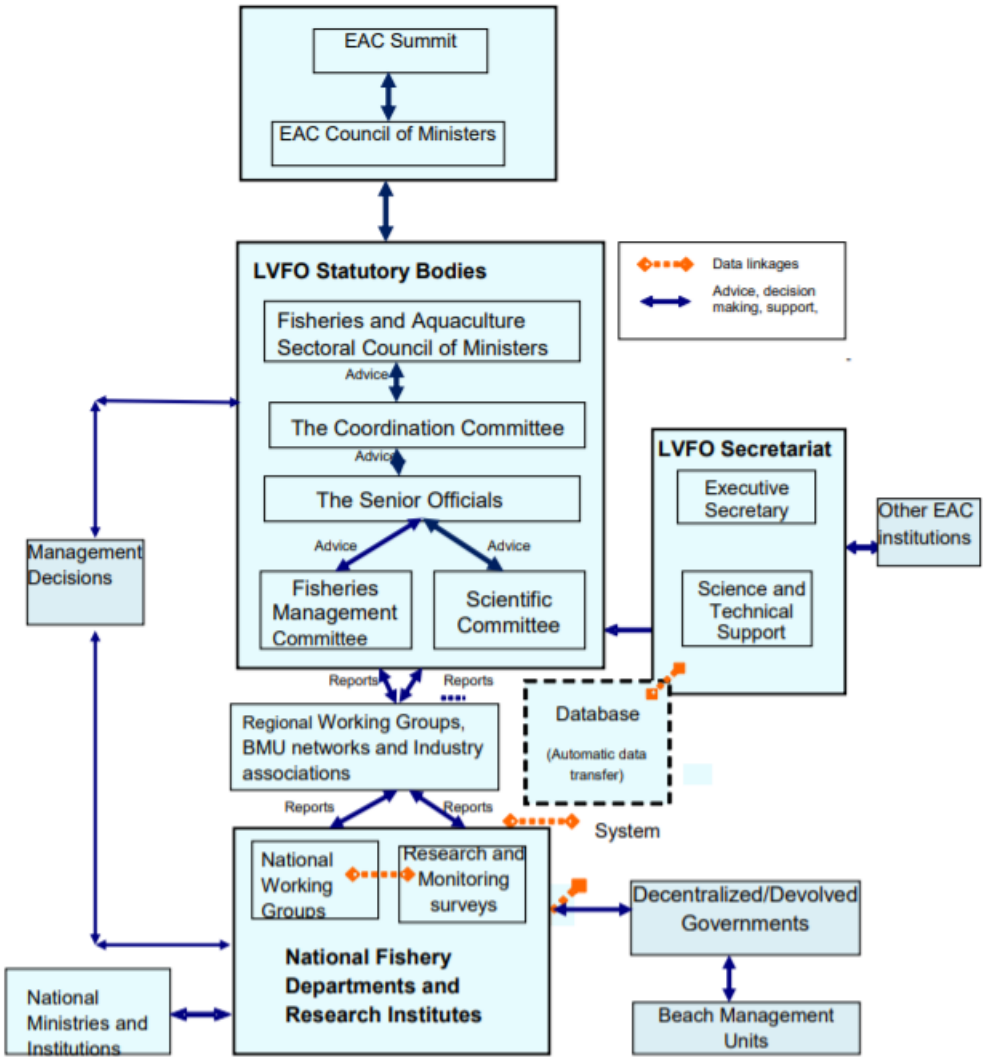
I agree to take part in the survey and understand that the data collected will only be used for the purpose stated therein and will be kept confidential.

Date:
Name and contact of respondents.
Name of Institution and department
Designation of respondent
What is the role and responsibilities of your institution in?
Aquaculture production
the detection and control of aquatic animal diseases

