Promoting Environmentally Sustainable Commercial Aquaculture Project in Uganda

MINISTRY OF AGRICULTURE ANIMAL INDUSTRY AND FISHERIES

CONSULTANCY FOR DEVELOPMENT OF A NATIONAL BIOSECURITY AND BIOSAFETY SYSTEM FOR AQUACULTURE IN UGANDA

Report

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PREPARATION OF THIS DOCUMENT

This report is the outcome of desk work and field investigations related to the development of a National Biosecurity and Biosafety System for Aquaculture 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 over sight by Mr Dave Russell, PESCA TAT. International consultant, Dr David Huchzermeyer, contributed the framework for the NBBSA and prepared the report based on a review of pertinent literature and information supplied by the TAT. The local consultant, Dr John Walakira, undertook the stakeholder consultations around Uganda and collated the data for inclusion in the final report. For details on the recommended components of the NBBSA, the authors have drawn on international literature and guidance from documents used by FAO and OIE for the development of biosecurity strategy and planning in other countries.

EXECUTIVE SUMMARY

The formulation of aquatic animal biosecurity plans flows from a country's aquatic animal biosecurity strategy which in turn is guided, in the case of Uganda, by the commitment expressed by the Government through its Fisheries and Aquaculture Policy. This provides the roadmap for the actions required by the government to implement effective aquatic animal biosecurity. A functional biosecurity plan follows a risk assessment process and is subject to a range of variables such as the particular farmed species (tilapia, catfish, carp, ornamentals, etc.), the particular farming situation (hatchery, grow out, land-based ponds, lake-based cages; etc.) and the objectives of the biosecurity plan (providing specific-pathogen-free (SPF) guarantees for seed stock, protection of brood stock, access to export markets, containment and mitigation of disease losses during grow-out, protection of wild fish stocks, eradication of specific pathogens, establishment of disease free compartments and zones, etc.). Situation-specific and species-specific biosecurity plans are drawn up at farm level with the inputs of multiple stakeholders and can be implemented from farm to national level. Together with the national aquatic biosecurity strategy, these represent the components of the national aquatic animal biosecurity plan of the country.

Disease issues relevant to Uganda have been identified and are reflected in the proposed national list of prioritized diseases. Current diagnostic facilities in Uganda have been identified, and recommendations for expansion of diagnostic capabilities have been provided by the MCS thematic project. Aquatic animal biosecurity awareness and competency needs have been established at various farming levels through stakeholder consultations and use of semi-structured questionnaires. The current legislative and institutional frameworks and existing relevant policies governing aquatic animal health management and biosecurity in Uganda have been reviewed, and are discussed.

From the information collected during the stakeholder consultations (the farm visits), and from the analysis of this information, critical control points have been identified. Amongst others, these include porous borders, inadequate border controls, major water bodies shared with neighbouring countries, and industry pressure to import genetically improved seed stock. These need to be addressed at the level of both the National Aquatic Animal Biosecurity and Biosafety System as well as at the biosecurity plan template (Table 1) level. From this, best management practice (BMP) and standard operating procedures (SOP) can be implemented at both national and farm level. Short- and long-term actions are proposed that address the improved aquatic animal health and biosecurity governance including emergency preparedness and contingency planning. These actions should be implemented rapidly to improve fish health for grow-out in cages and ponds and in hatcheries, to allow the safe importation of genetically improved seed stock, ensure access to international markets, and ensure the economic sustainability of the aquaculture sector in Uganda.

To formulate a biosecurity plan at farm level, Palić, Scarfe & Walster, (2015), of the International Aquaculture Biosecurity Consortium (IABC), have proposed a structured process. This entails a number of well-defined steps that need to be followed when developing and implementing an effective biosecurity programme designed around one or more defined epidemiological units. Such programmes identify relevant infectious diseases that pose significant risk, and are justifiable, practical and economical. The effectiveness of a biosecurity programme in prevention, control and eradication of diseases provides the strongest incentive for implementation. The level of biosecurity achieved is determined by the expected outcome of the biosecurity plan as reflected in a number of different levels that can be achieved. A structured biosecurity approach according to level of required

biosecurity, where each of these levels consists of well-defined formal biosecurity processes or steps, is outlined in Table 1.

Table 1. An integrated approach to effective biosecurity planning for aquaculture. From Palic *et al*., (2015).

Biosecurity level	Biosecurity question	Formal biosecurity steps	Documentation/records (the biosecurity plan)
Level I	*Which diseases pose serious potential hazards?*	Hazard identification and prioritization	Prioritized disease list
	Is an aquaculture operation at risk? How great is this risk? What is the operational impact of this risk?	Risk-impact assessment	Evaluation of disease impacts
Level II	*Where can hazardous diseases gain entry?*	Critical control point (CCP) evaluation	Identification of correctable critical control points
	What can be done to prevent hazardous disease entry or escape?	Mitigation, management and remediation of critical control points	Implementation of critical control point corrective actions
Level III	W*hat should be done if disease gains entry?*	Contingency planning	Isolation, treatment, depopulation plans
	Are any of these diseases on the farm?	Clinical evaluation and diagnostic testing	Farm, laboratory and veterinary records
Level IV	*How to continue ongoing disease monitoring and surveillance?*	Ongoing disease surveillance and monitoring	Farm, laboratory and veterinary records
	How to achieve third party recognition of disease freedom?	Veterinary auditing and certification	Certificate of veterinary inspection
Level V	*How to achieve international recognition of disease freedom?*	Competent Authority (Veterinary Authority) verification and endorsement	Government endorsed certificate of veterinary inspection and disease status guarantees

Whereas commercial producers should aim at achieving at least Level I, II and III to ensure sustainability of their operations, hatcheries should reach Level IV in their biosecurity planning in order to avoid the risk of transferring disease through seed stocks that they sell to other farmers. For hatcheries and producers wishing to export live fish or seed stock, Level V biosecurity needs to be achieved reflecting full compliance with national regulations or requirements and with international

trade agreements and standards. This allows the Competent Authority of the exporting country to issue Animal Health Certificates that reflect freedom from disease guarantees in accordance with the import conditions stipulated by the importing country and provides the greatest incentive for biosecurity planning through access to international markets. The programmes and recommended activities outlined in Chapter 6 of the NBBSA provide the Government of Uganda with the necessary guidance required to achieve all five levels of biosecurity planning, thereby effectively protecting Uganda's natural aquatic resources and the sustainable growth of its aquaculture industry.

The cost of biosecurity planning is highly variable. As part of national and farm level emergency preparedness, risk mitigation practices need to be kept in place constantly, irrespective of whether an outbreak occurs. During outbreaks of disease, the cost of biosecurity is likely to increase. Cost is further influenced by numerous variables linked to the objectives of biosecurity programmes and the level of biosecurity planning that needs to be achieved. Disease surveillance at national, zone or compartment level generates the greatest variable cost and is largely driven by the cost of diagnostic testing that needs to be meet statistically relevant levels in order to achieve the expected outcomes of a biosecurity plan. Difficult to define costs relate to human resource, institutional and infrastructural capacity linked to the Competent Authority where services may overlap with other sectors. At the farm level, operational bio-treatment, hygiene, and veterinary professional inputs have situation-variable costs. As an example, the annual biosecurity costs for production of specific-pathogen-free tilapia seed stock based on three viral diseases is estimated to be in the region of US$ 40 000 – 50 000, excluding costs linked to the Competent Authority (Table 2).

Table 2. Breakdown of estimated annual costs of producing biosecurity Level V-certified specific-pathogen-free Nile tilapia seed stock (based on similar costs incurred in the production of SPF certified salmonid seed stock).

Activity	Estimated cost in US$ per annum
Drafting of surveillance testing protocol	US$ 150.00
Drafting and annual review of farm level biosecurity plan	US$ 300.00
Surveillance sampling – veterinary professional fees. Two six monthly events per annum	US$ 2700.00
Laboratory testing by PCR of samples from 150 fish twice per year per pathogen tested	US$ 9000.00 – 15 000
Drafting of annual biosecurity and surveillance report	US$ 100.00
Drafting of veterinary certificate of inspection	US$ 50.00

ABSTRACT

Governments use policy to outline, broadly, the expected achievements of long-term national programmes including goals and objectives and recommendations for sustainable development of a sector. A strategy provides the mid-term plan that outlines how the results of a national policy are achieved.

This assignment is aligned to the aim of the Fisheries and Aquaculture Policy 2017 of the Republic of Uganda to increase fisheries and aquaculture production to 1.7 million tonnes annually to achieve the United Nations Sustainable Development Goal 2 (to end hunger, achieve food security and improved nutrition and promote sustainable agriculture). Through the Fisheries and Aquaculture Policy, the Government of Uganda s states the political will to establish and implement aquatic animal health and biosecurity protocols as a security measure to protect biological diversity of fisheries and the life support system. However, implementation of these protocols needs to be guided by a relevant biosecurity strategy which is lacking. Guiding principle 5 of the Fisheries and Aquaculture Policy: *The Precautionary Approach* instructs that: '*fisheries and aquaculture management shall be premised on scientific evidence as it applies to the Ugandan context and the lack thereof should never be premise for failure to act in face of risk of serious or irreversible harm to fish stocks and or habitats*'.

The needs of Uganda's aquaculture sector development are reflected in Scenario 1 of the FAO's PMP/AB initiative: '*Country with no aquaculture biosecurity strategy (AB) nor National Strategy on Aquatic Animal Health (NSAAH) but with aquaculture or initiating aquaculture development'*. The PMP/AB addresses the lack of effective national plans by focusing on the national aquaculture biosecurity strategy development processes (mid- to long-term) and by promoting a co-management approach to actively engage stakeholders.

This report is presented in 8 chapters. Chapter 1 provides an introduction to the background of the assignment, the current situation in the sector, the context of the assignment, international and regional agreements, the policy framework for a National Biosecurity and Biosafety System for Aquaculture in Uganda (NBBSA), and the broad objectives, purpose, vision and guiding principles for development of the NBBSA. In Chapter 2 the international literature relevant to development of an aquatic animal health strategy and aquatic animal health planning is reviewed.

The policy and legal framework for the NBBSA are discussed in Chapter 3. An assessment of national aquatic animal health performance and capacity in biosecurity, based on stakeholder interviews is provided in Chapter 4[1]. Chapter 5 discusses how national aquatic animal health performance and capacity in biosecurity should be aligned to the standards of the OIE. The components of an aquatic biosecurity strategy that are recommended for the development of the NBBSA in Uganda are provided Chapter 6. These are based on 15 programmes, each with a specific objective providing guidance on implementation of the strategy.

Crucial to the effective implementation of an aquatic biosecurity strategy is the identification of the Competent Authority (CA) responsible for aquatic animal health and the support of relevant legislation.

[1] As a result of travel and other restrictions caused by the COVID-19 pandemic, the international consultant was not able to visit Uganda and was unable to assist in collection and processing of stakeholder information The activities of the local consultant were similarly hampered and delayed by the pandemic.

In the case of Uganda, aspects of the responsibilities of the CA for aquatic animal health currently rest with both the Directorate of Fisheries Resources and the Directorate of Animal Resources. A brief conclusion providing an outline for the way forward is provided in Chapter 7. Chapter 8 reflects the literature that was consulted in preparation of this report.

Following key stakeholder acceptance, the NBBSA needs to be incorporated into the government of Uganda's policy documents. Implementation will require considerable resources and these will need to be mobilized through joint engagement with partners. To harness the full benefit of improved aquatic animal biosecurity management, regional engagement with countries sharing the Nile Basin water bodies is strongly encouraged to accept a common regional aquatic biosecurity strategy.

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CONTENTS

ABBREVIATIONS AND ACRONYMS

ALOP	appropriate level of protection
AMR	antimicrobial resistance
AMU	antimicrobial usage
ARDC	Aquaculture Research and Development Centre, Kajjansi
AU	African Union
BMP	better management practice
BP	Biosecurity Plan
CAADP	Comprehensive Africa Agriculture Development Program
CBD	Convention on Biological Diversity
CCRF	Code of Conduct for Responsible Fisheries of the FAO
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COPS	Codes of Practice
CA	Competent Authority
COFI	FAO Committee on Fisheries
CVO	Chief Veterinary Officer
DAMD	Department of Aquaculture Management
DAR	Directorate of Animal Resources
DFR	Directorate of Fisheries Resources
EAC	East African Community
EC	European Community
EIFAC	European Inland Fishery Advisory Council
EDRT	Emergency Disease Response Team
EMS	early mortality syndrome
EUS	epizootic ulcerative syndrome
FAO	Food and Agriculture Organisation
FVN	field veterinary network
GMO	genetically modified organism
GoU	Government of Uganda
HH	high health
IAAS	invasive alien aquatic species
ICES	International Council for the Exploration of the Sea
IRA	Import risk analysis
ISA	infectious salmon anaemia
IUCN	International Union for the Conservation of Nature
KNV	Koi herpesvirus
LMO	living modified organism
LVFO	Lake Victoria Fisheries Organisation
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MoFPED	Ministry of Finance, Planning and Economic Development
MOU	Memoranda of Understanding
NADDEC	National Veterinary Laboratory
NADSAP	National Aquaculture Development Strategy and Action Plan
NaFRRI	National Fisheries Resources Research Institute

NaGRIC	National Genetic Research Centre
NARO	National Agricultural Research Organisation
NARS	National Agriculture Research System
NBBSA	National Biosecurity and Biosafety System for Aquaculture in Uganda
NBI	Nile Basin Initiative
NDPA	National Drug Policy Authority
NEPAD	New Partnership for Africa's Development
NSAAH	National Strategy on Aquatic Animal Health
NST	National Surveillance Team.
NTFAAB	National Task Force on Aquatic Animal Biosecurity
OIE	World Organisation for Animal Health
PFRSFA	Policy Framework and Reform Strategy for Fisheries and Aquaculture
PMP/AB	Progressive Management Pathway to improve Aquaculture Biosecurity
RECs	Regional Economic Communities
RFBs	Regional Fisheries Bodies
SCA	COFI Subcommittee on Aquaculture
SKNV	spleen and kidney necrosis virus
SPF	specific pathogen free
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
UNBS	Uganda National Bureaux of Standards
TADs	transboundary animal diseases
TAADs	transboundary aquatic animal diseases
TiLV	Tilapia lake virus
VHP	Veterinary Health Plan
VSB	veterinary statutory body
WAFICOS	Walimi Fish Cooperative Society
WSS	white spot syndrome

1. INTRODUCTION

1.1 Background

The development of a national biosecurity and biosafety system for aquaculture in Uganda falls under the current EU funded support for *Promoting Environmentally Sustainable Commercial Aquaculture in Uganda Project*. This Project commenced on 13th January 2017 following the signature of the Financing Agreement between the EUD and Government of Uganda (GoU). The National Authorizing Officer (NAO) is the Ministry of Finance, Planning and Economic Development (MoFPED), the Supervising Authority is the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), and the Department of Aquaculture Management and Development (DAMD) houses the Project Management Office (PMU). A Technical Assistance Team (TAT) (provided by AGT SpA) is hired through the EU to support the overall implementation of the Project.

1.2 Current situation in the sector

Capture fisheries represent a finite resource not expected to exceed 750,000t per annum. In 2018 capture fisheries produced 447,000t of which approximately 20,364t of Nile perch dominated exports to international markets earning Uganda US$153.2 million. Capture fisheries represented about 3% of GDP and 12 % of total agricultural GDP. Aquaculture production of around 120,000t in 2018 generated about US$389,000. This falls short of an envisaged production of 340,000t required to meet the country's anticipated per capita fish consumption. Due to the increasing demand for fish, resulting from a growing middle class across the country, there is a deficit of fish. To meet both local and export demand, the Government is focusing on producing 1,750,000t of fish per annum. This represents 1 million tonnes more than capture fisheries can yield, and aquaculture is expected to make up the shortfall. This is expected to require 2.5 billion fish seed stock (fingerlings/fry) and about 1.5million tonnes of fish feed per annum. Currently, the country produces only about 200 million seed stock and about 80,000t of feed. Most of the raw materials needed for locally made fish feeds are available from Uganda's agriculture and fisheries production. The export of Nile perch products to Europe has driven development of the fish processing sector and associated infrastructure and quality systems in Uganda. This vital infrastructure / framework system would be able to also support processing and export requirements of the aquaculture sector, allowing the supply of high-quality raw material for 'added value' products for local, regional and international markets. Coupled with good conditions and enormous water resources for fish growth in the country, there is great potential in terms of fish productivity, employment and economic benefits.

Uganda has suitable conditions and enormous water resources for fish production that provide the potential to fill the current and future supply gap in domestic, regional and international markets, through promoting efficient, commercial, profitable and sustainable aquaculture production. Through emergence of commercial agriculture as a means to increase the livelihoods of actors along the value chain, the Government, through MAAIF adopted the Commodity Based Approach (CBA) to increase agricultural production and productivity. Fish is one of the priority commodities that the MAAIF is pursuing under the Agriculture Sector Strategic Plan, and promotion of commercial aquaculture has been identified as a priority intervention.

Extensive freshwater resources in Uganda support fast growing fish species such as Nile tilapia and African catfish that are suitable for cage, pond and tank-based aquaculture systems. The trajectory of expansion in aquaculture in Uganda, brought about largely by development of cage culture, has in the most recent decade flattened off. This has been attributed to poor availability of quality aquaculture inputs, insufficient genetic advancement and poor brood stock management on the farms, poor or lack of differentiation of aquaculture products from the capture fisheries, inadequate and incompetent extension and technical service providers, increasingly erratic weather associated with climate change, and generally poor aquaculture practices at farmer's level (Anon. 2021a)**.** Future rapid expansion in the aquaculture sector especially in the area of cage culture comes with a challenge of increasing threat of fish diseases that can easily cripple the subsector.

1.3. Context of the assignment

This assignment is tasked to develop a national biosecurity system that will guide Government on how to reduce the risk of introduction and spread of pathogens that negatively impact on aquaculture development in the country. At a national level, effective implementation of biosecurity plans requires guidance by a national biosecurity strategy. This defines the goals and time frames of multiple activities required to improve a country's ability to deal with biosecurity risks posed by infectious agents. This report deals with the development of an aquatic animal disease biosecurity strategy for the Republic of Uganda, the National Biosecurity and Biosafety System for Aquaculture (NBBSA). The term 'biosafety' may be misleading in this context but has been retained to draw attention to important issues of consumer safety related to the prudent use of antimicrobials and other chemicals in aquaculture, and to address the urgent issue of antimicrobial resistance development. The term also makes consideration for the dangers posed by inadequate screening of feed ingredients for toxicants such as aflatoxin.

The national biosecurity system provides the Government of Uganda with the procedures by which the necessary resources are identified and put in place for implementation of improved biosecurity at multiple levels. This offers the blue print for farmers to come up with farm specific plans on how to reduce the risk of infection and disease in their farms, with the overall goal of protecting farmed and wild fisheries from the effects of harmful infectious diseases. By strengthening prevention and control measures to ensure food safety and security, the economic benefits of domestic and international trade in aquatic animals and their products will be increased.

Beneficiaries of the assignment are primary stakeholders represented by all sectors of the aquaculture and fisheries industry of Uganda, the nation's natural ecosystems and biodiversity. Further benefits accrue to secondary stakeholders including government agencies tasked with managing aquatic animal health, and the universities and training institutions in Uganda responsible for education and training in aquatic animal health, and in raising public awareness amongst the broader population and industry role players.

The standard international terminology as defined in the Aquatic Animal Health Code of the World Organisation for Animal Health (OIE) will be used throughout the assignment. A '*biosecurity plan*' in this context means '*a document that identifies potential pathways for the introduction of pathogenic agents into, or spread within, or release from, a zone, compartment or aquaculture establishment and describes the measures applied to mitigate the identified risk, in accordance with the recommendations in the OIE*

Aquatic Code (OIE 2019a)'. The term '*aquatic animals*' means '*all viable life stages (including eggs and gametes) of fish, molluscs, crustaceans and amphibians originating from aquaculture establishments or from the wild*'. Fish farms fall under the term '*aquaculture establishment*' meaning '*an establishment in which amphibians, fish, molluscs or crustaceans for breeding, stocking or sale are raised or kept'.* The term '*aquaculture'* is used to describe '*the farming of aquatic animals with some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.*'

1.4. International and regional agreements

Uganda as a member of FAO upholds the voluntary guidelines of the FAO's Code of Conduct for Responsible Fisheries which provide a global consensus on principles and guidance for small scale fisheries governance and development under a co-management arrangement. The Code has a strong persuasive effect on administrators, policy makers and lawmakers of states who are members of FAO and is reflected in the Uganda National Fisheries and Aquaculture Policy 2017 (Anon. 2017a).

As a member of the World Organisation for Animal Health (OIE), Uganda has a binding commitment to uphold the international standards set by the OIE to ensure safe international trade in live aquatic animals and their products as set out in the OIE Aquatic Animal Health Code (OIE 2019a), and the OIE Manual of Diagnostic Tests for Aquatic Animals (OIE 2019b).

Furthermore, Uganda is a party to the Convention on Biological Diversity (CBD) of 1992 and the Convention on Wetlands signed in Ramsar, Iran in 1971; an intergovernmental treaty, that provides the framework for the national action and international co-operation for the conservation and wise use of wetlands and their resources. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to which Uganda is a party, provides support to the Uganda National Fisheries and Aquaculture Policy 2017 as it contains a number of clauses relevant to conservation and trade in endangered fishes.

At the continental level, the African Union established a Policy Framework and Reform Strategy for Fisheries and Aquaculture (PFRSFA) to facilitate a coherent policy development environment for sustainable management and development of fisheries and aquaculture in the AU Member States including Uganda (AUC/NEPAD, 2014). The African fisheries policy framework and reform strategy reflects the need to address the numerous challenges that continue to deny Africans the benefits that could be derived from the exploitation of fisheries and aquaculture resources. These challenges are limiting the full contribution of the fisheries and aquaculture sector to food security, livelihoods and economic growth. Some of the reasons have been attributed to lack of policy coherence and coordination, increasing levels of IUU fishing, weak intra-regional and international trade, weak capacity for aquaculture development, and poor development of the artisanal fisheries sector (FAO, 2018).

The AU PFRSA aims to create an enabling environment facilitating African Union (AU) Member States, Regional Economic Communities (RECs) and Regional Fisheries Bodies (RFBs) to develop realistic fisheries and aquaculture policies. The PFRSA elaborates and makes explicit essential guiding principles for good governance of Africa's fisheries for increased coherence and coordination of the sector. It aims at:

- facilitating African Union (AU) Member States, Regional Economic Communities (RECs) and Regional Fisheries Bodies (RFBs) to develop realistic fisheries and aquaculture policies by suggesting standards and best practices to the sector's benefits to AU member states, in terms of food security, employment and income;
- facilitating regional collaboration and integration in shared fisheries and aquaculture resources management.

By facilitating regional collaboration and integration in shared fisheries and aquaculture resources management, this will provide fishers and fish farmers with incentives and confidence to invest in fisheries resources while moving towards a progressive recovery of fish stocks and improvement in the safety and quality of fish on the market. Uganda is signatory to the Malabo Declaration of Comprehensive Africa Agriculture Development Program (CAADP) compact that calls for a commitment to enhancing resilience in livelihoods and production systems to climate variability and other shocks. As a member state, the NEPAD– Partnership for Africa Fisheries (PAF) calls upon Uganda to leverage key partnerships through research and foreign direct investment to introduce new technologies and innovations that have worked elsewhere, and to elevate the levels of sustainable production and quality of fish and aquaculture products.

Amongst the ten countries of the Nile Basin, the Nile Basin Initiative (NBI) provides an intergovernmental partnership amongst Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda, with Eritrea participating as an observer. The NBI' s shared vision is "*To achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources*". Fisheries and aquaculture in Uganda rely on Lakes Victoria, Kyoga, Edward and Albert, which are all part of the Nile catchment. NELSAP is one of the regional investment programs of the Nile Basin Initiative (NBI) that covers issues and is harmonizing policies and legal frameworks on lakes Albert and Edward.

At the regional level, the East African Community (EAC) Treaty requires Governments to recognize and promote aquaculture as a distinct enterprise in order to optimize its economic contribution. The Lake Victoria Fisheries Organization (LVFO), established by the Republic of Kenya, the United Republic of Tanzania and the Republic of Uganda in 1994, calls upon all the EAC countries to support the regulation, management and development of the fisheries and aquaculture sector and invest in interventions that ensure sustainable production that enhance food security, increase incomes and contribute meaningfully to poverty reduction. The treaty aims to foster cooperation among the parties and harmonize national measures for the sustainable utilization of the living resources of Lake Victoria through the development and adoption of conservation and management measures. This policy is an actualization of the requirement to align to the East Africa Fisheries and Aquaculture Policy (2016). The LVFO is composed of the fisheries management and research institutions in the EAC Partner States and is coordinated by a secretariat based in Jinja, Uganda (LVFO Strategic Plan 2016-2020) (Anon., 2016).

1.5. Policy framework for the National Biosecurity and Biosafety System for Aquaculture in Uganda

1.5.1. Introduction

The government of Uganda has the vision to transform Uganda from a peasant to a modern prosperous country by 2040. Through a 5-year rolled National Development Plan (NDP) the strategic government interventions for development in all the sectors are envisioned harmoniously to attain the 2040 development vision. The period 2020/21 to 2025/26 represents the third phase of the NDP that aims to increase household incomes and improve quality of life through sustainable wealth creation, employment and inclusive growth. Among the key plans for the NDP III is the Agriculture Sector Strategic Plan (ASSP) which provides the framework for implementation of agriculture sector intervention priorities. The ASSP III 2020/21-2024/25, which is being finalised, is focused on agro-industrialization, promoting quality processing and value addition of key commodities for competitive high value markets across the globe.

The fisheries sub-sector and the development of aquaculture in Uganda are guided by the National Fisheries Policy (2004), the National Investment Policy for Aquaculture Parks (2012), and the Fisheries and Aquaculture Policy (2017). These are implemented through a strategic framework at the level of the Government: the Uganda National Aquaculture Development Strategy (2008) and the provisional Fisheries Sector Strategic Plan with legislative backing provided by The Fish Act (Cap. 197) and the Fish (Aquaculture) Rules 2003 which are currently in the process of being updated to become the The Fish (Aquaculture) Rules, 2020. Currently, Uganda does not have a national policy on aquatic animal health although some aspects are covered by the Fisheries and Aquaculture Policy.

1.5.2. Legislative and policy environment

Through the 1995 Constitution of the Republic of Uganda (as amended) Section XIII, the State undertakes to protect important natural resources, including land, water, wetlands and fauna on behalf of the people of Uganda. In addition, the Constitution under Objective XXII mandates the State to ensure food security and proper nutrition in order to build a healthy state. Vision 2040, launched in 2010, envisages a transformed Ugandan society from a peasant to a modern and prosperous country in which Uganda is one of the leading producers of fish. The Vision 2040 is being implemented under six National Development Plans (NDPs) and the third National Development Plan (NDP III) 2020/21-2024/25 is currently being implemented under the theme: “strengthening Uganda’s competitiveness for sustainable wealth creation, employment and inclusive growth”. Agriculture, including animal industry, crop and fisheries has been identified as a top priority. In 2013, the Ministry of Agriculture Animal Industry and Fisheries developed an overall National Agricultural Policy (NAP) framework whose vision is “a competitive, profitable and sustainable agricultural sector” that will be realised by transforming the sector from subsistence to commercial agriculture. This framework is being implemented through a series of supportive sub-sector policies – one of which is this Fisheries and Aquaculture Policy.

The Uganda National Fisheries and Aquaculture Policy 2017 is implemented consistent with the National Environment Management Act. Implementation of the NFAP 2017 is carried out within the confines of the National Agricultural Policy 2013 and its Agricultural Sector Strategic Plan (ASSP) 2015-2020. This policy paves the way for a comprehensive amendment of the Fish Act Cap 197. The Directorate of Fisheries Resources (DFR) under Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) functions as a

semi-autonomous Directorate that oversees and strengthens the institutional function of fisheries and aquaculture management. The DFR has the power to inspect fish fry and seed production by the National Genetic Research Centre (NaGRIC) and by private producers. DFR also generates the research agenda through which the National Fisheries Resources Research Institute (NaFRRI) supports academia and research organizations with the aim to generate and disseminate appropriate, safe, cost effective fisheries and aquaculture technologies.

DFR works with the Directorate of Agricultural Extension Services to empower farmers to embrace new technologies through protracted demand-based extension, advisory and training services that include training for fisheries best practice. MAAIF supports efforts to restock water bodies, multiply fish seed and ensure access to improved fish seed and feed as well as fish disease control commodities. For optimal biosecurity management, the promotion and collaboration for fisheries production and marketing zones, including aqua-parks, to achieve economies of scale must be based on biosecurity principles from the outset.

MAAIF is responsible for the regulation of all players in the aquaculture sector and, through the Uganda National Bureaux of Standards (UNBS), for compliance with national regional and international standards. Support and traceability through strengthened responses by disease, pest and vector control systems is further provided by MAAIF. Local Government is supported by MAAIF in its routine inspection and coordination of fisheries and aquaculture initiative projects and programmes, and provision of technical assistance, support supervision and training to technical fisheries, fishers and fish farmer producer groups and associations and to facilitate initiatives to build them institutionally.

MAAIF through its support of local Governments strengthens District Production and Water offices in their work to reach out to fishers and fish farmers so that issues affecting fisheries including disease, pest and vector control are adequately and expeditiously resolved. The functions of districts and lower-local governments are to implement the national policy and associated regulations, and ensure application and monitoring at district and local level, and to develop and pass fisheries and aquaculture ordinances and by-laws based on the national law, but tailored to specific needs of the local situation. Technical assistance is provided through an extension system with the intention to mobilize, increase awareness and empower fish farmers and fishers to protect fisheries production and natural resources and implement adaptation measures to the adverse effects of climate change.

Through MAAIF, all key stakeholders including the private sector, other non-state actors (NGOs, CSOs) and Development Partners are included in the National Fisheries and Aquaculture platforms, set up at both national and district level, that through biannual meetings provide an opportunity to discuss issues facing fisheries and aquaculture and to devise means and ways to resolve these as well as introduction of new practices to elevate the sector.

The proposed Fisheries and Aquaculture Policy Implementation Unit housed in the Directorate of Fisheries will ensure smooth implementation of the policy at all levels and provide the necessary guidance to district local governments. In turn, all feedback and accountability from the local governments will be submitted to this Unit for analysis and compilation of quarterly reports on the state of performance. MAAIF works

with other stakeholders to ensure that the Fish Act (Cap 197), and in future the Fisheries and Aquaculture Bill, and the regulations therein are enforced both at national and regional levels.

Through the national budget framework, in line with the Public Finance Management Act (2015), Government intends to revitalize mechanisms to mobilize resources from within the sector including internally generated resources such as: fish levies, registration and licensing fees, inspection fees, testing fees and fines. These resources will be managed to support the operation cost of the proposed strengthened DFR as well as lending support to its decentralized structures to increase their capacity to supervise, regulate and be responsive to some of the needs of stakeholders at that level.

1.6. Broad objectives

The broad objectives of this assignment fall under the general objective of the Promoting Environmentally Sustainable Commercial Aquaculture Project (UG/FED/2016/038-334) to contribute to a competitive, job-intensive, environmentally-sustainable and climate-resilient agriculture sector in Uganda with the specific objective to support the development of a competitive, job-intensive, environmentally-sustainable and climate-resilient aquaculture value chain in a comprehensive manner.

Trade in live aquatic species holds particular risk of transboundary disease transfer and environmental damage. The National Biosecurity and Biosafety System for Aquaculture in Uganda (NBBSA) seeks in accordance with the OIE Code, to create an enabling environment for effective implementation of relevant international standards for trade in aquatic animals and their products and living aquatic resource conservation, particularly those of the OIE (2019a) and the World Trade Organisation (WTO) (WTO 1995). To ensure effective implementation, laws, regulations and administrative procedures applicable to trade in aquatic animals and their products need to be transparent, simple, comprehensible and, when appropriate, based on scientific evidence.

An effective NBBSA aims to create an environment conducive to trade within the principles, rights and obligations established by the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) (FAO 2011). The non-discriminatory principles, rights and obligations established in the SPS Agreement and the Agreement on Technical Barriers to Trade of the WTO must be taken into account where risks to aquatic animal life, consumers of aquatic animal products, and conservation require appropriate management. Where scientific uncertainty or lack of data provides insufficient evidence in support of disease control measures, the NBBSA may encourage the ‘precautionary approach’.

In support of the responsible development of aquaculture and protection of the environment and aquatic biodiversity, through formulation of a national biosecurity system, codes of practice and best management procedures are encouraged. Amongst others, these include effective fish health management practices favouring sanitary measures and vaccine use, the regulation of chemical inputs hazardous to human health and the environment, and the safe disposal of fish processing wastes, dead and diseased fish, sludge, and excess veterinary pharmaceutical and chemical inputs.

Implementation of biosecurity plans on multiple levels that facilitate safe trade in live aquatic animals and their products supports job creation, economic growth and maintenance of species diversity into the

future. Regional cooperation is essential to managing transboundary disease risks, and relevant regional and sub-regional cooperation structures should be established.

1.7. Purpose

The purpose of the National Biosecurity and Biosafety System for Aquaculture in Uganda is to strengthen and improve coordination of aquatic biosecurity at all levels through developing and enhancing aquatic animal health management capacity, creating awareness of aquatic animal disease risks, improving understanding of biosecurity principles, creating an understanding of how effective biosecurity planning can improve the sustainability of the aquaculture sector while contributing to preservation of biodiversity, and how biosecurity planning can enhance market accessibility.

