National Aquaculture Strategy for Rwanda 2023 – 2035

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Acronyms used

AfDB ..... African Development Bank

ARES..... Académie Belge de recherche et d'enseignement supérieur (EU funded project)

bn ..... billion

c.a..... *circa (about)*

CAPEX ..... capital expenditure

CAVM ..... College of Animal Sciences and Veterinary Medicine

COMESA..... Common Market for Eastern and Southern Africa

COP..... cost of production

Dept. ..... Department

DRC..... Democratic Republic of Congo (also DR Congo)

e.g. ..... for instance, or for example

EAC ..... Eastern Africa Community

Enabel ..... Belgian development agency

ESIA ..... environmental and social impact assessment

EU ..... European Union

EUS ..... epizootic ulcerative syndrome

FAO ..... Food and Agriculture Organisation (United Nations)

FDA ..... Food and Drug Agency

FERG ..... Food Disease Burden Epidemiology Reference Group

FSMS ..... food safety management system

FTE..... full-time equivalent

GDP..... gross domestic product

GGCRS ..... Rwanda Green Growth and Climate Resilience Strategy

GIFT ..... genetically improved farmed tilapia

GIS ..... geographical information system

GoR ..... Government of Rwanda

Ha..... hectare (10,000 m^2)

HVLD..... high volume low density (fish cages)

ISKNV..... infectious spleen and kidney necrosis virus

IFC..... International Finance Corporation

ITC..... International Trade Centre, joint agency of the World Trade Organization & the United Nations

KPI..... key performance indicator

LVHD..... low volume high density (fish cages)

MINAGRI..... Ministry of Agriculture and Animal Resources

MINECOFIN ..... Ministry of Finance and Economic Planning

MINICOM ..... Ministry of Trade

MINIJUST..... Ministry of Justice

NAEB..... National Agricultural Export Development Board
NAP ..... National Agricultural Policy (2018)
NAPA..... National Adaptation Programme of Action (2006)
NASR ..... National Aquaculture Strategy for Rwanda
NCST..... National Council for Science and Technology
nei..... not elsewhere included
NIRDA ..... National Industrial Research and Development Agency
NISR..... National Institute of Statistics of Rwanda.
NSDI..... National Spatial Data Infrastructure (Hub)
NSTI ..... National Strategy for Transformation 2017 – 2024
OIE ..... World Organisation for Animal Health (French acronym OIE used internationally)
pa ..... by year (*per annum*)
PAIGELAC ..... *Projet d'Appui à l'Aménagement Intégré et à la Gestion des Lacs Intérieurs*
PCC..... per capita consumption
pers. comm..... personal communication
PSTA4..... Strategic Plan for Agriculture Transformation, 2018 – 2024
RAB ..... Rwanda Agriculture and Animal Resources Development Board
RALIS..... Rwanda Agriculture and Livestock Inspection and Certification Services
RAS ..... recirculating aquaculture systems
RBC..... Rwanda Biomedical Centre
REMA..... Rwanda Environmental Management Authority
RFDA..... Rwanda Food and Drugs Authority
RICA..... Rwanda Inspectorate, Competition and Consumer Protection Authority
RLMUA..... Rwanda Land Management and Use Authority
RRA..... Rwandan Revenue Authority
RSB ..... Rwanda Standards Board
RWB ..... Rwanda Water Resource Board
RWF ..... Rwanda Franc
RW-FDA..... see RFDA
SDG..... Sustainable Development Goals
SWOT..... Strengths, Weaknesses, Opportunities and Threats
t ..... Tonnes (1 000 kg)
Tbd or tbd..... to be determined
TiLV ..... Tilapia lake virus
UR ..... University of Rwanda
USAID ..... US Agency for International Development
USD..... United States Dollar (approx. USD 1 = RWF 1,065 as of January 2023)
WFE ..... whole fish equivalent
WHO..... World Health Organisation
yr ..... year

1. Background and Rationale

1.1 Background

Through its **National Strategy for Transformation 2017-2024**, Rwanda intends to stimulate decades of accelerated transformation and sustained economic growth. This agenda comes at a unique period when the country is transitioning from the national Vision 2020 to Vision 2050. 2035 – which is the end point of this National Aquaculture Strategy for Rwanda, represents a mid-point in the implementation of Vision 2050, by which time the country intends to achieve high standards of living, high-quality livelihoods for its people and transformation from a low-income to an upper middle-income economy, with a larger, wealthier population.

Agriculture is a key pillar of Rwanda's plan to drive economic growth, to contribute to poverty eradication, and to contribute to food security. The National Strategy for Transformation 2017-2024 (NST1) therefore prioritizes agriculture and sets out interventions to modernize and increase the productivity of the agriculture and livestock sectors. To accelerate agricultural transformation, the Ministry of Agriculture and Animal Resources (MINAGRI) devised a **Strategic Plan for Agriculture Transformation, 2018-2024 (PSTA4)** under the general framework of NST1. PSTA4 sets out the priority areas that provide strategic direction for achieving transformation of Rwandan agriculture from a subsistence sector to a value creating sector that contributes more to the national economy.

PSTA4 recognizes that aquaculture – the farming of fish and other aquatic species - has the potential to make a significant contribution to the agriculture sector. With aquaculture producing only around 4,900 t in 2021 (RAB data), MINAGRI aspires to spur aquaculture production through promoting sustainable growth, especially over the long term. Rwanda possesses the fundamentals necessary to build a thriving aquaculture industry – there are abundant water resources, and the climate is considered generally favourable for aquaculture – although there are undoubted challenges that will need to be addressed through this strategy.

In order to **catalyse the growth of aquaculture in Rwanda, there is need for proper planning,** without which the industry may not achieve its potential. Planning will guide the evolution of the sector by exploiting opportunities, minimising risks, providing incentives and safeguards, attracting investment, and boosting development. Moreover, it will help to ensure the long-term economic, environmental and social sustainability of the sector, and its ultimate contribution to economic growth and poverty alleviation. As a first step towards planning for aquaculture, MINAGRI/RAB has prepared this medium term **(2023 – 2035) sector strategy** to guide the ambition of moving towards a thriving Rwandan aquaculture industry.

The development of this **National Aquaculture Strategy for Rwanda (NASR)** has been supported by **Gatsby Africa** and prepared with the assistance of **Poseidon Aquatic Resources Management Ltd**.

1.2 Current status and potential for sustainable aquaculture development in Rwanda

1.2.1 Current status

Overview

Although small-scale pond aquaculture has existed in Rwanda for over seventy years, it is only really in recent times that more intensive aquaculture - mainly in the lakes – has emerged as a serious alternative source of fish to wild fisheries and imports in Rwanda. This, largely private sector driven expansion, has provided the confidence for the Government to promote aquaculture as an important means to increase per capita consumption of fish and contribute to their *Vision 2050* of a high-income country fed through '*professional farmers and commercialised value chains'*.

Current policy over 2017 – 2024 is largely production-driven, expecting total fish production to reach an ambitious 112,000 t by 2023 / 2024, of which aquaculture might have been expected to contribute around 60,000 t. Although aquaculture production has risen sharply over the last decade (from around 500 t in 2012 to an estimated 4,900 t[1] in 2021) progress has not been fast as anticipated.