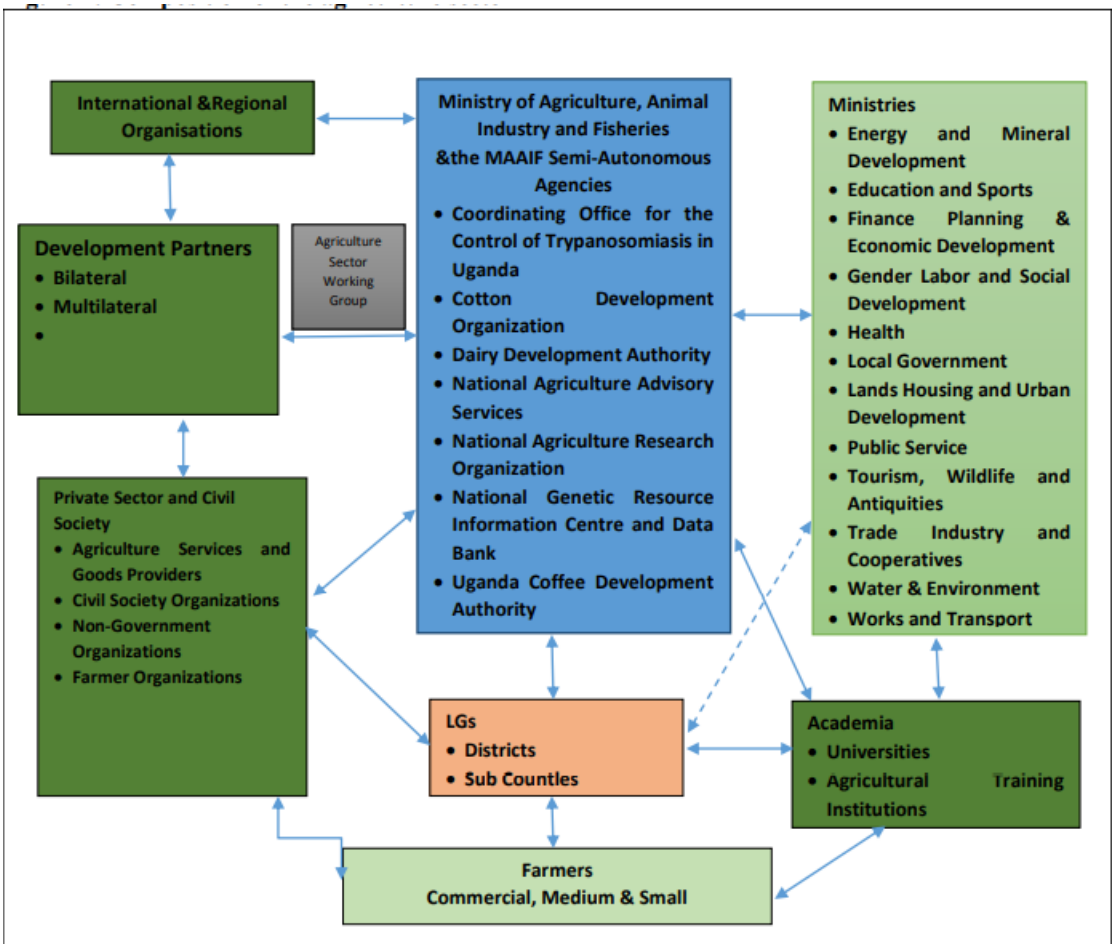
If your are a *Policy management, training, research, extension, disease surveillance, diagnosis and control scope of service provided (national, regional, local) etc.??*

training institution, principally what courses do you offer?
Farm managers
Laboratory technicians
Academic training
Farmers
Short-courses, professional
Do you have any documents to share?
Policy documents, official guidelines, certification schemes, reporting structures.
Reports from studies, needs assessments, evaluations, etc.
On-going work/programs in fish disease control
Outreach programs
Etc
What are you views on the status and prospects for fish disease control within the country and region?

APPENDIX 4. Institutional Set-Up and Linkages of LVFO



APPENDIX 5. Institutional Linkages of the Agricultural Sector



APPENDIX 6. Regulations for Inland Transfer of Animals

NINTH SCHEDULE

Rule 16 (5)

THE REPUBLIC OF UGANDA

FORM C

APPLICATION FOR FISH TRANSFER IN UGANDA

Name .....

Establishment .....

District .....

Sub-county .....

Species to be transferred .....

Numbers of species .....

Origin of species (lake, valley dam, ponds, or other)

Final destination .....

Purpose for which fish is transferred .....

.....

Evidence of adherence to all the quarantines .....

.....

Fees paid (Shs) .....

.....

Signature of Applicant

Date.....

Original: Applicant
Duplicate: District Fisheries Officer
Triplicate: Department of Fisheries Resources

TENTH SCHEDULE

Rule 16 (4)

THE REPUBLIC OF UGANDA

FISH TRANSFER PERMIT

This is to permit .....of .....District, ...Sub-county to transfer fish of species .....from ..... to ..... in quantities of.....(kilos/numbers)

Fees paid (Shs) .....