The NBBSA is intended to guide the development of fish farming towards addressing diseases associated with intensification and commercialization of fish to ensure the following:

- Prevent introduction of exotic diseases or disease-causing agents;
- Reduce the occurrence of disease in fish held in culture facilities;
- Minimize spread of disease to stocks within and outside fish farming establishments;
- Maintain an environment that promotes the health and productivity of cultured fish and reduces the susceptibility of fish to disease;
- Protect public health and minimize disease risks to cultured and wild fish through judicious use of drugs and chemicals.

This will provide fish farming systems and operators of fish culture facilities with a management and regulatory framework to prevent and control fish disease in accordance with acceptable standards and regulations.

1.8 Vision

The long-term vision of the National Biosecurity and Biosafety System for Aquaculture in Uganda is to enhance and maintain aquatic animal biosecurity capacity in Uganda that will be able to support the sustainable development and management of the aquaculture sector, while protecting regional biodiversity and aquatic ecosystems from the impacts of exotic pathogens and epizootic disease.

1.9. Guiding principles

- Aquatic animal biosecurity management should enable aquaculture to make a positive contribution to the national economy through being internationally competitive in the marketplace and economically viable at a national level.
- Aquatic animal biosecurity management measures should facilitate aquaculture to develop in harmony with nature, managing and minimizing transient environmental impacts and avoiding significant, cumulative, long-term or irreversible changes to ecosystems, to cultural remains or to valued landscape and scenery.

- Aquatic animal biosecurity measures should be based on strong public-private-partnerships, and foster links amongst stakeholders, recognizing and supporting the needs of private-sector stakeholders and working with community initiatives to manage local environments for mutual benefit.

- Aquatic animal biosecurity should contribute to social, economic and environmental sustainability and embrace the precepts of transparency, integration, coordinated government and fit-for-purpose regulation, partnership and stakeholder participation, accountability, ethics and regard for animal welfare, and a culture of best practice and continuous improvement.

- Aquatic animal biosecurity may introduce or maintain sanitary measures resulting in a higher level of protection than would be achieved by measures based on the relevant international standards, guidelines or recommendations (e.g. the OIE Aquatic Animal Health Code – OIE 2019a); however, such measures must be justifiable based on science (i.e. risk analysis) and be consistent with the country's appropriate level of protection (ALOP). Control measures applied to movements of aquatic animals within the country must also be consistent with this ALOP.

- Aquatic animal health is important for economic, social, developmental and public resource purposes. Collaboration among all stakeholders including governments, public institutions, the private sector and existing aquaculture and fishing industries, is important to achieve effective biosecurity management.

- The aquatic animal biosecurity system of Uganda and related procedures, should adhere to international and regional standards and be harmonized on as wide a basis as possible.

- Uganda should encourage its aquaculture sector to use preventative measures to limit exposure to pathogens and disease. Such measures include but are not limited to the use of better management practices (BMPs), health certification, specific pathogen free (SPF) and high health (HH) stocks, biosecurity and vaccination protocols.

- Health management measures should be effective, practical, cost-effective and utilize readily available resources, subject to development of appropriate national and regional policies and regulatory frameworks as required to reduce the aquatic animal health risks inherent in the culture, reproduction and movement of aquatic animals.

- Access to relevant national aquatic animal health capacity (infrastructure and specialized expertise) is crucial for health management of aquatic animals. Collaboration with international organizations, and with other regional organizations, should be sought wherever possible to further increase regional and national capacities in aquatic animal health issues.

2. REVIEW OF LITERATURE

2. 1. Introduction

For a number of decades aquaculture has been one of the fastest growing sectors of world food production (FAO 2014). To maintain sustainable growth in this sector, development and implementation of animal health and biosecurity strategies is increasingly recognized by countries and industries as essential (Håstein *et al*., 2008; Hine *et al*., 2012). Disease outbreaks challenge aquaculture development and all levels of aquatic resource management that play an important role in food security and the broader economy, with far reaching effects on rural development, water management, the environment, poverty alleviation, livelihood, trade, and gender and household nutrition (FAO/RAP, 2003). With expansion and intensification of aquaculture to meet growing local and global demand, countries are ever more challenged by the task of maintaining a sustainable environment in which the impact of infectious disease can be limited, allowing the full benefits of the aquaculture industry to manifest.

The effective management of aquatic animal health becomes an essential element in economic, environmental and marketing success of the aquaculture industry (FAO, 2014). Globally, serious transboundary aquatic animal diseases (TAADS) that spread rapidly causing serious economic losses have emerged repeatedly. Identification and confirmation of the responsible pathogen leading to global awareness, implementation of surveillance and reporting systems and development of cost-effective control measures, may take many years following occurrence of the first field mortalities associated with emergence of a serious disease. Various factors, drivers and pathways of aquatic disease emergence in aquaculture have been identified, and can be divided into four broad categories (FAO 2019):

- Invasive pathogens and animals that are associated with the trade and movement of live aquatic animals and their products;
- Knowledge on pathogens and their hosts lagging behind aquaculture development;
- Aquatic animal health management that inadequately addresses biosecurity risks;
- Ecosystem changes brought about by direct and indirect human impacts.

Aquatic animal diseases can have potentially devastating economic and ecological consequences, for wild fisheries and aquaculture development. The incursion of epizootic ulcerative syndrome (EUS), a serious infectious disease of freshwater and estuarine fish, notifiable to the OIE, onto the African continent in 2006 underscored the vulnerability of Africa's aquatic resources to transboundary spread of infectious diseases (Andrew *et al*., 2008; FAO 2009a; Huchzermeyer and van der Waal, 2012). In response, the OIE, the FAO, the EU and other regional role players have endeavoured to encourage African countries to strengthen knowledge of aquatic animal diseases and their control amongst the officers of the respective competent authorities (CA), and to develop effective national aquatic animal health and biosecurity strategies (Anon. 2015). The recent emergence of Tilapia lake virus (Mugimba *et al*., 2018; Jansen, Dong and Mohan, 2018) and infectious spleen and kidney necrosis virus (Ramírez-Paredes *et al.*, 2020) in a number of countries, underscores the vulnerability of tilapia production also in African countries that are often linked by common waterways and trade routes. The risk of transboundary spread of infectious diseases needs to be minimized and relevant preparedness for the eventuality of a disease incursion must be developed.

Once a pathogen establishes within the natural ecosystem, treatment and eradication may become virtually impossible (Hine *et al*., 2012). This has been evident in the case for EUS where outbreaks affecting natural floodplain fisheries in Africa have occurred repeatedly on a seasonal cycle (Huchzermeyer *et al*., 2018) and where the disease has spread rapidly through south and central Africa. Timeous measures therefore need to be applied to prevent transfer and introductions of such pathogens and to limit the consequences of disease outbreaks (Hine *et al*., 2012).

Aquaculture farming creates an environment, with densely stocked populations of aquatic animals, that is conducive to expression of diseases that may remain undetected in wild aquatic populations sharing the same water source. The expression of disease (morbidity and mortality) within a susceptible population of aquatic animals will depend on numerous factors, including life stage of the host and environmental and husbandry conditions. Water provides an effective medium for the transfer of pathogens, and where farmed and wild aquatic animals share a common water source, pathogen transfer may take place not only amongst the farmed population but also from farmed-to-wild, and from wild-to-farmed individuals. Inadvertent release of infectious agents from aquaculture farms into the natural environment poses serious ecological concerns and has the potential to impact on natural species diversity. By incorporating biosecurity zoning and compartmentalisation strategies within aquatic animal health and ecosystem policy, the threats posed by such diseases are managed holistically, with the aim of establishing and maintaining sustainable populations of aquatic animals with distinct health status, and effectively separating these from populations with a different health status (Brummett, 2013; Zepeda *et al*., 2008; World Bank/FAO 2015).

Commercialization of aquaculture through Aquaparks provides the opportunity to implement biosecurity planning through zoning and compartmentalisation before administrative, production and marketing needs are aligned with the Aquaparks (Huchzermeyer & Bondad-Reantaso, 2017; Zepeda, Jones & Zagmutt, 2008). The improved biosecurity within a biosecurity-aligned Aquapark provides famers with a competitive advantage, the ability to trade and the prospect of improved livelihood.

Infectious diseases pose a significant threat to the sustainability and profitability of aquaculture and fisheries sectors, particularly where these industries are rapidly expanding. Epidemiological links exist between natural environments, including fisheries, and aquaculture farming environments through the translocation of fish, fish product, people, equipment and vehicle movements, and shared water ways. Where these risks are shared, diseases will move within and between aquaculture facilities (Anon, 2014). The potential for accidental spread and incursion of diseases into new populations and geographic regions increases with the ease with which live aquatic animals are transported between farms, catchments and across borders. Of particular concern are movements of hatchery-produced stocks, introduction of new species for culture, and enhancement and development of the ornamental fish trade (Subasinghe, Bondad-Reantaso and McGladdery, 2001).

Aquatic animal health management therefore requires a coordinated national approach involving government and all aquatic animal industries, including commercial fishery, artisanal fishery, recreational fishery, aquaculture, and ornamental fish sectors.

2.2. International trade and translocation of diseases

Trade in live aquatic animals, within and between countries, has become an integral part of aquaculture development. The liberalization of world trade and the efficiency of modern transportation methods have created opportunities for highly contagious trans-boundary aquatic animal diseases (TAADs) to spread rapidly across national borders (Subasinghe, 2005). Marketing of live aquatic animals, movement of hatchery-produced stocks, new species for culture and the ornamental fish trade have become increasingly important routes of pathogen spread (Oidtmann *et al*., 2011; Rodgers, Mohan and Peeler, 2011; Subasinghe, Bondad-Reantaso and McGladdery, 2001). The ability to move and trade aquatic animals and their products free of specific pathogens is one of the strongest incentives for implementing national biosecurity programmes (Håstein *et al*., 2008; Scarfe *et al*., 2009), and reflects international recognition of a country's ability to demonstrate effective biosecurity and zoning strategies, including the ability to maintain zones and compartments of known disease status (OIE, 2019a). To ensure that aquaculture producers are able to access international markets, the Competent Authority (CA) of exporting countries must have the capacity to meet clearly defined international standards and to comply with requirements set by importing countries.

2.3. Background to international and other technical guidelines

The rapidly changing needs of modern society require biosecurity systems to be based on robust and transparent scientific inputs to standard setting processes, particularly those relating to agricultural products (FAO, 2007a) (Figure 1 and 2). A number of international codes, guidelines and agreements have been developed that standardise the approaches to reducing risk of spreading disease through movements of live aquatic animals and their products. Modern standard setting processes have evolved from the fundamental principles of the General Agreement on Tariffs and Trade (GATT), established after the end of World War II. This ensured that all non-tariff barriers to international trade should be prohibited, and was retained in full with the establishment of the World Trade Organization (WTO) in 1995 (Chillaud, 1996). To minimize the effects of health restrictions on international trade, the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) was ratified in 1995 to ensure that animal health measures established by countries to safeguard the protection of human and animal life and health are based on international standards, guidelines and recommendations (Chillaud, 1996). These are primarily those developed by the World Organization for Animal Health (OIE) and the Codex Alimentarius Commission (FAO/WHO, 2010). The SPS Agreement ensures that sanitary and phytosanitary measures are based on risk assessment, and require that measures implemented by states to protect and maintain animal health should not result in a higher measure of protection than that advocated by these international standards, unless scientific justification for the need for such measures can be demonstrated (WTO, 1995). The SPS Agreement also emphasizes the need for transparency in import health measures which states enforce (Chillaud, 1996). Similarly, the Codex Alimentarius Commission, established by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) of the United Nations in 1963, provides international food standards, guidelines and codes of practice, including those relating to veterinary drug residues that contribute to the safety, quality and fairness of international food trade (FAO/WHO 2010). Through the SPS Agreement, the Codex also has far reaching implications for resolving trade disputes.

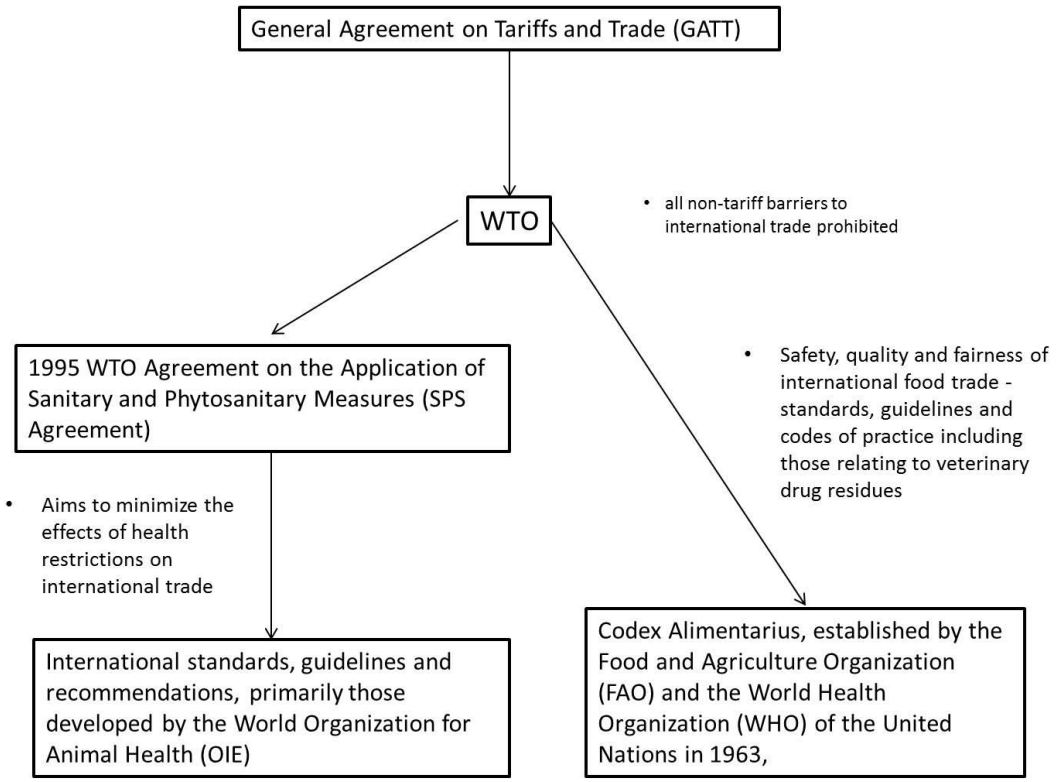


Figure 1. Summary of international standard setting agreements (From Huchzermeyer, 2015)

The OIE is recognized by its member countries as the international organization responsible for development and promotion of international animal health standards, guidelines and recommendations affecting safe international trade in live animals and their products. These are documented in the OIE Aquatic Animal Health Code (OIE, 2019a) and the OIE Manual of Diagnostic Tests for Aquatic Animals (OIE, 2019b). The Code and Manual are reviewed and updated annually taking into account contributions of member countries and the input of experts and working groups. Authorities should refer to the most recent issue. Central to these documents is a list of diseases that are notifiable to the OIE. Where new outbreaks of these diseases occur, the member states are obliged to report on these outbreaks to the OIE. For a disease to be listed, several standard criteria are applied (OIE, 2019a):

- The disease has been shown to cause significant production losses at a national or multinational level,
- The disease has been shown to or scientific evidence indicates that it is likely to cause significant morbidity or mortality in wild aquatic animal populations,
- The agent is of public health concern,
- An infectious aetiology of the disease is proven,
- An infectious agent is strongly associated with the disease, but the aetiology is not yet known,
- Likelihood of international spread exists, including via live aquatic animals, their products or fomites,

- Several countries or countries with zones may be declared free of the disease based on the general surveillance principles outlined in the Code,
- A repeatable and robust means of detection/diagnosis exists.

All countries that are members of the OIE have a commitment to apply the OIE standards through relevant national policy and legislation (Oidtmann *et al*., 2011). The relevance of particular OIE-listed diseases will depend on the presence of susceptible host species in a country, and the respective disease challenges faced by that country, and should be reflected in a country's national list of priority diseases (national pathogen list). In addition to OIE-listed diseases, at regional and country level, many more diseases other than those notifiable to the OIE may have significant impacts on aquaculture productivity, but the core aquatic animal health policy of a country should be structured to address those OIE-listed diseases relevant to susceptible host species in the country.

Supernational and political unions, such as the European Union (EU) may apply common policies and legal frameworks to ensure that member countries apply equivalent standards in order to facilitate trade between member states. Council Directive 2006/88/EC (on animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals) provides the instrument for the biosecurity framework applied in the EU with an emphasis on promoting prevention of aquatic animal diseases (Anon, 2006; Oidtmann *et al*., 2011). This is particularly relevant to countries outside of the EU, so-called third countries, wishing to export aquatic animals or their products to the EU. Whilst standardising aquatic animal health controls across the European Community (EC) to facilitate trade within the EU, it makes provision for protecting areas of higher health status. Additional animal health control measures applying to certain diseases and areas may include a requirement for provision of specific disease guarantees. These will reflect on relevant model animal health certificates required for imports into the country from third countries. For example, England and Wales have import requirements for a number of diseases in addition to diseases considered exotic to the European Community (EC) (Oidtmann *et al*., 2011).

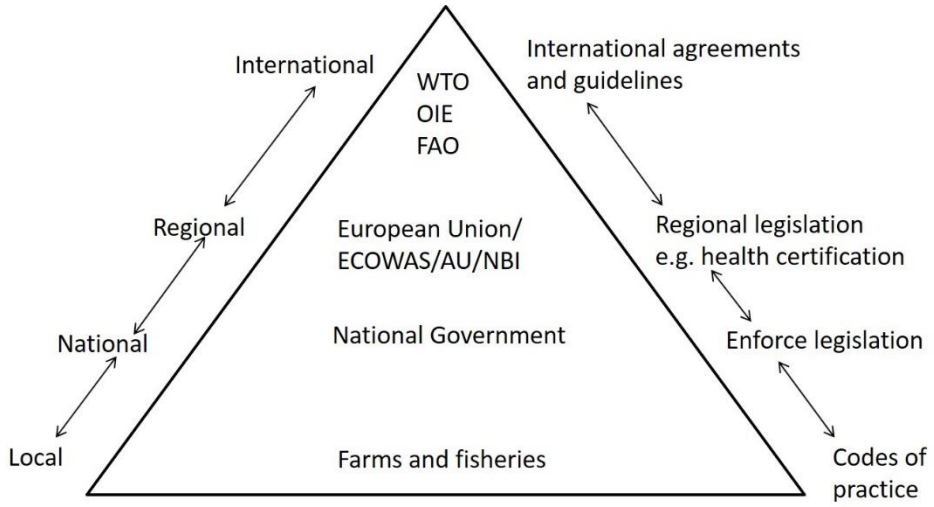


Figure 2. Biosecurity pyramid (adapted from Oidtmann *et al*., 2009)

At regional level, the Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals, and their associated implementation plan, The Beijing Consensus and Implementation Strategy (FAO/NACA, 2000), were adopted by Asian countries in an effort to reduce and manage the risk due to the trans-boundary movement of live aquatic animals in this region (Mohan *et. al.*, 2008). These guidelines provide a comprehensive framework for dealing with aquatic animal disease emergencies in Asia where the bulk of world aquaculture production takes place. In North American, the Great Lakes Fish Health Committee of the Great Lakes Fishery Commission provides the guidelines for the management of fish health in this region (Anon 2020a)**.**

A number of non-binding international codes and guidelines provide technical information on fisheries, aquaculture and biodiversity with information relevant to biosecurity. The Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries applies to both fisheries and aquaculture, and provides principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity (FAO, 2011). Although the Code is not binding, by endorsing it governments commit to abide by its principles and standards. Technical information is provided by the FAO Technical Guidelines for Responsible Fisheries Nos. 1-13 (FAO, 1996-2015) with specific information on health management for the responsible movement of live aquatic animals being provided in the FAO Technical Guidelines for Responsible Fisheries No. 5, Suppl. 2. (FAO, 2007b).

Further codes and conventions contribute to standardization of international protocols and responsibilities (Håstein *et al*., 2008). These include:

- International Council for the Exploration of the Sea (ICES)2005 Code of Practice on the Introductions and Transfers of Marine Organisms,
- International Maritime Organization Guidelines for Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Organisms and Pathogens,
- International Union for the Conservation of Nature (IUCN) Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species,
- European Inland Fishery Advisory Council (EIFAC) Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms,
- United Nations Convention on Biological Diversity (UN, 1992).

2.4. Aquatic animal health policy, strategy and control programmes

At national level, aquatic animal health policies and disease control programmes have been implemented in many countries, particularly those with well developed economies. Including effective diagnostic accreditation programmes and quality assessment and control procedures, these emphasize good husbandry, sanitation, site selection, zoning and compartmentalisation and strict quarantine and biosecurity management. Well defined legislation, including mandatory reporting of disease outbreaks

and pathogen detection, recommended mitigation measures and training and education underscore the success of these programmes (Subasinghe, Bondad-Reantaso, and McGladdery, 2001).

Australia's 5 year national strategic plan for aquatic animal health, AQUAPLAN 2014-2019 (Anon, 2014) is a collaborative initiative that was developed and implemented by the Australian and state and territory governments and aquatic animal industries. It represents one of the leading frameworks for managing aquatic animal health and is based on 5 objectives. These address priorities needed to strengthen aquatic animal health management to ensure sustainability of aquaculture industries, to maintain productivity in aquaculture and fisheries enterprises, and to ensure market accessibility and the profitability of the aquatic animal food sector (Anon, 2014), and include:

- Improved biosecurity – at national and farm level;
- Strengthening emergency disease preparedness and response capability;
- Improved disease detection – surveillance and diagnostic services;
- Improving availability of appropriate and safe veterinary medicines;
- Enhanced education, training and awareness.

The described initiatives range from border controls and import certification, through to enhanced veterinary education and capacity to manage incursions of exotic aquatic diseases. Similar approaches are reflected in the National Aquatic Animal Health Plan for the United States (Anon, 2008a) and Canada's National Aquatic Animal Health Program (Anon, 2005), whereas Directive 88/2006: European Union Animal Health Requirements for Aquaculture Animals and Products Thereof provides those of the European Union countries (Alday-Sanz, 2009). These provide general principles and guidelines for government agencies with jurisdiction over aquatic animal health and tasked to protect farmed and wild resources, facilitate safe trade, and make available diagnostic testing, training and other programs as needed to implement the respective national aquatic animal health policies.

AQUAPLAN 2014-2019 provides Australia's clearly defined objectives that also reflect the purpose of this assignment in terms of Uganda's need. Each objective defined in AQUAPLAN 2014-2019 has a number of relevant activities that form a clear and concise platform for addressing the specific aquatic animal health issues. A similar approach is recommended by the SADEC Regional Aquatic Biosecurity Strategy (Anon, 2018) and the National Aquatic Animal Health Strategy for Bosnia and Herzegovina (FAO, 2009b) and the National Aquatic Animal Health and Biosecurity Strategy for The Federated States of Micronesia (MacKinnon *et al*., 2020).

During each of six consecutive sessions of the FAO Committee on Fisheries (COFI) held between 2009 and 2018, the importance of aquatic animal health and biosecurity was repeatedly recognized, leading to development of the Progressive Management Pathway to improve Aquaculture Biosecurity (PMP/AB) initiative of the FAO (FAO 2019), and noting the need for Member States to better manage biosecurity issues.

The FAO defines biosecurity as a strategic and integrated approach that encompasses both policy and regulatory frameworks aimed at analysing and managing risks relevant to human, animal and plant life and health, including associated environmental risks. It covers food safety, zoonoses, introduction of

animal and plant diseases and pests, introduction and release of living modified organisms (LMOs) and their products (e.g. GMOs), and the introduction of invasive alien species.

As an effective tool to determine the sustainability of the aquaculture sector, biosecurity planning needs to be incorporated into governmental regulations as well as farm operational plans and requires effective governance at policy, legislative and farm levels (FAO 2019). Biosecurity as a means to reducing antimicrobial resistance (AMR) and zoonotic diseases from farmed aquatic animals, is also a major player in the "One Health" concept (FAO 2019).

Development of a national biosecurity system falls within the scope of the PMP/AB initiative of the FAO that focuses on building the required management capacity through combined bottom-up/top-down approaches with strong stakeholder engagement. In support of a coordinated national approach, it aims at promoting the application of risk management at the producer and industry levels (FAO 2019). Since aquatic animal health and biosecurity challenges continue to threaten the sustainability of aquaculture operations, the COFI Subcommittee on Aquaculture (SCA) has recommended a critical evaluation of the drivers of aquatic animal disease emergence and the sustainability implications in order to find novel, innovative and cost-effective and sustainable means to deal with these. PMP/AB is thus a new initiative that FAO and partners are promoting after a consensus was reached during two multi-stakeholder meetings held at the World Bank headquarters in Washington D.C. (April 2018) and at OIE headquarters in Paris (January 2019), and a Technical Working Group meeting held at FAO headquarters (March 2019).

In the context of PMP/AB, aquaculture biosecurity refers to the cost-effective management of risks posed by pathogenic agents to aquaculture through a strategic approach at enterprise, national and international levels with shared public-private responsibilities (FAO 2019).

The PMP/AB consists of four stages namely:

Stage 1 – development of a biosecurity strategy using a risk-based approach;

Stage 2 – implementation of biosecurity measures/systems;

Stage 3 – enhancement of biosecurity and preparedness; and

Stage 4 – establishment of sustainable biosecurity and health management systems to support the national aquaculture sector.

For countries belonging to the Southern African Development Community (SADC), a Regional Aquatic Biosecurity Strategy serving the period 2015-2020 was drafted as an output of the Regional Workshop on Improving Aquatic Animal Health Management and Strengthening Biosecurity Governance in Africa held in Durban, South Africa, in 2014 (Anon 2015). The workshop was supported by the Africa Union Inter-African Bureau for Animal Resources (AU-IBAR) through the STDF TILAPIA project and the European Union (EU), the South African government through the Department of Agriculture, Forestry and Fisheries (DAFF), and the Food and Agriculture Organization of the United Nations (FAO) in South Africa. Whilst this document provides a framework to assist countries to formulate their own aquatic animal health strategy, the development of realistic and effective policies and the successful implementation of aquatic animal health plans, requires the support and participation of relevant stakeholders (Sevaly, 2001).

2.5. Lessons learned from some recent major disease outbreaks

Consequences for both farmed and wild aquatic animals may be far reaching when exotic diseases are introduced, often inadvertently, into the aquatic environment. Where diseases have become established, changes in the behaviour or distribution of an endemic disease, or the emergence of a previously unknown disease, may be equally detrimental (Arthur *et al*., 2005). Disease outbreaks have in certain instances resulted in the complete collapse of aquaculture fisheries with serious socioeconomic impact (Subasinghe, 2005).

Economic losses to farmers caused by disease outbreaks can be substantial. Income reduction is associated with both reduction in revenue and increase in disease control costs. To calculate the opportunity costs and potential savings of implementing good biosecurity planning, an understanding of the cost of aquatic animal diseases is essential. This provides guidance on where to most effectively channel often limited resources and investment possibilities (FAO, 2019).

There are numerous examples where in recent years outbreaks of aquatic animal diseases have resulted in tens of thousands of lost jobs, billions of dollars in direct loss and collapse of economies reliant on aquatic animal production, particularly in developing countries (World Bank 2014). The combined global estimated losses in production value due to shrimp diseases across 11 countries during the period 1987-1994 were in the order of USD 3 019 million (Israngkura and Sae-Hae, 2002). The emergence, at national level, of infectious salmon anaemia (ISA) cost the Scottish farming industry GPB 20 million in the 1998/1999 outbreak and resulted in a continued annual cost to the Norwegian and Canadian industries of USD 11 million and USD 14 million, respectively (Hastings *et al.*, 1999).

The introduction of the infectious salmon anaemia virus into Chilean salmon farms, and the emergence of viral diseases such as early mortality syndrome (EMS) in shrimp farms of the Mekong Delta, and white spot syndrome (WSS) virus in the countries bordering the Mozambique channel, underscore the vulnerability of aquaculture farming (World Bank 2004; Oidtmann *et al.,* 2011). Such disease outbreaks have the potential of seriously compromising investment in future aquaculture development. Exotic disease incursions do not only affect aquaculture; they may also pose serious risk to natural fish stocks as illustrated by epidemics of Pilchard herpesvirus that decimated wild Australian pilchard stocks following introduction of this disease into these water in the late 1990's (Whittington *et al.* 2005).

In its Annual Report on Aquatic Animal Health in China (2017) (cited in FAO 2019) the People's Republic of China, the world's biggest aquaculture producer, reports substantial economic losses due to diseases that show an increasing trend. From 2016 to 2017, disease-related losses in China involving 62 cultured species and 96 diseases were approximately USD 5.3 billion representing an increase of USD 1.2 billion over the losses registered the previous year. Of the total losses, 33.8% related to fish production, and of these tilapia diseases caused by several pathogens ranked first, with an estimated loss of USD 450 million. (FA0 2019)

In Brazil, where more than 70% of fish production comes from intensive farming of freshwater finfish, losses related to direct and indirect economic costs of disease were estimated in US$ 84 million per year (Tavares-Dias and Martins, 2017).

A World Bank report on reducing disease risk in aquaculture (World Bank, 2014) has analysed experience gained from three recent significant disease outbreaks affecting aquaculture. Case studies of the outbreaks of infectious salmon anaemia (ISA) in Chile, WSS in the Mozambique Channel and EMS in the Mekong Delta have highlighted the importance of:

- The cost benefit of biosecurity.
- The importance of implementing best aquaculture practices.
- The limitations of physical isolation.
- Recognition of high water through flow as a major risk for horizontal transmission.
- Priority for breeding programs for specific-pathogen-free (SPF) and disease resistant breeding stock.
- The critical importance of surveillance programs to national biosecurity.
- The critical importance of strong national aquatic animal health policies and institutions to support effective national biosecurity.
- National and regional biosecurity requires cooperation amongst all stakeholders.

Less well understood are the actual biodiversity impacts of diseases affecting aquaculture. These may include disease and/or mortalities in the expected host species within and outside of the culture system, or may affect unexpected host species (Subasinghe, Bondad-Reantaso and McGladdery, 2001).

A number of factors affect how the economic loss caused by disease in aquaculture animals is expressed, and this has bearing on the optimal investment required to control disease. Israngkura and Sae-Hae (2002) have shown that measuring economic loss by using the volume of dead animals multiplied by the market price tends to result in overestimation of the loss. Consequently, use of this method could result in an over-investment in aquatic animal disease control. As a more accurate method, these authors propose that measurement of farmers' economic loss should examine the difference between the expected income when the animal is fully grown and the actual income realised, and the farmers' expenditure on disease control inputs. Their empirical results show that the economic loss of the farmers decreases as cultivating time increases.

2.6. The PMP/AB initiative of the FAO in the context of Uganda

The PMP/AB provides guidance to countries wishing to improve aquatic biosecurity planning. Entry level into the PMP/AB depends on a country's stage of aquaculture development and is reflected in a number of scenarios:

Scenario 1: Country with no aquaculture biosecurity strategy (AB) nor National Strategy on Aquatic Animal Health (NSAAH) but with aquaculture or initiating aquaculture development;

Scenario 2: Country with NSAAH or other strategies from FAO projects or other assistance projects, at various levels of implementation where it can be investigated how best these strategies can be used, revised and/or expanded to fit the context of PMP/AB;

Scenario 3: Country with advanced biosecurity strategies where these strategies can be reviewed and revised/expanded/updated to fit the context of PMP/AB; identification of bottlenecks/lessons and good practices that can be used;

Scenario 4: Countries sharing water bodies and regions with regional biosecurity strategies are prime candidates for the transboundary and other elements of the PMP/AB.

In the case of Scenario 1, which applies to the current situation in Uganda, the PMP/AB addresses the lack of effective national plans by focusing on national aquaculture biosecurity strategy development processes (mid- to long-term), and by promoting a co-management approach to actively engage stakeholders. Specifically, this enhances awareness and adoption of appropriate biosecurity governance at the producer and sector levels, which can lead to reduction in the incidence and impact of targeted priority diseases, and thus promotes greater recognition of the important role of biosecurity. The PMP/AB's strategic and implementation plans should be jointly developed by industry stakeholders and governance authorities providing a solid platform for public-private sector partnership. This ensures buy-in and best-fit for each country and provides a template that delivers a degree of consistency between participating countries or regions. Ongoing monitoring, evaluation, self-assessment (e.g. FAO self-assessment tool), gap and pathway analysis (e.g. OIE Performance of Veterinary and Aquatic Animal Health Services) are essential components of the process, and are needed to develop national ownership of the principles, responsibilities, and coordination, with other activities necessary for biosecurity management.

2.7. Conclusion

Infectious diseases pose a significant threat to the sustainability and profitability of aquaculture and fisheries sectors, particularly where these industries are rapidly expanding. Epidemiological links exist between natural environments, including fisheries, and aquaculture farming environments through the translocation of fish, fish product, people, equipment and vehicle movements, and shared water ways. Where these risks are shared, disease will move within and between aquaculture facilities (Anon, 2014). Aquatic animal health management through biosecurity planning therefore requires a coordinated national approach involving government and all aquatic animal industries, including commercial, artisanal fisheries, recreational fisheries, aquaculture, and ornamental fish sectors. A biosecurity system describes the overarching government initiatives required to enhance biosecurity planning through best management practices, and standard operating procedures from national to farm level. The policy statement of Uganda's *National Fisheries and Aquaculture Policy (2017)* clearly states the political will to develop and implement fish health and biosecurity protocols. However, implementation of these protocols needs to be guided by a relevant biosecurity strategy which is lacking. The needs of Uganda's aquaculture sector development are reflected in Scenario 1 of the FAO's PMP/AB initiative: *Country with no aquaculture biosecurity strategy (AB) nor National Strategy on Aquatic Animal Health (NSAAH) but with aquaculture or initiating aquaculture development*. The PMP/AB addresses the lack of effective national plans by focusing on the national aquaculture biosecurity strategy development processes (mid- to long-term) and by promoting a co-management approach to actively engage stakeholders.