There are numerous reasons for this, among them three that comprise the major hurdles for the growth of aquaculture. Firstly, is the limited skills and capability in Rwanda for science-based, productive, and sustainable aquaculture. Secondly is Rwanda's high elevation and relatively cool temperatures that are sub-optimal for the production of the sub-Saharan African staple aquaculture species, the Nile tilapia. Thirdly is the shortage of high-quality fingerlings and difficulties in obtaining quality aquafeeds at competitive prices.

These three key issues combine to make commercially viable aquaculture a challenge in Rwanda. The purpose of this Strategy is therefore to provide a long-term approach to overcoming these barriers and allowing a steady expansion and diversification of aquaculture in Rwanda that is sustainable in both environmental and financial terms.

Current character of the aquaculture sector in Rwanda

Governance: with an annual production of less than 5,000 t per annum, aquaculture is currently a fairly minor part of Rwanda's overall agriculture and livestock output. However, aquaculture is recognised to have considerable growth potential and there is a strong appetite for the public sector to increase its support to its sustainable development and contribution to national food security.

Currently considered as a 'program' under animal resources within RAB, it has a small technical team whose mandate combines both capture fisheries and aquaculture across a broad range of technical and geographic remits. This unit has made good recent progress in setting up aquaculture licensing and management systems but needs to be considerably strengthened in order to support the anticipated growth in production, which will be largely driven by the dynamic private sector. In particular forward-looking legislation and regulations need to be put in place to ensure that this growth is both economically and environmentally sustainable. Government planning in areas such as spatial planning (to encourage aquaculture in areas where conditions are favourable and works in harmony with other water and land users) as well as RAB's operator licensing and permitting systems all need to be upgraded and 'future-proofed'.

[1] c.a. 85% from pond farms, 10% from small-scale cages and 5% from large-scale cages

Topography, water resources and climate: Rwanda is a high elevation, equatorial country with an altitude that ranges from approximately 900 to 4,700 meters above sea level, with most of the country at between 1,300 and 2,000 meters. The terrain consists of hills and valleys (*marais*), with earthen ponds usually at the margin between valley and hill. There are 24 inland lakes with a total surface area of 128,000 hectares, but due to their high altitude and shallow nature, not all are suitable for aquaculture. Rwanda has three major deep-water lakes, Lake Kivu, Lake Burera and Lake Ruhondo. The remaining lakes are relatively shallow (see table below).

Table 1: Summary of key characteristics of major lakes in Rwanda

Lake	Area (Rwanda jurisdiction)	Height above sea level (m)	Average depth (m)	Average temperature (°C)	Suitability for aquaculture
Lake Kivu	2,700 km² (1,330 km² in Rwanda)	1,460	220.0	24 °C (23 – 26)	Deep and suitable but risk of out-gassing (CH_4 & CO_2)
Lake Burera	55 km²	1,860	179.0	10-25 °C	Suitable but cool water
Lake Ruhondo	26.6 km²	1,752	68.0	10-24 °C	Suitable but cool water
Lake Muhazi	33 km²	1,443	10.0	12 – 27 °C	Suitable with medium depth
Lake Ihema	100 km²	1,292	5.0	16-26 °C	Shallow
Lake Rweru	133 km² (47 km² in Rwanda)	1,325	2.1	14-24 °C	Shallow
Lake Mugesera	40 km²	1,300	3.5	25 °C	Shallow
Lake Cohoha South	74 km² (19 km² in Rwanda)	1,348	5.2	21 °C	Shallow

Rwanda has over 15 dams (hydropower and irrigation) with a total surface area of 63.6 hectares (ha.). There are a number of districts that have dams more than 3 m deep, valley tanks, and water pools associated with the rivers (*ibidendezi*) that are more than 5 metres deep. These all offer opportunities for cage farming. Rwanda has an extensive river system, and the major rivers include the Mwogo, Mukungwa, Rugara, Nyabarongo, and Sebeya.

Precipitation ranges from 1,000 to 1,300 mm/yr depending on location. There is a dry season from June to August (with July as the driest month) and two rainy seasons from March to May (rainiest months are usually April and May) and from September to November. Rainfall affects water supply to pond farms, with lower water availability in June, July and August. Rainfall varies geographically with higher levels in the west and lower levels in the east. However, water flows from the hills into the water networks in the valleys are heavily silted, making some rivers and lakes unsuitable for aquaculture.

Production: Rwanda has two main aquaculture systems, the farming of fish in pens (or cages) in lakes and the farming of fish in earthen ponds in low-lying wetland areas. MINAGRI estimates that aquaculture production stood at 1,600 t in 2016 (almost all from earthen ponds) and approximately 4,900 t in 2021 by which time cage culture accounted for 55% of production and ponds 45%. These two systems are very different in terms of land / business ownership, site selection, stock husbandry and intensity, and these are briefly described below:

- Cage-rearing of fish in water bodies. Fish are stocked into floating cages (or pens) located either in large public water bodies (e.g., lakes) and less frequently in privately owned reservoirs. Most cage rearing of fish is intensive or semi-intensive, using both low-volume, high density and high-volume, low-density production models. Given the need for large numbers of fingerlings and artificial feed, pen farming tends to be practised by wealthier individuals or by medium to large

companies. It is anticipated that cage farming will dominate aquaculture production in Rwanda, with large companies (i.e., companies producing over 2,000 t per annum) the mainstay of the sector.

- Farming of fish and / or aquatic animals in earthen ponds. The main pond farming areas are concentrated in the Eastern Province (due to the presence of irrigation dams for rice growing), followed by the Southern province (where the water temperatures are higher). There are a wide variety of pond and farm sizes in Rwanda, mostly rearing Nile tilapia, although the African catfish is growing in popularity. These vary from single-owner extensive farms which depend upon fertilisation of ponds to generate natural feed for the fish, to more intensive systems where different levels of supplementary feeds are added, often operated by small-holder groups or cooperatives. Although simple, these different systems require considerable skill and experience to operate profitably. In the past they have been subsidised through low-cost inputs. which has limited their long-term commercial sustainability. The development of production models more appropriate to Rwanda's particular conditions, and more importantly the upskilling of farmers and new entrants, is key to their future development. This Strategy considers that although total pond production by 2035 might only reach around 11,000 t (i.e., *c*. 13% of the total target of 80,620 t) it will be socio-economically important, as input costs are lower and small extensive ponds are accessible to a wide variety of social units, including the youth and women.

Historically the government has played a major role in aquaculture, directly supporting the sector through the provision of fingerlings from government farms and by supporting feed production. As with other rapidly developing countries transitioning to an upper middle-income economy, government support will need to withdraw from such direct interventions, leaving this to the private sector, and focus on providing an enabling environment for sustainable development.

As earlier mentioned, there are a number of constraints to aquaculture production in Rwanda. Despite this, the necessary technical and business skills to drive the aquaculture sector's growth are beginning to emerge, particularly in cage aquaculture. Further, there are early investments in hatcheries and in local feed mills. However, at present these investments are fragmented and exist within individual farms. They will need to evolve in the direction of consolidation in order to serve the sector as a whole.

Rwanda is – like much of Africa – currently dependent upon the Nile tilapia. This is unlikely to change, although more cold-water tolerant strains may be desirable in the long run, together with production systems that maximise growth performance. However, there are opportunities to farm other species such as African catfish in ponds and tanks, carp (e.g., the common carp, *Cyprinus carpio*) as well as a number of other native and exotic species, each with their own advantages, risks and markets.