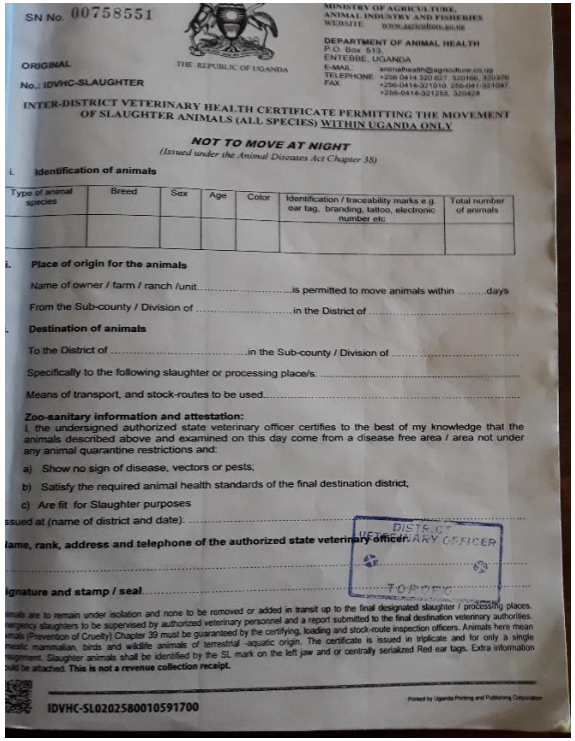
.....

Chief Fisheries Officer

Date .....

Original: Applicant
Duplicate: District Fisheries Officer
Triplicate: Department of Fisheries Resources

Above: Requirements for the transfer of fish within Uganda *(Aquaculture Rules, 2003).* Evidence of adherence to 'all the quarantines' are referred to in the Ninth Schedule. However the Rules have no definition of what a quarantine is nor what the evidence required to show 'adherence'



SN No. 00758551

ORIGINAL

THE REPUBLIC OF UGANDA

MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES
WEBSITE: www.agriculture.go.ug

DEPARTMENT OF ANIMAL HEALTH
P.O. Box 513
ENTEBBE, UGANDA
E-MAIL: animalhealth@agriculture.co.ug
TELEPHONE: +256 0414 320 627, 320166, 320376
+256-0414-321010, 256-041-321047,
FAX: +256-0414-321255, 320429

No.: IDVHC-SLAUGHTER

INTER-DISTRICT VETERINARY HEALTH CERTIFICATE PERMITTING THE MOVEMENT OF SLAUGHTER ANIMALS (ALL SPECIES) WITHIN UGANDA ONLY

NOT TO MOVE AT NIGHT

(Issued under the Animal Diseases Act Chapter 38)

i. **Identification of animals**

Type of animal species	Breed	Sex	Age	Color	Identification / traceability marks e.g. ear tag, branding, tattoo, electronic number etc	Total number of animals

ii. **Place of origin for the animals**

Name of owner / farm / ranch /unit.....is permitted to move animals within .....days

From the Sub-county / Division of .....in the District of .....

iii. **Destination of animals**

To the District of .....in the Sub-county / Division of .....

Specifically to the following slaughter or processing place/s. .....

Means of transport, and stock-routes to be used.....

Zoo-sanitary information and attestation:

I, the undersigned authorized state veterinary officer certifies to the best of my knowledge that the animals described above and examined on this day come from a disease free area / area not under any animal quarantine restrictions and:

a) Show no sign of disease, vectors or pests;

b) Satisfy the required animal health standards of the final destination district;

c) Are fit for Slaughter purposes

ssued at (name of district and date): .....

lame, rank, address and telephone of the authorized state veterinary officer:

DISTRICT VETERINARY OFFICER TORORO

ignature and stamp / seal.....

imals are to remain under isolation and none to be removed or added in transit up to the final designated slaughter / processing places. ergency slaughters to be supervised by authorized veterinary personnel and a report submitted to the final destination veterinary authorities. imals (Prevention of Cruelty) Chapter 39 must be guaranteed by the certifying, loading and stock-route inspection officers. Animals here mean mestic mammalian, birds and wildlife animals of terrestrial -aquatic origin. The certificate is issued in triplicate and for only a single signment. Slaughter animals shall be identified by the SL mark on the left jaw and or centrally serialized Red ear tags. Extra information ould be attached. **This is not a revenue collection receipt.**