3. POLICY AND LEGAL FRAMEWORK FOR THE NATIONAL BIOSECURITY AND BIOSAFETY SYSTEM FOR AQUACULTURE IN UGANDA

3.1 Assessment of existing management policy, legislation and institutional framework

The fisheries sub-sector and the development of aquaculture in Uganda are guided by the National Fisheries Policy (2004) (Anon 2004), the National Investment Policy for Aquaculture Parks (2012) (Anon. 2012) and the Fisheries and Aquaculture Policy (2017) (Anon. 2017a). In addition, the Uganda National Aquaculture Development Strategy (2008) (Anon. 2008b) and the provisional Fisheries Sector Strategic Plan provide the strategic framework at the level of the Government. The Fish Act (Cap. 197) 2000 and the Fish (Aquaculture) Rules 2003, which are currently in the process of being updated, provide the legal framework.

The draft National Aquaculture Development Strategy and Action Plan of Uganda (NADSAP) 2021–2025 is aligned with and draws guidance from Agenda 2030 of the United Nations; Uganda's Vision 2040 policy document; the National Development Plan III (2021-2025); the National Agricultural Policy (2013) and the National Fisheries and Aquaculture Policy (2018). The aim of the NADSAP (2021-2025), to guide investment and support to the aquaculture sub-sector, is closely linked to implementation of regulations imparted by the Fish Act, 2000; the Fish (Aquaculture) Rules, 2003; the Environment Act, 1998; and the Water Act, 2001. Decentralisation and transfer of powers to the Districts and Co-management Units along the lake shores has disrupted the chain of command between MAAIF as policy makers and the Ministry of Local Government as enforcers creating challenges in enforcing these laws (Anon, 2021a)

The Fish Act (2000), which is currently under review, is the principal Act from which regulations for aquaculture have been developed. The Fish (Aquaculture) Rules, 2003, are the existing aquaculture rules and guidelines which regulate aquaculture practices, especially at the commercial level. These are currently being updated under the same arrangement as the NADSAP, as the Fisheries and Aquaculture Bill 2020 Bill No. 29, to become The Fish (Aquaculture), Rules, 2020 (Statutory instruments 2020 No…… Under section 35 (f) of the Fish Act, Cap. 197) (Anon 2020b). In addition, the National Agriculture Research System (NARS) Act, 2005, regulates public fisheries and aquaculture research among other agriculture research areas.

According to the NADSAP (2021-2025) Uganda's regulatory requirements must maintain standards of biosecurity and food safety that are equivalent to international standards, and meet Uganda's appropriate level of protection. The Agriculture Sector Strategic Plan 2020/21-2024/25 (Anon 2019), however, lists amongst others, as key issues in the aquaculture value chain that need to be addressed:

- the lack of adequate management knowledge and skills;
- biosecurity and biosafety issues (fish diseases);
- enabling laws & policies;
- inadequate extension staff and extension materials;
- that existing extension staff require skilling & retooling; and
- inadequate subsector funding.

The NASSP 2020/21-2024/25 identifies the need for developing and promoting biosafety and biosecurity measures for aquaculture production systems and improving and disseminating disease diagnostic tools for detection and prevention of fish diseases in fish culture systems. It has as a target, development of a National Biosecurity Strategy by 2025 and supports building capacity of farmers to develop on-farm biosecurity measures, and government institutions to monitor and certify biosecurity with reporting to OIE.

The mandate of the MAAIF as it relates to Fisheries draws from the National Fisheries and Aquaculture Policy 2017 by which the status of the Directorate of Fisheries Resources, as Competent Authority, is elevated to a semi-autonomous Directorate to strengthen the institutional function of fisheries and aquaculture management. This mandates MAAIF, to amongst others, strengthen human capacity in both quality and quantity to manage fisheries and aquaculture work at district and local government level including: strengthening District Production and Water offices in their work to reach out to fishers and fish farmers adequately and expeditiously in resolution of issues affecting fisheries including disease, pest and vector control. This includes training and empowering fish farmers to embrace new technologies, support for the research agenda of the NaFRRI and NaGRIC and related academia and research organisations, support for improved fish seed and access to improved fish feed and disease control commodities. MAAIF will also promote collaborations to enhance fisheries production and marketing zones that include aquaparks to achieve economies of scale. MAAIF's responsibility to ensure quality assurance and traceability lies with its role to regulate, monitor and ensure adherence to national, regional and international standards including those of the OIE.

In Uganda, aquaculture operations are regulated by the Statutory Instrument: Fish (Aquaculture) Rules 2003, and the associated Standard Operating Procedures for Inspection of Aquaculture Establishments and Practices. The Fish (Fishing Rules), 2010 in Statutory Instrument 2010 No. 33 makes provision for permits for the movement of fish and fish products including those derived from aquaculture, and invests MAAIF through the Chief Fisheries Officer and authorised officers with the powers of inspection and seizure (Anon 2010).

3.2. The Fisheries and Aquaculture Bill 2020 Bill No. 29 as it applies to aquatic animal health

The Fisheries and Aquaculture Bill 2020 Bill No. 29 aims to empower the Chief Fisheries Officer to, amongst other, enforce destruction without compensation of fish stocks in aquaculture establishments where this is deemed necessary in the event of outbreak of epidemic disease. The bill further provides the means to regulate quality of feeds used in aquaculture and tasks the Chief Fisheries Officer in consultation with the Chief Veterinary Officer, with approval of veterinary therapeutic products and medicinal premixes for inclusion in fish feeds.

The draft Codes of Practice (COPS) for Aquaculture Establishments aim to provide guidance on the environmental, food safety and quality measures to be undertaken by the aquaculture and other business operators to minimise contamination, and reduce or eliminate hazards in aquaculture products. They encourage operators of aquaculture establishments to improve commitment to ecologically sustainable aquaculture development and to meet the requirements for international markets.

These documents lay down legal requirements and administrative enforcement procedures for aquaculture operations and aquaculture products. For the legal and administrative requirements to achieve their intended purposes, the requirements have to be understood and implemented by the aquaculture farmers and business operators.

3.3 The draft Codes of Practice (COPS) for Aquaculture Establishments as they apply to aquatic animal health

The draft Codes of Practice (COPS) for Aquaculture Establishments encourage aquaculture establishments to use documented Veterinary Health Plans (VHP) and Biosecurity Plans (BP) for their farming operations with the following recommendations:

1. VHPs and BPs should be reviewed at the end of each production cycle.
2. All staff engaged in the production of fish should be familiar with the relevant aspects of the VHP and BP.
3. Aquaculture facilities should have written procedures to ensure that production staff notifies management immediately when disease is suspected, where abnormal behavior is evident, or where morbidity or mortality levels are unusually high or subject to rapid increase.
4. Persons with fish under their care must notify the proposed Fish Health Inspectorate of the presence or suspicion of listed or notifiable diseases.
5. Dead fish should be removed from the fish holding enclosure as soon as possible.
6. At all stages, the number of dead fish must be recorded, along with, where possible, a record of the cause of death.
7. Fish should be disposed of according to relevant disposal methods.
8. Where a notifiable disease is present on a site and movement restrictions are in place, farmers must seek and obtain permission to remove dead fish from the site.
9. The veterinary surgeon that has the fish under his or her care should also be notified.
10. Subject to safe operating conditions, in the event of a disease outbreak, dead fish should be removed daily.
11. Dead fish must be handled and disposed of in a manner that minimizes the risk of spread of disease and in accordance with statutory requirements.
12. Fish farm personnel and visitors to fish farms should be made aware of the role they play in minimizing the risk of disease transmission, following good hygiene practice and procedures. Good hygiene practice includes within its scope the conduct and hygiene of persons concerned, their personal clothing, personal protective equipment and other equipment used by them on site.
13. Risk assessments should be conducted by trained personnel experienced in the appropriate methodology.
14. The outcome of risk assessments should be communicated to the relevant production personnel and other members of personnel responsible for implementation of the outcomes.
15. Farmers should reduce any risk to fish health associated with the presence of wild birds, mammalian predators and vermin by ensuring the secure storage of feed, good feeding practice and the secure temporary storage of dead fish.

Each farm should have access to a veterinary surgeon experienced in fish health, to advise on fish health matters and medicine usage, and who is available to attend at short notice. Guidelines for developing a farm level veterinary health plan (VHP) and biosecurity plan (BP) and the protocol to follow for performing a risk assessment for fish health are provided in Annexes to the Codes of Practice (COPS) for Aquaculture

Establishments. To effectively address the management and control of aquatic animal diseases, the responsibilities of the Competent Authority responsible for veterinary activities need to be closely aligned with those of the DFR as Competent Authority for fisheries and aquaculture management. It is not clear whether these activities fall under the DFR as CA for fisheries and aquaculture or under the Directorate of Animal Resources (DAR) as the Competent Authority for veterinary activities.

3.4. The Fish (Aquaculture) Rules as they apply to aquatic animal health

In Uganda, aquaculture operations are currently regulated by the Statutory Instrument: Fish (Aquaculture) Rules 2003, and the associated Standard Operating Procedures for Inspection of Aquaculture Establishments and Practices. This document is outdated in relation to its applicability to aquatic animal health. The proposed Fish (Aquaculture), Rules, 2020 (Statutory Instruments 2020 No…… Under section 35 (f) of the Fish Act, Cap. 197) aim to revoke The Fish (Aquaculture) Rules 2003. Under the Fish Act, the Chief Fisheries Officer designates Fish Officers as Aquaculture Inspectors and gives them the powers to enforce the proposed Fish (Aquaculture), Rules, 2020.

Amongst others, the proposed rules aim to make provision for the control of contaminants and disease-causing agents, including veterinary drugs and agricultural chemicals used by aquaculture establishments (Rule 15). Furthermore, the rules mandates that all establishments need to conform with the standard sanitary measures for aquaculture issued in accordance with the guidelines provided by the Code of Practice for Aquaculture Establishments (Rule 15); and that the management of commercial establishments must put in place sanitary measures to ensure health for animals, and safety and quality of aquaculture products and environments (Rule 16). These sanitary measures are intended to comply with the basic sanitary requirements issued by the Chief Fisheries Officer which are intended to cover best recognized international practices for amongst others drugs, chemicals and hormone use, movement and storage; control of drugs and chemical residues; sanitation and hygiene management; fish health and disease control; and proper harvesting and observance of withdrawal periods.

The proposed rules compel persons or establishments engaged in commercial aquaculture to keep records relating to the measures put in place to control biological and chemical hazards and health related hazards (Rule 19). These include veterinary drug usage, treatment regimens and occurrence of diseases, and analytical results for water, soil, fish and feeds, and veterinary drugs.

According to the proposed rules, issuance of an aquaculture certificate is subject to submission by the management of an intensive type of aquaculture establishment, of an aquatic animal health management plan to the Chief Fisheries Officer (Rule 20). This should contain details of:

(a) preventive measures for disease outbreaks;
(b) emergency response measures;
(c) chemicals banned for use in aquaculture in Uganda;
(d) availability of diagnostic services and treatment from a qualified veterinarian;
(e) reporting disease outbreaks.

It is proposed that the management of fish health at the farm should be in accordance to the Guidelines and Code of Practices for Aquaculture, and should be monitored and supervised by a qualified veterinary

practitioner or designated fish pathologist who has received adequate training in the prevention, control and treatment of fish diseases and other health conditions (Rule 21).

The rules further propose that a person or establishment engaged in production for sale and distribution or importation of veterinary drugs or chemicals used in aquaculture must maintain records on the source, types, concentrations, dosage, methods of administration, and withdrawal periods for drugs or chemicals, which must be provided on request to the aquaculture inspectors (Rule 22).

The proposed rules make provision for approval of veterinary therapeutic products and medicinal premixes for inclusion in fish feeds to be applied to fish by the Competent Authority (Rule 23). According to these rules the Competent Authority is tasked to approve such products and premixes in consultation with the responsible relevant government agencies. Persons or establishments may not use veterinary drugs unless the drugs contain clear instructions, labels of drug name and contents, withdrawal and expiry periods, and a person or establishment engaged in aquaculture may only use veterinary drugs in the list permitted by the Competent Authority and relevant international bodies.

The proposed rules make provision for making it illegal to use certain drugs and chemicals in aquaculture that have not been approved for this purpose or that have been banned (Rule 24). The Eighth Schedule of the proposed rules lists the following banned substances:

Table 1.: Proposed list of chemicals banned for use in aquaculture in Uganda (Part D, Eighth Schedule)

	Name
Antibiotics	Chloramphenicol Fluroquinolones Nitrofurans Quinolone
Antimicrobial	Malachite green
Others	Dimetridazole, metronidazole and anabolic substances administered for growth promotion purposes with exception of sex reversal; where methyl testosterone in tilapia hatchery operations is allowed

The Chief Fisheries Officer is tasked with issuing the Guidelines and Code of Practice for Aquaculture to ensure that all drugs or chemical products in aquaculture are used in accordance with the intended purposes including feed supplements, transportation of live fish, breeding or disease, prevention, treatment and control or sex manipulation and growth promotion (Rule 25).

The rules propose that the use of veterinary drugs by aquaculture establishments must be under the supervision and direction of the qualified veterinarian or fish pathologist who has prescribed the drugs and who is tasked to keep appropriate records (Rule 26). The rules further propose that aquaculture establishments using veterinary drugs or other related chemical products must keep prescribed records of all the treatments (Rule 27).

Where an establishment is to be placed in a trans-boundary aquatic system, Rule 28 proposes that the Chief Fisheries Officer is guided by the relevant International Codes and Protocols that are recognised by all neighbouring countries.

The proposed rules task the Competent Authority to conduct annual residue monitoring in both fish and the environment, and compel aquaculture establishments to put in place routine checks to ensure proper usage of chemicals or veterinary drugs (Rule 42).

3.5. The Fish and Aquaculture (Quality Assurance) Rules 2017 as they apply to aquatic animal health

The Fish and Aquaculture (Quality Assurance) Rules 2017 (Anon 2017b) and the associated Standard Operating Procedures for Fish and Aquaculture Inspection and Quality Assurance make provision for veterinary monitoring whereby commercial aquaculture establishments are obliged to engage the services of a qualified veterinarian or fish pathologist to carry out diagnostics, treatment and monitoring. In addition, the veterinarian or pathologist is tasked to keep record of the acquisition and application of veterinary drugs. The ninth Schedule of this instrument deals specifically with quality assurance and provides the acceptable limits of microbial and chemical contaminants, and the maximum acceptable residue levels in the flesh of fish from aquaculture establishments.

3.6. National Drug Policy Authority (NDPA) Act 1993 and Regulations (Chapter 206) as it relates to supply and use of veterinary medicines

National Drug Policy Authority (NDPA) Act 1993 and Regulations (Chapter 206) establish a national drug policy and a national drug authority to ensure the availability and appropriate use of drugs. The drug authority is charged with the implementation of the national drug policy and is responsible for assessment and registration of animal medicines. Veterinary medicinal products in Uganda fall under the regulation of the Act which aims to ensure the availability, licensing and dispensing procedures, and identifies classified medicinal products that may only be used under prescription from a registered medical practitioner, dentist or veterinary surgeon. Under the Act a “drug” is defined as *any substance or preparation used or intended to be used for internal or external application to the human or animal body either in the treatment or prevention of disease or for improving physiological functions, or for agricultural or industrial purposes* (Anon, 1993). The NDPA is tasked with providing inspectorate and enforcement services.

3.7. The Animal Diseases Act (Chap 38)

The current Animal Diseases Act (Chap 38) stems from 1918 and is outdated. The Act is mainly concerned with diseases of terrestrial domestic livestock and excludes aquatic animals and their diseases. Nevertheless, the Act makes provision for the terms “animals” and “diseases” to be amended as needed by declaration of the Minister via Statutory Instrument.

3.8. The Ministry of Agriculture Animal Industry and Fisheries (MAAIF) as it relates to aquatic animal health

The Ministry of Agriculture Animal Industry and Fisheries (MAAIF) is structured into a Directorate of Fisheries Resources (DFR) and a Directorate of Animal Resources (DAR) (Anon 2021b).

The objective of the DFR is to support sustainable, market-oriented fish production, and the management, development and control of quality and safety of fisheries products. The DFR is made up of three departments:

a. The Department of Aquaculture Management and Development which supports sustainable, market oriented fish production and value addition.
b. The Department of Fisheries Resource Management and Development (Natural stocks) which supports sustainable exploitation of natural fisheries resources for fish and fish products.
c. Department of Fisheries Control, Regulation and Quality Assurance which formulates, reviews and enforces fisheries legislation, regulations and standards for fish production, capture fisheries and processing.

The objective of the Directorate of Animal Resources (DAR) is to support sustainable animal disease and vector control, market-oriented animal production, food quality and safety. The DAR is made up of three departments: Animal Production; Animal Health; and Entomology.

The Department of Animal Production has three divisions: Dairy and Meat; Animal Nutrition; and Veterinary Public Health. The Veterinary Public Health Division lists as its key functions;

- formulation, review and implementation of policies, legislation, regulations, standards plans and strategies in regard to both edible and non-edible animal products; supervision and monitoring of implementation of veterinary public health policies, plans and legislation
- Promotion of environmentally friendly and economically viable veterinary public health systems
- Establishment and maintenance of an effective veterinary public health management information system
- Provision of technical backup and capacity building for veterinary public health in local governments
- Provision of advice to MAAIF and LGs on establishment and maintenance of the appropriate infrastructure for veterinary public health
- Guidance and promotion of veterinary public health
- Provision of technical guidance for planning, siting and construction of slaughter houses and ensure that recommended plans are available to stakeholders and
- Provision of technical guidance to establishment of local tanneries and leather craft industry.

Department of Animal Health is responsible for support and control of animal diseases and vectors. The department has several divisions: Animal Disease Control Division; Veterinary Diagnostics and Epidemiology Division; and Veterinary Regulation and Enforcement Division

The Animal Disease Control Division has as its function to:

- Review, update, formulate and implement policies, plans and strategies for controlling animal diseases
- Control animal diseases
- Monitor outbreaks and prevalence of animal diseases countrywide with a view to controlling them
- Advise LG and the MAAIF on animal disease control strategy
- Collaborate with research and other organizations nationally, regionally, internationally on control of animal diseases
- Support the provision and monitor availability and use of major animal diseases, vaccines and drugs.

The Veterinary Diagnostics and Epidemiology Division has as its functions to:

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

The Veterinary Regulation and Enforcement Division has as its function to:

- Formulate, review and implement veterinary legislation, regulations and standards
- Develop strategies and plans for enforcement of national veterinary legislation, regulations and standards
- Create effective awareness in the population on veterinary legislation, regulations and standards
- Support the identification, development and use of strategic animal quarantine infrastructure in the country
- Put in place and enforce systems for identification and traceability for animals and animal products related to animal health, veterinary public health, quality and safety of animal products
- Conduct animal health and veterinary public health risk analysis for import/export and internal animal/animal products movements in the country

- Inspect and certify animal and animal products for exports, import and for local markets
- Promote and regulate veterinary professional practice, animal trade and welfare
- Collaborate with national, regional and international organisations on veterinary legislative and enforcement issues.

3.9. The veterinary profession

The veterinary profession in Uganda is regulated by the Uganda Veterinary Board, established under the Veterinary Surgeons Act of 1958, which serves as the veterinary statutory body (VSB) of the country. The Uganda Veterinary Board is empowered to register veterinary surgeons, establish the qualifications for registration, prohibit practice by non-registered individuals and to discipline misconduct by registered veterinary surgeons. The Veterinary Surgeons Act, however, does not provide authority for the Board to establish continuing education requirements for re-registration of veterinary surgeons or to recognize, register and regulate veterinary paraprofessionals. For these reasons, among others, the Uganda Veterinary Board does not meet the international standards for veterinary statutory bodies as set forth by the OIE in Chapter 3 of the Terrestrial Animal Health Code.

In an effort to address these insufficiencies, a new Veterinary and Para-Veterinary Bill of 2007 was drafted to repeal and replace the obsolete Veterinary Surgeons Act of 1958. While the Bill has not been enacted, the Uganda Veterinary Board continues to lack a full range of necessary functions to meet international standards. The OIE PVS Evaluation for Uganda conducted in 2007, the OIE Veterinary Legislation Identification Mission conducted in 2010, and the OIE PVS Gap Analysis Mission conducted in 2011 all identified the existing constraints on the authority of the Uganda Veterinary Board and recommended a review of the draft Veterinary and Para-Veterinary Bill with the goal of modification and enactment (Kauta and Sherman, 2013). Around the same time, Kenya was adopting a new Veterinary Surgeons and Veterinary Para-Professionals Act (2011) and Uganda saw an opportunity, not only to review their own existing draft Bill but to harmonize it with the Kenyan Act. In 2011, Uganda requested a Veterinary Legislative Agreement with the OIE in order to, inter alia, review and revise the Veterinary and Para-Veterinary Bill with the goal of enactment in order to ensure that the Uganda Veterinary Board has the necessary powers and authorities to meet international standards for a Veterinary Statutory Body (Kauta and Sherman, 2013).

3.10. Stakeholders and their designated institutional roles in Uganda (information supplied by the MCS project).

The Commissioner Animal Health is the official OIE Delegate for Uganda. The Commissioner is designated to:

i. Notify OIE on animal diseases in the country in accordance to both the Terrestrial and Aquatic Animal Codes.
ii. 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 complies with the WTO/SPS Agreement.
iii. Ensure that resolutions of World Assembly of Delegates are applied.

iv. Ensure that Veterinary Services are kept updated on OIE standards.
v. Ensure that the national animal disease diagnostic laboratories are informed of activities of OIE's worldwide network of Reference Laboratories and Collaborating Centres to promote scientific and technical cooperation in this field.
vi. Designate (if possible) national focal points, and to support their compliance with national obligations.
vii. Determine what level of WAHIS access to give each of the respective national focal points.

Commissioner Aquaculture, as Competent Authority for Aquaculture has as responsibility:

i. The support of sustainable, market-oriented fish production and value addition; for improved food security and household income.
ii. Formulation, review, and implementation of policies, legislation, standards, plans and strategies on fish production and value addition
iii. Provision of guidance on the transfer of improved and appropriate fish production technologies to service providers, processors, traders and consumers
iv. To establish and operationalize collaborative frameworks with national, regional and international fisheries research institutions and organizations to ensure sustainable development of the sub sector
v. Provision of quality assurance on advisory services relating to fish production
vi. To build capacity of service providers on fish production
vii. To provide guidance and promote the use of improved fish fry and fisheries stocking materials and sustainable natural resources management
viii. The conduct of fisheries surveillance (fish aquaculture) in the country for the development of the fisheries industry

As OIE Aquatic Animal Health Focal Point the Commissioner is responsible for:

i. Communication with the country's network of aquatic animal health experts.
ii. Establishment of dialog, cooperation and communication with the CA for aquatic. animal health and relevant authorities.
iii. Collection and submission of aquatic animal disease information to OIE.
iv. Reception of reports and the conduct of in-country consultation processes of the Aquatic Animal Health Standards Commission
v. Preparation of comments for the Delegate (CA AH) on relevant meeting reports, including comments on proposals for new or revised OIE standards related to aquatic animal diseases.

Principal Fisheries Officer

i. Provide linkage, information flow and collaboration with MAAIF in general and the DFR in particular.
ii. Ensure control of fish diseases, aquatic weeds and pests.
iii. Ensure inspection and certification of fish and fish products, vessel and vehicles transporting fish and fish products (Local Government, 2017).

Senior Fisheries Officer

i. Identify and report fish pests, aquatic weeds and disease outbreaks.
ii. Supervise fisheries establishments including collecting and sending samples to referral laboratories.
iii. Monitor fish stocks in natural water bodies and fish farms in collaboration with research institutions and MAAIF.
iv. Collect, collate, analyse and disseminate data on fisheries sub sector.
v. Conduct monitoring, control and surveillance in the fisheries sub sector in the district.
vi. Support fish inspection and certification activities in the district.
vii. Prepare and submit activity reports to the supervisor (Local Government, 2017).

Fisheries Officer (Aquaculture)

i. Identify and report fish pests, aquatic weeds and disease outbreaks.
ii. Collect and send samples of fish, pests, feeds, sediments and water to referral laboratories.
iii. Collect, collate, analyse and disseminate data on aquaculture production and development.
iv. Participate in monitoring, control and surveillance in the fisheries sub sector in the district.
v. Support fish inspection and certification activities in the district (Local Government, 2017).

Fisheries Officer (Subcounty Level)

i. 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.
ii. 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

i. Detect when animals are not well.
ii. Maintain farm data records
iii. Passive reporting of disease outbreaks

Fish traders and transporters

i. Can transmit diseases through commercial activities

3.11. Conclusion

The roles and responsibilities of the Competent Authority for aquatic animal health are currently split between the DFR and DAR and are inadequately defined. Under the existing laws of Uganda, the Department of Aquaculture Management and Development (DAMD), headed by Commissioner of Aquaculture, under the DFR, acts as CA for aquaculture, and is responsible for strengthening the institutional function of fisheries and aquaculture management, including disease, pest and vector control, improving disease control commodities, and monitoring and ensuring adherence to national, regional and international standards including those of the OIE. Many of these tasks would better reside with the veterinary services under the DAR. According to the National Fisheries and Aquaculture Policy (2017), the Commissioner Aquaculture is also responsible for ensuring aquaculture biosecurity.

In Uganda, the Commissioner of Aquaculture has been designated by the Delegate to the OIE to act as the National Aquatic Animal Disease Focal Point. Although the OIE recognises a split role of CA between fisheries and veterinary services, according to the standards of the OIE, disease reporting should be through a country's chief veterinary officer (CVO) who is usually the country's delegate to the OIE.

To effectively address the management and control of aquatic animal diseases under the current laws of Uganda, the responsibilities of the Competent Authority responsible for veterinary activities need to be closely aligned with those of the DFR as Competent Authority for fisheries and aquaculture management and their respective roles need to be clarified. This is particularly relevant to the issuing of zoosanitary certificates (aquatic animal health certificates). At present, it is not clear whether these activities fall under the DFR as CA for fisheries and aquaculture or under the Directorate of Animal Resources (DAR) as the Competent Authority for veterinary activities. Most importing countries require international zoo-sanitary health certificates to be signed by an official veterinarian who has been delegated to this role by the country's CVO. The veracity of guarantees that are provided by such certificates needs to be supported by the competence of the signing party. This must be backed by the activities and capacity of a country's veterinary services including diagnostic services and reporting, responsibilities that fall under the CVO as CA for aquatic animal health.

A further conflict of responsibility between the CAs, with implications for biosafety, is reflected in the oversight for veterinary drug use in aquaculture in Uganda. Under the current Fish (Aquaculture) Rules, the Chief Fisheries Officer is tasked with issuing the Guidelines and Code of Practice for Aquaculture to ensure that all drugs or chemical products in aquaculture are used in accordance with the intended purposes including feed supplements, transportation of live fish, breeding or disease, prevention, treatment and control or sex manipulation and growth promotion. These are clearly veterinary oversight functions that should reside with the CVO under the DAR.

4. ASSESSMENT OF NATIONAL AQUATIC ANIMAL HEALTH PERFORMANCE AND CAPACITY IN BIOSECURITY (Results of stakeholder consultations)

4.1. Level of understanding of biosecurity as applied to aquaculture and the trade in live aquatic animals and their products.

A) Farmers/producers:

(i) Small-scale Subsistence farmers: lack knowledge on biosecurity and biosafety needs for aquaculture and trade. All respondents lacked knowledge on fish diseases.

(ii) Small-scale commercial farmers: A few (< 10%) with minimal knowledge or application of biosecurity and biosafety measures for aquaculture. Farmers mainly access information from district/sub-county fisheries extension staff, fellow farmers, research and/or academia. Live fish seed or brood-stock is usually sold without accompanying documents (permits) hence traceability of live aquatic materials is difficult.

(iii) Large scale commercial farmers:

- Individually owned farms: level of knowledge of fish diseases and implementation of biosecurity and biosafety measures is good but not adequate. Permits for farm products are usually issued by District Fisheries Staff. Farm records of movements of live aquatic animals into and out of establishments are available.
- Group farmers: levels of knowledge on fish diseases and implementation of biosecurity and biosafety measures is minimal. Permits for farm products are issued by District Fisheries Staff. Farm records or information of movements of live aquatic animals into or out of farms is not adequate.
- Cage farms (especially on Lake Victoria) are close to each other, and this may increase the spread of diseases during outbreaks. There is an urgent need to Zone lake-based aquaculture farms.

B) Extension staff/planners: acquired basic knowledge on fish diseases, biosecurity and biosafety but incapacitated to implement due to lack of policy and/or guidelines, facilities, logistics and equipment. However, records of live aquatic seed or brood-stock movements are available in districts when movement permits are issued.

C) Ministry Officials: (Nelly's input)

D) Research and academia: Scientists/researchers are more knowledgeable on fish diseases, biosecurity and biosafety measures required for aquaculture. They generate information on fish diseases in Uganda and have built networks with international competent authorities. They provide technical guidance to farmers, extension agents and planners.

4.2. Level of emergency preparedness.

A) Farmers/producers (farm level):

i) Small-scale subsistence farmers: no mechanisms or strategies available.

ii) Small-scale commercial farmers: a few hatchery operators have established some strategies to manage epizootics or fish diseases. Most farmers in this category lack mechanisms to contain any disease outbreaks.

iii) Large scale commercial farmers: a few farms have put mechanisms in place to manage disease outbreaks after past experience.

B) District level: No strategy/framework available.

C) National level: No strategy/framework available.

The Aquaculture sector is vulnerable to aquatic diseases or epizootics which affect production and quality of farmed fish. The sector lacks a framework to respond to emergencies, and this makes aquaculture a risky venture in Uganda.

4.3. Capacity for disease prevention and control.

A) Farm level:

(i) Small-scale subsistence farmers: No capacity to prevent or control diseases.

(ii) Small-scale commercial farmers: low capacity to prevent and control diseases/epizootics.

(iii) Large scale commercial farmers: low capacity to prevent and control diseases/epizootics.

B) District level:

Low capacity to prevent and control diseases/epizootics.

D) National level:

Low capacity to prevent and control diseases/epizootics.

4.4. Capacity to register fish farms.

A) District and Sub-county level:

Capacity to register fish farms is high.

B) National level:

Capacity to register fish farms is high.

4.5. Capacity of quarantine, inspection and control services (effectiveness of border controls).

Uganda lacks capacity to prevent and contain transmission of diseases across borders mainly due to:

- No emphasis on fish diseases at border points;
- No set guidelines on import or export of live fish;
- Fish inspectors not capacitated to detect pathogens and/or prevent entry of fish pathogens;
- No quarantine facilities available;

- Free movement of fish from wild catch and farmed harvests;
- No control of aquatic inputs;
- Competing interest between biosecurity issues and market forces;
- Lack of formulated policies for biosecurity and biosafety in aquaculture.

However, border points have been improved with laboratory facilities that can facilitate screening of fish that enters or leaves the country.

4.6. Capacity for disease diagnostics, surveillance, monitoring and reporting.

The following challenges in disease diagnosis were reported in the results of a study performed in 2016 by Nakayima *et al*.:

- Lack of laboratory space for some districts.
- Lack of trained personnel in disease diagnostics for example, technicians. They have resorted to using animal husbandry officers or Veterinary doctors who are not trained in disease diagnosis.
- Lack of funds for supplies and other necessities for laboratory diagnosis.
- Lack of equipment.
- Veterinary staffs are not motivated to carry out disease diagnosis.
- Farmers are not motivated to support laboratory diagnosis.
- Lack of confirmatory tests for most diseases- treatment is based on clinical diagnosis and hence not accurate. Result is that animals are exposed to drugs they do not need resulting in drug resistance.

Most laboratory diagnostic tests were aimed at diagnosing diseases of terrestrial animals. The authors identified an urgent need, particularly at district level, for training of diagnosticians in clinical and laboratory diagnosis through refresher courses and for training in new diagnostic techniques such as PCR. They further recommended the development and dissemination of rapid diagnostic kits for on-site use, and the training of farmers in improved husbandry techniques (Nakayima *et al*., 2016).

4.7. Availability and regulation of appropriate and safe veterinary medicines and capacity for residue monitoring,

Hatcheries and some grow-out operators often use veterinary drugs for all-male tilapia seed production (hormones for androgenisation) and for treating against infections (antimicrobials and antiparaciticides). Farmers rarely seek veterinary advice when using these drugs, and these drugs are easily accessed on markets. Therefore, incidence of antimicrobial resistance may emerge in future if use of veterinary drugs is not adequately regulated. Currently, the National Drug Authority (NDA) is mandated to regulate medicinal agents. If poorly regulated use of antimicrobial drugs is allowed to continue, this will eventually lead to disease-causing organisms that affect aquatic animals to become resistant to common antimicrobial medicines. The resistant microbes can spread from one animal to the other and eventually to humans. Antimicrobial resistance may also spread from one microorganism to another through plasmid transfer of resistance genes, further increasing the number of resistant microorganisms. Antimicrobial resistance may affect

humans and animals, and international marketability of farmed fish from Uganda. The fight against antimicrobial resistance (AMR) is an important component of the One Health concept of managing human and animal diseases.

4.8. Level of feed quality control.

The Uganda National Bureau of Standards (UNBS) is mandated to enforce standards in protection of public health and safety against dangerous and sub-standard products (including feeds). It has laboratory facilities to monitor the quality of animal feeds manufactured and imported into Uganda. Feed producers send samples for analysis and maintaining quality. Universities, research institutes and private laboratories (e.g., Chemiphar) also offer services to producers.

A) Farm level:

(i) Small-scale subsistence farmers: rarely use commercially available fish feeds instead use animal manure to fertilize ponds.

(ii) Small-scale commercial farmers: low levels of feed quality control. The majority lack knowledge on feed quality control. Feeds are usually not properly stored. Few farms keep records of fish feeds. Other farmers formulate and manufacture their own fish feeds but the quality is not evaluated.