Markets: Rwanda is a mid-range consumer of fish, with an annual per capita consumption of around 7.9 kg (see detained discussion in Section 4, Annex B of the NASR). Aquaculture now supplies around 4,900 t (17% of fish production in Rwanda), up from 2% in 2011 and is set to continue grow to contribute 75% of total fish production by 2035. In addition, there are currently large volumes – around 19,000 t – of imported fish, mainly dried freshwater small pelagic fish, as well as frozen fillets, such as tilapia from China. Given this substantial expansion in the farmed fish supply, it is important that this is matched by market demand – and therefore prices – to ensure that aquaculture remains financially sustainable.

Tilapia, at around USD 4.37 for fresh whole fish at retail is the highest-priced farmed fish in Rwanda and is priced 20% higher than carp and 30% higher than catfish, the main contender species for aquaculture in Rwanda. Recent commercial studies suggest that USD 2.50/kg is a representative farm-gate price for farmed tilapia in East and SE Africa. In short, Rwandan tilapia appears to be priced USD 1/kg higher - all along the value chain - than in much of the region. This dynamic is however likely to face pressure from the lower priced imports from other countries in the region. Frozen whole imported tilapia from China is

also comparatively cheap at around USD $1.60/kg. All this suggests that controlling costs through good management, as well as maintaining premium prices, will be essential for growing successful aquaculture in Rwanda.

Constraints and approaches to developing sustainable aquaculture in Rwanda

Participants at the final stakeholder validation of the draft NASR identified and prioritised a series of constraints to the sustainable development of aquaculture in Rwanda. These are provided below, included the proposed approaches and the corresponding Development objectives (DOs) in in the NASR Action Plan.

Constraint	Proposed approach	Corresponding DOs
1. Poor availability of fingerlings	Better production of fingerlings is necessary to support planned programme of aquaculture development interventions in NASR for next 10 years.	P3
2. Low production capacity and poor production systems	Improved yields are necessary through rehabilitation of existing ponds, zoning requirements for cage culture fish farming, introducing new fish farming methods such as rice cum fish farming, tank farming (inc. RAS).	P1
3. Poor availability of fish feeds	Strengthening the investment program for attracting private investment in aquafeed plants in Rwanda, and forward-looking raw material sourcing in Rwanda and the region.	P2
4. Shortage of skilled personnel in the aquaculture industry	Develop linkages between universities/ academia and aquaculture industry for enhancing skills and capabilities of workforce and farm management protocols	Public sector: G2 All: K1, K2 & K3
5. Outdated regulations & policies in aquaculture	Upgrading and revising existing laws, ministerial regulations and guidelines for further refinements and improvement of procedures and approval processes is necessary to revamp aquaculture development.	G1, G3 & G4
6. Poor availability of cold chain facilities, logistics services and other key infrastructure	Promote the mobilisation of funds through private sector investments, public private partnerships and involvement of development partners, donor funding and government support budget programme is underway for revamping aquaculture industry in Rwanda.	M2, R2
7. Poor quality of fish produced and weak certification system.	Better quality of fish and fish products is necessary. Certification system to be enhanced through capacity development interventions.	P3, B1
8. Genetics and veterinary service centres are needed.	Update of exiting and establishment of new aquatic health veterinary centres.	R1
9. Market access to be improved.	Species diversification and post-harvest product development.	M1, M2, M3, M4 & M5
10. Access to finance through mobilization of financial institutions.	World Bank Group (inc. IFC) to inject more funds into aquaculture industry at cheaper interest rates below 10%.	B2

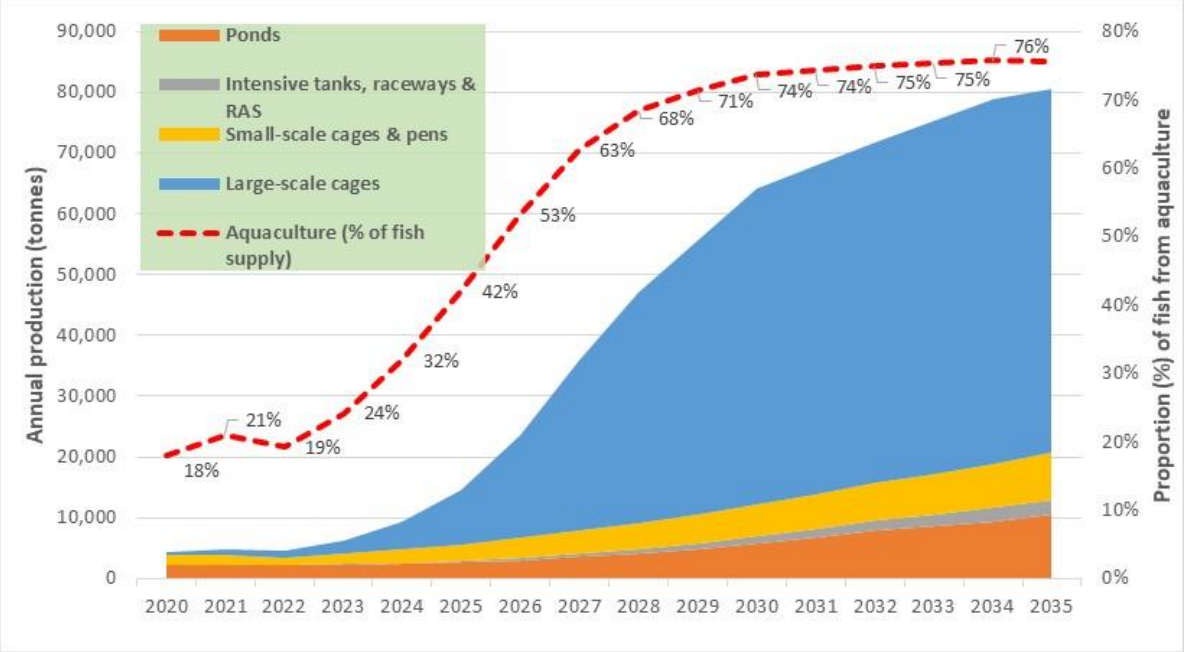
Source: Discussions at Serena Hotel Rubavu District on the draft report of the NASR strategy and the subsequent final NASR validation workshop in the Gisenyi Serena Hotel (5-6 April 2023).

A more detailed analysis of the current status of aquaculture in Rwanda is provided in Annex B of the Strategy.

1.2.2 Outlook for Rwandan aquaculture

The analysis in **Annex B of the NASR** suggests that just over 106,000 t of fish could be produced by Rwanda by 2035, of which around 80,620 t will be from aquaculture, with an estimated 26,000 t from wild fisheries. Of the aquaculture component, around 3% is from intensive tanks, raceways and recirculated aquaculture systems (RAS), 13% is forecast to be from small-scale pond farms, 9% from small-scale cage farms and the remaining 74% from larger cage farms. This is in line with Vision 2050's foresight of a shift from subsistence to commercial agriculture.

Figure 1: Predicted additional increase in aquaculture production up to 2035 (tonnes)



Source: Poseidon

The species in production will predominantly be tilapia (based mainly on the Nile tilapia, with other species gaining in importance later). However, production might grow to include increasing amounts of catfish and carp, especially in pond farming, and possibly some rainbow trout in the colder upland waters. This level of production would mean that per capita consumption of fish could increase to around 10 kg p.a., even with a predicted increase in population from 12.6 million in 2020 to 18 million in 2035. Direct employment in the aquaculture value chain could reach over 30,000 men and women by the end of the Strategy period in 2035.