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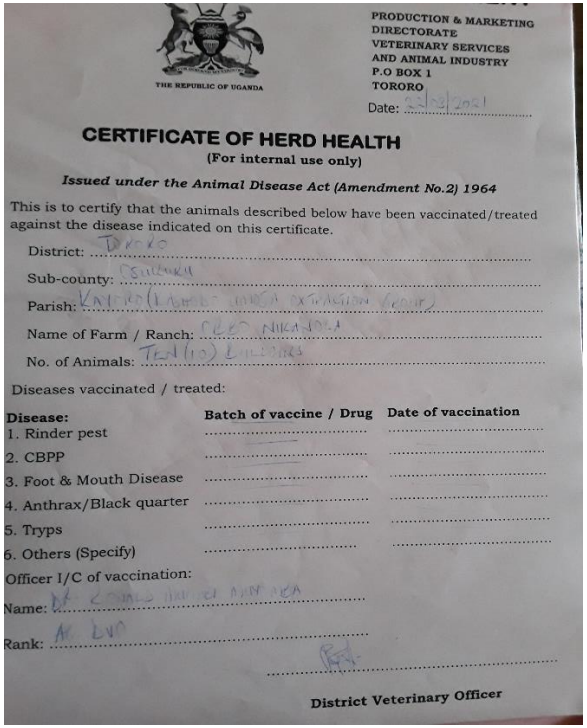


THE REPUBLIC OF UGANDA

PRODUCTION & MARKETING
DIRECTORATE
VETERINARY SERVICES
AND ANIMAL INDUSTRY
P.O BOX 1
TORORO

Date: 22/03/2021

CERTIFICATE OF HERD HEALTH

(For internal use only)

Issued under the Animal Disease Act (Amendment No.2) 1964

This is to certify that the animals described below have been vaccinated/treated against the disease indicated on this certificate.

District: TORORO

Sub-county: .....

Parish: .....

Name of Farm / Ranch: .....

No. of Animals: .....

Diseases vaccinated / treated:

Disease:	Batch of vaccine / Drug	Date of vaccination
1. Rinder pest	.....	.....
2. CBPP	.....	.....
3. Foot & Mouth Disease	.....	.....
4. Anthrax/Black quarter	.....	.....
5. Tryps	.....	.....
6. Others (Specify)	.....	.....

Officer I/C of vaccination:

Name: .....

Rank: .....

District Veterinary Officer

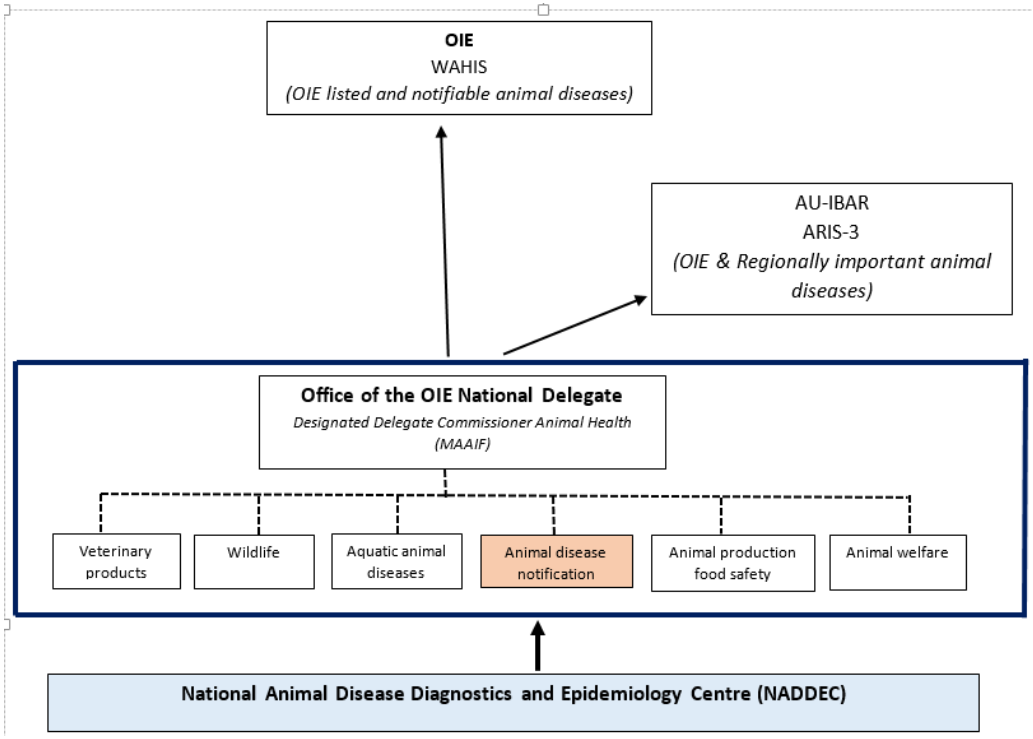
Below: Requirements for the transfer of animals under the *Animal Disease Act (Cap 38)*