(iii) Large scale commercial farmers: high level of feed control because of huge investments incurred (> 60% of cost of production). Farmers import fish feeds that are kept in properly aerated stores. Records for feeds are kept but lack disposal.

B) District Level: low capacity for feed quality control.

4.9. Capacity for education, training and awareness building.

A) District or sub-county level: Fisheries Department conduct quarterly trainings and awareness for fish farmers, and fish health management is part of the package disseminated.

B) Fisheries Training Institute: Offers a certificate and diploma in aquaculture which includes fish health management.

C) Universities: Makerere, Busitema, Muni and Gulu Universities have aquaculture course modules that include aquatic health. They also offer short-term trainings to extension agents and farmers.

D) Research: Aquatic animal health is part of the research agenda in NARO, and scientists are recruited with laboratory facilities established.

However, there is urgent need to further train aquatic animal specialists and Veterinary Officers as the aquaculture industry is growing.

5 ALIGNING NATIONAL AQUATIC ANIMAL HEALTH PERFORMANCE AND CAPACITY IN BIOSECURITY AGAINST THE STANDARDS OF THE OIE

According to the OIE, aquatic animal health services should be able to demonstrate that they are able to anticipate the requirements for, and have control of, the establishment and application of aquatic animal health measures, and of international aquatic animal health certification activities (OIE, 2019a). This should be demonstrated by means of appropriate legislation and regulations, sufficient financial resources and effective organisation. The Aquatic Animal Health Code of the OIE provides guidance on the fundamental principles of ethical, organisational, legislative, regulatory and technical requirements of a country's aquatic animal health services. The ability of a country's aquatic animal health services to deliver appropriate services, monitor and control aquatic animal diseases is based on Member Countries' aquatic animal health legislation and regulation. This can be measured through an evaluation or audit process using the OIE *Performance of Veterinary Services and/or Aquatic Animal Health Services* (OIE *PVS Tool*: Aquatic) (OIE, 2013) that Member Countries can request from the OIE.

For the purposes of this report a brief assessment of the current aquatic animal health services in Uganda against the OIE standards is provided below. However, a full assessment using the OIE PVS Tool: Aquatic is strongly recommended.

According to the standards set by the OIE, aquatic animal health services should have at their disposal effective systems for disease surveillance, diagnosis and notification of disease problems that may occur in the national territory, in accordance with the provisions of the Aquatic Code. They should at all times endeavour to improve their performance in terms of aquatic animal health information systems and aquatic animal disease control. Such services may be provided by means of governmental and non-governmental organisations that implement animal health and welfare measures and other standards and recommendations in the Aquatic Code and should be under the overall control and direction of the Competent Authority. Private sector organisations, veterinarians or aquatic animal health professionals are normally accredited or approved by the Competent Authority to deliver the delegated functions (OIE 2019a).

Aquatic animal health legislation and regulations are a fundamental element that supports good governance and provides the legal framework for all key activities of the Aquatic Animal Health Service. Legislation and regulations should be suitably flexible to allow for judgements of equivalence and efficient responses to changing situations. In particular, they should define and document the responsibilities and structure of the organisations in charge of traceability and control of aquatic animal movements, aquatic animal disease control and reporting systems, epidemiological surveillance and communication of epidemiological information (OIE 2019a).

Table 2. Implementation of animal health and welfare measures and other standards and recommendations in the Aquatic Code:

Services	Provided by government	Provided by accredited non-governmental organisation	Provided by accredited private veterinarian/ aquatic animal health professional	Not available/ not in place	Responsible competent authority
Aquatic disease surveillance	✔				Fisheries & Veterinary Department, National Agricultural Research Systems
Aquatic disease diagnosis	✔				Fisheries & Veterinary Department, National Agricultural Research Systems
Ability to notify outbreak of disease	✔				Fisheries & Veterinary Department, National Agricultural Research Systems
Aquatic animal health information system in place				✔	Fisheries & Veterinary Department, National Agricultural Research Systems
Aquatic animal disease control system in place				✔	Fisheries & Veterinary Department, National Agricultural Research Systems
Traceability and control of aquatic animal movements				✔	Fisheries & Veterinary Department, National Agricultural Research Systems

Aquatic Animal Health Services should define and document their policy and objectives for, and commitment to, quality, and should ensure that this policy is understood, implemented and maintained at all levels in the organisation. Where conditions allow, they may implement a quality system corresponding to their areas of activity and appropriate for the type, range and volume of work that they have to perform. Each position within the aquatic animal health services that has an impact on their

quality should be described. These job descriptions should include the requirements for education, training, technical knowledge and experience (OIE 2019a).

Table 3. Quality assurance of aquatic animal health services

Services	In place	In draft format	Not yet formulated
Aquatic animal health legislation and regulations in place and implemented			✔
Policies and objectives of aquatic animal health services defined			✔
Aquatic animal health services positions described	✔(DiFR and NARO)		
Aquatic animal health services job descriptions defined	✔(DiFR and NARO)		
Education and training in aquatic animal health available	✔		

According to OIE standards (OIE 2019a), the procedures and standards that should be developed and documented by the aquatic animal health services should include:

1. programming and management of activities, including international aquatic animal health certification activities;
2. prevention, control and notification of disease outbreaks;
3. risk analysis, epidemiological surveillance and zoning;
4. emergency preparedness for disasters which could have an impact on aquatic animal health and welfare of farmed fish;
5. inspection and sampling techniques;
6. diagnostic tests for aquatic animal diseases;
7. preparation, production, registration and control of biological products for use in the diagnostic or prevention of diseases;
8. border controls and import regulations;
9. disinfection; and
10. treatments intended to inactivate pathogens in aquatic animal products.

When applying aquatic animal health measures and when issuing certificates, the standards applied by the aquatic animal health services of a country must comply with those in the Aquatic Code or in the Aquatic Manual, and the aquatic animal health services need to define and document the responsibilities and structure of the organisation (in particular the chain of command) in charge of issuing international aquatic animal health certificates.

Table 4. Chain of command and responsibilities for issuing international aquatic animal health certificates

Responsibility	Directorate of Fisheries Resources		Directorate of Animal Resources		
Competent Authority	Department of Aquaculture Management and Development	Department of Fisheries Control, Regulation and Quality Assurance	Animal Disease Control Division	Veterinary Diagnostics and Epidemiology Division	Veterinary Regulation and Enforcement Division
Chain of command	Chief Fisheries Officer		Chief Veterinary Officer		
Approval of certificate and confirmation that conditions of import permit have been met	National Fisheries Officer		National Veterinary Officer		
Confirmation of disease-status guarantees	District Fisheries Officer		District Veterinary Officer		
Inspection that consignment complies with the animal health certificate that has been issued	Border Inspection Officer		Border Inspection Officer		

5.1. Identification and development of basic minimum national capacity and standards for disease diagnostics

Fish farmers usually access disease diagnostic services from NARO and Makerere University (The College of Veterinary Medicine, Animal Resources and Bio-security [COVAB], and the College of Natural Science [CONAS]). However, farmers generally complained of delay in receiving results from the laboratories which has forced some of them to send samples to other countries like France.

Other key findings from stakeholders:

- The threat posed by global diseases which may enter Uganda aquaculture systems through illegal/legal importation of live fish;
- Importation of fish feeds is not properly regulated and may bring in exotic pathogens into Uganda.
- Lack of harmony between institutes is deterrent to aquaculture growth.

The outcomes of a PVS-Gap Analysis 2011 indicated that Uganda's national strategy is to ensure that the National Veterinary Laboratory (NADDEC) has the immediate capacity and resources to perform the required laboratory analyses for animal diseases - including zoonoses - present in Uganda especially those targeted by national control programmes. This was preferred to the recourse to regional or international referenced laboratories, for easier access and national independence reasons. To do so, the PVS-Gap Analysis 2011 recommended that current facilities need to be renovated and proper coordination established with other national laboratories such as those of Ministry of Health and the Fisheries Department. Participation in a regional laboratory network was also proposed as a way to improve national laboratory practices. The relevance of the deployment of a laboratory network in the country at regional and district level needed to be assessed in a feasibility study (Fernet-Quinet *et al.* 2011).

5.2. Identification of national reference diagnostic laboratories and capacities

There is urgent need for Uganda to identify national reference laboratories that are capable of diagnosing those diseases listed in Uganda's National Pathogen List. The national reference laboratories should develop linkages to international reference laboratories so that pathogen identifications can be rapidly confirmed. This is particularly important in the case of epidemic disease outbreaks where rapid response depends on accurate identification of the relevant pathogen. For diseases listed by the OIE, reference experts and laboratories are listed in the current Manual of Diagnostic Tests for Aquatic Animals, together with a list of collaborating centres for diseases of aquatic animals (OIE, 2019b).

5.3. Identification of issues relevant to border controls and import regulations

In order to increase efficiency in the quality of fish trade and fish revenue, MAAIF has recruited fish inspectors in major ports of entry/exit. The main aim of this deployment arose from pressure from the fish consumers of Ugandan fish to improve transparency in the food value chain so as to improve traceability of fish products. This was hoped to improve monitoring, control and sustainability of fish trade and ultimately improve service delivery. The main reason for deployment of these inspectors was evidence-based data collection, regulation control and management. Therefore, national and regional reference laboratories will have to be identified, established and accredited to offer aquatic animal health services. Competent authorities will have to be trained and skilled in diagnostics and delivery of timely reporting and services to the industry.

Generally, the main traded commodities were frozen whole (tilapia) or filleted (Nile perch) fish (export), fish feeds (imported), processed fish (dried/smoked) export, and fish organs (imported). It was noted that although there was trade in live fish, it was mainly illegal and not documented as there were no set guidelines for import of live fish. It was again noted that anyone appearing with live fish without documentation was advised to retrieve permits from places of origin.

Recommendations:

- Need for refresher courses aimed at fish inspectors on fish disease detection and mitigation strategies;
- Need a policy guideline on aquatic input imports especially fish feeds;
- Need a policy to regulate import of live fish so as to facilitate trade;

- Need a policy guideline on importation of fish in general. Fish in transit ending up as Ugandan export needs urgent attention;
- Need to formulate guidelines for biosecurity and biosafety in aquaculture;
- Need to emphasize services of fish pathologists to improve biosecurity for both consumers and farmed fish.

5.4. Preparation of guidelines for control of pathogenic agents in aquatic animal feed

The Codex Allimentarius Commission, through application of the Code of Practice on Good Animal Feeding (CAC/RCP- 54 2004) encourages use of international standards when applied to aquatic animal feed. The code establishes a feed safety system for food producing animals to cover the entire food chain, taking into account relevant animal health and environmental aspects to minimize risks to consumers. Amongst others, it provides standards for good management practices during procurement, handling, storage, processing, distribution of animal feeds and feed ingredients for food producing animals and good animal feeding practices at farm level. Specifically, it provides guidance on feed ingredients, labelling, traceability and record keeping, inspection and control procedures, and health hazards associated with feed. Priority areas include addressing transfer of pathogens (viruses, Mycobacterium, Salmonella, Campylobacter, and pathogenic *E. coli*) with feed; chemicals, contaminants and residues (mycotoxins, metals, bisphenol A, pesticide and veterinary drug residues) in feeds; and the role of antimicrobial resistance, feed safety, and recombinant vaccines in food animal production. Since the SPS Agreement specifically identifies Codex standards, guidelines, and recommendations as the international benchmark for food safety, national regulations consistent with Codex standards are deemed to meet the requirement of the SPS Agreement

Several information exchange mechanisms are available via the Codex and include:

1. International Portal on Food Safety, Animal & Plant Health, a joint initiative with IPPC, OIE, Codex & WTO (www.ipfsaph.org).
2. International food safety authorities network (INFOSAN) for dissemination of important global food safety information.
3. FishPort, a web based system for dissemination of technical and scientific information on fish safety and quality (www.fishport.org)
4. Web page on Veterinary and Public Health, Feed and Food Safety (www.fao.org/ag/AGAinfo/programmes/en/A6.html)
5. Emergency prevention and early warning in the area of food safety (EMPRES Food Safety) (EMPRESFS@fao.org)

Amongst a number of capacity building tools, the On-farm Mycotoxin Control in Food and Feed Grains training manual (Golob, 2007) is probably the most relevant to aquaculture due to the high susceptibility of fish to the effects of mycotoxins, in particular aflatoxin.

Governments are encouraged to support implementation of safety and quality management and assurance in the feed industry through appropriate legislation, procedures and implementation mechanisms; to raise awareness among farmers, feed producers, food processors, government authorities on feed and food safety and their linkages; to promote the code on good animal feeding; and develop screening methods for detection of contaminants and residues (e.g. aflatoxin B1)

All veterinary drugs for use in fish farming should comply with national regulations and international guidelines (in accordance with the Recommended International Code of Practice for Control of the Use of Veterinary Drugs (CAC/RCP 38-1993) and the Codex Guidelines for the Establishment of a regulatory programme for control of veterinary drugs residues in foods (CAC/GL 16-1993) (OIE, 2019a);

As stakeholders in the Codex, WHO and OIE documents, governments possess the authority to make laws that mandate specific actions through national veterinary medicine legislation. To this end, countries should draft veterinary prescription legislation that enables future responsible use of antimicrobials while implementing restrictions on the use of certain antimicrobial products or indications (Shyrock, 2012).

5.5. Establishment of procedures for the evaluation of Aquatic Animal Health Services for Aquaculture based on OIE PVS Tool (OIE 2013)

A Performance of Veterinary Services (PVS) pathway evaluation was performed in Uganda in 2007 followed by a PVS Gap-Analysis in 2011 that was published in the public domain. This was based on the current structure applying to Veterinary Services and did not address the dichotomy created in terms of aquatic animal health in the Directorate of Animal Resources with the Directorate Livestock Health and Entomology as the seat of Veterinary Services being responsible for livestock other than fish, and the Directorate of Fisheries Resources as the competent authority for fish and aquaculture. According to OIE, further PVS on Legislation and Laboratories were performed in 2010 and 2015 respectively with a follow-up PVS Evaluation in 2018 but reports are not available.

A PVS Gap Analysis mission facilitates the definition of a country's Veterinary Services objectives in terms of compliance with OIE quality standards, suitably adapted to national constraints and priorities. In practice, these define, together with the Veterinary Services, and in accordance with national priorities and constraints, the expected result (i.e. level of advancement defined in the OIE PVS tool) at the end of a five-year period for the critical competencies of the OIE PVS tool which are relevant to the national context. They determine the activities to be carried out in order to achieve the expected results for the critical competencies of the OIE PVS Tool which are relevant to the national context of the country. With the help of information, data or interviews, they determine the tasks and human, physical and financial resources required to implement these activities to enable the Veterinary Services to function appropriately (Fernet-Quinet *et al.* 2011).

Veterinary legislation is an essential element of the national infrastructure that enables Veterinary Services to efficiently carry out all their key functions and is one of the 46 critical competencies of the OIE PVS Tool. Uganda is engaged in a Memorandum of Understanding with OIE about a comprehensive legislation review to develop the authority and capability of the Veterinary Services. This aims to elaborate and/or modernize the national veterinary legislation and regulation, thereby helping the Veterinary Services to meet the OIE standards, and to enforce regulation and take legal action or initiate prosecution in instance of non-compliance.

A PVS Gap-Analysis by OIE Experts was performed at the request of the Government of Uganda in 2011. Priority for livestock development to first ensure self-sufficiency in animals and animal products to satisfy the needs of the domestic market and then to gradually move towards an export orientated marketing system was identified as key importance. To enable this, it would be essential that for both the veterinary

public health and animal health activities within the Veterinary Services, the aim should be to move towards compliance with international standards of the OIE and that clear national strategies be identified to address the threat of transboundary animal diseases (TADs) and zoonosis and to address the shortcomings in ensuring the safety of food of animal origin intended for both local consumption and the export of animal products (Fernet-Quinet *et al.* 2011). An essential prerequisite is the urgent need to re-establish a single chain of command within the national Veterinary Services in accordance with OIE international standards; effective legislation to enable such a single chain of command and to define a clear long-term strategy for establishment of a reliable, accessible and sustainable Field Veterinary Network for animal health. An effective field veterinary network (FVN) under the control of the national veterinary services would, through the control of a regional network be similar to the arrangements and structures that apply to the Fisheries or Natural Environment Administrations, be responsible for animal health, veterinary public health and related extension activities. The establishment of such a structure of the VS within a single chain of command would be possible with the existing contingent of veterinarians and para-veterinary personnel currently available within Uganda (Fernet-Quinet *et al.* 2011).

The report recommends provision for material expenditure for the establishment of effective border control operations at 13 border posts in collaboration with the Plant health authorities and for renovations for the import and export control activities at Entebbe international airport.

The Directorate Animal Resources in the Ministry of Agriculture and Animal Industries and Fisheries (MAAIF) is structured into three divisions: Animal Production, Livestock Health & Entomology and Fisheries Resources. All veterinary functions fall under the Commissioner Livestock Health and Entomology. To meet international certification and equivalence and other types of sanitary agreements, the strategy is for the Veterinary Services to carry out certification programmes in compliance with international standards for selected animals and selected products of animal origin including fish. Residue testing is already carried out for certain export products including fish). In the case of such export (private business), the need for international certification should be done on a cost recovery basis, in laboratories accredited by the Veterinary Services in compliance with the international standards at no cost to the Veterinary Services or Ministry of Health. The Veterinary Services should only establish the relevant procedures of certification and accreditation. In the current situation, it is not envisaged to mount and implement a national residue monitoring programme for the domestic market (Fernet-Quinet *et al.* 2011). However, a feasibility study is proposed to help define the outlines of such a programme, based on OIE and Codex Alimentarius standards, on risk analysis and through the preparation of an indicative budget, to be supported by the national budget (VS or MoH) in the future (Fernet-Quinet *et al.* 2011).The national strategy is to ensure that the National Veterinary Laboratory (NADDEC) has the immediate capacity and resources to perform the required laboratory analyses for animal diseases - including zoonoses - present in Uganda especially those targeted by national control programmes. This is preferred to the recourse to regional or international referenced laboratories, for easier access and national independence reasons. To do so, the current facilities need to be renovated and proper coordination established with other national laboratories such from MoH and the Fisheries Department. Participation in a regional laboratory network is also proposed as a way to improve national laboratory practices. The relevance of the deployment of a laboratory network in the country at regional and district level will also be assessed in the feasibility study.

6. COMPONENTS OF AN AQUATIC BIOSECURITY STRATEGY USED FOR THE DEVELOPMENT OF THE NATIONAL BIOSECURITY AND BIOSAFETY SYSTEM FOR AQUACULTURE IN UGANDA (NBBSA)

6.1. Introduction

Governments use policy to outline, broadly, the expected achievements of long-term national programmes including goals and objectives and recommendations for sustainable development of a sector. A strategy provides the mid-term plan that outlines how the results of a national policy are achieved. A strategy consists of specific objectives and outputs within a time frame, and includes indicators of performance and makes provision for monitoring and review. Crucial to the effective implementation of an aquatic biosecurity strategy is the identification of the Competent Authority responsible for aquatic animal health, and the support of relevant legislation.

Harmonising aquatic animal health policy and strategy across regions and with international trading partners facilitates trade in live aquatic animals and their products, and improves aquatic biosecurity for all affected countries. Development of a National Biosecurity and Biosafety System for Aquaculture in Uganda (NBBSA) is needed to counter the threat and impact of incursions of serious aquatic animal diseases. It is needed to manage the risks inherent in transboundary trade in live fish, in particular, ornamental fish, and those posed by escape of invasive species and diseases they harbour that may impact wild fisheries.

The NBBSA provides the strategy by which the country intends to improve biosecurity in the aquaculture sector. The first stage of FAO's PMP/AB recommends a risk-based approach to development of a national biosecurity strategy. Key considerations and outcomes include: production chain mapping; description of the current situation and identification of priority commodities and diseases, threats and vulnerabilities; identification of critical control points to mitigate key threats/vulnerabilities; development of basic capacity in emergency management; development of an enabling environment (e.g. Competent Authority identified, draft national pathogen list (NPL), public-private PMP taskforce, legislative review); and national and sector-level strategies. These strategies are written documents (also referred to as gateway passes) that lead to implementation of biosecurity systems in the second stage. During the third stage biosecurity and preparedness are enhanced, leading to established sustainable biosecurity and health management systems that support the national aquaculture sector.

In line with FAO's recommendations, the NBBSA is comprised of 15 major programmes which contain a number of activities. These represent the first step of the MPM/AB for Uganda. Each programme is defined by the following sections (FAO, 2018):

(i) Background – a brief overview of the programme

(ii) Current Status – a summary of the current status of activities related to the programme, based on findings of the stakeholder analysis conducted during March and April 2021.

(iii) Objectives – a brief statement of what the programme will achieve

(iv) Activities – brief summaries of the key activities (projects) that will be recommended within each programme.

Each Activity is prioritized as low, medium or high:

- Low (desirable but not essential)
- Medium (important and essential, but less urgent)
- High (urgent, requires immediate action)

With an associated time frame for completion:

- Short (1–2 yrs)
- Medium (2–5 yrs)
- Long (5–10 yrs)

And with a designated responsibility for completion:

The Programme Components recommended by FAO consist of 15 broad interrelated thematic areas:

1. Policy, legislation and enforcement
2. Risk analysis
3. National aquatic pathogen list
4. Disease diagnostics
5. Border inspection and quarantine
6. Farm-level biosecurity and health management
7. Use of veterinary drugs and avoidance of antimicrobial resistance (AMR)
8. Surveillance, monitoring and reporting
9. Emergency preparedness and contingency planning
10. Research and development
11. Communication and information system
12. Human resources and institutional capacity development (institutional structure and training)
13. Infrastructure
14. National, regional and international cooperation
15. Ecosystem Health

6.2. Implementation

Mechanisms for implementation of the NBBSA that are recommended as the second step of the PMP/AB need to be developed that detail the associated responsibilities and funding for projects in consultation between the DFR, the DAR, diagnostic and research laboratories, the NDA, private sector and other stakeholders. The lead agency needs to be established (probably the DFR) under which a National Task Force on Aquatic Animal Biosecurity (NTFAAB) can oversee the implementation and monitoring of the NBBSA. A detailed implementation plan needs to be prepared that includes prioritising of activities; identification of responsibilities and resources; and that provides the time frame for activities. Progress should be reviewed annually with revision and updating of the NBBSA after a 3–5-year period. Implementation of the NBBSA requires a strong will from stakeholders to drive of the process, as well as full commitment of the government and the adoption of appropriate institutional and legal frameworks by the competent authority.

6.3. Programmes of the NBBSA

6.3.1. Policy, legislation and enforcement

Background

Uganda is a member of the OIE and of the WTO and as such has a binding commitment to apply the standards of these organisations. Uganda does not have a specific policy to address aquatic animal health in the country. However, the National Fisheries Policy (2004), the National Investment Policy for Aquaculture Parks (2012) and the Fisheries and Aquaculture Policy (2017) outline Uganda's general policy for development of the fisheries and aquaculture sector. The Fisheries and Aquaculture Policy (2017) explicitly mentions the need for biosecurity and biosafety planning for the sector. In addition, the Uganda National Aquaculture Development Strategy (2008) and the provisional Fisheries Sector Strategic Plan provide the strategic framework at the level of the Government.

Various legislation in Uganda covers aquatic animal health and is currently being reviewed and updated. This provides the possibility of making required changes so that legislation better meets the demands of improved biosecurity. Critical to this is the revision of the Fish Act (Cap. 197) and the Fish (Aquaculture) Rules 2003 and the ratification and implementation of the updated Act and its rules. Implementation and enforcement need to be improved by enhancing the chain of command to address the decentralisation arrangement between MAAIF as strategy maker and the Ministry of Local Government (Districts and Co-management Units) as enforcer. Based on Uganda's location in the Nile River catchment and its actively developing aquaculture industry, the National Fisheries and Aquaculture Policy 2017 identifies an urgent need for Uganda to develop a strong biosecurity system for aquatic animal diseases that is reflected in its policy statement.

Current Status

To accelerate the development of Uganda's Aquaculture Industry to become the leading source of fish in the region, there is need for an efficient, effective and supportive regulatory environment that reflects best management practices.

a. Policy

The National Fisheries and Aquaculture Policy, 2017 provides under sections 2.11 & 5.0 for *development of a strong biosecurity system for aquatic animal diseases*. This need is guided by the occurrence of fish diseases, fast growing aquaculture industry and the critical location of Uganda in the Nile basin that possesses a great risk of disease spreading to and from neighbouring countries.

Therefore, the policy illustrates that Government shall establish and implement fish health and biosecurity protocols as a security measure to protect biological diversity of fisheries and the life support system. This will involve verification, building the requisite infrastructure and capacity to detect and deter water contamination, and other illegal practices.

b. Legislation

The Fish Act CAP 197 (2000) is the major legal instrument that regulates the management of the fisheries and aquaculture sub-sector.

With regard to biosecurity, the act under section 69 provides for *prevention and control of contaminants and other disease-causing agents* in all aquaculture establishments and compliance with the standard sanitary measures for aquaculture prescribed by guidelines issued by the Chief Fisheries Officer.

Secondly, the Act provides for *notification of epidemic disease outbreaks* **a**nd destruction of all fish, aquatic plants or animals or fish products in the affected establishment, or for the taking of such appropriate measures as the Chief Fisheries Officer may specify in the notice. Any person who receives a notice under subsection (l) shall comply with the requirements set out in the notice.

Thirdly, Section 76, emphasizes that all establishments must *comply with guidelines and codes of practice for aquaculture* which clearly spell out biosecurity practices that aquatic establishment need to comply with. Section 79 provides for *import or export permits for live fish***.** A person shall not import or expert live fish into or out of Uganda for aquaculture production without an import or export permit issued by the Chief Fisheries Officer and a fish health certificate from the country of origin.

Statutory Instruments have also been drawn from the Act to streamline the need for biosecurity in aquaculture. The fish (Aquaculture) Rules 2003, made under section 43(g) of the Fish Act, provide for control of activities relating to aquaculture. *No person shall engage in fish breeding or shall export or import live fish for purposes of aquaculture without a permit issued by the Chief Fisheries Officer*. Importation of live fish also requires a certificate of import of live fish into Uganda.

The Fish (Fishery and Aquaculture Products) (Quality Assurance) Rules, 2017 define conditions for placement of aquaculture products on the market, traceability of aquaculture products, inspection and monitoring of aquaculture production processes and national reference laboratories. These are essential to the effective and efficient implementation of a biosecurity system.

The Animal Diseases Act, and its rules, makes provision with respect to measures to prevent and control diseases affecting animals, quarantine measures and qualified personnel to handle affected animals. The Animal Diseases Act (Chap 38) stems from 1918 and is outdated. In its current state, the Act makes no provision for aquatic animal diseases, being mainly concerned with diseases of terrestrial domestic livestock. Nevertheless, the Act does make provision for the terms “animals” and “diseases” to be amended as needed by declaration of the Minister via Statutory Instrument. *This Act makes provision with respect to measures to control diseases affecting animals. “Animals” means all stock, camels and other ruminating animals, cats and dogs, but does not include any other animal, except such as may be declared by the Minister by Statutory*

Instrument to be included in the term "animals" for the purposes of this Act. Also the diseases to which the Act shall apply shall, in addition to those specified in this Act, be declared by the Minister by Statutory Instrument.

c. Enforcement

The Competent Authority for Aquaculture rests with the Department of Aquaculture Management and Development (DAMD) and is headed by the Commissioner of Aquaculture housed within the Directorate of Fisheries Resources (DFR) of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The CA is supported by District Fisheries Officers and Fisheries Officers employed under the local government structure. Fisheries Officers report to the Commissioner of Aquaculture through their respective District Local Governments. The competent authority (DFR) through its concerned departments has developed Standard Operation Procedures (SOPs) and guidelines to ensure compliance with the formulated laws and rules, namely:

- The Manual of Standard Operating Procedures for Fish and Aquaculture Inspection and Quality Assurance.
- Standard Operating Procedures (SOP) for Enforcement

The district local government also plays a delegated role in certification, inspection and routine monitoring of the aquaculture establishments to ensure compliance with the rules and regulations. The newly formed Fisheries Protection Force is also at the fore front of enforcement to ensure compliance with the guidelines, rules and regulations.

Uganda has a longstanding trade arrangement with the EU for processed Nile perch products. There are plans to utilize the EU compliant processing plants used for processing Nile perch for the processing of Nile tilapia for export to the EU and elsewhere. MAAIF is responsible for the regulation of all players in the aquaculture sector and, through the Uganda National Bureau of Standards (UNBS), for compliance with national regional and international standards. Support and traceability, through strengthened responses by disease, pest and vector control systems, is further provided by MAAIF. Local Government is supported by MAAIF in its routine inspection and coordination of fisheries and aquaculture initiative projects and programmes, and provision of technical assistance, support, supervision and training to technical fisheries, fishers and fish farmer producer groups and associations and to facilitate initiatives to build them institutionally.

Under the current NFAP, institutional arrangements in Uganda place the responsibility for aquatic animal disease control under the DAMD and Local Government (Fisheries Officers). In practice, other stakeholders also play a role in aquatic animal disease diagnosis and control, including the National OIE Delegate, ARDC and MAK, and aquaculturists.

Table 5. Major stakeholder's activities 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 Officers	• Farmer implements control measures on farm
Disease reporting	• Fisheries Officers (FOs)	• FOs report to CA-ADAM (MAAIF) • ARDC research and activity reports to DG-NARO • MAK remain as research reports
Disease Surveillance	• DAMD (CA) • CA AH (OIE Delegate)	• On-going TiLV Surveillance program supported by FAO, under supervision of CA
Disease control inputs	• Agro-vet suppliers • National Drug Authority (NDA)	• Most agro-vet stores are managed by veterinarians/animal husbandry officers • NDA quality control of veterinary inputs
Permits for the movement, export/import of fish and fish sanitary certificates	• 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 from ADAM and DFQA • URA verify products crossing border and collate national data on volumes of export/imports

Objectives

i. to harmonize Uganda's legislation related to aquatic animal health with relevant international legislation and standards (e.g. EU Directive 2006/88/EC and the OIE standards);

ii. to establish and legally define the responsibilities of the Competent Authority for aquatic animal health management among existing fisheries and veterinary service institutions; and

iii. to adopt legally binding and clearly defined national lists of aquatic animal diseases (including notifiable diseases).

Activities

Activity 1: Harmonize Uganda's legislation related to aquatic animal health with international legislation (e.g. EU Directive 2006/88/EC) and the OIE standards, and with neighbouring countries sharing common water bodies.

Priority: high

Time frame: medium term

Responsibility: national

Description: create a legal working group comprised of national and international experts to review the status of aquatic animal health and biosecurity-related legislation in the Nile Basin countries and prepare a regional status report and associated recommendations. The relevant legislation and requirements of major trading partners (e.g. European Union (EU) Directive 2006/88/EC and the OIE standards) need to be examined with proposals for draft amendments to legislation so that these fully conform and harmonise with international laws and standards. It will be the Competent Authority's (CA) responsibility to formally adopt a National Pathogen List developed under Activity 7 and 8, and to provide the mechanisms for periodic review and updating.

Activity 2: Conduct in-depth reviews of national legislation related to aquatic animal health, and where inadequate, promulgate new legislation.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: drawing on outputs of Activity 1, a more comprehensive assessments of legislative and regulatory needs to implement sound aquatic animal health and biosecurity policy may be required. National legislation should be reviewed and compared with model legislation drafted by Activity 1. This may require adaptation to the national situation. Under Activity 2, the country should formally adopt the National Pathogen List drafted under the activities under Programme 3: Pathogen Lists.

6.3.2. Risk analysis

Background

Risk analysis is the structured process that provides a flexible framework within which the risks of adverse consequences resulting from a course of action can be evaluated in a systematic, science-based manner. Import risk analysis (IRA) is an internationally accepted method for deciding whether trade in a particular commodity (a live aquatic animal or its product) poses a significant risk to human, animal or plant health and, if so, what measures, if any, can be applied to reduce that risk to an acceptable level. IRA is an important component of the certification process required for importation and exportation of live aquatic animals and their gametes. Qualitative risk analysis applied to the aquaculture sector (in the context of the PMP/AB), should include the ability to conduct (Arthur *et al.* 2008; Arthur *et al*., 2009):

a. A situational analysis.

b. Preliminary identification of hazards.

c. A biosecurity vulnerability analysis.

d. Risk pathway mapping.

e. Identification of critical control points along the pathways.

f. Identification of risk management measures.

g. Monitoring and implementation of corrective actions.

Current status

Various categories of hazards are known to potentially impact aquaculture and fisheries in Uganda. These include (see Appendix Ia. for more details on a risk-based approach to biosecurity planning):

a. Biological hazards

Land-based systems: Farmed fish are raised in earthen ponds and outdoor tanks that are exposed to:

i. birds that defecate on production systems while preying on farmed fish. Some of these birds are secondary hosts of parasites (e.g. digenetic trematodes) or pathogens that affect the health and quality of farmed fish;
ii. other potential hosts of parasites and pathogens to open systems that include snails, domestic animals (e.g. livestock) and neighbouring communities who have direct access to these production systems;
iii. wild fish that can transfer pathogens if production systems are not adequately screened or introduced into systems during floods;
iv. movement of seed stock and other live fish carrying pathogens;
v. water sources that may be contaminated with pathogens.

The expansion of aquaculture in the East African region has accelerated demand for seed stock, which is exported or imported as live aquatic materials. Live fish exports include Tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*) and mirror carp (*Cyprinus carpio*) seed in form of fry/fingerlings/juveniles, which are rarely recorded at border points. This increases the risk of introduction and spread of serious transboundary aquatic animal diseases (TAADs).

Water-based systems: farmed fish raised in cages are usually inadequately protected against birds and wild fish and pathogen exposure from the surrounding water. This exposes the aquatic animal stocks to parasites and pathogens with potentially negative effects on the health and quality of fish. Furthermore, some cage farms (particularly group farms) are close to each other but with limited biosecurity measures.