This anticipated expansion will need to be supported in a number of ways. RAB's governance capacity will have to be considerably increased in order to support robust licensing, sector planning, management, and support. In particular, the planning and environmental management of cage farming in the large lakes will need to be considered to ensure that it (and other lake and lakeside development) does not exceed the carrying capacity of these unique waterbodies. Rwanda's research capacity will also need to be expanded to support this, as well as improving stock performance, high-quality, locally produced feeds and appropriate production systems that work with the particular conditions in different parts of Rwanda. Productive engagement between the government and the private sector will be key to this progress.

The market for farmed fish will also have to be expanded, both within the different economic strata of Rwanda, as well as into neighbouring markets such as DR Congo.

This scenario is entirely possible. Although often regarded as preferring meat rather than fish, Rwandans consume around seven kilograms (kg) of fish per annum, thus putting Rwanda up in the mid-range of East African countries. More encouragingly, there is recent evidence of a rapid and flexible response to increased availability of competitively priced fish – demonstrated by a rise in per capita consumption (PCC) of 5.6 to 7.1 kg p.a. between 2011 and 2017, mainly from imported mackerel.

In terms of production, Nile tilapia production can be made more profitable with more well-managed hatcheries and grow-out farms, as well as better feeds that will become more competitively priced as the scale of Rwandan aquaculture production expands Over the longer-term it should be possible to maximise growth within Rwanda's cooler climate (as has been done in Egypt, see **Annex B**), as well as improve the production models of marginally commercial species such as catfish and carp.

Any development of aquaculture in Rwanda will need to recognise the risks to its environmental and commercial sustainability. One key risk is that of disease, with both an expansion in production and a greater movement of fish within and outside of Rwanda increasing vulnerability. This highlights the need for a comprehensive biosecurity plan as an essential part of the Strategy. As mentioned above there are also environmental risks associated with increased expansion, especially in the larger lakes, suggesting that both license-based restrictions on biomass and proportionally comprehensive environmental impact assessments will also be essential. The indirect impacts of aquaculture also need to be considered, such as an increased demand for both animal and plant protein raw materials for feeds that might have consequences for terrestrial and aquatic ecosystems, both in Rwanda and beyond.

Underpinning this will have to be the creation of skilled and motivated workforce throughout the value chain. This will apply particularly to the private sector, where technical skills and business capabilities will be needed to ensure efficient, sustainable and adaptive production. Public sector participants will also need to have the technical and administrative skills and capability to support sustainable aquaculture production that meets the country's long-term economic, social and environmental goals.

1.3 Purpose, Structure and Scope of the Strategy

The **purpose** of the National Aquaculture Strategy for Rwanda (hereafter, the 'Strategy' or 'NASR') is to provide an ambitious yet realistic vision of Rwandan aquaculture in 2035 (i.e., in around twelve years' time) and to develop a strategy and action plan to achieve this. It should be noted that this Strategy is a framework and will be transposed into government programming in due course.

The Strategy is a short, concise document providing the vision for Rwandan aquaculture in 2035, together with a set of principles, goals and outcomes for the sector and how these may be achieved. The Strategy has two sets of annexes:

Annex A: The Action Plan. A more detailed document that provides a time-bound plan of actions to realise the Strategy's goals, as validated over three workshops in May 2022, December 2022 and April 2023.

Annex B: The Evidence Base. A set of 'Foundation Documents' that provides a detailed description of the aquaculture sector in Rwanda in terms of its current status and development needs. This was developed around a series of stakeholder consultations and a sector-wide workshop in Kigali in May 2022. This evidence base is also supported by a supplementary report entitled 'Feasibility analysis for existing pond infrastructure'.

All three parts of the NASR are based around the same six pillars, these being:

1. **Governance and regulation**: how the Government plans for, manages, supports and monitors sustainable aquaculture in Rwanda. This covers policy and legislation, the licensing and permitting of aquaculture, as well as how the sector is co-managed with the private sector.

2. **Production development**: covers the farming of fish, from hatching to final harvest, including the technical aspects of aquaculture. Production development also includes critical support areas such as aquafeed production and broodstock management.

3. **Market development**: covers the aquaculture value chain and the markets for Rwandan aquaculture products. It includes value-adding through processing as well as international trade and local consumption elements.

4. **Risk management**: ensures that biosecurity, food safety, environmental and socio-economic risks, both to and from Rwandan aquaculture production and its outputs, are identified, managed and where necessary mitigated.

5. **Business and economics** given that aquaculture growth in Rwanda will be driven by the private sector, this pillar covers the different business models that might be developed over the Strategy's lifetime and how they can be supported and facilitated.

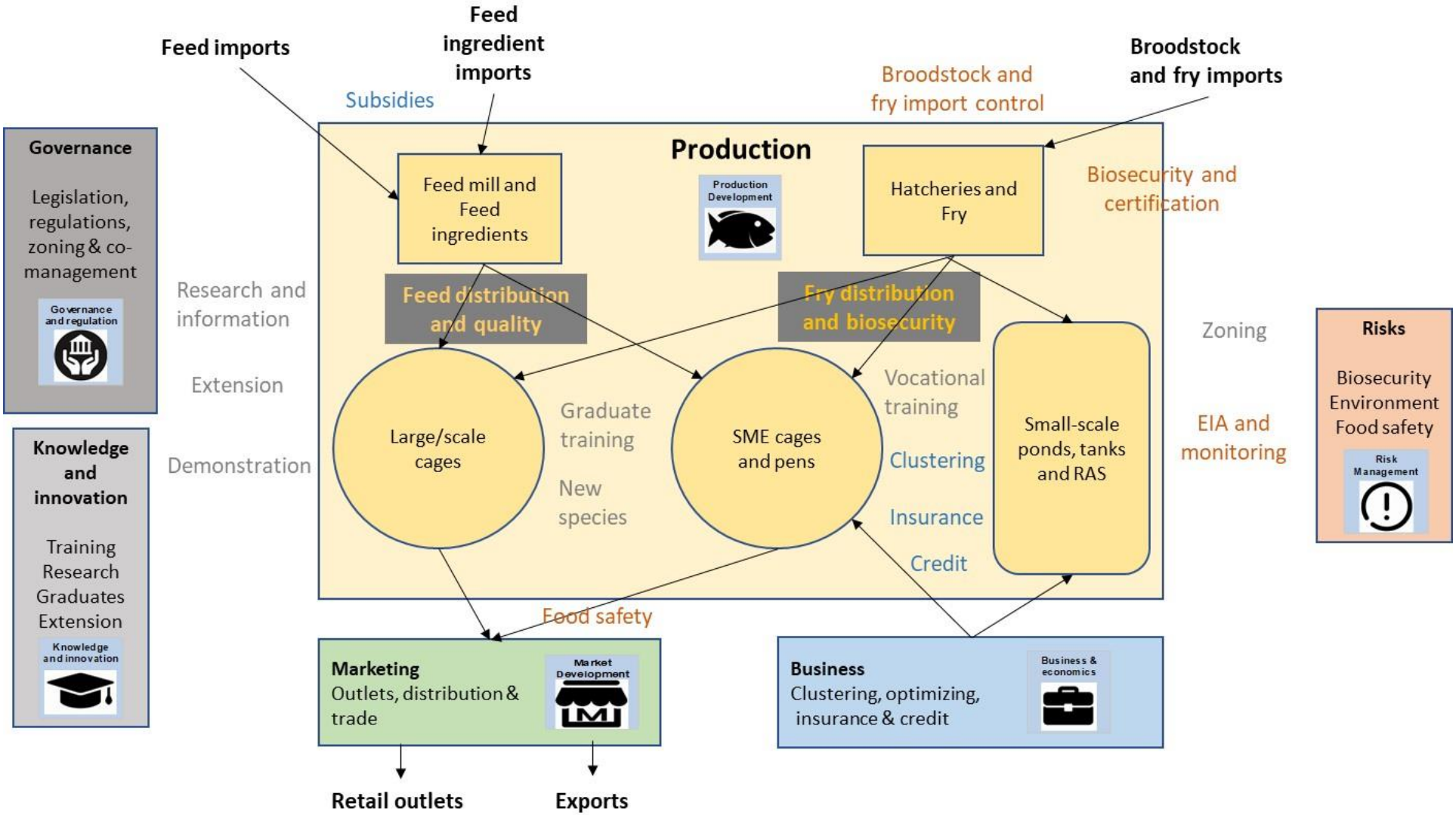
6. **Knowledge and innovation**: this final pillar covers two main areas, firstly needs-driven aquaculture research and technical innovation in Rwanda and secondly skills and management capacity development across the sector.