APPENDIX 7. Stakeholders and their Designated Institutional Roles

Stakeholders	Roles/Responsibilities	Responsibilities
Primary Stakeholders		
Commissioner Animal Health	*OIE Delegate, Uganda* • Designated to notify OIE on animal diseases in the country in accordance to both the Terrestrial and Aquatic Animal Codes. • Ensure animal health legislation in the country is based on OIE reference standards or scientific risk analysis in accordance with the Terrestrial and Aquatic Animal Health Codes, and WTO/SPS Agreement. • Ensure that resolution of World Assembly of Delegates are applied • Ensure Veterinary Services are kept updated on OIE standards. • Maintain informed the national animal disease diagnostic laboratories of activities of OIE's worldwide network of Reference Laboratories and Collaborating Center's to promote scientific and technical cooperation in this field. • Designate (if possible) national focal points; and support them comply with national obligations. There are 6 positions for national focal points under the delegate (see figure….). • Determines what level of WAHIS access to give each of the respective national focal points (Elacher-Vindel, 2019)	• OIE delegate is the 'unique' or 'only' official representative of the country. • All information submitted to the Delegate for reporting done through the 'Animal Disease Notification focal point' who according to OIE recommendations be the person responsible for the National Epidemiology Unit (i.e. in Uganda's case NADDEC). • After verification through NADDEC, reported to 'Officer of the OIE Delegate'.
Commissioner Aquaculture	*As Competent Authority Aquaculture* To support sustainable, market-oriented fish production and value addition; for improved food security and household income. • Formulate, review, and implement policies, legislation, standards, plans and strategies on fish production and value addition • Provide guidance on the transfer of improved and appropriate fish production technologies to service providers, processors, traders and consumers • Establish and operationalize collaborative frameworks with national, regional and international fisheries research institutions and organizations to ensure sustainable development of the sub sector • Provide quality assurance on advisory services relating to fish production • Build capacity of service providers on fish production • Provide guidance and promote the use of improved fish fry and fisheries stocking materials and sustainable natural resources management	

Stakeholders	Roles/Responsibilities	Responsibilities
	• Conduct fisheries surveillance (fish aquaculture) in the country for the development of the fisheries industry (MAAIF, ..) *As OIE Aquatic Animal Health Focal Point* • Communicate with country's network of aquatic animal health experts • Establish dialog, cooperation and communication with CA for aquatic animal health and relevant authorities • Support collection and submission of aquatic animal disease information to OIE • Receive reports and conduct in-country consultation processes of Aquatic Animal Health Standards Commission • Prepare comments for the Delegate (CAH)on relevant meeting reports, including comments on proposals for new or revised OIE standards related to aquatic animals (Elacher-Vindel, 2019)	
Principal Fisheries Officer	• Provide linkage, information flow and collaboration with MAAIF in general and the Directorate of Fisheries Resources in particular. • Ensure control of fish diseases, aquatic weeds and pests. • Ensure inspection and certification of fish and fish products, vessel and vehicles transporting fish and fish products. .(Local Government, 2017)	
Senior Fisheries Officer	• Identify and report fish pests, aquatic weeds and disease outbreaks. • Supervise fisheries establishments including collecting and sending samples to referral laboratories. • Monitor fish stocks in natural water bodies and fish farms in collaboration with research institutions and MAAIF. • Collect, collate, analyse and disseminate data on fisheries sub sector. • Conduct monitoring, control and surveillance in the fisheries sub sector in the district. • Support fish inspection and certification activities in the district. • Prepare and submit activity reports to the supervisor .(Local Government, 2017)	
Fisheries Officer (Aquaculture)	• Identify and report fish pests, aquatic weeds and disease outbreaks. • Collect and send samples of fish, pests, feeds, sediments and water to referral laboratories. • Collect, collate, analyse and disseminate data on aquaculture production and development. 6. Participate in monitoring, control and surveillance in the fisheries sub sector in the district.	