During disease outbreaks, farmers do not properly dispose of the dead fish. Mortalities are usually abandoned in production systems, and birds or other scavengers will pick up and spread infected material to other units or neighbouring farms.

b. Chemical hazards

Farmers use chemicals (e.g. potassium permanganate and salt) to reduce stress and prevent infections on farmed fish or eggs, with advice from extension officers, fellow farmers, scientists, academia or existing information. In some farms use of antibiotics (oxytetracycline) is applied without veterinary prescriptions but using guidance from internet/online information. Some farmers are inadequately guided, and this may cause them to misuse these chemicals affecting the outcome of treatments, welfare of the fish and the quality of fish products entering the consumer chain.

Land-based systems: Most earthen ponds are in close proximity with crop gardens, car-washing bays, manufacturing industries and housing settlements that use upstream water for irrigation, industrial use, livelihoods and domestic use. Therefore, farmed fish may be exposed to chemicals like pesticides, herbicides, industrial waste (e.g. heavy metals) and detergents that affect their health, and may cause food safety issues through bioaccumulation.

Water-based systems: Some cage farms are located in close proximity to heavily populated areas. Hence, farmed fish are likely to be exposed to municipal and domestic wastes which include heavy metals and medical drug residues.

c. Physical agent hazards

Most production systems depend on streams, rivers, reservoirs and/or lakes to raise fish. These water resources are also “dumping” sites of wastes particularly plastics. Therefore, bioaccumulation of nano-plastics may affect the health of farmed fish, and the quality of food fish.

Fomites: farm inputs like harvesting nets, water testing kits and weighing scales are usually not disinfected after utilisation within or between farms.

1. Risk assessment and management

Inadequate biosecurity measures at most establishments and absence of diagnostic capacity in different sub-regions/agro-ecological zones augments the spread of diseases within and between close farms. Most hatcheries have minimal restriction to public, and generally have limited access to aquatic animal health services. Cage farms are more vulnerable to disease infections since farm units or establishments are relatively close to each other.

Aquatic health services are absent or not adequately provided in most regions of the country. Small scale farmers usually rely on advice from fellow farmers while large scale farmers consult extension agents, scientists, fellow farmers and on-line information (e.g. google). As a result, farmers face economic losses during disease outbreaks especially when virulent pathogens attack production units.

Other risk factors include

i. General lack of knowledge on fish diseases;

ii. Fish breeds: some breeds are more susceptible to fish diseases than others;

iii. Live fish trade (brood stock, eggs, post-larvae, fry and fingerlings): increases the risk of moving diseased fish/fish pathogens from one location to another. Movement also stresses the fish making them more susceptible to diseases;

iv. Infected parent/seed stock from a contaminated farm or water bodies presents a risk for introduction of disease-causing organisms into the farm. It is advisable to get stock from certified commercial hatcheries that can provide official guarantees of disease freedom;

v. Infected wild fish coming in contact with farmed fish;

vi. Increased organic matter in the water using animal manure to fertilize ponds for primary production: This favors multiplication of pathogens/ parasites and phytoplankton;

vii. Poor or lack of adherence to effective biosecurity measures: contaminated feeds may still be fed to the fish, and equipment (fomites) are rarely disinfected.

2. Corrective measures

Most small-scale or subsistence farmers are not aware of fish diseases, hence rarely respond to fish kills that occur in production units. A few report to the sub-county Fisheries Extension Officers or to police when they suspect that stocked fish have been poisoned by neighbours.

Commercial large farmers usually report to competent authorities, contact international laboratories for advice or use Google for information. However, consultations are usually done after weeks of infections when drugs or chemicals like salt, potassium permanganate solution, formalin and oxytetracycline have been applied. Minimal biosecurity measures are often followed by hatchery and cage farms: use of disinfectants for fomites, restriction of visitors, fencing or

protecting production units, use of protecting gears, records of source of seed and feed, and management and sales are often lacking.

Objectives

i. to base development and implementation of the NBBSA and the mechanisms and procedures for dealing with import and export of live aquatic animals and their products on a science-based, consultative and transparent pathogen risk analysis process;

ii. to review and improve policy, mechanisms and procedures with regard to domestic, regional and international movement of live aquatic animals and their products so as to prevent the spread of important aquatic animal pathogens;

iii. to develop capacity on risk analysis at the national level; and

iv. to develop a regional commodity-based risk assessment framework for the Nile Basin countries.

Activities

Activity 3: Establish a pathogen risk analysis team and risk analysis working groups.

Priority: high

Time frame: short, medium and long term

Responsibility: national and regional

Description: a national pathogen risk analysis team consisting of local/regional/international experts in pathogen risk analysis and aquatic animal biosecurity will be established. This will be responsible for identifying current or future trade in live aquatic animals or their products likely to pose significant risks to aquaculture development and the natural biodiversity of Uganda and the Nile Basin region. This activity overlaps with the activities of a National Surveillance Team (NST).

Activity 4: Development of a regional commodity-based risk assessment framework.

Priority: medium

Time frame: short, medium and long term

Responsibility: regional

Description: the basic framework for import risk analysis (IRA) is provided by the World Organisation for Animal Health in its Aquatic Animal Health Code (the Code, OIE 2019a), and allows individual countries considerable flexibility in how they conduct risk analyses. Drawing from the wide array of guidance available on IRA, the risk analysis team, described in Activity 3, will develop and publish a

recommended risk analysis framework and associated guidance that will facilitate the conduct of IRAs by both Uganda and its neighbouring Nile Basin countries.

Activity 5: Development of regionally harmonized standards and guidelines for risk management requirements for importing ornamental aquatic animals.

Priority: high

Time frame: short term

Responsibility: national and regional

Description: an expert review of published risk analyses (IRA and ecological/pest risk analyses) in the context of international and regional standards and guidelines related to importations of live ornamental aquatic animals will be conducted. A set of standards and guidelines will be developed to assist Nile Basin countries in regulating international trade (importations) of live aquatic animals destined for the aquarium and ornamental trade within the Nile Basin Region. This Activity will be coordinated with Programme 5: Border Inspection and Quarantine, Activities 13, 14 and 16. Following regional approval of the standards and guidelines, individual Nile Basin countries will be expected to adopt these as minimum national standards and use the guidelines to ensure that a uniform approach is applied throughout the region.

Activity 6: Promote cooperation to prevent the entry of biosecurity hazards by integrating import risk analysis/pathogen risk analysis (PRA) with associated genetic and ecological risk analyses.

Priority: high

Time frame: short term

Responsibility: national and regional

Description: various guidance and procedures for IRA/PRA, genetic risk analysis and pest/ecological risk analysis will be examined. An integrated approach and framework for evaluating the risks associated with a proposed importation of a commodity (a live aquatic animal or its product) will be developed for use by Nile Basin countries.

6.3.3. National aquatic pathogen list

Background

A national aquatic pathogen list, with clear criteria for listing and delisting of diseases, based on international standards, is essential to emergency response planning and prevention and control of diseases in aquaculture establishments, and for health certification and international trade in live aquatic animals and their products as it provides the basis for disease surveillance and monitoring. OIE-listed diseases are those of internationally traded commodities. They are relevant to national conditions where host or vector species are present in the country. However, national pathogen lists must also consider other serious diseases of national concern. National pathogen

lists require knowledge of a country's disease status. This can only be obtained through passive and active disease surveillance programmes requiring generalized disease/pathogen surveys, disease record keeping and reporting, and a national disease database.

Current status

Uganda does not have a national priority list for aquatic pathogens and diseases affecting fisheries and the aquaculture sector. The national list of pathogens/diseases guides the implementation of the national surveillance, monitoring and control plans, management of notifiable diseases, especially transboundary aquatic animal diseases (TAADS), and biosecurity and biosafety planning (see Appendix III for more detailed pathogen risk tables relevant to Uganda).

Through the Aquatic Animal Health Code of the OIE, member countries are obliged to report or notify on the existing list of diseases or pathogens through the Chief Veterinary Officer (CVO), and using criteria adopted by the OIE Commission. The CVO is an employee of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) who receives notification from the Directorate of Fisheries Resources and the Department of Animal Health.

Uganda is currently relying on information generated from research conducted by Universities (Makerere University) and Research Organisations (National Agricultural Research Organisation). The list of common pathogens reported to be associated with fish kills or affecting quality of farmed products includes:

Bacteria: *Aeromonas hydrophila*, *Edwardsiella ictaluri, E. tarda, Francisiella sp., Flavobacterium columnare*

Parasites: Protozoans (*Ichthyophthirius multifiliis* and myxosporidia), *digenetic trematodes (Clinostomum sp.)*

However, following OIE criteria of listing diseases, none of the above belongs to the notifiable category. Nevertheless, these pathogens are associated with occasional disease outbreaks that cause enormous economic loss to farms particularly hatcheries, tank and cage systems.

Objectives

i. to prepare a national list of notifiable pathogens based on uniform criteria for listing and delisting of diseases (international standards set by OIE) and a national list of diseases of concern.

Activities

Activity 7: Develop criteria for listing and delisting pathogens and harmonizing national criteria.

Priority:	high
Time frame:	short term
Responsibility:	national

Description: the criteria provided by the OIE will be used for listing and delisting of pathogens on the National Pathogen List that are of international concern. An expert working group will draw upon these to develop the criteria that will apply to the list of pathogens of national concern, in as far as these may differ from the list of pathogens of international concern. Once approved, Uganda will officially adopt these criteria.

Activity 8: Develop national criteria for emerging diseases and a mechanism for their listing.

Priority: high

Time frame: short term

Responsibility: national

Description: the emergence of new diseases and the change of behaviour of existing diseases present special problems to national and regional aquatic biosecurity. When such diseases arise, they may be spread rapidly through pathogen-shedding into the water column, the movement of infected aquatic animals for aquaculture development and/or the ornamental fish trade. As long as the cause of such a disease remains unknown, reliance is made on a case description. Identification of the responsible pathogen and a reliable and rapid diagnostic test may take months or even years to develop, after which official listing by the OIE may occur. In the meantime, the expert working group, established under the Activity 7, will examine the relevant scientific literature and past experiences in other regions to establish a set of criteria that will be used for rapid listing of emerging diseases of significant (or potentially significant) impact to national aquaculture development and natural aquatic biodiversity. This may take into account the precautionary approach.

6.3.4. Disease diagnostics

Background

The success of implementing a national biosecurity programme depends on relevant disease diagnostic capability. In the case of disease outbreaks, establishing appropriate mitigation measures requires determining the cause of unfavourable health (morbidity and mortality/ suspicious or clinical cases) through appropriate diagnostic testing. Maintaining healthy populations of farmed aquatic animals requires the diagnostic ability to demonstrate freedom from infection within a farming facility; screening of aquatic animals prior to introduction to the facility, or for transfer out of a facility; and detection of infected individuals during quarantine (Caraguel, Gardner and Hammell, 2015).

Disease diagnostics has two significant roles in health management and disease control:

- Firstly, to screen stocks of aquatic animals that are intended to be moved from one area or country to another to ensure that they are not carrying specific pathogens at subclinical infection. Of particular importance are hatcheries that provide seed stock for distribution to farms. Disease surveillance, monitoring, and zoning or compartmentalisation (including demonstration of national freedom from a disease) are key elements of quarantine and health certification, and are also required for import and export of live aquatic animals.
- Secondly, diagnostics plays an important role to determine the cause of unfavourable health or other abnormalities so that appropriate corrective measures can be applied. Accurate and rapid diagnosis of the cause of a disease outbreak allows timeous interventions to prevent further losses through implementation of correct treatment, disease containment and where possible eradication.

Diagnostics may range from simple, pond-side methods to more advanced laboratory-based techniques requiring a high level of expertise and infrastructure. Choice of diagnostic test depends on the intended purpose of testing and may vary depending on the diagnostic sensitivity and specificity of the test.

The level of diagnosis allows interpretation of pathogen data enabling effective control and avoidance strategies. Level I diagnosis reflects the observations of morbidity (numbers of sick fish) and mortality (numbers of dead fish) without specific identification of the responsible microbial pathogen. Previous experience with the pathogen or knowledge of its distribution may lead to a tentative suspicion pointing to a specific pathogen. Level II diagnosis involves culture or histological examination to demonstrate the microbial pathogen and strengthens the diagnosis of involvement of a microbial pathogen. Identification and confirmation of the microbial pathogen requires Level III diagnosis through use of molecular and serological techniques or electron microscopy. Maintaining good diagnostic records is essential to obtaining the objectives of effective pathogen control and mitigation strategies.

Current status

The below information on the current disease diagnostic situation in Uganda has been provided by the MCS project.

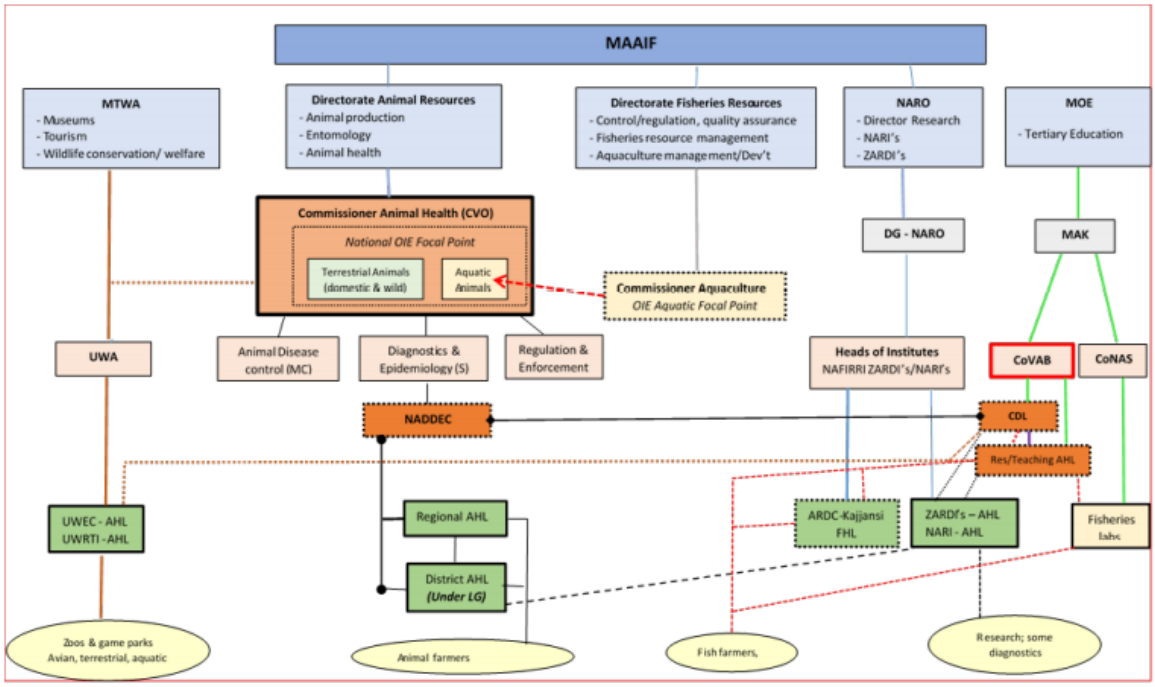


Figure 6.1. Institutional arrangement of the MAAIF showing diagnostic and reporting linkages (Figure supplied by MCS team).

- Red dotted lines – aquatic animal diagnosis (laboratory requests) flow & referrals.
- Black dotted lines – terrestrial animal (livestock & pets) 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 Aquaculture.
- Brown solid lines – Executive Director, Uganda Wildlife Authority.
- Light pink circles – major clients/beneficiaries.

Laboratory Assessment[2]

The available diagnostic capacity has been analysed based on OIE guidelines for veterinary diagnostic laboratories Standard/ISO17025 and the OIE Aquatic Code and Manual, and biosafety/biosecurity guidelines for animal health laboratories *vis-à-vis* what is currently present. In selecting tests, consideration was also given to costs.

NADDEC does have, and is, the reference laboratory to handle infectious diseases and verify their presence on behalf of the CVO. They also have functional linkages with the OIE and other global animal disease diagnostic reference laboratories. All samples sent for validation to reference laboratories for notifiable diseases have to be done through NADDEC if they are to be officially reported and national surveillance or controls to be enacted. Therefore all cases confirmed in-country will still need to be sent to respective OIE reference laboratories as per OIE agreements.

NADDEC is not yet fully accredited (but is in process of getting accreditation) as are CDL and CoVAB.

NADDEC has also just recruited a veterinarian assigned to aquatic and wildlife diseases.

Capacity building will be necessary as outlined in the tables below.

So generally, Uganda has the basic capacity to undertake surveillance which can be improved with some capacity building as outlined in the following pages for respective diseases.

[2]Information supplied by MCS team

Table 6. Laboratory Diagnostic Capacity for Notifiable Aquatic Animal Diseases[3]

Laboratory Category	Gross Signs	Light microscopy	histopathology	Isolation in tissue culture	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 he 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

Guidance notes to coloration of Table 6: Level of Bio-security and Biosafety Laboratory (BSL)[2]

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

*CoVAB and NADDEC have pathogen banks. These are used/useful for retrospective studies. Also follow up with proficiency testing, laboratory data, epidemiological capacity, and response.

[3]Information supplied by MCS team

Table 7. Laboratory diagnostic capability for EUS[4]

	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		b	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

[4]Information supplied by MCS team

Table 8. Laboratory diagnostic capability for KHV[5]

	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

[5] Information supplied by MCS team

Table 9. Laboratory Diagnostic Capability for TiLV[6]

	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

[6]Information supplied by MCS team

Table 10. Laboratory Diagnostic Capability for ISKNV[7]

	Category of Diagnosis and Laboratory	Recommended Tests								Recommended Laboratory	
		Gross Signs	Bioassay (virus isolation in cell culture & identification by IFAT or	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

[7]Information supplied by MCS team

Table 11. Capacity for Diagnosis of Non-Listed Pathogens[8]

Laboratory Category	Water quality	Plankton analysis	Gross Signs	Light microscopy	parasitology	haematology	microbiology	histopathology	Toxicology	mcyology	virology	cytology	serology	RT/conventional PCR	Clinical biochemisty	Transmission EM	Aflatoxins	Feeds (nutritional profil	contaminants	radiography	Health assurance testing	Laboratory standards
Farm Level	±	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CoNAS	+	+																				
Government Chemist	+	+															+	+	+	-		**N**
District Veterinary Laboratories	-	-	+	+	+	+	+	-	-	-	-	±	±	-	-	-	-	-		-	-	**N (±)**
ARDC - Kajjansi	+	+	+	+	+	-	±	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Regional Animal health laboratories	-	-	+	+	+	+	+	-	-	±	-	-	±	-	-	-	-	-	-	-	-	**N**
CoVAB	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	-	+	±	-	-	**N**
CDL	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	**N**
NADDEC	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-?	+	+	+	-	+	**N**

[8]Information supplied by MCS team

Objectives

i. to improve the capacity of Uganda to diagnose important diseases of aquatic animals to international standards;

ii. to harmonise disease diagnostics in Uganda with that of its Nile Basin neighbours applying the same standards;

iii. to identify regional and international reference laboratories and expertise for high-level diagnostic activities; and

iv. to link up with a regional network of diagnostic laboratories.

Activities

Activity 9: Identify and develop basic minimum national capacity and harmonize with international standards for disease diagnostics.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: develop harmonized standards for diagnosing diseases of national and regional importance. These will primarily target diagnostic methods for those diseases listed in the National Pathogen List to be developed under Programme 3. These standards will draw upon the OIE Aquatic Animal Health Code (OIE, 2019a) and the Manual of Diagnostic Tests for Aquatic Animals (OIE, 2019b), as well as other regional and national diagnostic manuals such as the Asia Diagnostic Guide to Aquatic Animal Diseases (Bondad-Reantaso, *et al.,* 2001).

Activity 10: Identify regional reference laboratories and expertise for high-level diagnostic activities.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: where the existing laboratory systems in Uganda are unable to satisfy the standards of the OIE Manual of Diagnostic Tests for Aquatic Animals (OIE, 2019b), a survey will be conducted of diagnostic expertise and dedicated infrastructure present in countries of the region to identify laboratories that have the capacity to diagnose to international standards (i.e. for OIE-listed diseases, the standards specified in the OIE Code and Manual) the diseases of regional importance that have been identified under Programme 3: National Pathogen List. Identified laboratories can then be designated as regional reference laboratories for the diagnosis of specific diseases and the mechanisms that give access to these will be established. In the short term this assists Uganda to meet diagnostic demand for the

country's most relevant listed diseases while developing the requisite diagnostic capacity within Uganda. Establishing connections to recognized reference laboratories, however, remains important in the medium and long term to enable Uganda to deal with future challenges of emerging and new exotic pathogens.

Activity 11: Develop a national network of public and private diagnostic laboratories.

Priority: high

Time frame: short, medium and long term

Responsibility: national and private sector

Description: this will draw upon an assessment of diagnostic expertise and infrastructure to be conducted under Activity 12, and will seek mechanisms to link public and private diagnostic laboratories to improve their diagnostic capabilities and interlaboratory communication. This will include developing a database of laboratories linking those with basic diagnostic capabilities with higher-level laboratories so that diagnostic assistance is more easily obtained and information on disease occurrence is routed to the disease reporting systems of the Competent Authority.

Activity 12: Develop national diagnostic laboratories

Priority: high

Time frame: medium and long term

Responsibility: national

Description: Uganda will designate a National Aquatic Animal Disease Diagnostic Laboratory based on a national assessment of diagnostic needs and existing capacity. This will develop the required specialist expertise and infrastructure, including adequate annual operating budget.

6.3.5. Border inspection and quarantine

Background

Competent authorities (CA) use import risk analysis (Programme 6.3.2.) when deciding on the conditions under which to allow live fish imports from other countries. This usually applies the standards of the OIE which were specifically formulated to facilitate the safe trade in live aquatic animals. A process of negotiation based on risk analysis is usually initiated between the CA of the importing country and the CA of the exporting country. This paves the way for formulating realistic import conditions that are reflected on the import permit and need to be met by the guarantees provided by the aquatic animal health certificate that is issued by the CA of the exporting country.

Inspection activities that regulate the importation and exportation of live aquatic animals and their products are conducted by the national Competent Authority and national customs officers at international airports, land border posts and sea ports of international entry. Quarantine is one of a number risk mitigation measures that may be applied to shipments of

live aquatic animals to reduce the risk of introducing serious pathogens and pests. Quarantine requires the holding of aquatic animals under conditions that prevent their escape, and the escape of any pathogens they may be carrying, into the surrounding environment. For aquatic animals, this requires appropriate disinfection procedures for effluent water leaving a quarantine facility. Quarantine may be applied in the exporting country, at the border post of the importing country or at a quarantine facility operated directly by the Competent Authority or by the private sector, under the standards and supervision of the Competent Authority.

Current status

Cross-border movement and trade of aquaculture produce and products is supervised by the Department of Fisheries Control, Regulation and Quality Assurance (DFCRQA) and the Uganda Revenue Authority (URA). There are four main border points through which live fish products (fish seed, brood-stocks and ornamentals) are transported or traded; Entebbe airport, Busia (Eastern Uganda), Gatuna (South-western), and Vurra (West Nile). Infrastructure and human capacity to inspect live fish consignments has not been established or built. Quarantine facilities are not available. Consequently, inspection or screening of live fish products is based on visual inspection or permits issued by the district fisheries department from where the fish have originated. As a result, there is a danger of transmitting aquatic diseases or pathogens across borders since capacity is limited.

Objectives

i. to assist Uganda in reducing the risk of spreading serious diseases of aquatic animals through improved importation and exportation procedures, including border inspection of live aquatic animals and their products and the use of other risk management measures such as health certificates and quarantine;

ii. to harmonize standards for handling importations of live aquatic animals and their products at the regional level, including associated health certificates; and

iii. to prevent the introduction into the region of harmful aquatic species (invasive alien aquatic species (IAAS) and aquatic pest species) by establishing a regional list of those species whose importation should be prohibited by all the countries of the Nile Basin.

Activities

Activity 13: Harmonize standards for handling importations of live aquatic animals and their products at the regional level, including associated health certificates.

Priority: high

Time frame: short term

Responsibility: national and regional

Description: in consultation with national Competent Authorities of regional neighbours of the Nile Basin, experts will undertake a review of the standards and procedures applied by Nile Basin countries in handling the importation of live aquatic animals. Based on the results of this review, and on best international practice, regional standardized guidelines will be

developed for procedures to be followed during the importation of live aquatic animals and their products (including standards for health certificates to accompany imported shipments and recommended standards for the construction and operation of quarantine facilities).

Activity 14: Evaluate current import practices and existing standards for quarantine facilities.

Priority: high

Time frame: short term

Responsibility: national

Description: based on the guidelines and recommended procedures developed by Activity 13, Uganda will review and, where necessary, revise current import practices and existing standards for the construction and operation of quarantine facilities.

Activity 15: Capacity building at the national level.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: a national programme for improving the capacity of Uganda, in particular the appropriate personnel from the Competent Authority, to implement the recommended standards and procedures for the safe importation of live aquatic animals will be developed based on the assessment of national and regional needs conducted under Activities 13 and 14. This will require appropriate training by international and national resource experts with the assistance of academia in Uganda, and will require the necessary funding to be made available or sought.

Activity 16: Develop a list of aquatic species not wanted/prohibited in Uganda.

Priority: high

Time frame: short term

Responsibility: national

Description: experts, in consultation with the Competent Authority, will review regional and international experiences with exotic aquatic species to identify those species that, due to their invasiveness or other negative characteristics, have caused serious harmful economic, environmental and/or human health impacts to importing countries, both within the Nile Basin Region and elsewhere in the world.
Based on this review, the CA will draw up a list of aquatic animal species that, if absent, should not be imported into Uganda or the Nile Basin countries or, if already introduced, should be prevented from further spread and, if possible, will be eradicated.

Following approval of the list, it is expected that the necessary regulatory actions will be taken to prohibit the importation of these listed species into Uganda's waters. The CA will develop criteria for listing of an aquatic species as "prohibited" and a mechanism for regular review and updating of the species listing.

6.3.6. Farm-level biosecurity and health management

Background

Improving farm level biosecurity and health management requires aquaculture establishments to developing and implement an effective and practical biosecurity plan that focuses on the prevention, control and eradication of infectious diseases in any epidemiological unit, where an epidemiological unit is defined as a population of animals, separated to some degree from other populations, in which infectious and contagious diseases can be transmitted. This requires teamwork and close cooperation on the farm. Important members of a farm veterinary team should include the person who oversees daily biosecurity operations on the farm; the farm's attending veterinarian (or other animal health professional); and an official of the government who is familiar with OIE Standards (Code/Manual) and animal health/disease regulations that might affect the farm. Developing a farm-level biosecurity plan requires gathering information about an epidemiological unit (a fish farm); identifying and prioritizing disease hazards that might affect the farm; determining the risk and impact of the prioritized disease/s hazards; determining, prioritizing and mitigating critical points where disease can enter or leave an epidemiological unit; determining if priority diseases (hazards) are present through availability of clinical evaluation and diagnostic tests; interpreting diagnostic results for presence or absence of disease; epidemiologic disease sampling, surveillance and monitoring; developing a contingency plan if disease is found; and veterinary auditing and certification for disease freedom and acquiring official recognition from the CA (Scarfe *et al*., 2009; Palić, Scarfe, Walster, 2015).

Such procedures form the basis for disease-status guarantees that are required for the production and sale of specific-pathogen-free (SPF) seed stock. Providing official health attestations allow farms to access international markets. The reduced risk of transferring serious pathogens with SPF and high-health seed stock provides hatcheries that apply effective biosecurity planning with a competitive advantage when selling seed stock to other farmers.

Commercialization of aquaculture through Aquaparks provides the opportunity to implement biosecurity planning through zoning and compartmentalisation before administrative, production and marketing needs are aligned with the Aquaparks (Huchzermeyer & Bondad-Reantaso, 2017; Zepeda, Jones & Zagmutt, 2008). The improved biosecurity within a biosecurity-aligned Aquapark provides famers with a competitive advantage, the ability to trade and the prospect of improved livelihood.

Some important risk considerations for introduction of catastrophic infectious and contagious diseases onto a farm include: the movement of infected fish; introduction of contaminated water or feed; fomites including contaminated equipment, or vehicles; and vectors such as people, fish-eating birds or wildlife. Farmers need to be educated on the value of biosecurity

planning. In particular, when purchasing seed stock, they should understand the value of insisting on SPF or high–health (HH) seed when they purchase live fish for introduction to their farms.

Current status

Currently, disease episodes occur in semi-intensive fish farms (hatchery and grow-out systems) but many cases are not diagnosed, treated, and documented, imposing increasing risk of spread of diseases between, and within farms. Most fish hatcheries have minimal biosecurity measures in place to prevent diseases. Cage farms installed in open waters (lakes and large reservoirs in Uganda require effective biosecurity plans as they are occasionally faced with disease outbreaks, and are close to each other, for example the Napoleon gulf on Lake Victoria.

Effective biosecurity and health management plans are urgently required, and are dependent on development of: (i) robust and reliable communication mechanisms between farms and relevant authorities, and (ii) cooperation among producers and competent authorities.

Objectives

i. improve level of biosecurity and animal health management on aquaculture establishments;

ii. enhance knowledge of aquatic biosecurity planning from farm to national level; and

iii. put in place mechanisms to prevent, control and eradicate infectious diseases from epidemiological units.

Activities

Activity 17: Draft aquatic biosecurity plan templates and best management practice standard operating procedures.

Priority: high

Time frame: short term

Responsibility: national and private sector

Description: aquatic biosecurity experts will draft templates for farm-level biosecurity plans and standard operating procedures for best management practices. These will be adapted to specific circumstances, risk profiles and objectives by appropriate aquatic veterinary specialists or aquatic animal health practitioners with experience in biosecurity planning, and knowledge of local disease challenges that affect aquaculture in Uganda, in consultation with the management of individual aquaculture establishments. As incentive, it is proposed that aquaculture establishments that comply with biosecurity plans and auditable best management practices should benefit from government subsidies.

6.3.7. Use of veterinary drugs and avoidance of antimicrobial resistance (AMR)

Background

Veterinary medicines are used for disease prevention (vaccines), as therapeutants (antimicrobials and antiparaciticides) and for husbandry purposes (anaesthetics for handling, hormones to enhance reproduction and production, and disinfectants). The number and diversity of species cultured, lack of information on efficacy and safety for many species, and the relatively small market size result in limited interest by pharmaceutical companies to invest in costly product registration. This requires a simplified and more cost-effective approach to the registration process for pharmaceuticals critical to the aquaculture sector.

FAO's Code of Conduct for Responsible Fisheries (CCRF) (FAO, 2011) emphasizes the need for Member Countries to encourage the prudent and responsible use of veterinary medicines in farmed aquatic populations. They emphasize, among the guiding principles, that responsible use of veterinary medicines in aquaculture requires collaboration among all stakeholders and a strong commitment to governance, awareness, best practices, surveillance and research, including monitoring of antimicrobial resistance (AMR), tracking of antimicrobial usage (AMU), assessing risk in different settings and evaluating strategies to reduce AMR and maintain efficacy of antimicrobial agents. These require implementation of relevant legislation with the power to enforce rules guiding the responsible use of antimicrobials. Where the national fisheries authority is the Competent Authority (CA) for aquatic animal health, the role of the national veterinary services within the National Drug Authority as CA for veterinary medicine usage needs to be clearly defined within the responsibilities of the national fisheries authority.

The OIE has developed guidelines for the prudent use of antimicrobials in aquatic animals, monitoring quantities and usage patterns and harmonizing national antimicrobial resistance surveillance and monitoring programs. These comprise of practical measures and recommendations that confer benefits to aquatic animal and public health (Teale and Moulin, 2012). The increasing use of vaccines has resulted in significant reductions in antimicrobial use in aquaculture and has become an increasingly important component of biosecurity planning (Gudding, Lillehaug & Tavornpanich, 2015).

Current status

Hatcheries and some grow-out operators often use veterinary drugs for all-male tilapia seed production (hormones for androgenisation) and for treating against infections (antimicrobials and antiparaciticides). Farmers rarely seek veterinary advice when using these drugs, and these drugs are easily accessed on markets. Therefore, incidence of antimicrobial resistance may emerge in future if use of veterinary drugs is not adequately regulated. Currently, the National Drug Authority (NDA) is mandated to regulate medicinal agents. If poorly regulated use of antimicrobial drugs is allowed to continue, this will eventually lead to disease-causing organisms that affect aquatic animals to become resistant to common antimicrobial medicines. The resistant microbes can spread from one animal to the other and eventually to humans. Antimicrobial resistance may also spread from one microorganism to another through plasmid transfer of resistance genes, further increasing the number of resistant microorganisms. Antimicrobial resistance may affect humans and animals, and international

marketability of farmed fish from Uganda. The fight against antimicrobial resistance (AMR) is an important component of the One Health concept of managing human and animal diseases.

Objectives

i. improve access to relevant veterinary medicines, including vaccines, within legal frameworks that comply with international standards;

ii. ensure that standards of best practice are applied to the prudent use of antimicrobials in aquatic animals to minimize development of antimicrobial resistance (AMR);

iii. ensure that aquatic animals and their products pose no risk of drug residues to human consumers; and

iv. ensure that use of medicinal products in aquatic animals poses no threat to the environment and to other non-target species;

Activities

Activity 18: Prepare a manual of best practice for use of antimicrobials in aquatic animals.

Priority: high

Time frame: short term

Responsibility: national and private sector

Description: aquatic veterinary experts will be tasked to draft a manual that outlines the responsibilities around antimicrobial use in aquatic animals within the correct legal frameworks to comply with international standards and best practice, including maintaining drug registers and following the correct prescription cascade.