Whilst the Strategy is structured around these six distinctive themes, it is important to note that **they are highly inter-connected with strong dependencies across the pillars**. For instance, the good governance in Pillar 1 and increased production in Pillar 2 are both reliant on knowledge development and focused research in Pillar 6 (see **Figure 2** overleaf).

The **scope** of the Strategy is for all aquaculture development in Rwanda over the period 2023 – 2035. This covers the entire value chain, including pre-production inputs such as aquafeeds supply, all scales of aquaculture production (e.g., subsistence, small-scale commercial and industrial) as well as the post-harvest supply chain. The strategy also covers the cross-cutting elements of governance and regulation, risk management and knowledge and innovation.

The **NASR does not cover wild capture fisheries**. However, there is a recognition of both the synergies and interlinkages, especially across national and regional fish markets, as well as in such aspects as aquafeed supply from wild fisheries.

Figure 2: Schematic showing inter-linkages between the Six Pillars



2. The Strategy

2.1 Strategic Principles

The future development of Rwandan aquaculture and implementation of this Strategy are based on the following core principles:

- **Aquaculture production should be environmentally, economically and socially sustainable**. It should be within the carrying capacity of the aquatic environment, have no significant impacts on aquatic biodiversity and habitats, be responsive to climate change and be balanced with the needs of other users.
- **The main production methods will be cage- and pond-based.** Large scale cage production will provide production volume to supply the local market and for export. Small scale pond farming will provide livelihoods and an affordable fish supply to rural communities.
- **Growth in the aquaculture sector will largely be driven by a skilled and capable private sector**, in particular the larger farms who are prepared to invest and innovate. At the same time, medium and small-sized farm will continue to play a significant role in the sector.
- **As the industry's technical capacity to produce high-quality feed grows, in-country feed will become the primary source of feed.** However, initially, and for the near term, high-quality imported feed will drive sector growth. This is likely to require government support through import tariff reductions or eliminations, for example.
- **Commercially produced fingerlings from well-run local hatcheries** will become the mainstay of the aquaculture sector.
- In the near term, the continuous growth of the Rwandan aquaculture sector will be dependent on prudent management of fish health risk factors. As more capital is invested in the sector, risk management to avoid major stock losses will be important. In tandem with this growth trajectory, **a mix of both publicly provided and privately available veterinary services will provide support to the industry.**
- **Aquaculture operations both establish and follow good practice across the supply chain** in terms of animal health and welfare, environmental stewardship, food safety and working conditions.
- **Aquaculture development should be regulated in a proportionate and balanced way.** Aquaculture planning and licensing should be responsive to the needs of the industry and sensitive to the scale and nature of proposed development, taking into account the levels of environmental risk it presents. Regulatory decisions will be evidence-based and where appropriate, precautionary.
- **Innovation will be a key part of the development of new production systems, feeds and products.** These will contribute to a circular economy through maximising the use of domestically produced raw materials where possible, locally manufactured containment systems, and a focus on local and regional markets to maximise value added and socio-economic benefits.
- **The domestication, development and diversification of suitable species for farming in Rwanda's particular conditions should be encouraged where possible.** The focus is on those species that can be reared profitably using readily available feed materials and have an existing or potential market demand.
- **Aquaculture can develop at different scales and for different markets, but there is a presumption that the primary focus will be on supporting national food security.** The primary focus of this strategy is on supporting fish production as a nutritious, low-carbon alternative to poultry and red meat for Rwandans. There is also a role for the larger-scale production of finfish and shellfish for more extended supply chains, including exports.

- **Market development in Rwanda will be dominated by growth in the local market occasioned by an increased per capita consumption of fish.** This in turn will be driven - among other factors - by deliberate efforts to educate the Rwandan population on the benefits of eating fish.
- **In addition, viable export markets, particularly within the region, will continue to provide an important outlet** for Rwandan fish.
- **Aquaculture can provide a diverse range of job opportunities across the supply chain.** It is important that the strategy provides an enabling environment for secure and rewarding jobs for men and women alike, and that the necessary skills development processes are in place, especially for younger people.
- **A co-management, partnering approach is developed between RAB and MINAGRI, the industry, universities and research organisations, local communities and other key sector participants.** This should be based upon a mutual understanding and respect, common ambition and open communication.
- **Strategy implementation will occur through a combination of national and regional actions.** This Strategy will provide a high-level action plan and framework for regional initiatives, such as area-specific aquaculture strategies and spatial planning.
- **Funding of the Strategy's implementation must be a national responsibility.** The governance costs must be from recurrent Government funding, and the private sector is expected to pay for applied research, innovation and capacity-building. There may be a role for some external funding to kick-start critical activities where appropriate.
- **Public subsidies to the private sector should be avoided**. Government subsidies to private sector aquaculture reduces competitiveness and erodes resilience. In some circumstances time-limited incentives might be considered to encourage good practice and support innovative behaviour. Short-term support might also be considered in the case of significant external shocks, such as the recent COVID pandemic.

2.2 Vision of aquaculture in Rwanda in 2035

A strategic vision is an ambitious picture of the future, in this case how aquaculture in Rwanda might look like in 2035. This is presented in two forms:

1. In the form of a short, high level '**vision statement'**, and
2. **From the perspective of a selection of fictional stakeholders across the sector**.

2.2.1 Vision statement

By 2035 aquaculture will be Rwanda's main source of fish, with nearly 80,000 t of sustainable production from a mixture of smallholder pond and cage farms and a growing large-scale commercial cage and tank sector. This will be based on regionally sourced, low-carbon aquafeeds, a safe, value-additive post-harvest value chain and will be underpinned by a skilled and confident work force, supported by a capable and efficient aquaculture administration.