Stakeholders	Roles/Responsibilities	Responsibilities
	• Support fish inspection and certification activities in the district. .(Local Government, 2017)	
Fisheries Officer (Sub-county Level)	• Management of fish health measures:- *(i)* Active fisheries Disease Surveillance, i.e. collection of various samples for laboratory Investigations. *(ii)* Prompt reporting and mitigation of fish disaster outbreaks such as poisoning, and use of explosives. • Create awareness and enforcement of fisheries laws, regulations and standards through inspection, issuance of permits and certificates at landing sites, markets and processing plants.(Local Government, 2017)	
Fish Farmers	• Detect when animals are not well	
Fish Traders and transporters		


OIE
WAHIS
(OIE listed and notifiable animal diseases)
AU-IBAR
ARIS-3
(OIE & Regionally important animal diseases)
Office of the OIE National Delegate
Designated Delegate Commissioner Animal Health (MAAIF)
Veterinary products
Wildlife
Aquatic animal diseases
Animal disease notification
Animal production food safety
Animal welfare
National Animal Disease Diagnostics and Epidemiology Centre (NADDEC)

APPENDIX 8. Animal Health Permits, Kenya

PERMIT PAYMENTS - DIRECTORATE OF VETERINARY SERVICES

Organization	Permits/licenses e.g. COC	Payment document e. g invoice	Dues/Charges/ fees collected	Fixed/ Variable/ %	Currency	Pre/post payment	Manual/ automated
Directorate of Veterinary Services	Import permit for feed consignment	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for fertilizer consignment	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for cattle for breeding, or dog or cat or small game, each or consignment of rabbits	Cash or bankers cheque	500	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for cattle for slaughter, or small wild animals, each	Cash or bankers cheque	20	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for pigs for slaughter	Cash or bankers cheque	15	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for camel for breeding, each	Cash or bankers cheque	350	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for camel for slaughter, each	Cash or bankers cheque	50	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for sheep or goat for breeding, or parrot, each	Cash or bankers cheque	300	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for sheep or goat for slaughter, each	Cash or bankers cheque	10	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for pig or donkey, each	Cash or bankers cheque	200	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for horse or large game, each or consignment of live fish	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for live poultry or poultry egg, each	Cash or bankers cheque	0.50	Fixed	Ksh.	Prepayment	Manual

Page 1 of 3

Directorate of Veterinary Services	Import permit for ostrich or ostrich egg	Cash or bankers cheque	100	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for meat, milk, table eggs, honey & their products	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for wool	Cash or bankers cheque	500	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for trophies with animal-derived products	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit of skins of game	Cash or bankers cheque	2,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for bull semen	Cash or bankers cheque	20	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Import permit for embryo	Cash or bankers cheque	200	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary (health) certificate for live cattle, camel, pig, donkey, each	Cash or bankers cheque	200	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for sheep or goat, each	Cash or bankers cheque	100	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for horse, each or consignment of live fish	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for large game, each	Cash or bankers cheque	1,200	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for small game, dog, cat, each	Cash or bankers cheque	500	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for live poultry or fertile poultry egg, each	Cash or bankers cheque	0.50	Fixed	Ksh.	Prepayment	Manual

Directorate of Veterinary Services	International veterinary certificate for rabbit consignment	Cash or bankers cheque	600	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for live ostrich or ostrich egg, each	Cash or bankers cheque	300	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Application to import or export milk or milk products	Cash or bankers cheque	600	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for milk, meat, honey, table eggs or their products or hides or skins per consignment	Cash or bankers cheque	1,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for wool	Cash or bankers cheque	500	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for skins of game	Cash or bankers cheque	2,000	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for bull semen	Cash or bankers cheque	5	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	International veterinary certificate for embryo	Cash or bankers cheque	200	Fixed	Ksh.	Prepayment	Manual
Directorate of Veterinary Services	Inspection certificate at port of entry	Free	Free	N/A	N/A	N/A	N/A

PREPARED FROM LEGAL NOTICE 98 OF 1998