Activity 19: Maintain an up-to-date list of veterinary drugs and chemicals approved for use in aquatic animals.

Priority: high

Time frame: short, medium and long term

Responsibility: national and private sector

Description: aquatic veterinary experts will be identified who, in consultation with the CA for aquatic animal diseases and the NDA, will be tasked to review the list of approved and non-approved veterinary drugs and chemicals for use in aquatic animals, and to keep this list up to date with international standards, particularly those of Uganda's main trading partners.

Activity 20: Monitor veterinary medicine usage and AMR development.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: a national surveillance programme will be initiated to track antimicrobial usage by aquaculture establishments and to monitor development of AMR. The CA for aquatic animal health will identify the required human and institutional resources and will make provision for the necessary budget. Development of the necessary diagnostic capacity and infrastructure is dealt with under Programme 4.

Activity 21: Monitor veterinary drug residues in farmed aquatic animals and their products.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: a national surveillance programme will be initiated to monitor veterinary drug residues to ensure that products derived from farmed aquatic animals do not exceed minimum residue levels according to the international standards of the Codex Alimentarius Commission. Development of the necessary diagnostic capacity and infrastructure is dealt with under Programme 4.

6.3.8. Surveillance, monitoring and reporting

Background

Disease surveillance is a fundamental component of any official aquatic animal health biosecurity programme. Surveillance is the ongoing systematic collection and analysis of data and the provision of information that leads to action being taken to prevent and control disease (Morgan, Cameron & Gustafson, 2015). Surveillance provides the information necessary to have an accurate picture of the distribution and occurrence of diseases relevant to disease control and international movement of aquatic animals and their products. Increasingly, trading partners demand surveillance to support statements of national disease-status. Disease surveillance is used to establish the disease status of populations of aquatic animals that forms the basis of zonation and compartmentalisation.

Surveillance can be passive (reactive and general in nature) or active (proactive and targeted), and in both cases requires adequate reporting mechanisms so that suspected cases of serious disease are quickly brought to the attention of the Competent Authority. Detection of significant disease outbreaks, and the mounting of a rapid emergency response, requires surveillance and monitoring programmes. These form the basis for early warning of incursions of exotic or newly emerging diseases. Surveillance and monitoring programmes require the support of adequate diagnostic capability (including appropriately trained expertise, suitably equipped laboratories and rapid-response field diagnostics, and standardized field and laboratory methods), information system management (systems to record, collate and

analyse data and to report findings), legal support structures, transport and communication networks, and need to be linked to national and international (OIE) disease reporting systems. Reporting systems are based on a national pathogen list and defined disease notification and reporting procedures. Surveillance to demonstrate freedom from a specific disease requires a well-designed active surveillance programme that meets the standards outlined in the OIE Aquatic Animal Health Code (OIE, 2019a).

Current status

Uganda has no systematic arrangement in place to conduct monitoring, surveillance and reporting of aquatic animal pathogens and disease outbreaks. Occasional implementation of surveillance and monitoring is undertaken by the Directorate of Fisheries Resources under MAAIF, The National Fisheries Resources Research Institute (NaFIRRI) and Makerere University, i.e. The College of Veterinary Medicine, Animal Resources and Bio-security (COVAB) and the the College of Natural Science (CONAS) with support from the Government of Uganda (GoU) and development agencies (e.g. FAO).

The reporting system is not well coordinated but is the responsibility of the CVO and Competent Authorities. Lack of proper policies has created gaps in the reporting system to an extent that reports are presented internationally without knowledge of the CVO.

Objectives

i. to establish a national surveillance programme for four priority diseases (EUS, KHV, TiLV and ISKNV);

ii. to establish a compartment/farm-level surveillance programme for these and other OIE-listed diseases to demonstrate their absence from hatcheries;

Activities

Activity 22: Establish national surveillance programmes for four priority diseases (EUS, KHV, TiLV and ISKNV).

Priority: high

Time frame: short term

Responsibility: national

Description: a national surveillance/monitoring programme will be conducted for four important diseases of freshwater finfish: epizootic ulcerative syndrome (EUS) affecting all species; koi herpesvirus (KHV) affecting carp and koi; Tilapia lake virus (TiLV) affecting tilapia; and infectious spleen and kidney necrosis virus (ISKNV) affecting tilapia. Development of the required diagnostic capacity and infrastructure is dealt with under Programme 4.

Activity 23: Establish a surveillance programme at compartment or farm-level

Priority: medium

Time frame: medium term

Responsibility: national and private at farm-level

Description: identify the most regionally relevant OIE-listed diseases including EUS, KHV, TiLV and ISKNV and conduct surveillance to meet OIE criteria for demonstrating the absence of disease in order to certify seedstock for live fish transfers as specific-pathogen-free. Development of the necessary diagnostic capacity and infrastructure is dealt with under Programme 4.

Activity 24: Establish passive surveillance for exotic and emerging disease not covered under activities 22 and 23

Priority: medium

Time frame: medium term

Responsibility: national and private at farm-level

Description: monitor international emergence and spread of exotic diseases that pose potential risk to aquaculture and wild fisheries in Uganda, other than those identified in Activities 22 and 23, and establish passive surveillance to provide early warning of possible incursions

6.3.9 Emergency preparedness and contingency planning

Background

Emergency preparedness is the ability to respond effectively and in a timely fashion to disease emergencies (e.g. disease outbreaks, mass mortalities) and to be prepared for contingencies. Importation and transboundary movement of live aquatic animals carries with it the risk of serious disease outbreaks due to introduction of exotic pathogens. Many aquatic animal pathogens are known to exist in subclinical carrier and vector hosts in the absence of clinical disease. Where they escape detection when their hosts are translocated across borders, they may become established and spread leading to substantial losses to both aquaculture and fisheries. The speed with which an emergency response is mounted depends on the effectiveness of disease surveillance, diagnostics, reporting and communication, and the rapidity and effectiveness with which governments recognize and react to the first reports of serious disease. This requires contingency planning that will determine the extent to which losses can be curtailed and whether the pathogen can be eradicated or will need to be contained.

Current status

Uganda currently has no emergency preparedness and contingency planning for aquatic animal diseases.

Objectives

i. to develop a national emergency response and contingency plan for key diseases;

ii. to establish a national emergency disease response team; and

iii. to establish a regional emergency response and contingency fund.

Activities

Activity 25: Develop a Uganda Aquatic Veterinary Emergency and Contingency Plan.

Priority: high

Time frame: short term

Responsibility: national

Description: based on the example of AQUAVETPLAN, the Australian Aquatic Veterinary Emergency Plan, a series of manuals will be drafted outlining Uganda's approach to national disease preparedness and the proposed technical response and control strategies to be activated in a national aquatic animal disease emergency. The manuals will be authored by Uganda's aquatic animal health experts with extensive stakeholder consultation and each manual will be formally endorsed by government and relevant industry sectors. The manuals will be in the form of Disease Management Strategy Manuals that cover the most important diseases identified under Programme 3 (National Pathogen List)

Activity 26: Establish a national-level Emergency Disease Response Team.

Priority: high

Time frame: short term

Responsibility: national

Description: Under this Activity, the CA will establish a national Emergency Disease Response Team (EDRT) comprised of national aquatic animal health experts. In the case of an aquatic disease emergency, the EDRT will assist in activating the relevant sections of the Uganda Aquatic Veterinary Emergency Plan.

Activity 27: Establish an emergency response fund.

Priority: high

Time frame: short term

Responsibility: national

Description: a national emergency response fund will be established to support emergency response interventions by the EDRT to be established through Activity 26.

6.3.10 Research and development

Background

Successful development of the aquaculture sector requires capacity in research in aquatic animal health. Targeted and basic research can provide insight into country-specific aquatic disease problems, improved diagnostic methods, cost effective treatment and control options that lead to improved disease management, better understanding of national aquatic animal health status, and provide support to risk analysis.

Where specific research capacity is lacking in a country, reliance is placed on research conducted in other nations. While such research is valuable it may not be directly applicable to local situations and a paucity of research on country-specific disease problems may hamper development of the aquaculture sector.

Mechanisms to improve research capacity require funding and include development of national aquatic animal health research laboratories, supporting linkages and research programmes within universities and the private sector, as well as contracting of targeted research with foreign and regional institutions.

The impact of diseases originating from aquaculture animals that have spread to indigenous species and the spread of such diseases among divergent catchments provides on important area of research. Knowledge of transboundary aquatic animal diseases (TAADs) under local conditions is important for the sustainable development of aquaculture production and the maintenance of aquatic biodiversity.

Current status

Public research in aquaculture in Uganda, including aquatic animal health research, is the responsibility of the National Agriculture Research Organisation, an agency of MAAIF. A designated National Aquatic Animal Health Reference Laboratory is housed in the Aquaculture Research and Development Centre (ARDC) of the National Fisheries Resources Research Institute (NaFIRRI).

According to the National Agricultural Research (NAR) Act, 2005, The National Agricultural Research Organisation (NARO) is mandated to coordinate, oversee and guide agricultural research (including animal health research) in Uganda.

It does this in partnership with NARO's institutes like academia (Universities) and private research organizations, development partners, private sector, policy or planners, and end-users (usually farmers). However, this Act needs to be amended to include aquatic animal health research.

The NARO has a ten-year strategic plan (2018-2028) who's mission is to innovate for sustainable agricultural transformation in Uganda and is aligned to the National Development Plan III. One of the areas of focus is to provide solutions for preventing diseases affecting livestock and fish.

The National Fisheries Resources Research Institute (NaFIRRI), The National Livestock Resources Research Institute (NaLIRRI) and other Public Agricultural Research Institutes

(PARIs) are mandated to conducted research or innovations geared to improve aquatic animal health in Uganda. The capacity, however, needs to be strengthened and enhanced to engage in productive research. The country needs more scientists and technicians to develop technologies or innovations that address the needs of the aquaculture industry.

Objectives

i. to increase research activity in those areas that have greatest potential to contribute to the improvement of regional aquatic animal health and biosecurity.

Activities

Activity 28: Identify research establishments that will contribute to research efforts.

Priority: high

Time frame: short term

Responsibility: national

Description: the CA for aquatic animal health will conduct a survey of government, university and private research facilities to identify the expertise and infrastructure available in the Uganda and establish a national database of facilities, scientists, expertise and mandates/interests. This database can then be used to identify potential participants in projects targeting specific research needs for the advancement of national aquatic biosecurity.

Activity 29: Identify and prioritize aquatic animal health research and development programmes for Uganda (including research on emerging pathogens).

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: The CA for aquatic animal health will identify and prioritize current and potential aquatic animal health research and development programmes that can contribute to the advancement of aquatic animal health management and biosecurity in Uganda and the Nile Basin region.

Activity 30: Identify and mobilize funding sources for aquatic animal health research in Uganda.

Priority: high
Time frame: short, medium and long term
Responsibility: national
Description: Based on the findings of Activities 27 and 28, proposals will be developed for priority aquatic animal health research projects in Uganda and will identify potential international, regional and national funding sources for individual projects based on the interests of potential funding agencies and the priorities of national agencies.

6.3.11. Communication and information system

Background

Communication provides the flow of information between and among national policy-makers, Competent Authorities, regional organisations and international agencies such as the OIE. The flow of information, between diagnosticians, aquatic animal health experts, quarantine officers, policy-makers, and aquaculture establishments, is important to alerting relevant authorities of changes in disease-status of farmed aquatic animals, and is essential to monitoring and surveillance activities that require disease reporting and notification. Communication activities assist with problem solving, and keep researchers and national experts, who may be working in relative isolation, up to date with the regional and global aquatic animal health situation. An effective national aquatic animal biosecurity programme relies heavily on good communication and linkages between national veterinary services and national fisheries authorities. The information stemming from Licensing; Monitoring, Certification and Surveillance; and Biosecurity activities needs to be linked through an effective communication system under the control of the CA.

Each member country of the OIE is committed to apply standards of the OIE and to follow the correct chain of reporting when there is suspicion or confirmation of an outbreak of an OIE-listed disease. In such a case, the information flow from a farming establishment, a veterinarian or aquatic animal health practitioner or from a diagnostic laboratory is via the country's Chief Veterinary Officer (CVO). The final responsibility for notifying the OIE of an outbreak of disease lies with the CVO who is usually also the country's delegate to the OIE.

Current status

Exchange of information is generally between producers, extension agents (private and public), planners (MAAIF) and the NARS (Research and Academia), international universities, international private laboratories, and international organizations such as FAO and OIE.

At sub-county and district level, the fisheries officers (FO) are in regular contact with producers and input suppliers. Small-scale subsistence producers receive general information on fish health management from FOs. Commercial farmers equally receive information from public and private extension services, internet and fellow farmers. Information is delivered through local seminars, symposia, field days, media (radio, mobile phones and TV) and print materials (brochures, posters). Farmers report directly to the FO on any health related issues. The FO can either report to the District Fisheries Officer or to a Scientist from a University or NARO. A few commercial large producers, however, have established contacts with international private laboratories where samples are sent for analysis.

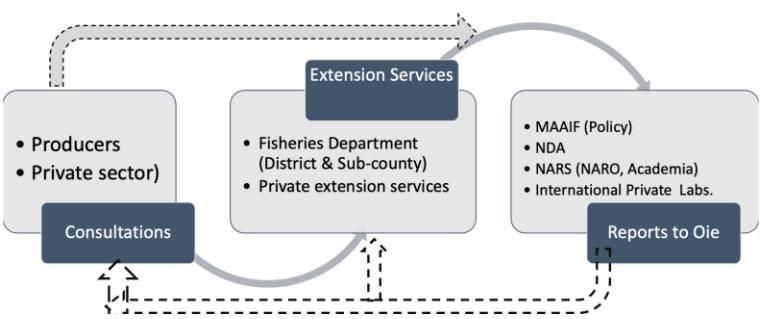
At National level, MAAIF (Fisheries and Animal Health) receives information from district extensions or directly from producers especially during disease outbreaks. The NARS (research and academia) organisations are also engaged in outreach programmes to offer services to the producers. International organizations like OIE and FAO have linkages with MAAIF where information on fish health is exchanged.

Producers rarely receive fast feedback from aquatic health experts/MAAIF, especially during disease outbreaks, because of challenges experienced in diagnostic laboratories.

Consequently, some commercial farms have established direct linkages with international laboratories that are providing rapid services. However, samples are submitted without following OIE protocols, hence there is danger of concealing information that may be of national and regional importance.

Generally, Uganda lacks a proper communication and information system for the industry. Different agencies or relevant authorities are working in isolation or independently, therefore, there is need for harmonization to support the industry. An effective ccommunication system between the Fisheries Department, Aquatic Animal Health experts and Veterinary Services will facilitate the implementation of the NBBSA.

Current Communication pathways



Objectives

i. to increase communication among key individuals and agencies concerned with aquatic animal health and biosecurity issues.

Activities

Activity 31: Integrate aquatic animal health information within existing aquaculture networks. Where a terrestrial animal health information system exists, this should be extended to include aquatic animal health information.

Priority: high

Time frame: short term

Responsibility: national and regional

Description: there are a number of existing aquaculture and biosecurity-related networks in Africa such as the Aquaculture Network for Africa (ANAF) and the Sustainable Aquaculture Research Networks for Sub-Saharan Africa (SARNISSA). Mechanisms will be sought to incorporate and/or increase the dissemination of information relevant to regional aquatic animal health and biosecurity by seeking cooperation with these networks and providing them with a regular source of information concerning recent happenings and advances in aquatic animal health in Uganda, the Nile Basin Region and globally.

Activity 32: Establish a regional communication hub for aquatic animal biosecurity amongst Nile Basin countries.

Priority: high

Time frame: short term

Responsibility: national

Description: a regional programme on aquatic animal biosecurity will be established and a regional communication hub (a dedicated Website) will be established to provide a source of information and communication for regional aquatic animal health and biosecurity workers. The Website will disseminate information on advancement of regional biosecurity planning (e.g. activities, proposals, projects), contain databases developed by the various activities, and provide current information on aquatic animal health and biosecurity topics of interest, both nationally and regionally. It will also link agencies and individuals involved in implementation of the NBBSA with for example, a regional experts database and a regional discussion group.

6.3.12. Human resources and institutional capacity development (institutional structure and training)

Background

Human resources and institutional capacity development refer to having the correct number of staff with the appropriate expertise to accomplish the essential tasks that have been identified as part of a national aquatic animal health strategy or aquatic biosecurity plan. Sufficient veterinarians, animal scientists and technical support staff, possessing the relevant expertise and training in aquatic animal diseases, are required to provide the key services in disease diagnostics, aquatic epidemiology, risk analysis, aquatic biosecurity, emergency preparedness, aquatic veterinary medicine, extension services, enforcement, border control and information services. Critical expertise requires specialisation at MSc, DVM or PhD level. Programmes such as veterinary board mandated continuing professional development activities provide opportunities to maintain and upgrade expertise through short-term and other training, attendance at international conferences and meetings and international collaboration.

Informed decisions about aquatic disease management and implementation of an aquatic biosecurity programme require a sound knowledge of aquatic animal diseases. To ensure development of the aquaculture industry, veterinarians and fisheries officers must be sufficiently well trained to provide the required support. Ongoing training in aquatic animal health is required to assist many countries to finalise and implement their respective national aquatic animal health and biosecurity plans and corresponding control measures. With the anticipated rapid growth in aquaculture, it is important that sufficient training opportunities are made available. In particular, training opportunities should provide the academic foundation for veterinary officials to make informed decisions when dealing with the trade in aquatic animals and to assist farmers in setting up individual health management plans for their animals. This will support international market acceptance of fish exports from Uganda and protect indigenous stocks from disease threats associated with importation of live aquatic animals, thus maintaining aquatic biodiversity.

Current status

Uganda has a number of tertiary training institutions that offer training in aquaculture production. These 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 areas. Mbale Medical School, CoVAB – MAK and the Faculty of Medicine, Mbarara University offer training of laboratory technicians who work within the country's animal health laboratories. Fisheries and aquaculture technicians are trained at the FTI.

Objectives

i. to increase the knowledge and expertise of aquatic animal health workers and aquaculturists in Uganda through targeted short-term training;

ii. to identify universities and other institutions that can offer aquatic animal health training in Uganda;

iii. to assist Uganda's universities by developing appropriate guidelines for curricula addressing the aquatic animal health needs of the country and engaging them to accept the need for related degree programmes;

iv. to mobilize funding to support the development of human resources and institutional capacity; and

v. to investigate Memoranda of Understanding (MOUs) and other means to facilitate collaboration between universities.

vi. to identify roles and responsibilities relating to implementation of the NBBSA.

Activities

Activity 33: Build and expand on existing training programmes on aquatic animal health from producer to service-provider levels.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: conduct a review of short-term (non-degree) training opportunities related to aquatic animal health that are currently available in Uganda. Conduct a survey of relevant agencies, organizations and private-sector aquaculturists to identify and prioritize short-term training needs. Seek mechanisms and funding to meet the identified training needs.

Activity 34: Identify universities and institutions that can offer aquatic animal health training in Uganda.

Priority: high

Time frame: short term

Responsibility: national

Description: conduct a survey of universities and other training facilities to determine the opportunities for degree-related (BSc, MSc, PhD, DVM) training in aquatic animal health-related subjects in Uganda.

Activity 35: Investigate Memoranda of Understanding (MOUs) and other means to facilitate collaboration, such as twinning options, between universities in Uganda and elsewhere.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: the CA for aquatic animal health, with the collaboration and guidance from Uganda's universities, will seek to develop MOUs and other mechanisms (e.g. twinning options) for the sharing of specialized expertise and capacity and the promotion of collaborative research between universities.

Activity 36: Mobilize funding to support development of human resources and institutional capacity.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: Uganda government, regional bodies and international donor agencies will be solicited for funding support for the development of Uganda's human and institutional capacity in aquatic animal health and biosecurity.

6.3.13. Infrastructure

Background

Provision of adequate and appropriate infrastructure is essential to the success of any national aquatic biosecurity programme. Infrastructure for aquatic animal health encompasses the essential facilities and systems serving a country. This includes dedicated physical structures such as buildings for office space, diagnostic and other laboratories, quarantine facilities, tank rooms, experimental ponds, etc.

Surveillance is an integral component of biosecurity programmes and is most demanding in terms of resource use. Where resource limitations exist for national biosecurity programmes, surveillance can still be effectively applied to zones or compartments with significant benefits for aquaculture producers.

Current status

The following laboratories can offer diagnostics and research services at national and regional levels. However, these laboratories are not accredited to provide aquatic animal health services.

At national level these are: the National Animal Disease Diagnostics and Epidemiology Centre (**NADDEC**) under MAAIF; NaFIRRI Aquatic Animal Health laboratory, the Central Diagnostics Laboratory at COVAB, and the CONAS Laboratory.

Regional Level: Regional Veterinary Laboratories

Objectives

i. to ensure that Uganda has sufficient and appropriate infrastructure to meet the national aquatic animal health and biosecurity objectives and to accomplish its goals.

Activities

Activity 37: Identify gaps in infrastructure requirements to support the programmes of the NBBSA.

Priority: high

Time frame: short term

Responsibility: national

Description: the CA for aquatic animal health will undertake a review and analysis of infrastructure needed and currently dedicated or available to support the NBBSA. The review will identify gaps in essential infrastructure needed to implement the NBBSA.

Activity 38: Develop appropriate infrastructure to support the NBBSA programme for diagnostics, research, surveillance, etc. including integration with existing facilities for terrestrial animal health.

Priority: high

Time frame: long term

Responsibility: national

Description: recommendations for the upgrading or establishment of essential aquatic animal health and biosecurity infrastructure will be made and funding sources to support its development will be sought.

6.3.14. National, regional and international cooperation

Background

Cooperation refers to the sharing of effort and resources (e.g. staff, infrastructure, funding) between and/or among countries, government agencies, universities, the private sector and other stakeholders to achieve common objectives or goals. International agencies such as the FAO and OIE cooperate in research and training with foreign universities and experts. At

regional level, particularly where borders follow shared water bodies such as Lake Victoria, the potential for cooperation and networking should be developed in all areas of aquatic animal health. Cooperation should include the development of standardized procedures for import and export of live aquatic animals, harmonization of legislation, shared communication structures (websites, newsletters), development of a regional aquatic animal health information system (pathogen database, regional disease diagnostic and extension manuals), cooperative research programmes, development of regional strategy and policy, regional disease reporting, a regional emergency response system, regional reference laboratory, regional risk analysis case studies, and coordinated training efforts). Cooperation at national level, in particular between agencies responsible for fisheries and aquaculture, veterinary services and environmental conservation, should be promoted.

Current status

At sub-county level: the Fisheries officer (FO) is deployed to manage and coordinate aquaculture activities. There are no or very few aquaculture associations at the sub-county level. Farmers report directly to the FO on any health related issues. The FO can either report to the District Fisheries Officer or Scientist from a University or NARO.

At national level: a national task force on Aquatic Animal Health is in place but is not fully functional. Experts work independently with minimal collaboration.

At regional level: experts collaborate with regional partners when projects exist. LVFO is now proposing a platform of experts to expedite the regional biosecurity plan.

Most of the aquaculture in East Africa, including Uganda, occurs in the Equatorial Nile subsystem whose hydrology constitutes the Lake Victoria sub-basin, Albert Nile sub-basin and Victoria Nile sub-basin. These represent transboundary water bodies that drain through Uganda to the Sudan. Potential risks consequently exist for aquatic animal pathogen entry and spread through a number of countries sharing these water bodies. The East African Member States, through the Lake Victoria Fisheries Organization (LVFO) have in place a common regional Strategic Plan 2016 – 2020 (LVFO, 2016) and Fisheries Management Plan III (FMP III) for Lake Victoria Fisheries (2016 – 2020) to foster the sustainable utilization of these shared resources for aquaculture management and development in the region. The Fisheries Management Plan III (FMP III) for Lake Victoria Fisheries (2016 – 2020) aims to enhance aquaculture production in Lake Victoria and its catchment through environmentally sustainable commercial aquaculture. The expected outcomes being improved infrastructure and services for enhanced production, environment, fish health and bio-safety of fish.

The Eastern Africa Regional Animal Health Network (EA-RAHN), Eastern Africa Regional Animal Health Laboratory Network (EA-RAHLN) and Eastern African Regional Animal Health Epidemiology Network (EA-RAHEN) provide Uganda with the possibility for cooperation at the regional level specifically with respect to animal health. The Commissioner Animal Health represents Uganda on these networks with the purpose of facilitating the control of trans-boundary animal diseases within the region.

The East African Community (EAC) represents a rapidly growing regional economic community. The Trade of Agriculture Safely and Efficiently in East Africa (TRASE) Assessment

of SPS Legal/ Regulatory Frameworks in the EAC Partner States (Land O'Lakes Venture37, 2021) identifies a number of issues relating to Sanitary and Phytosanitary (SPS) weaknesses that constrain trade of agricultural products from this region. Animal health, one of the distinct functions of the SPS system under the Sanitary and Phytosanitary Measures (WTO SPS Agreement), is supported by a large body of national laws, regulations, and institutions in EAC Partner States but is hampered by:

- Duplication and overlaps in regulatory functions that increase the cost of trade;
- Poor notification by Partner States when laws are updated or when new regulatory rules are introduced as is evident by the low utilisation of the tripartite web-based reporting mechanism;
- Unclear procedural rules and timelines for administrative resolution of trade complaints;
- Poor adoption of EAC Standards in domestic SPS controls; and
- Poor use of Equivalence and Mutual Recognition Agreements/Arrangements (MRAs).

Lack of emergency response capabilities of the national competent authorities to respond to outbreaks of diseases was identified as a key cross cutting challenge in all five partner states assessed, including Uganda. To implement SPS requirements at all levels of the production and distribution chains, the EAC has developed an umbrella SPS protocol that, when ratified, is expected to provide EAC partner states with a blue print on which to develop national SPS legislation

The Land O'Lakes Venture37 (2021) assessment noted a number of trade constraints relating to the enforcement of SPS controls in Uganda. These included:

- Poor awareness among traders of SPS requirements;
- Lack of mutual confidence between enforcement agencies in different countries;
- Few signed Mutual Recognition Agreements (MRAs) to facilitate trade;
- Weak coordination mechanisms in enforcing SPS compliance resulting in duplicated, overlapping or redundant controls, overlapping mandates among different authorities, lack of adequate transparency, poor notification of measures and procedures, and an ineffective complaint redress system.

Objectives

i. to improve regional aquatic animal biosecurity by identifying mechanisms for increasing appropriate regional and international cooperation among Competent Authorities and other relevant stakeholders.

Activities

Activity 39: Promote cooperation among Nile Basin countries in the control of serious aquatic animal diseases that are present in the region.

Priority:	high
Time frame:	long term
Responsibility:	national

Description: Uganda will identify and facilitate mechanisms to increase cooperation among neighbouring countries that share the Nile Basin water bodies that will assist in controlling serious aquatic animal diseases that are present in the region. The support provided by linkages between the LVFO and FAO, WorldFish and programmes such as the EU-EAC TRUE-FISH Programme will be sought.

Activity 40: Facilitate research collaboration between aquatic animal health experts and their local, regional and international counterparts.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: the CA for aquatic animal health will identify and facilitate mechanisms to increase cooperation between aquatic animal health and biosecurity experts in Uganda and their local, regional and international counterparts.

6.3.15. Ecosystem Health

Background

Ecosystem health refers to the environmental in which aquatic animals are farmed, and has bearing on their health. Conversely, the farming of aquatic animals can cause negative impacts, such as the escape of invasive species and the pathogens they carry into the natural environment, transfer of AMR determinants to environmental bacteria, and pollution and loss of species diversity, that can be detrimental to the natural ecosystem and wild fisheries. Ecosystem health addresses the high priority of invasive species, conservation efforts and climate change.

Worldwide there has been a terrestrial bias in conservation, yet the functioning of aquatic and terrestrial ecosystems is closely linked (Castello, 2021). The impacts that losses of habitat connectivity and degradation have on the productivity and biodiversity of aquatic ecosystems often goes unnoticed (Huchzermeyer *et al*., 2017). Integrated river basin management allows planning based on river catchment areas as operational landscape units. However, environmental management efforts aimed at conserving terrestrial ecosystems may not translate to aquatic ecosystems, which, due to their connectivity, need to be conserved on a catchment-wide basis. Care needs to be taken that terrestrial biases do not lead to marginalisation of freshwater ecosystem issues such as fisheries, biodiversity, design of protected areas, conservation priorities and systematic conservation assessments. Addressing freshwater ecosystem impacts therefore requires a long term basin-wide approach that combines conservation with basin-wide collaboration on socio-environmental issues. While community-based initiatives are key to conserving aquatic ecosystems, government agencies with sufficient human and financial resources play an indispensable role. Improving social justice through gender equality, sharing of economic benefits, and prevention of power grabbing in decision-making and resource access allows communities to promote

conservation objectives, laying the foundation for future conservation efforts and increasing the benefits they derive from aquatic ecosystems (Castello, 2021).

Current status

Uganda has an equatorial climate with water bodies that are suitable for the culture of a number of alien commercial species, both food fish and ornamental. These have the potential to escape from aquaculture establishments and invade natural ecosystems with potentially far-reaching negative consequences for biodiversity. The introduction of alien species for aquaculture carries the risk of introducing pathogens that may be well adapted to the invasive host but that can potentially cause epidemic disease outbreaks in naïve susceptible species that may affect both aquaculture and wild fisheries. Additional concerns exist about the potential genetic impact on indigenous species when genetically improved strains of the same species, such as Nile tilapia, escape from aquaculture establishments. Environmental impact studies based on risk analysis should be used to address these concerns.

Objectives

i. to identify invasive species that may carry serious diseases that are of concern to Uganda and its shared water bodies in the Nile Basin;

ii.to identify conservation efforts to address the impact of invasive species;

iii. address the impact of climate change on the spread of invasive species; and

iv. address the decline in native species that have been displaced by invasive species.

Activities

Activity 41. Maintain a list of and formulate control measures for alien species that may be hosts or vectors of serious aquatic diseases.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: building on the activities under Programmes 2 and 5, and, in particular, in conjunction with Activity 6 and 17, the national CA will develop and maintain a list of alien species that may be hosts or vectors of serious aquatic diseases and that should not be released into Uganda's waters. If found present, mechanisms for their control and eradication will be put in place. This list will be subject to regular review as new information on invasiveness becomes available.

Activity 42. Engage with neighbouring countries that share the Nile Basin water bodies to ensure harmonisation of approaches to invasive species.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: building on the activities of Programme 5 and 14, Uganda will engage with its neighbours that share the Nile Basin water bodies to ensure harmonisation of legislation and conservation approaches to deal with the risks posed by invasive species and the impacts that climate change may have on their invasiveness and the diseases they may harbour.

Activity 43. Monitor development of antimicrobial resistance (AMR) in environmental microbes associated with the vicinity of aquaculture establishments.

Priority: high

Time frame: short, medium and long term

Responsibility: national

Description: the monitoring and surveillance for AMR development is closely linked to the usage of veterinary antimicrobials and overlaps with Activity 20 under Programme 7. AMR surveillance and monitoring is a shared responsibility between neighbouring countries that share the Nile Basin water bodies and will be addressed through linkages established under Activity 41.

7. CONCLUSION AND WAY FORWARD

This short consultancy has put together the framework for a National Biosecurity and Biosafety System for Aquaculture in Uganda. The recommended activities of the NBBSA provide MAAIF with the programmes required to guide the sustainable development of the aquaculture sector through implementation of improved biosecurity planning, whilst providing protection to Uganda's ecosystems and natural fisheries resources, and ensuring the safety of consumers of aquaculture products.

A summary of key issues that need to be addressed is grouped below. These are relevant to:

i. Improving national and regional biosecurity. These include inadequate and fragmented regulations, a high risk of disease incursion, a high risk of outbreaks of catastrophic disease epidemics, insufficient movement - control of live aquatic animals, inadequate border controls, inadequate disease surveillance, inadequate controls over the intensity of fish farming clusters, and lack of biosecurity planning at all levels.
ii. Emergency preparedness and response capability. These include: a high level of exposure to the risk of catastrophic disease outbreak, inadequate early warning and response systems, lack of contingency planning, inadequate capacity and number of service providers, poor linkages to international reference laboratories, and poorly defined funding mechanisms to deal with aquatic animal disease emergencies.
iii. Enhancing surveillance and diagnostic services. These include: weak surveillance as a result of low level of capacity, inadequate logistic support for surveillance and diagnostic operations, inadequate diagnostic capacity, ineffective reporting systems, and a lack of a prioritized list of diseases.
iv. Improving availability of appropriate aquatic veterinary pharmaceuticals. These include: lack of effective control and use of drugs/chemicals, conflict in regulatory responsibility and control governing registration of aquatic veterinary drugs and chemicals, lack of an aquatic animal veterinary pharmaceutical register, weak supervision of pharmaceutical use, and a high likelihood of antimicrobial resistance (AMR) development.
v. Improving education, awareness and training. These include: low level of understanding about aquatic animal diseases and biosecurity in the industry, inadequate technical training and knowledge transfer in aquatic animal health, and biosecurity.

Through implementation of improved biosecurity at multiple levels, from farm to national, economic benefits will accrue to both primary and secondary stakeholders within the aquaculture value chain. The NBSSA will need to be adopted as official policy, and the necessary resources will need to be sought, for the detailed implementation planning that will be required to pave the way to improved aquatic animal disease and biosecurity management in Uganda. Prior to finalising the NBSSA as official policy, a further round of national consultation should be organised to seek feedback from all stakeholders.

The development of Aquaparks in Uganda provides a unique opportunity to fully harness the benefits of biosecurity planning. Improving aquatic animal disease biosecurity on Uganda's shared water bodies will, however, require a common approach by neighbouring countries. For this reason, it is crucial that Uganda encourages the neighbouring countries of the Nile Basin to develop a common approach to regional biosecurity. Disease surveillance and reporting forms an integral part of such biosecurity planning. This is a resource demanding activity and depends on availability of financial, infrastructural and human resource support. Implementation of surveillance activities targeting priority-listed diseases related to biosecurity planning will require close consultation with

stakeholders so that resources are applied effectively, and will require a regional approach on water bodies shared by neighbouring countries.