2.2.2 Vision of how aquaculture might look like in 2035 from the perspective of five fictional stakeholders and businesses:

- **Cage farm manager**: Augustine looked over his neat array of fish cages in Lake Burera with pride. The cages were alive with healthy fish in the clear lake waters, competing for the advanced pelleted feed – incorporating local ingredients – in Rwanda Feed's new mill just outside Kigali. This feed sprayed out from floating pipes, fed from a floating, automated food hopper, powered by solar panels and the latest rechargeable battery system. Looking at his smartphone at the helm of his hybrid power work boat, the farm's app' showed how his stock's growth and survival from his fifth generation broodstock had exceeded the expectations of his research manager. Augustine was glad that the Rwandan Aquaculture Association, of which his farm was a member, had paid to supervise their lower temperature tilapia strain development programme. This, combined with the excellent husbandry staff who had all been trained at the regional vocational polytechnic and undergone further specialist fish health and welfare short courses, had made all the difference in terms of ensuring fast growth and low mortality. Augustine looked forward to harvest time with excitement, confident he could pay off his generous bank loan a year earlier than anticipated.
- **Pond farm employee**: Godfrey connected his electric motor bike to his house charging point, relaxing after a good day's work. Ever since the fish biology and husbandry training course his boss had paid for him to do, the feed conversion ratios had improved and he was sure he would get another good bonus this year, allowing him to pay his daughter's first year university fees. Next year he hoped to be trained to look after the catfish broodstock ponds. As he started to take on more responsibilities, he looked forward to joining his boss at the regular co-management meetings held with other SME pond producers and RAB in the local area.
- **Government official**: Deputy Chief Licensing Officer in the Department of Aquaculture and Fisheries, took one last look at the integrated multi-trophic aquaculture (IMTA) fish farm licence application in the Eastern Province and sent it to her supervisor for final approval and e-signature. She still marvels at how well tilapia and catfish farming can be combined with rice and duckweed growing. Following the positive EIA (environmental impact assessment), the approval process had gone smoothly, with the Rwanda Environmental Management Authority (REMA) and the Rwanda Water Resource Board (RWB) reviews received well within the maximum response time via the online aquaculture portal that was the main tool for the 'one stop centre' RAB had set up with the RDB ten years ago. Her next job would be to email the successful applicant a copy of their new licence, together with the operational and environmental conditions that RAB's aquaculture monitoring unit would be checking in due course.
- **Fish wholesaler**: Stephanie looked at the new delivery of red tilapia fillets with delight. They had arrived well chilled, having been harvested and processed just the previous day. She scanned the bar code on the insulated, lightweight cardboard box to record the traceability data that her customers demanded. She then allocated the batch to the new supermarket that had just opened in Butare, whose new fresh fish section was talk of the town. She mused that aquaculture had really developed over the last ten or so years, now providing her business with an ever-increasing variety of top quality chilled and frozen fish.
- **Consumer**: it was Gahiji's twelfth birthday today. He had asked his mother if some of his friends could come around for a special birthday dinner and asked if she could make some of the farmed catfish goujons he adored so much. He especially loved the crunchy coating, sweet white meat and the spicy tomato sauce. The best thing was his mom promised that the catfish's high protein content would ensure him as the top scorer in the school's football team that season.

2.3 Development Goals and Objectives

The following six **Development Goals** and associated **Objectives** have been identified across Rwanda's aquaculture sector. These are aligned with the sector pillars described **Section 1.3** and are as follows:

Pillar	Development Goal	Development Objectives
GOVERNANCE & REGULATION	**A well-regulated sector that ensures long-term sustainable aquaculture development and that contributes to national development objectives**	G1: A **policy and regulatory framework** for Rwandan aquaculture that provides both clear direction and support for the sustainable development of fish farming in Rwanda.
		G2: An **active and capable administration** that supports and manages the sustainable development of aquaculture in Rwanda.
		G3: **Spatial planning of Rwandan aquaculture** that allows the identification and sustainable management of aquaculture areas and their integration into the wider rural and lake economies.
		G4: A **partnership approach** between the public and private sectors involved in Rwandan aquaculture.
PRODUCTION DEVELOPMENT	**A transition to large-scale commercial aquaculture operating alongside vibrant subsistence and small-scale fish farming, together maximising sustainable production in Rwanda's unique aquatic ecosystems**	P1: **Increased production** from Rwandan aquaculture to a sustainable circa 80,000 tonnes per annum by 2035.
		P2: A **local fish feed industry** producing quality species-specific and production system-specific feeds at affordable prices, using local ingredients where possible.
		P3: **Hatchery production** of high quality, well-performing and disease-free fry to support the expanding grow-out sector.
MARKET DEVELOPMENT	**Sufficient supplies of farmed fish are available to meet increased fish consumption goals, supported by efficient and economic post-harvest systems**	M1: Respond to Rwanda's ambition to increase national wealth by ensuring this is matched by the **availability of domestically reared or imported fish**.
		M2: Further deve**lop Rwanda's regionally leading fish distribution system** to extend supplies throughout Rwanda in order to maximise access to fish whilst minimising spoilage losses and hygiene risks.
		M3: **Raise the profile of fish** as a key component in Rwandan's diet and national food security.
		M4: Build upon the re-**export fish trade regional markets** by facilitating and regularising this to maximise economic advantage to public and private interests whilst avoiding threats to the Rwandan domestic fish supply.
		M5: Evaluate potential value of, and if positive, **promote third party certification** for sustainability covering environmental, social & governance (ESG) aspects to improve access to prime markets, encourage external investment and improve overall business performance.

Pillar	Development Goal	Development Objectives
RISK MANAGEMENT	**The biosecurity, food safety, environmental and socio-economic risks, both to and from Rwandan aquaculture production and its outputs, are identified, managed and where necessary mitigated.**	R1: Rwandan aquaculture is **resilient** to existing and emerging biosecurity threats.
		R2: The produce from Rwandan aquaculture is **nutritious and safe to eat** across the value chain.
		R3: The **environmental risks** from Rwandan aquaculture are identified, monitored and managed where necessary to ensure the sector's sustainable development.
BUSINESS & ECONOMICS	**Improve the individual and overall performances of aquaculture businesses to increase production, profitability and employment opportunities for all Rwandans, thus contributing to the sustainable growth of the rural economy.**	B1: Aquaculture ventures, large and small in scale, are based upon **sound business practice** to ensure their commercial sustainability.
		B2: **Economic and other forms of support** available for promising aquaculture ventures including production, processing, distribution and marketing ventures.
		B3: Widening of the **positive economic and socio-economic impact** of viable aquaculture ventures achieved.
		B4: **Encouragement of ancillary activities** and industry dependent upon aquaculture.
		B5: Have **insurance contracts** implemented per year to cover business risks (2030) and technical risks (2035).
		B6: Set up and operationalise a **Business Development Service** entity (by 2025) to support the implementation of capable and sustainable aquaculture enterprises and gather valuable data about the sector.
		B7: **Clustering of small-scale farms** to provide support services and encourage coordination for the bulk purchase of inputs and sales of products.
KNOWLEDGE AND INNOVATION	**Widely accessible vocational training with an efficient and widespread transfer of technologies to benefit farmers and improve overall aquaculture productivity in Rwanda, supported by a coordinated national aquaculture research and development programme**	K1: A well-functioning and **Vocational Training programme** for aquaculture technicians in farm operation and business managers for farm development and management.
		K2: A wide spread and effective **extension service** aimed at small scale and SME at the district level across the country.
		K3: **Graduate and postgraduate education** program.
		K4: A **National Aquaculture Research program** that is based on farmer needs and the development of new species and efficient culture systems.