Mechanisms for implementation of the NBBSA need to be developed that detail the associated responsibilities and funding for projects in consultation between the DFR, the DAR, diagnostic and research laboratories, the NDA, private sector and other stakeholders. The lead agency needs to be established (probably the DFR) under which a National Task Force on Aquatic Animal Biosecurity (NTFAAB) can oversee the implementation and monitoring of the NBBSA. A detailed implementation plan needs to be prepared that includes prioritising of activities; identification of responsibilities and resources; and that provides the time frame for activities. Progress should be reviewed annually with revision and updating of the NBBSA after a recommended 3–5-year period.

Implementation of the NBBSA will require a strong will from stakeholders to drive the process, as well as full commitment of the government and the adoption of appropriate institutional and legal frameworks by the competent authority.

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APPENDIX Ia

A RISK-BASED APPROACH TO BIOSECURITY PLANNING

Prepared by Dr D. Huchzermeyer (International consultant) and Dr J. Walakira (Uganda consultant)

1. INTRODUCTION

This Appendix to the report on development of a National Biosecurity and Biosafety System for Aquaculture in Uganda (NBBSA) provides the background to the recommended analysis of data collected from stakeholder consultations in support of the development of the NBBSA.

Risk is the potential occurrence of unwanted, adverse consequences associated with some action over a specified time period. It reflects the possibility that a negative impact will result from an action or decision and the magnitude of that impact. Pathogen risks and food safety and public health risks need to be subjected to risk analysis standards developed under international agreements in application to international trade and food safety (Arthur *et al.* 2009).

The Aquatic Animal Health Code of the World Organisation for Animal Health (OIE, 2019a) provides details on pathogen risk analysis with attempts to establish consistency across aquatic animal production systems regardless of operating environment. There are numerous pathogen risks associated with aquaculture. These include the importation of live organisms as food, feed products, fry, fingerlings, spat, and broodstock, as well as uncooked products. Various commodities can potentially transfer pathogens into cultured and wild stocks in a receiving country. These include live invertebrates (e.g. molluscs, arthropods) and vertebrates (e.g. finfish, amphibians) in various life-cycle stages and their products (e.g. gametes, non-viable chilled aquatic animals [whole, or in various forms] for human food, feed products, etc.) (Arthur *et al.* 2009).

Food safety and public health risk analyses within the aquaculture production sector include assessments to allow international trade (e.g. development of import health standards, generally via Import Risk Assessments), industry-wide closures due to pathogen outbreaks and detection of tainted products on importation or in the marketplace. The food safety and public health risk analyses have also been developed in the international community under the Codex Alimentarius.

Risk analysis requires posing a clear risk question that includes the specific hazard of concern, the vector/vehicle(s) of the hazard of concern, the specific risk to be assessed, and the particular time frame of interest (Arthur *et al.* 2009). The process is elaborated in the OIE Aquatic Code, which provides for both qualitative and quantitative assessments of risk and seeks answers to the following questions:

- What can occur? (Hazard identification)
- How likely is it to occur? (Risk assessment: likelihood assessment through release assessment and exposure assessment)
- What would be the consequences of it occurring? (Risk assessment: consequence assessment and risk estimation; risk management: risk evaluation); and

- What can be done to reduce either the likelihood or the consequences of it occurring? (Risk management: option evaluation, implementation, monitoring and review). The entire process includes risk communication, the communication of the risk to others in order to generate a change in management, regulation or operation.

In terms of biosecurity planning, applying risk analysis through hazard analysis and critical control point (HACCP) methodology reduces the uncertainty in management decisions and allows a structured approach to management actions that are determined by an acceptable level of risk (ALOR). This process requires collection and processing of information from relevant stakeholders.

2. METHODOLOGY

For analysis of data collected, through the use of questionnaires, during stakeholder consultations in the nine agro-ecological zones of Uganda, the risk-based approach to biosecurity planning based on concepts from FAO (2019) and hazard analysis and critical control point methodology (HACCP) (MacLehose, 2003; Palić, Scarfe and Walster, 2015; Arthur and Bondad-Reantaso; 2012) will be used. This comprises the six steps reflected in the FAO's Progressive Management Pathway for Improving Aquaculture Biosecurity PMP/AB (FAO, 2019):

1. Situational analysis
2. Hazard identification
3. Biosecurity vulnerability analysis
4. Risk pathway analysis
5. Critical control points
6. Monitoring and corrective actions

2.1. SITUATIONAL ANALYSIS (stakeholder questionnaires)

2.1.1. The objectives of the situational analysis are to:

1) identify all aquaculture sectors;

2) identify all key stakeholders in each sector;

3) involve stakeholders in the risk analysis process; and

4) conduct a value chain analysis for all aquaculture sectors.

Global trends in aquaculture production, new species being cultured and aquatic species that neighbouring countries have introduced and attempted to culture are considered, particularly where aquaculture establishments utilize water bodies that are shared by neighbouring countries, such as the Nile Basin. The situational analysis takes into consideration new species the national aquaculture sector is likely to want to introduce for aquaculture development in the next 5–10 years, in particular GIFT strain in the case of Uganda. Potential key stakeholders include producers (i.e. small-scale farmers, seed stock suppliers, large-scale farmers and farming corporations), aquatic animal health

professionals (aquaculture specialists, veterinarians, biologists, extension workers), industry partners (i.e. feed manufacturers, drivers, traders), and government officials (i.e. local, state/provincial, national). Stakeholders with a high level of power and interest in aquaculture biosecurity are involved closely in development of the strategies (informed, consulted and engaged). Other stakeholders are kept informed through regular updates on strategy development. Stakeholders with little power or interest have less time and effort spent on them (MacKinnon *et al.* 2020).

The concept of a value chain analysis consists of a descriptive overview of the systems involved in producing aquaculture commodities from suppliers, through producers, to the marketing system, processors and consumers. Value chain analysis describes places where each process occurs and the stakeholders involved, and can include seasonal trends, product volumes/values, and numbers of enterprises or livelihoods supported at each point. The situational analysis provides the starting point for risk analysis and promotes risk communication (MacKinnon *et al.* 2020). It provides information on the current status of aquaculture development and aquatic animal health management in Uganda.

2.1.2. Results to be achieved:

2.1.2.1. Identification of all aquaculture sectors.

List of all aquaculture sectors present in the country and any new sectors that may be introduced in the future (within 5–10 years).

Sectors ranked by level of production or value ($).

Description of geographic distribution of aquaculture activities in the country.

2.1.2.2. Identification of all KEY stakeholders in aquaculture sectors.

(e.g. farmers, vets and aquatic animal health professionals, industry suppliers, traders, dealers, exporters, banks/creditors, international organizations, government officials)

Table 1. Stakeholder involvement

Stakeholder	Stake in aquaculture biosecurity	How can they help improve aquaculture biosecurity?	How should they be engaged
(Name & brief description.)	*(What is of interest to them? What do they want to see happen? How are they affected? How motivated are they? Etc.)*	*(What skills, attributes do they have to bring to the project?)*	*(What levels of engagement do you need to consider, and what processes of engagement would suit? Are there conflicts amongst some stakeholders?)*
Philip Borel PESCA commercial aquaculture sector industry representative.	While GIFT remains controversial, particularly within MAAIF circles, there is the reality that some may bring it in illegally through the back door. If this industry is to grow in Uganda, it must be competitive, and genetics is a critical element. What is required is a good Biosecurity Plan, and through this following international protocols, bringing in fish in a professional manner with all the proper controls.	Timely reporting of diseases affecting aquaculture establishments. Expert capability to manage basic steps in designing & managing biosecurity plans for quarantine facilities, to ensure best management practices and welfare of aquatic animals. Identification of fish diseases, quarantine methods and an efficient feedback mechanism. Adopt EU regulations or standards to ease exportation of farmed fish products and ensure good safety standards. Rapid detection of pathogens by inspection body & carry out due diligence for import and export based on	Private sector should be involved at all levels of biosecurity & biosafety measures; i.e. policy formulation, decision making and implementation process. Divergence of opinions exist among stakeholders especially on importation of improved strains like tilapia but emphasis should be on genetic improvement and ensuring biosecurity measures at farm and national levels. Proper coordination among key stakeholders will ensure effective biosecurity and biosafety plans.

Stakeholder	Stake in aquaculture biosecurity	How can they help improve aquaculture biosecurity?	How should they be engaged
		OIE recommendations. Application of SOPs & COPs as is expected from farmers to ensure biosecurity measures at farm levels (LEVEL 1 and 2). Basic analysis of biosecurity and biosafety measures at farm level: e,g welfare of animals and use of drugs.	
IG Investment: Mr. Kimalyo (Operation manager) Large cage farm (production > 1000 t per yr) at Buikwe district	Quick relay of information on preventing diseases and other hazards associated with water quality should be fast and reliable especially for cage establishments. Multi-sectoral platforms which share experiences, ideas and strategies to strengthen biosecurity and biosafety measures at farm level. Research is not adequately responsive to large scale farmers hence their loss of income in business	Experience in management of farmed fish in cages, and marketing strategies.	Involvement at all levels: Farm and national levels in policy formulation and implementation. Participatory research to solve problems of fish kills and water quality. No conflicts observed.
Women Group in Cage fish farming Bugiri District.	The most important aspect of biosecurity is prevention of disease outbreaks and	The farm has access experience in fish growth and handling	At all levels to ensure that gender issues are included, streamlined and implemented.

Stakeholder	Stake in aquaculture biosecurity	How can they help improve aquaculture biosecurity?	How should they be engaged
(Andrew Arinaitwe; Technical Manager)	introduction of exotic pathogens into farms. Ensure that no new pathogens enter fish farms and increase survival along the growing cycle. Determined to minimise the impact of diseases and foreign harmful invasive species.	of fish raised in cages sustainably. Women famers can execute measures on instruction, and can track data, keep records, analyse and develop reports.	
MAAIF, NADDEC, Dr Ben Ssenkera	Emphasis should be on prevention of pathogens into and out of production systems, sub- regions and border points. At farm levels: production units should have protective measures in place against birds, wild fish, infected fomites and unwanted persons. Farmers adopting /implementing biosecurity and biosafety measures. Applying sustainable prophylaxis methods that avoid use of medicated feeds Fast diagnostic services for farmers and the industry. There is government will to support farmers and build	Ministry has staff in NADDEC who is knowledgeable about biosecurity and biosafety standards and procedures. Research skills in biosecurity and bio-safety, especially epidemiology (e.g. risk analysis & mitigations). Coordination with OIE member countries (globally).	NADDEC should be involved at all levels: farm, district, sub-regional, national and regional level. Engage NADDEC in; (i) policy formulation and implementation, (ii) Research and development, (iii) Reporting systems. Conflicts: lack of adequate harmonisation among competent authorities in research, reporting and dissemination of information. The roles of Chief Veterinary Officer and Director of Fisheries Resources should be spelt out clearly e.g. who is responsible to inspect fish products

Stakeholder	Stake in aquaculture biosecurity	How can they help improve aquaculture biosecurity?	How should they be engaged
	capacity of relevant key stakeholders.		into and out of the country?
Catherine Agoe, Fish pathologist (NaFIRRI-NARO)	Importation of exotic live fish products to be streamlined, controlled and monitored to avoid introduction and spread of diseases. Skilling and training of Competent Authorities, farmers and planners in biosecurity and biosafety measures Harmonisation in research and reporting between Fisheries Department, Animal Health Department, Academia, Research and private sector. Lack of coordination and less knowledge on fish diseases has contributed to loss of revenue or income. Lack of adequate finance to implement programs/projects e.g. to perform molecular diagnostics largely frustrate to report quickly.	Parasitology, microbiology and general fish health management; Diagnostics up to level II; Public health.	Policy formulation at all levels of planning. Setting up biosecurity measures at farm. Conflicts: detrimental to aquaculture development is that some Competent Authorities, researchers, private sector and extension agents competing for knowledge generation instead of working together. Furthermore, different labs appear to work independently instead of twinning services for the industry.

2.1.2.3. Understanding how to involve stakeholders in the risk analysis process. Identified stakeholders are plotted based on their perceived "*Power and Interest*" below:

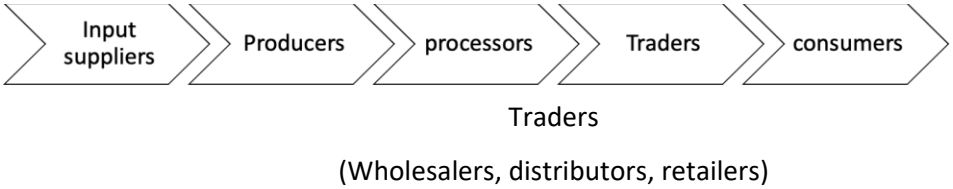
Table 2. Stakeholder interest matrix in terms of power and interest

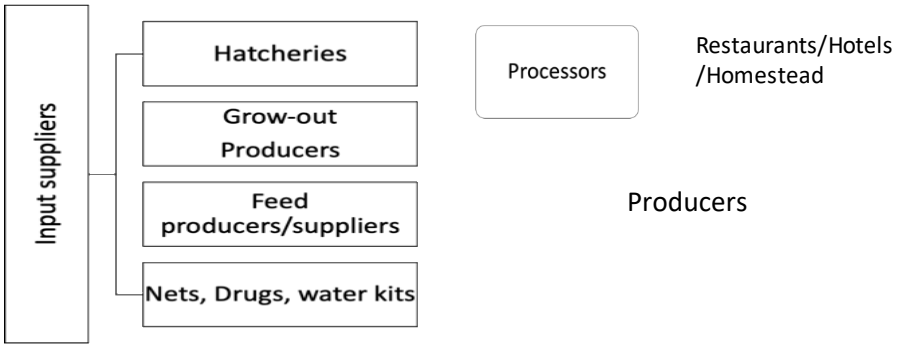
Power	High	Subsistence and small scale farmers		Private Sector MAAIF
	Medium		Small scale commercial fish farmers	Large Scale Fish Farmers
	Low			
		Low	Medium	High
	Interest in issue			

Subsistence farmers have political backing as majority are voters in the constituency. Hence, anything that affects their production will attract a quick response from the political platform.

2.1.2.4. Production chain analysis for all aquaculture sectors

Production chain analysis sketches out the production chain(s) related to each aquaculture sector that has been identified. It indicates: place or movements; product or animal sector; and people involved. It starts at product-level (consumer) and works back towards the production-level (producer). Most important is the production chain analysis with respect to tilapia and ornamental fish as there is high likelihood of live fish imports and movements of both commodities and both have been linked to spread of a number of serious aquatic animal pathogens. A straightforward organogram can be used to illustrate the risk hotspots (to be completed by local consultant).





2.1.3. Conclusion

Results of the situational analysis provide the following important information on Uganda required for biosecurity planning:

a. Level of understanding of biosecurity as applied to aquaculture and the trade in live aquatic animals and their products.

b. Level of emergency preparedness,

c. Capacity for disease prevention and control,

d. Capacity to register fish farms,

e. Capacity of quarantine, inspection and control services (effectiveness of border controls),

f. Capacity for disease diagnostics, surveillance, monitoring and reporting,

g. Availability and regulation of appropriate and safe veterinary medicines and capacity for residue monitoring,

h. Level of feed quality control,

i. Capacity for education, training and awareness building.

2.2. Hazard identification

Hazards are identified that are appropriate to the aquatic species present or potentially present in Uganda (farmed or wild) and that may lead to exotic, emerging or enzootic diseases. They include hazards that are established in the country but have not yet spread to all geographical areas, are under national control and/or eradication programmes, or are exotic but whose entry and spread may pose serious risks to national aquatic resources. The National Aquatic Pathogen List (NAPL) should include pathogens and diseases listed by the OIE (as appropriate, e.g. infection with *Aphanomyces invadans* (EUS), as well as other pathogens of national significance such as Tilapia lake virus (TiLV) and infectious spleen and kidney necrosis virus (ISKNV). These pathogens should merit the efforts required to control their entry, establishment or spread within the country or region. Compilation of the NAPL is a consultative process, involving state policy-makers, experts and relevant representatives from the aquaculture sectors. The process should be transparent to enable understanding and acceptance by potential exporting countries. The NAPL needs to undergo periodical review based on changing global, regional and national situations. Where hazards/diseases are present in the country that are important to national aquaculture or wild fish stocks but do not cause catastrophic losses, these hazards/diseases should be considered for inclusion on the "Other Pathogens of National Importance List". These may be ubiquitous, cause serious losses to national aquaculture, have control programmes in place, or may not be a concern for international trade. This list may include bacterial pathogens such as *Streptococcus agalactiae* and *Lactococcus garvieae*. Fundamental knowledge about the hazards/diseases of concern (i.e. basic epidemiology, hazard characteristics) should be gathered. Local and regional patterns of disease occurrence should be known via passive or active surveillance (i.e. incidence/prevalence of disease, temporal/spatial patterns of outbreaks, production systems/species affected, morbidity/mortality rates) (MacKinnon *et al.* 2020).

Results to be achieved

2.2.1. All hazards (pathogens) for all key aquaculture sectors, from a national and producer-level perspective are identified;

2.2.2. National Aquatic Pathogen List is defined;

2.2.3. Knowledge about basic epidemiology of hazards/diseases of concern is summarized; and

2.2.4. Local and regional patterns of hazard/disease occurrence are summarized.

Table 3. Criteria matrix for development of a National Aquatic Pathogen List (see overlap with the MCS project). This is for reference and provides the criteria by which future possible additions to the national pathogen list should be analysed. The pathogen list is already reflected in Appendix III. Five high priority diseases are included for illustrative purposes. Further diseases will need to be assessed other pathogens of national importance.

Disease/ Pathogen	**Infection with *Aphanomyces invadans* (EUS)**	**Tilapia lake virus (TiLV)**	**Infectious spleen and kidney necrosis virus (ISKNV)**	**Koi herpesvirus (KHV)**	**Infectious haematopoietic necrosis (IHN)**
OIE listed? (yes/no)	Yes	No	For marine species, but not tilapia	Yes	Yes
Infectious aetiology? Or infectious agent strongly associated with disease, but aetiology not yet known? (yes/no)	Yes	Yes	Yes	Yes	Yes
Pathogenicity / Socioeconomic impact (low, medium, high)	High	High	High	High pathogenicity, socio-economic impact high in carp producing countries	High pathogenicity , low socio-economic impact
Repeatable and robust means of detection/ diagnosis exists? (yes/no)	Yes	Yes	Yes	Yes	Yes
Affects species cultured in country or likely to be cultured? (yes/no)	Yes	Yes	Yes	Yes	Yes
Affects wild aquatic animal species present in country? (yes/no)	Yes	Yes	Yes	No	No
Already present in country? (yes/no) If yes, limited distribution? (yes/no)	No reports?	Possibly	No reports?	No reports?	No reports?
National control programme present for this pathogen/ disease?					

Disease/ Pathogen	**Infection with *Aphanomyces invadans* (EUS)**	**Tilapia lake virus (TiLV)**	**Infectious spleen and kidney necrosis virus (ISKNV)**	**Koi herpesvirus (KHV)**	**Infectious haematopoietic necrosis (IHN)**
Concern to international trade? (yes/no)	Yes	Yes	Likely	Yes	Yes
Should be included on NAPL? (yes, no) If no, should be included on "Other Diseases of National Important List"?	Yes	Yes	Yes	Yes	Yes

2.3. Biosecurity vulnerability analysis

Biosecurity vulnerability analysis aims to: 1) identify important biosecurity vulnerabilities ("risk hotspots") for key aquaculture sectors in the country; 2) determine distributions of vulnerabilities (risk hotspots) in the country; and 3) prioritize risk hotspots within the value chains. Aquaculture sectors continuously evolve to meet the changing needs of a globalized society creating potentially new and changing disease risks. Risk analysis can provide a basis for studying disease risk and risk mitigation in aquaculture value chains. Aquaculture biosecurity refers to the cost-effective management of risks posed by pathogens to aquaculture through a strategic approach at enterprise, national and international levels with shared public-private responsibilities.

Numerous factors, including hazards (pathogens), management practices, illegal and informal trade, and lack of capacity in public and private institutions can undermine the achievement of good biosecurity. "Risk hotspots" are points in the production chain where biosecurity is most vulnerable. This can be related to a geographical location, management practices, or actions by stakeholders that decrease the capacity to manage health risks. These are points in the value chain where the combined effect of the probability of pathogen entry/spread and the consequences of pathogen entry/spread are greatest. The spread of diseases in aquaculture is linked to movements of input materials (i.e. feed, water), aquatic animals, animal products, people, equipment, and other fomites during transport. As movements in value chains are driven and controlled by people, the use of value chain analysis with risk analysis allows identification and characterization of risk hotspots in the aquaculture sector (MacKinnon *et al.* 2020).

Results to be achieved

2.3.1. Important biosecurity vulnerabilities (risk hotspots) and their distribution for key aquaculture sectors in the country are identified.

2.3.2. "Risk hotspots" within the value chain are prioritized.

Table 4. Ranking of risk hot spots on a scale of 1-5

Production chain sector	Risk hotspot	Probability of pathogen entry or spread (high, mod, low, very low)	Consequences (high, mod, low, very low)	Overall Ranking
Border controls: import of live ornamental fish	5	5	5	15
Border controls: Import of genetically improve Nile tilapia seed stock	5	5	5	15
Hatcheries selling seed stock	5	5	5	15
Pond aquaculture	3	3	3	9
Lake-based cage farming	4	4	5	13
Fresh fish trade	2	1	1	4
Frozen fish trade	1	1	1	3
Export of fish produce	3	1	5	9

2.4. Risk pathway analysis

Risk pathway analysis aims to develop risk pathways for risk hotspots. This allows the probability (likelihood) for the occurrence of each step in the pathways to be assessed. The analysis focuses on the most important risk hotspots and describes each stage in the disease transmission process as it occurs in the value chain. When developing the risk pathway, all of the steps necessary for the disease outbreak to occur are identified. To make an assessment of risk, the likelihood (probability) of each of these steps to occur is assessed either qualitatively or quantitatively. Risk pathways are a useful tool for determining risk factors in the value chain, which are the most important factors that affect the level of risk at risk hotspots (can increase or decrease the level of risk) (MacKinnon *et al.* 2020).

Results to be achieved

Develop risk pathways for risk hotspots and assess the probability of this occurring:

2.4.1 A risk pathway for a key risk hotspot identified during the Biosecurity Vulnerability Analysis is developed.

2.44.2. A qualitative probability (likelihood) for that to occur (i.e. negligible, very low, low, moderate, high) is assigned for each step in the risk pathway.

2.5. Critical control points

Critical control points (CCPs) need to be identified in order to determine risk mitigation practices that can be used to address critical control points and reduce the risk of disease introduction. These are points in the risk pathway where control measures exist. These control measures provide an opportunity to prevent, eliminate or reduce risk to an acceptable level (as determined by the risk manager). Risk reduction is achieved by a combination of several control measures (or management practices). In aquaculture, these focus on the five main pathogen introduction pathways: introduced animals, water, fomites, vectors and feed. Control measures (or management practices) are based on limiting or preventing pathogen introduction through these pathways. Examples include using specific-pathogen-free (SPF) seed-stock, egg disinfection, water treatment, cleaning and disinfection of fomites, movement restrictions of people, and using feed from trusted suppliers. Importantly, control measures should be focused upstream in value chains because if material, such as seed-stock, entering the chain is lower risk, then the whole chain is at lower risk (i.e. hatcheries). Surveillance is a line of defence against the spread of disease since a sensitive surveillance system can detect the presence of disease early on. Good surveillance and quick response can reduce the impact of disease outbreaks and lower risk. If control measures cannot be identified along a risk pathway, surveillance is a legitimate risk management response (MacKinnon *et al.* 2020).

Results to be achieved

2.5.1. Critical control points are described

2.5.2. Risk mitigation practices that can be used to address CCPs are identified (See IABC Process).

2.5.3. The most likely impact of the control measure on stakeholders is rank?

2.6. Monitoring and corrective actions

Monitoring and corrective actions provide an understanding of what can affect compliance; determine what strategies can be used for the monitoring process; and determine corrective actions that can be implemented. The benefit of decreased incidence of disease may not outweigh the cost of the control measures for all stakeholders. Control may not always be economical for all stakeholders, which affects compliance. Compliance can be increased through consultation with all stakeholders in the value chain that would be affected by the control measures. Incentives, research, education, subsidies, compensation, sanctions, and/or legislation/enforcement may improve compliance.

Implementation of control activities can be monitored through activities such as site inspections or audits. Monitoring provides risk managers with evidence that the control measures being implemented are effective. This may be via disease surveillance on farms (evidence that disease prevalence is reduced), and analysis of farm records, diagnostic testing records, and/or aquatic animal health professional records. Analysis of the results from monitoring activities can be analysed to determine the impact of the control measures and whether they are being effectively implemented. These may indicate areas that need improvement. Where a CCP is not under control, corrective actions need to be implemented. Local, provincial, and national regulations ensure that corrective actions comply with international standards (MacKinnon *et al.* 2020).

Results to be achieved

Will reflect as an outcome following implementation of improved biosecurity planning.

3. DISCUSSION

Aquatic animal disease biosecurity risks are manifold and are significantly influenced by stakeholders and behaviour of stakeholders in the production value chain. In order to adequately address these risks through biosecurity planning, a risk-based approach is required. The risk-based approach to biosecurity planning is presented in this Appendix to the NBBSA as an example of the framework and methodology that should be followed. Risks may change rapidly over time as industries grow and change, and may be influenced, amongst others, by disease emergence, effectiveness of emergency response and contingency planning and implementation, and biosecurity practices in neighbouring countries. This can have a profound effect on the ability to trade fish and fish products with international trading partners. For this reason, a regional approach to biosecurity planning is strongly recommended.

Currently, the high demand for importation of genetically improved seed stock and the import of live ornamental fish pose a serious risk of introduction of unwanted pathogens. Special note should be taken of the rapid spread of EUS through Southern and Central Africa, as this disease threatens not only aquaculture development but also natural freshwater fisheries. The recent emergence of TiLV and ISKNV, as serious pathogens of tilapia, poses considerable risk to both commercial and subsistence tilapia farms. KHV, a disease frequently spread by the transboundary trade in ornamental koi carp, threatens the carp industry while IHN is a risk to the salmonid industry, particularly as IHN has been reported from neighbouring Kenya.

4. CONCLUSION

Appendix Ia to the NBBSA details the guidance for using a risk-based approach to biosecurity planning. The Appendix should be read together with Chapter 6 of the NBBSA: Programme 6.3.2. *Risk analysis*. This is an ongoing process as the aquaculture industry in Uganda, and the countries that share Uganda's water bodies, grows; as new aquatic animal species are introduced for aquaculture; as new serious pathogens emerge; and as the transboundary trade in live aquatic animals and their products expands.

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APPENDIX Ib

ASSESSMENT OF AQUACULTURE AND AQUATIC ANIMAL HEALTH AND BIOSECURITY IN UGANDA

1. ASSESSMENT OF THE AQUACULTURE SECTOR IN UGANDA

1.1. Objectives

The assessment was aimed at collecting relevant information essential to support the aquaculture sector through development of a National Biosecurity and Biosafety System for Aquaculture and improved biosecurity planning to ensure sustainable healthy production of aquatic species. This assessment was also used to identify major gaps related to aquaculture development and biosecurity while sensitising stakeholders to the importance of improved biosecurity management throughout the aquaculture value chain.

1.2. Participation

Aquaculture producers (seed and grow -out) in all nine (9) agro-ecological zones (AEZs) of Uganda were consulted (Figure 1 and Table 1). In addition consultations were held with District Extension staff, local leaders, fish feed producers/traders , the veterinary services of the Directorate Animal Resources, Directorate Fisheries Resources, National Veterinary Laboratory, regional veterinary laboratories, and academia.

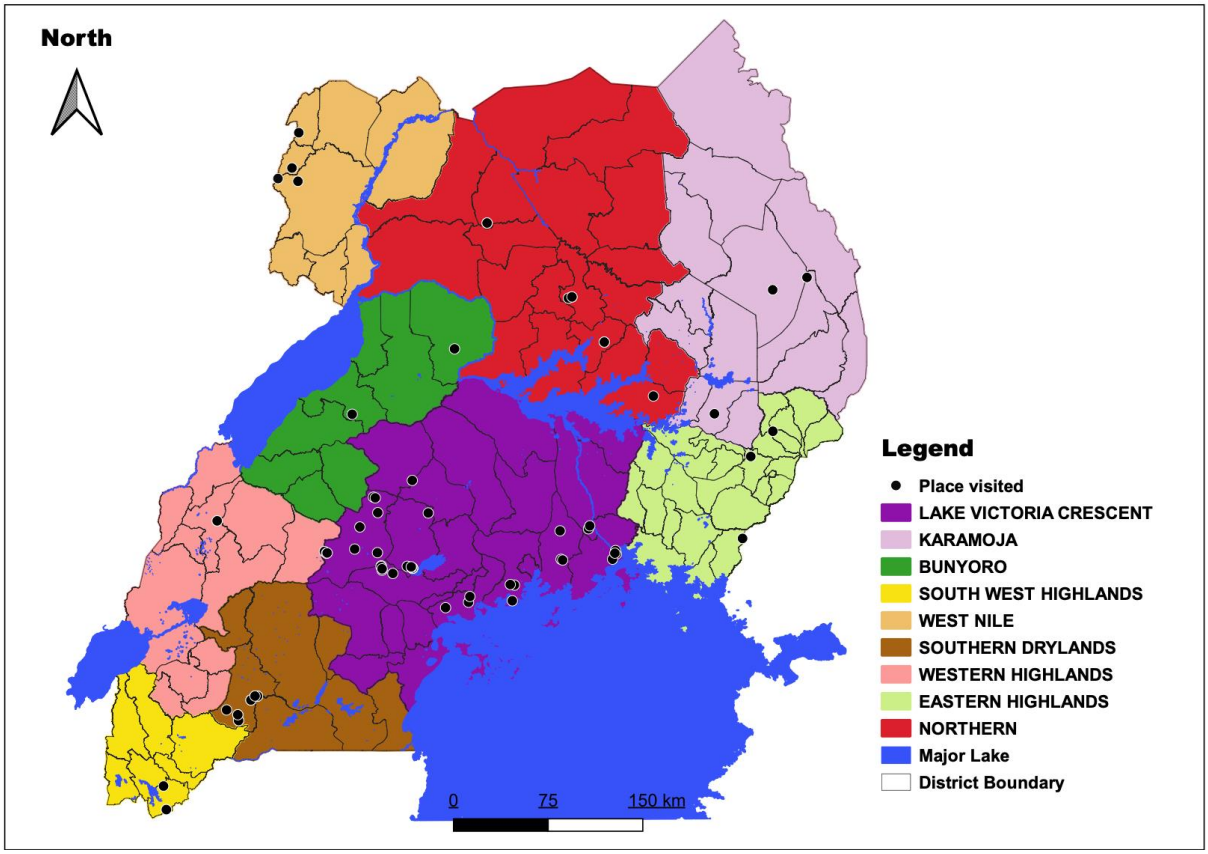

Figure 1. Map of Uganda illustrating agro-ecological zones and sites of aquaculture production

1.3. Participants

Table 1. Survey participants

Participant group	Number of interviews conducted
a) Seed producers (private and public): African catfish, tilapia, mirror carp;	Public: 10 (African catfish, tilapia & Mirror carp) Private: African Catfish (4); Tilapia (3); African catfish + Nile tilapia (3)
b) Grow-out producers: subsistence farmers, small-scale commercial farmers and large scale commercial farmers;	Subsistence: 19 Small-scale commercial: 23 Large commercial Scale: 14
c) District Extension Staff: Local level Fisheries and Veterinary department;	District Fisheries Officers: 7 District Veterinary Officers: 9 Sub-county Fisheries Officer: 9 Sub-county Veterinary Officer: 7
d) Fish feed producers and traders (i.e. agents of imported feed);	Five (5)
e) Border staff;	Four (4)
f) Local leaders (LC III Chairpersons and Production Chairperson) in four districts.	LC III: 3 Production chairperson 2:

Table 2. Survey participants interviewed by the Monitoring, Certification and Surveillance (MCS) team.

QN	Name of Laboratory	Institution	Ditrict	LATITUDE	LONGITUDE
14	NADDEC	NADDEC	Wakiso	-0.40564	33.20417
13	Vet Microbiology Research Lab	CoVAB	Kampala	0.34013	32.56775
12	Nakasongola	District LG	Nakasongola	1.30889	32.45639
11	Hoima	District LG	Hoima	1.44807	31.08601
10	Mukono	District LG	Mukono	0.36354	32.73912
9	Mbale	District LG	Mbale	1.08209	34.17503
8	Kasese	District LG	Kasese	0.18333	30.08333
7	Kazo	District LG	Kazo	0.052778	30.75694
4	Kayunga	District LG	Kayunga	1	32.86663
6	Ngora	District LG	Ngora	1.4575	33.77639
5	Kalangala	District LG	Kalangala	-0.321389	32.291944
3	Kabarole	District LG	Kabarole	0.599998	30.3
	Jinja	District LG	Jinja	0.420191	33.20446
2	Mbarara	District LG	Mbarara	-0.61012	30.64378

QN	Name of Laboratory	Institution	Ditrict	LATITUDE	LONGITUDE
18	ARDC-NaFIRRI	ARDC	Wakiso	-0.22209	32.53482
17	Busia	District LG	Busia	-0.46151	34.07933
17	Busia	URA	Busia	0.46573	34.09843
16	Tororo	District LG	Tororo	-0.68825	34.19043
15	CDL	CoVAB	Kampala	0.34013	32.56775
	Kabale	District LG	Kabale	-1.28321	29.9889
	Katuna	URA	Kabale	-1.42309	30.01042
16	Malaba	URA	Tororo	-0.63819	34.26445

1.4. Outcome of stakeholder questionnaires provided answers to the following:

- Current status of aquaculture development and
- Current status of aquatic animal health management
- Recent data on aquaculture production in volume and value and main species cultured
- Status of legislation pertaining to biosecurity
- Need for introductory training courses on risk analysis and biosecurity planning.

1.5. Stakeholders

List of major stakeholders involved in aquaculture development :

National Level:

I. Planners or policy formulators i.e.
Ministries
a) Ministry of Agriculture, Animal Industry and Fisheries specifically the Directorate of Fisheries Resource, Directorate of Agricultural Extension and Operation Wealth Creation;
b) Ministry of Water and Environment,
c) Ministry of Trade, industries and cooperatives,
d) Ministry of Transport

Regulatory Agencies
a) National Agricultural Research Organisation
b) Uganda Revenue Authority
c) Uganda Investment Authority
d) National Environment Management Authority
Research and Academia

a) Makerere University,
b) Gulu University,
c) Fisheries Training Institute

II. Private Sector
   a) Feed industry (e.g. Ugachick)
   b) Fish Processors (e.g. Greenfields)
   c) Input suppliers: (e.g. Uganda Fishnet)
   d) Farmer Associations that deal in farmed fish trade

III. Security: The marines and police in enforcing laws and regulations

1.6. Current and future potential farmed aquatic species in Uganda: Aquaculture species prioritization based on technical feasibility, economic viability and social acceptance

Current farmed species

1) Tilapia: Nile tilapia (*Oreochromis niloticus*); blue spotted tilapia (*O. leucostictus*)*; hybrid of O. niloticus & O.leucostictus;* Singida tilapia (*O.esculentus*)*;* redbelly tilapia (*Coptodon zillii*)
2) Catfish: African sharptooth catfish (*Clarias gariepinus*)*;* Smooth head catfish (*Clarias liocephalus*)
3) Cyprinids (Carps):
   i) Indeginous (*Labeobarbus altianalis, Labeo victorionus,*);
   ii) Exotic: common carp, mirror carp and koi carp (*Cyprinus carpio*)*;* Grass carp (*Ctenopharyngodon idella*); bighead carp (*Hypophthalmichthys nobilis*)*;* silver carp (*H. molitrix*)
4) Characins*: Alestes baremoze*
5) Crustaceans: red swamp crayfish (*Procambarus clarkii*)
6) Ornamental fish: goldfish (*Carassius auratus*) and other non-specified ornamentals
7) Others: marbled lung fish (*Protopterus aethiopicus*);

Future potential aquaculture species

Finfish

1) Nile perch (*Lates niloticus*)
2) Bagrus docmak
3) Trout (*Oncorynchus mykiss* and *Salmo trutta*)

Shellfish

1) Snail farming
2) Crayfish farming
3) Freshwater prawn farming (*Macrobrachium rosenbergii*)

1.7. Importation and exportation activities for aquatic animal commodities

Importations of live animals

1) Fry/fingerlings of ornamental fish: angel fish (*Pterophyllum scalare*), Oranda gold fish (*Carassius auratus*), rainbow finfish (*Epalzeorhynchos frenatum*), tiger barb (*Puntigrus tetrazona*) and albino tiger barbs, and Pangas catfish (*Pangasius pangasius*).
2) Improved Nile tilapia strains (No records but existing in some farms); molecular approach is planned to prove existence.
3) Chinese carps: *; Ctenopharyngodon idella; Hypothalmicthys nobilis; H. molitrix*

Exportation of live animals

1) Nile tilapia: fry, fingerlings and juveniles
2) African sharptooth catfish: fry, fingerlings and juveniles
3) Mirror carp: fry and fingerlings

1.8. Strengths, weaknesses, opportunities and threats analysis (SWOT) analysis:

The SWOT analysis was performed as recommended by the FAO framework for a National Strategy for Aquatic Animal Health in preparation of development of a National Aquatic Biosecurity and Biosafety System for Uganda.

1.8.1 Strengths

- Management authorities are in place.
- Diagnostic services are available. A country-wide network of animal health diagnostic laboratories with reporting network including the NADDEC is in place[1].
- International disease reporting mechanisms exist through OIE Aquatic Animal Focal Points and for disease notification in general[1].
- Collaboration with OIE international reference laboratories exists through NADDEC and CoVAB[1].
- Able to undertake Level II and Level III laboratory diagnosis and a national referral system is in place. (NADDEC and CoVAB host the national reference laboratories and samples from ARDC, CoNAS are also taken/referred to CoVAB for diagnosis) [1].
- Surveillance for TiLV is already taking place with assistance from FAO[1].
- The syllabi for undergraduate degrees in fisheries, aquaculture and veterinary medicine at AMK include aquatic animal health[1].
- A licensing system is in place.
- Shared rivers/waterbodies (Nile Basin Initiative, Lake Victoria).
- Aquaculture associations are established e.g. Walimi Fish Farmer Cooperative Society

([1]Information supplied by MCS report)

1.8.2. Weaknesses

- Lack of complete political will. Uganda lacks a specific aquatic animal health policy.
- Uganda currently lacks a formal aquatic animal health strategy.

- Pollution, environmental degradation.
- Lack of competence and personnel for aquatic animal health.
- Insufficient diagnostic capacity for rapid investigation of disease outbreaks.
- Lack of structured disease surveillance.
- Lack of a prioritised list of aquatic diseases.
- Insufficient legal support for aquatic animal health. Responsibilities of the Competent Authority for aquatic animal health lie with both the DFR and the DAR within MAAIF but are inadequately supported by existing legislation.
- Risk factors and pathways are not well understood and poorly documented.
- Insufficient communication results in slow response to emergencies.
- Poor emergency preparedness.

1.8.3. Opportunities

- Demand for aquaculture and fishery products from international markets.
- Uganda has several good universities with twinning arrangements that can be expanded to cater for the aquatic animal health needs of the country.
- Uganda has veterinary laboratories at national and regional level that can be equipped to deal with aquatic diseases.
- Continuing professional development refresher courses are possible through the initiatives of the Veterinary Board.
- Funding is available from external donors.
- Regional networks exist and can be further developed.
- Aquatic animal health services are available and can be enhanced.

1.8.4. Threats

- Serious transboundary aquatic animal diseases (TAADs) are present in the region (KHV, EUS, TiLV, ISKNV, IHN).
- Mechanisms for the control of importations of live aquatic animals and any diseases or pathogens they may carry are weak.
- Ornamental fish imports represent a known but unquantified risk of introducing diseases.
- High demand for importation of genetically improved strains of tilapia.
- Aquaculture poses the risk of spreading diseases to wild fish populations, introducing aquatic invasive species (AIS) and genetic harms.
- The spread of diseases from aquaculture farms to wild fish populations is possible.
- Emergence of new diseases is likely as aquaculture increases in magnitude and intensity.
- High likelihood of an increase in adverse weather events associated with climate change impacting on aquatic animal health and biosecurity.

1.9. Conclusions:

- Aquaculture in Uganda is focused on freshwater species
- Many small/medium scale aquaculture activities (based on production of Nile tilapia).
- Several large commercial cage farm establishments producing Nile tilapia.

- Slow genetic advancement with local species is hampering investment in and expansion of the aquaculture sector.
- Urgent demand for importation of genetically improved tilapia strains, as future brood stock, requires rapid implementation of biosecurity plans.
- Safe import of live aquatic animals requires close cooperation between the CA and border controls.
- Well established export markets to EU for Nile Perch filets.
- Good potential for export of Nile tilapia filets through existing processing and export facilities.
- Good opportunities for foreign investment in hatchery and fish-feed development.
- Limited aquaculture zoning, but establishment of Aquaparks provides potential zoning benefits.
- Many national stakeholders involved at all levels (national, local, regional, investors etc.)
- Important community involvement to be promoted.
- Problems mostly related to market access and socio-economic assessments.
- Investments (public and private) should also focus on research and development and training.

General national aspirations:

- Maintain and expand existing aquaculture activities.
- Increase involvement of communities along shared water bodies to take responsibility for biosecurity in aquaculture.
- Facilitate access to inputs (technology, seeds, feeds, genetically improved seed-stocks, SPF seedstocks, etc.).
- Promote sustainable and environmentally friendly aquaculture.
- Improve extension and research as national actions related to aquatic animal diseases.

2. AQUATIC ANIMAL HEALTH AND AQUACULTURE BIOSECURITY ASSESSMENT

2.1. Objective

To assess the current capacity of Uganda to implement aquatic animal health and biosecurity programmes. Stakeholder consultations were aimed at collecting relevant information essential to support the development of improved biosecurity in aquaculture and sought opinions on the components and activities that could be included in the National Biosecurity and Biosafety System for Aquaculture in Uganda

2.2. Methodology

Following the inception meeting held 8th February 2021 at Entebbe, field interviews were conducted in nine agro-ecological zones (AEZs) of Uganda: i.e. Lake Albert crescent (Bulindi and Rwebitaba zones), Lake Victoria crescent, Westnile ecological zone, Northern ecological zone (Ngetta and Nabuin zones), Eastern Highlands, South Western Highlands and Western Rangelands. Physical and phone interviews were conducted using semi-structured questionaries and group discussions. Face-to face interviews were also conducted following Ministry of Health Standard Operating Procedures (SOPs) against COVID-19. Target groups included; (i) small scale commercial producers (<500 tonnes per year) and large commercial scale producers (>500 tonnes per year), (ii) Hatcheries/ seed producers, (iii) feed producers, and (iv) District staff (Fisheries and Veterinary Departments), custom officers, traders, researchers, and academia stakeholders. A questionnaire-based survey generated information on internal risks or biosecurity and biosafety measures of aquaculture establishments, and farmed fish trade within and beyond Uganda. Managers, farm owners, feed producers and traders, fisheries and veterinary officers were interviewed.

Key stakeholders that were interviewed included:

a) Seed producers (private and public); African catfish, tilapia, mirror carp;

b) Grow-out producers: subsistence farmers, small-scale commercial farmers and large scale commercial farmers;

c) District Extension Staff: Local level Fisheries and Veterinary Department;

d) Fish feed producers and traders (i.e. agents of imported feed);

e) Border staff;

f) Local leaders (LC III Chairpersons and Production Chairperson) in four districts.

2.3. Results

The results focus on elements identified in the framework for a National Strategy for Aquatic Animal Health of the FAO and provide a summary of information obtained during stakeholder interviews.

1) Policy, Legislation and Enforcement:

	Yes	No
Has a biosecurity Act been passed?		NO
Is there a pending aquaculture development plan?	YES	

2) Risk Analysis:

	Yes	No
Is risk analyses being conducted in regard to aquatic animal health or aquaculture biosecurity?	YES	
Are preliminary risk analyses being conducted for the management of invasive species?		NO
Are impact analyses being conducted in regard to the implementation of risk management measures?		NO

2) Pathogen List:

	Yes	No
Is a National Pathogen List in effect?		NO

3) Border Inspection and Quarantine:

	Yes	No
Is there is an aquatic animal health quarantine programme in effect?		NO
Are there pre-border testing requirements for aquatic animals?		NO
Are permits are required for domestic movements of aquatic animals?	YES	
Is there a history of illegal imports that have led to the introduction of invasive species?	YES	
Is ballast water a concern with regard to the introduction of invasive species?	YES	

4) Disease Diagnostics:

	Yes	No
Do diagnostic laboratories exist in Uganda for the detection of aquatic animal diseases?	YES	
Are there are existing laboratories for microbial testing in food safety?	YES	

5) Farm-level Biosecurity and Health Management:

	Yes	No
Are farm-level biosecurity and health management in effect at aquaculture sites?		NO
Are there aquatic animal health professionals that practice in Uganda?	YES	

6) Use of Veterinary Drugs and Avoidance of Antimicrobial Resistance (AMR):

	Yes	No
Are veterinary drugs currently used in aquaculture in Uganda?	YES	

7) Surveillance, Monitoring and Reporting:

	Yes	No
Are active or passive surveillance activities being conducted for the detection of aquatic animal pathogens?	YES	
Are surveillance activities in the form of surveys being conducted for conservation purposes to manage invasive species?	YES	
Is Uganda an OIE member?	YES	

8) Communication and Information Systems:

	Yes	No
Are there youth programmes with schools and education for communities regarding ecosystem health, biodiversity and conservation? (Uganda Wildlife Authority, Makerere University, NARO and Fisheries Training Institute)	YES	

9) Zoning and Compartmentalization:

	Yes	No
Are zoning and compartmentalization programmes in effect in Uganda.		NO

10) Emergency Preparedness and Contingency Planning:

	Yes	No
Is emergency preparedness a priority for aquatic animal diseases?	YES	
Have contingency plans been developed for the introduction and spread of foreign aquatic animal diseases?		NO

11) Research and Development:

	Yes	No
Are there any conservation projects in development in Uganda?	YES	
Do any projects focus on aquatic animal health or aquaculture biosecurity?	YES	

12) Institutional Structure (Including Infrastructure):

	Yes	No
Are institutional structures in place for aquatic animal health or aquaculture biosecurity?		NO

13) Human Resources and Institutional Capacity:

	Yes	No
Has a Competent Authority for aquatic animal health and aquaculture biosecurity been identified?	YES	

14) Regional and International Cooperation:

	Yes	No
Are there any collaborative efforts regarding aquatic animal health and aquaculture biosecurity within the region or internationally?	YES	

15) Ecosystem Health:

	Yes	No
Are invasive species are a large concern in Uganda?	YES	
Are there conservation efforts currently in effect?	YES	
Are there issues arising due to possible climate change?	YES	
Is there a decline in the numbers of wild aquatic animals?	YES	

3. References

FAO. 2018. Development of a Regional Aquatic Biosecurity Strategy for the Southern African Development Community (SADC) FAO Fisheries and Aquaculture Circular No. C1149. Rome. 344p.

FAO. 2019 Preventing and managing aquatic animal disease risks in aquaculture through a progressive management pathway. Committee on Fisheries Sub-committee on Aquaculture. Tenth Session Trondheim, Norway, 23–27 August 2019 COFI:AQ/X/2019/5 http://www.fao.org/3/na265en/na265en.pdf

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APPENDIX II

BACKGROUND TO IMPLEMENTING A FARM-LEVEL BIOSECURITY PLAN SPECIFIC TO SEED-STOCK INTRODUCTIONS

Prepared by Dr D. Huchzermeyer (international consultant) 24 May 2021

1. Introduction

Biosecurity practices reflect the procedures that limit the impact of microbial pathogens including prevention, control and in some cases eradication of disease. A biosecurity plan provides a framework for disease management from farm to national level. When implemented through documented standard operating procedures this allows achievement of predicted outcomes. The implementation of biosecurity plans at farm level provides the means of managing the risks posed by unwanted microbial pathogens and mitigating the adverse effects they may have on health and productivity of aquaculture animals and the ability to trade with live aquatic animals and their products. Biosecurity planning is based on risk management and requires knowledge and understanding of: the species being cultured, the pathogens relevant to culture of this species and the applicable culture systems, the contamination pathways by which pathogens can enter an aquaculture system, the sources of healthy seed stock, the maintenance of good husbandry, prudent and responsible use of antimicrobials, and responsibility and respect for food safety and the environment.

2. The biosecurity plan and standard operating procedures

A biosecurity plan provides the process by which management procedures can be evaluated using hazard analysis and critical control point (HACCP) methodologies. Standard operating procedures (SOPs) address identification and prioritization of hazards posed by microbial pathogens (what can go wrong), assess the risk posed by microbial pathogens (how likely is it to go wrong), define the pathways by which microbial pathogens gain entry to a population of aquatic animals and the relevant control measures (critical control point evaluation and remediation). This includes disease surveillance and monitoring of existing health problems, contingency actions to mitigate the impact of microbial diseases and eradication measures where the possibility exists of a disease-free status being reinstated.

At the farm level, biosecurity SOPs reflect all farm activities relevant to the health of the aquatic animals and include for example: visitor protocols; disinfection procedures; disposal procedures for mortalities; quarantine and isolation measures; and how and where disease-free seed-stocks will be sourced or produced. Staff working on the farm needs to be regularly trained in the understanding and application of these SOPs.

Good biosecurity requires access to farms being restricted. Preventative measures include maintaining a record of visitors, provision of footbaths, hand washing stations, dedicated changing areas, decontamination areas and provision of protective clothing. The provision for quarantine and isolation of newly arrived aquatic animal introductions reflects a further risk mitigation. In the event of an emergency, a rapid response plan is required and a relevant SOP provides guidance on who to contact,

which samples to collect, data that needs to be collected, quarantine measures that should be instituted including movement restriction on of live animals, the reporting to a Competent Authority (CA) if a disease outbreak is associated with a listed disease, and when to notify neighbouring farms. Methods of removal, transport and disposal of mortalities are similarly described in SOPs. The SOPs of a biosecurity plan are continuously updated and improved as knowledge and experience is gained.

3. Sourcing healthy seed-stock

Health guarantees may apply to specified microbial pathogens that are the known causative agents of diseases relevant to an aquatic animal species. Surveillance testing or screening for these pathogens provides the data on which such guarantees of freedom from specific pathogens may be based, providing so-called specific-pathogen-free (SPF) animals. In countries where national surveillance data on diseases of aquatic animals is not available or where specific pathogens are known to occur, disease guarantees may be given at compartment level. A compartment may be a single farm where management practices reflect a suitable level of biosecurity and where closed brood-stock populations of aquatic animals are supplied by secure or pathogen-free water sources and are subject to repeated disease surveillance at levels that provide a high level of statistical confidence.

Specific-pathogen-free refers to aquatic animals that originate from parent populations held in a compartment (a farm on a secure water source) that is under the control of a Competent Authority and that complies strictly with mandated biosecurity measures and where, through disease surveillance at a statistically relevant level (according to the standards of the OIE), it can be shown that the specific pathogens do not occur. The strict surveillance testing required to produce SPF seed-stock is a costly activity, and hatcheries producing SPF seed-stocks need to recoup this through the higher price at which SPF seed-stocks are sold. For this reason, a second tier of hatchery that is unable to fully comply with the biosecurity measures (for instance surveillance testing at statistically significant level) required by a compartment producing SPF seed-stock may use brood stock that originates from SPF seed stock to produce high health (HH) seed-stock at a lower price. This provides a measure of risk reduction but the same guarantees that pertain to SPF seed-stock no longer apply.

Biosecurity plans may be applied to zones (geographically defined contiguous water systems with a distinct health status with respect to certain pathogens or diseases) or to compartments (farms where disease status is defined by management and biosecurity practices). The disease status of a zone or compartment may be (i) unknown; (ii) infected (if a pathogen has been shown to occur through surveillance or; (iii) disease-free where surveillance has demonstrated absence of a pathogen. It is important to note that for international trade, an unknown status is equivalent to an infected status.

A biosecurity plan provides an auditable process from farm to national level that allows third party endorsement by the CA, an essential requirement by many countries when live aquatic animals or their gametes are traded internationally. Where the provision of disease-status guarantees for SPS seed-stocks is required for international trade, this becomes the obligation of the responsible government CA that draws its mandate from a country's relevant policy and legislation.

4. The aquatic animal health certificate (AAHC)

An aquatic animal health certificate (AAHC) reflects the guarantees of disease-status pertaining to the pathogens or diseases listed, and the animals identified, in the document and describes the procedures that have been followed. Guarantees based on some form of quarantine combined with visual inspection for clinical signs of illness and mortality, as is still practice for much of the international trade in ornamental fish, are relatively ineffective and have been repeatedly shown to carry a high risk of pathogen transfer. Greater confidence is achieved where guarantees are based on strict biosecurity, surveillance and testing as has been successfully applied in the salmonid and shrimp industries. These guarantees reflect the disease-status of the brood-stock population from which the aquatic animals described in the AAHC are derived as well as the biosecurity measures that have been applied to this population. Depending on the species cultured, the parent populations may be either genetically improved farmed animals or wild animals that have been brought into culture systems. Where national surveillance activities demonstrate absence of a pathogen from a country or zone, an AAHC may be issued without reference to compartment- or farm-level testing provided the brood-stock population complies with the required biosecurity measures. However, this scenario is seldom applied, and most importing countries insist that guarantees must be provided at compartment level through surveillance testing.

An AAHC may be issued at multiple levels, from private sector to government, but carries most weight when it has been subject to third party endorsement by a Competent Authority (CA) as is required for the international movement of live aquatic animals or their gametes.

5. Quarantine

Quarantine is the procedure by which a defined population of aquatic animals is held in a facility from which neither the aquatic animals nor any pathogens they may harbour can escape. Quarantine provides an important critical control point that allows for a period during which clinical disease, brought about by the stress of translocation, is allowed to gain expression before such animals are introduced into existing populations of farmed aquatic animals. As aquatic pathogens transfer readily through water, the effective disinfection of effluent water leaving the quarantine facility is important. Numerous microbial pathogens circulate in both wild and farmed aquatic animal populations often without expression of clinical disease or mortality (subclinical carriers). This limits the value of health certificates based purely on quarantine and on visual inspection for clinical signs of disease and mortality. However, when combined with high-level government-endorsed certification, quarantine prior to introduction of newly acquired aquatic animals provides an additional tier of safety.

6. Tracing

The ability to trace seed-stock and live aquatic animal movements is essential to early-warning systems and to implementation of control and mitigation measures where disease incursions may have occurred. Traceability is an integral element in the production of healthy seed-stocks.

7. Biosecurity risk specific to tilapia farming

The disease risks posed to the sustainability of tilapia farming in Africa can be grouped into two broad categories that both need to be addressed through risk analysis and biosecurity planning.

1. The first category of risks is those posed by the development of opportunistic bacterial infection in fish that are stressed by a multitude of husbandry, environmental and nutritional factors. Examples of this are the physical trauma caused to fish by bunching during feeding, and exposure to chronically low or periodically low dissolved oxygen levels associated with inappropriate feeding practices, particularly when combined with elevated ammonia levels and organically enriched environments. By exposing fish with weakened immune systems to opportunistic bacterial infections, selection pressures are exerted on bacterial populations associated with the culture of the fish that favour development of more virulent strains of bacteria (Stewart, Logsdon, Kelly, 2005). The relative impact of certain strains of bacteria therefore increases over time and has the potential to cripple emerging aquaculture industries. This has been the case for a number of different Streptococcal bacteria including *Streptococcus agalactiae* and *Lactococcus garvieae*. The underlying causes of outbreaks of bacterial infections should always be investigated promptly, and reliance on antimicrobials should be avoided. Any live fish movements onto the farm also pose the risk of introducing virulent strains of these and other bacteria with the purchased fish. This risk needs to be addressed through implementation of an effective biosecurity plan.

2. The second category of risk is that posed by serious virus diseases that have been described from farmed Nile tilapia and that can be introduced with asymptomatic live fish. Two viruses affecting the culture of tilapia, Tilapia lake virus (TiLV) and infectious spleen and kidney necrosis virus (ISKNV), have recently emerged as a biosecurity threat to the tilapia industry in Africa. Purchase of fry and fingerlings from outside hatcheries holds potential risk of introducing these pathogens. It is difficult to quantify this risk but, even if low, the consequences for future production of the farm can be serious.

Specific-pathogen-free guarantees provided by reputable suppliers of high quality seed-stocks and reflected in a government (CA)-endorsed AAHC provide the foundation for sustainable growth and investment in aquaculture industries and should be applied to the farming of tilapia in much the same way that it has become an indispensable part of salmonid and shrimp farming.

8. Standard operating procedure for reducing risk of transfer of bacterial pathogens with seed-stock

Ova disinfection provides the method by which the transfer of pathogens carried by parent fish to their fry is reduced and in some cases prevented. Fish purchased as live eyed-ova (eggs) pose the lowest risk of disease transfer when accompanied by guarantees that the ova have been disinfected. Only few bacterial pathogens and several viruses are known to transfer transovarially. For such pathogens, disinfection of the ova is ineffective. However, as most bacterial pathogens are associated with the outside of the egg and the water being moved with the eggs, disinfection of eggs provides a practical and inexpensive risk-reduction method that should be standard operating procedure for commercial tilapia hatcheries that harvest ova from hen fish and incubate these in hatchery jars.

The ova should be treated with a buffered iodophore disinfectant prior to dispatch from the seller's premises. As the ova may start to hatch during shipping, the disinfection process cannot be repeated at destination. Alternatively, the following protocol can be insisted on where transport time is too long to prevent eggs from hatching during transport or when fry or fingerlings are purchased:

- Eggs are harvested from female fish.
- Eggs are disinfected with buffered iodophore at strength of 50 ppm for 10 minutes.
- Eggs are removed from the disinfectant and are quarantined in a designated UV-sterilized recirculated water system containing no other fish or eggs until the eggs hatch.
- Hatched fry are kept in the same isolated water system until ready for shipment.
- Once fry are sufficiently robust, they are packaged for export into bags containing only UV-sterilized water.

9. Standard operating procedure for egg disinfection

- Following fertilization, eggs must have water hardened before they can be safely disinfected. Most eggs collected from mouth brooding tilapia will have passed this stage already.
- Prepare a disinfectant solution containing 50 ppm available iodine with a pH of between 6 and 8. As close to pH 7 as possible.
- Eggs must be placed in approximately 10 times their own volume of disinfectant. The disinfectant bath should be lightly aerated through use of a diffuser.
- Eggs must be treated for 10 minutes with frequent agitation to allow contact between the surface of all the eggs and the disinfectant*.
- At the recommended strength, the disinfectant solution should appear deep yellow or amber in colour and fade to a pale yellow as iodine content is exhausted. If the colour of the disinfectant fades to a pale yellow during the treatment, a fresh solution must be made up and the disinfection procedure repeated.
- Following the 10 minute disinfection, the eggs should be rinsed in clean uncontaminated water before being placed in hatching jars.

(*Always do a trial disinfection of a small batch of eggs and monitor the result before disinfecting large numbers of eggs.)

10. Standard operating procedure for producing specific-pathogen-free tilapia seed-stock

Guarantees guarding against the introduction of unwanted diseases, in the form of Government-endorsed AAHCs, are an essential element of international trade in aquatic animals. Where a country has insufficient surveillance data to prove absence of a disease, the concept of zoning and compartmentalization allows a country's competent authority (CA) to provide internationally

accepted disease-status guarantees. In contrast to disease-free zones which are defined by geographical boundaries, a disease-free compartment is defined by management and biosecurity practices and can be applied to an individual farm or epidemiological unit.

For disease-freedom from specific viral diseases (according to Uganda's Prioritized National Pathogen List), the international standards for preventing transboundary transfer of pathogens are laid down by the World Organization for Animal Health (OIE). The CA of the importing country, in this case Uganda, must perform an import risk assessment based on the guarantees that can be provided by the CA of the exporting country. This often requires a negotiation process whereby the CA of the importing country states the disease-freedom guarantees that are required for the import, and the CA of the exporting country states how the exporting country can comply with, or meet, these requirements. To comply with WTO standards, the scientific processes provided by the standards of the OIE are applied.

Providing guarantees of freedom from disease at the level of a compartment requires hatcheries to maintain a closed population of parent fish on a protected water source, adherence to strict biosecurity measures, strategic sampling for screening of prioritized diseases at a statistically relevant confidence level at six-monthly interval, contingency planning that may necessitate eradication of known infected stock, and identification and remediation of critical control points to eliminate or minimize the risk of reintroducing disease. After a two-year period of surveillance with negative results, a Government-endorsed certificate of veterinary inspection can provide the guarantees required for sale and export of SPF fish or ova.

Biosecurity measures and testing procedures are developed in the light of current knowledge of prioritized and listed diseases and are based on requirements laid down by the competent authorities of the importing country for certification of a disease-free status. The process is guided by the standards of the OIE. Where trade restrictions apply to diseases that are not listed by the OIE, but where the risk of introduction is perceived to be high by the importing country, the same restrictions as those applicable to OIE-listed diseases may apply provided that the risks are scientifically justified. In the case of Uganda, this scenario applies to the virus diseases, TiLV and ISKNV, neither of which have yet been listed as pathogens of tilapia by the OIE although ISKNV, an iridovirus, has been listed under Red Sea Bream iridoviral disease affecting a range of marine fish species.

Official registration as an export hatchery requires compliance with:

10.1. Minimum biosecurity measures

These are usually mandated by the official CA, are regularly audited, and include:

- The hatchery must be based on a protected water supply, preferably pumped borehole water.
- No live fish may be introduced onto the farm.
- Live ova may only be introduced onto the farm from a site with an equivalent or greater disease-free status.
- The farm must be fenced with access control.

- Access by aquatic birds and predators must be precluded.
- Fertilized eggs must be disinfected with iodophore before they are moved into the hatchery.
- The health status of the fish must be closely monitored. Any untoward problems must be brought to the attention and investigated by a designated private fish veterinarian and a state veterinarian or aquatic animal health professional of the CA.
- All diagnostic and disease-screening data must be maintained.
- Stock registers tracing fish movements must be maintained.
- A register recording all mortalities must be maintained.
- A register of all treatments, including vaccinations, must be maintained.
- All eyed ova must be disinfected with iodophore immediately prior to packing for export.
- Where fry need to be sold, the eyed ova must be disinfected with iodophore immediately prior to placing the ova into the hatching jars of a hatchery based on a designated UV sterilized water system.
- In the case of tilapia fry, a designated UV sterilized water system must be maintained for hatching the ova.
- In the case of tilapia fry, a designated UV sterilized nursery water system needs to be maintained for raising fry until they are ready for shipment.
- The owner of the hatchery agrees to destruction of any population of fish held in the facility that is found to be infected with any one of the diseases for which the hatchery seeks to provide freedom-from-disease guarantees.

10.2. Farm inspections

To maintain the registration status as an export facility, a designated private fish veterinarian and a responsible state veterinarian perform a minimum of two farm inspections per year, to confirm compliance with the mandated minimum biosecurity measures, subject to which registration of the hatchery can be renewed annually.

10.3. Disease screening and testing

Tissue samples are collected from the parent fish population (brood stock) for screening of the relevant prioritized listed diseases (e.g. TiLV and ISKNV) twice per year at approximately 6 monthly intervals. Some countries also include betanoda virus in the screening of their brood stock. Disease screening is performed at the statistical 95% confidence level for detecting a disease with 2% prevalence in a population of fish exceeding 1000 fish. For practical purposes, this means sampling a minimum of 150 fish. This figure represents the minimum number of samples to be considered representative for the purpose of health certification according to international standards set by the OIE for establishing a disease-free status. As long as the farm wishes to maintain a disease-free status as an export facility, the testing procedure and intervals may not be interrupted. After a 24 month period of negative testing (4 negative tests at 6 monthly intervals), international disease guarantee

requirements are met provided the farm has maintained a valid export facility registration with the CA of the country.

11. References

Stewart, A.D., Logsdon, Jr. J.M., Kelly, S.E. 2005. An empirical study of the evolution of virulence under both horizontal and vertical transmission. *Evolution,* 59(4): 730–739.

See other references in main report on NBBSA

APPENDIX III

PATHOGEN RISK TABLES

Prepared by Dr D. Huchzermeyer (International consultant) and Dr J. Walakira (Uganda consultant)

Likelihood of occurrence

Pathogen	Occurrence in Uganda	Pathogenicity	Risk of disease occurrence	Critical control point evaluation – pathway of spread	Risk remediation
Tilapia lake virus	possibly	High	High	Translocation of infected seed stock	Egg disinfection. Hatchery certification for SPF fry
Infectious spleen and kidney necrosis virus	unknown	High	High	Translocation of infected seed stock. Import of ornamental fish	Egg disinfection. Hatchery certification for SPF fry
Betanodavirus	unknown	Unknown	Unknown	Translocation of infected seed stock	Egg disinfection. Hatchery certification for SPF fry
Streptococcus agalactieae	probable	High	High	Translocation of infected seed stock	Egg disinfection. Vaccination
Lactococcus garvieae	probable	High	High	Translocation of infected seed stock	Egg disinfection Vaccination
Epizootic ulcerative syndrome	No reports of occurrence	High except in Nile tilapia	High except in Nile tilapia	Translocation of seed stock in water contaminated with spore of A. invadans	Strengthen border controls. Avoid purchasing from hatcheries on infected waters

Pathogen	Occurrence in Uganda	Pathogenicity	Risk of disease occurrence	Critical control point evaluation – pathway of spread	Risk remediation
Francisella	present	High	?	Translocation of infected seed stock	Egg disinfection
Edwardsiella ictaluri	present	?	?	Translocation of infected seed stock	Egg disinfection

Mode of transmission, diagnostic testing and consequence of a positive diagnosis

Disease	Vertical transmission (via gametes)	Diagnostic testing procedure	Consequence in case of a positive diagnosis	Testing interval leading to third party recognition	Risk of introduction under standard operating procedures	Diagnostic tests available in Uganda
Tilapia lake virus	Unkown	PCR		6 months for minimum 24 month period	High	
Infectious spleen and kidney necrosis virus	Unknown	PCR and histology		6 months for minimum 24 month period	High	
Betanoda virus	Unknown	PCR and histology		6 months for minimum 24 month period	Low	
S. agalactieae	No	Culture and isolation		6 months for minimum 24 month period	High	
L. garvieae	No	Culture and isolation		6 months for minimum 24 month period	High	
Epizootic ulcerative syndrome	No	PCR, histology and culture		6 months for minimum 24 month period	High	

Disease	Vertical transmission (via gametes)	Diagnostic testing procedure	Consequence in case of a positive diagnosis	Testing interval leading to third party recognition	Risk of introduction under standard operating procedures	Diagnostic tests available in Uganda
Francisella	No	PCR, histology and culture		6 months for minimum 24 month period	Low	
E. ictaluri	No	PCR and culture		6 months for minimum 24 month period	?	