2.4 Transition to a modern, sustainable aquaculture sector by 2035

This Strategy is designed to facilitate a transition to a modern sustainable aquaculture sector in line with the overall national journey to Vision 2050.

2.4.1 Key directions of travel

In order to meet both the wider national goals of Vision 2050 and the sectoral Development Goals provided above, the aquaculture sector in Rwanda will need to change. The main changes are described below:

1. **Improving sector capability** –in terms of individuals, businesses and government – will be central to the Strategy. This increase in capability will be seen across a wide range of areas including fish husbandry, farm and business management, research and development, environmental management and monitoring, and good governance.
2. Overall, there will be **a move from the current extensive earthen pond production to more intensive commercial aquaculture**, mainly in cages. By 2035 it is anticipated that over 85% of the anticipated 80,620 t of farmed fish in Rwanda will be from cages, with 74% from larger (i.e., more than 1,000 t per annum) operations. These larger farms will be mainly in the larger, deeper lakes, with vertically integrated production models that will establish best practice benchmarks for both Rwanda and the wider region.
3. The **current 3,000 earthen ponds will still have an important role to play** (*c.a.* 15% of total aquaculture production), both in subsistence and small-holder forms, but will be much improved in terms of productivity and commercial performance. This will move away from the current government supported approach to becoming independently commercially viable. However, some pond clusters may be operated by groups, either at community level or under private company-led management. The key will be moving to fully unsupported commercial viability through better productivity and cost management. The main pond farming areas will remain concentrated in the Eastern Province of Rwanda due to the presence of irrigation dams for rice-growing, followed by the Southern province where the water temperatures are higher. Pond farming is also likely to diversify, with a mixture of subsistence, semi-intensive, and intensive pond farming, as well as polyculture and integrated crop / livestock models (see separate feasibility study for more details).
4. **Nile tilapia are likely to remain the mainstay of Rwandan aquaculture**, but new species and strains will need to be introduced and/or developed to suit Rwanda's particular environmental conditions. Other species, such as catfish and carps will also gain in importance.
5. **Juvenile production will become entirely private sector driven** with strict requirements on genetic and biosecurity standards.
6. Through a combination of policy and possibly fiscal support, **the development of locally milled aquafeeds** using high quality, cost-effective and environmentally sustainable raw materials will be encouraged.
7. **Farmed fish products will reflect the changing nature of Rwandan society** and their aspirations. In particular cage-farmed fish will be aimed at the burgeoning middle classes, providing an affordable but premium alternative to other animal protein products, with an ever-increasing range of value-added options. Pond-farmed fish will be more affordable, thus providing lower-income families with a high-quality protein source.

8. **Aquaculture will be primarily aimed at supporting Rwanda's food security needs as the population expands**. However, opportunities for value-addition of fish products will assist aquaculture businesses diversify and remain resilient to national market conditions and changing export markets.
9. **Government support will be focussed on wider-sectoral planning, environmental protection, ensuring straightforward permitting** reinforced by pre-agreed operating conditions and supporting small-scale farmers through appropriate extension support.
10. RAB aquaculture sector management will be disaggregated from the current joint fisheries program, with the **evolution of a cadre of skilled and experienced specialists** across the different needs of the sector.
11. The **private sector will become key co-management partners** with the government to ensure that regulation is both targeted and light touch, and long-term policy and planning responsive to changing national and external circumstances.
12. **Aquaculture research will become needs-driven**, with short and long-term priorities identified and addressed over annual and multi-annual planning. Both research planning and delivery will reflect a joint partnership between industry, academia and the government.

This transition process has been illustrated in two ways over the following pages:

- **Realisation of the Vision (see Section 2.4.2)**: Rwanda's aquaculture sector has struggled to achieve the government's growth targets as set out in the RAB Strategic Plan (2020 – 2024) and its predecessors. The analysis of the current status of the sector, conducted in the **Annex B: The Evidence base** and briefly described in **Section 1.2.1** above, has identified a number of critical constraints and barriers to sustainable development. The infographic in this section shows how these constraints will be addressed and the linkages with the Development Goals described in the previous section.
- **Roadmap of how Rwandan aquaculture will change over the lifetime of the Strategy (2025, 2030 and 2035 & beyond) (Section 2.4.3)**: this second section examines the progression of Rwandan aquaculture over the duration of the Strategy's implementation in the form of a roadmap.

2.4.2 Realisation of the Vision

	Current status and critical constraints	Actions over the Strategy period (2022 – 2035)	Development Goals for 2035 & beyond	VISION
GOVERNANCE & REGULATION	• Generic fisheries and aquaculture legislative framework. • Small joint fisheries & aquaculture administration that struggles with increasing aquaculture work load • Paper-based licensing system currently being rolled out • Limited and fragmented liaison between the public and private sectors over sector planning and sustainable development	• Aquaculture-specific policy and regulations put in place • A dedicated, structured and focused aquaculture unit, staffed by skilled and experienced personnel in place • Integrated aquaculture management information system and online portal designed and operating • Co-management (government / private sector) structures and systems put in place	• A well-regulated sector that ensures long-term sustainable aquaculture development and that contributes to national development objectives	By 2035 aquaculture will be Rwanda's main source of fish, with nearly 80,000 t of sustainable production from a mixture of small-holder pond and cage farms and a growing large-scale commercial cage and tank sector. This will be based on regionally sourced, low-carbon aquafeeds, a safe, value-additive post-harvest value chain and will be underpinned by a skilled and confident work force, supported by a capable and efficient aquaculture administration.
PRODUCTION DEVELOPMENT	• Lack of skilled managers and technical staff • Sub-level fish growth rates due to low ambient temperatures, low dissolved oxygen in higher lakes, etc. • Limited quantity and poor quality fingerlings • Expensive and poor quality aquafeeds • Limited suitable land area for pond farm development	• A cadre of well trained and experienced farm managers and technicians throughout the aquaculture sector • Adaptation to Rwanda's environmental conditions through a combination of technology (e.g. selected strains and environmental conditioning) and skilled husbandry • Develop adequate supplies of affordable, good quality feeds and certified high quality fingerlings	• A transition to large-scale commercial aquaculture operating alongside vibrant subsistence and small-scale fish farming, together maximising sustainable production in Rwanda's unique aquatic ecosystems and producing around 80,000 t of farmed fish	
MARKET DEVELOPMENT	• Relatively high cost of farmed fish that has to compete with cheap imports • Fish consumption relatively low compared to neighbouring countries, believed to be at least partially due to limited domestic supplies • Incomplete chill chain for farmed fish in some rural areas that limits market development	• Through better husbandry, quality juveniles and cost-effective diets, ensure that fresh Rwanda farmed fish compete with cheap imports and regionally farmed fish • Further develop Rwanda's fish distribution system to extend supplies throughout Rwanda • Whilst recognising the importance of farmed fish to Rwanda's food security, also build export markets (e.g. to DRC) to increase demand and price resilience	• Sufficient supplies of farmed fish are available to meet increased fish consumption goals, supported by efficient and economic post-harvest systems	
RISK MANAGEMENT	• Weak biosecurity to domestic and external disease threats, especially as production expands and diversifies • Environmental carrying capacity of smaller lakes / larger lake basins under threat without proper planning • Potential environmental / social impacts poorly monitored • Potential food safety issues from farmed fish as the value chain expands with increasing production	• Development of a comprehensive biosecurity monitoring and contingency plan to proactively address current and future disease and other related issues • Spatial zoning of aquaculture, including carrying capacity analyses for key aquaculture areas • Environmental monitoring included in operators' licence terms and conditions	• The biosecurity, food safety, environmental and socio-economic risks, both to and from Rwandan aquaculture production and its outputs, are identified and managed	
BUSINESS & ECONOMICS	• Aquaculture investors have difficulty in accessing finance • High production costs compared to regional competitor benchmarks • Need for proven business models for different species / systems / scales in Rwandan aquaculture • Lack of guarantee or Insurance schemes across the sector	• Business models developed and refined for different species / systems / scales in Rwandan aquaculture, including cluster / satellite farm models • Financial and economic support packages developed to support the transition to financially & environmentally sustainable aquaculture	• Improve the individual and overall performances of aquaculture businesses to increase production, profitability and employment opportunities for all Rwandans, thus contributing to the sustainable growth of the rural economy	
KNOWLEDGE & INNOVATION	• Current aquaculture research needs more planning and coordination • Lack of formal vocational training capability and opportunities aimed at farm supervisors and husbandry persons across the Rwandan aquaculture sector • Limited technical or managerial training opportunities in aquaculture systems relevant to Rwanda	• Aquaculture research responsibilities agreed across academia, industry and government • Multi-annual aquaculture research plan developed with industry and government under implementation and periodic evaluation • Vocational training courses developed in key aquaculture areas across Rwanda, specialising in local techniques and conditions • Higher education includes aquaculture and associated environmental and business skill development needs	• Widely accessible vocational training with an efficient and widespread transfer of technologies to benefit farmers and improve overall aquaculture productivity in Rwanda, supported by a coordinated national aquaculture research and development programme	

2.4.3 Roadmap of how Rwandan aquaculture will change over the lifetime of the Strategy (2025, 2030 and 2035 & beyond)

Pillar	Time period		
	By 2025	By 2030	By 2035 and beyond
Governance	• The aquaculture sector has a clear, forward-looking strategy for sustainable development over the foreseeable future, with a multi-annual action plan to address priority issues. • A modern regulatory framework specific to aquaculture is in place, with relevant legislative measures to ensure sustainable development. • A dedicated, well-resourced and focused unit of RAB specialises in managing and supporting the sector. • Aquaculture development zones identified and described in a 'Rwandan Aquaculture Atlas' (or similar). • The different elements of the private sector – from subsistence farms to large companies – are organised into a cohesive group that starts to engage in co-management of the sector with the Government.	• The Government continues to implement the strategy, updating its annual planning as progress is made and new issues arise. • Aquaculture licensing, management and monitoring is now managed through a single governmental 'one stop centre system', supported by a cloud-based IT portal linked with other relevant Government entities. • All aquaculture development zones have their own management plans. Will include spatial planning of all Rwanda's lakes and wetland areas. Aquaculture atlas developed and expanded. • The private sector is contributing to sector planning and management through regular meetings, needs assessments and reviews. • A levy-based 'Rwanda Aquaculture Association' (or similar) provides a non-partisan, broadly constituted platform for sector co-management with the government. • Towards the end of the period, a mid-term review of the strategy ensures that implementation over the next period remains relevant, efficient and sustainable.	• Aquaculture governance balances market-driven private sector development with light-touch support from the government to ensure it remains fully sustainable and in line with broader national development policy direction. • With production now over ten times that at the beginning of the Strategy, aquaculture is recognised as equivalent to terrestrial livestock production, as demonstrated by a substantial increase in RAB's expertise and capabilities at national and regional levels. • RAB's 'one-stop-shop' is fully integrated with other government systems (e.g., GIS, environmental management and trade). • In 2035 a final review allows the development of an updated National Aquaculture Strategy for Rwanda (2035 – 2050) that remains aligned with Vision 2050 and other Government policy goals at that time.

Pillar	Time period		
	By 2025	By 2030	By 2035 and beyond
Production	• Tilapia is the mainstay of Rwandan aquaculture production, with pilot farming of other species. • Cage aquaculture mainly centred around Lakes Kivu and Muhazi. • Whilst cage farming companies mostly have their own hatcheries, pond farms still depend on government-produced / subsidised fingerlings. • Following the removal of import tariffs in 2023, most aquafeeds are still imported, but locally produced feeds start to be developed and trialled.	• Overall FCRs, growth rates, and survival improve through newly skilled husbandry. • Tilapia remains the mainstay of Rwandan aquaculture, but other species (catfish, carps) are being successfully farmed. • Cage farming being increasingly used in high-altitude lakes with the use of low-temperature tolerant strains beginning to take root. • Although some cage farms remain vertically integrated, a specialist, fully certified broodstock / hatchery sub-sector emerges. • Profitable pond farming expands in the Eastern Province due to the presence of irrigation dams for rice growing followed by the Southern Province where the water temperatures are higher. • International standard feed mills established and over half of aquafeeds are locally produced.	• FCRs and growth rates equal or exceed regional benchmarks, even at low temperatures. • A wide variety of species are now farmed in a number of different systems. • Sustainable aquaculture can be found in almost all major water bodies in Rwanda, in line with national spatial planning. • A national network of certified hatcheries produces high-quality fingerlings from fully domesticated and selected broodstock. • High-performance broodstock lines established that are fully adapted to the different growing conditions around Rwanda, acting as a certified genetic reservoir for the private sector. This is expanded as conditions / markets change over time. • Almost all feed is locally made to international standards, with increasing levels of local / regional raw materials.
Markets	• Main market for farmed fish is for whole tilapia, mainly sold via associated distributors. • Market mainly in Rwanda, with a focus on the main urban classes. • Some exports to the DRC, mainly tilapia.	• Tilapia remains predominant species and is available whole in most areas of the country. • Secondary processed tilapia e.g., fillets increasingly available in supermarkets and urban centres. • If demand so dictates, availability and affordability of other species e.g., catfish and carp increasing in urban and rural areas. • Small volumes of high value exports e.g., to the DRC and wider region, but mainly nationally consumed.	• Wide array of tilapia products (whole, fillets, breaded fillets & portions) available throughout Rwandan chill chain. • Diverse array of other products also available, catering for increasingly diverse and sophisticated consumer demand, reflecting Rwanda's status as a middle-income economy. • As aquaculture production exceeds anticipated per capita consumption (10 kg / person/year), regional and international markets are developed to absorb excess production.

Pillar	Time period		
	By 2025	By 2030	By 2035 and beyond
Risk	• An aquaculture biosecurity plan is in place and starting to operate across the country. • Clear understanding of the environmental risks associated with likely Rwandan aquaculture development options formalised and impact assessment framework agreed. These will include eutrophication and limnological instability due to over-development, as well as biodiversity risks from introduced species. • A first spatial plan for aquaculture on lake Kivu completed, resulting in zoning and an understanding of the lake's carrying capacity.	• An aquatic disease surveillance network is in place across Rwanda, supported by diagnostic facilities and a response capability. • Spatial planning for all Rwanda's lakes and wetland areas completed to help focus sustainable development of aquaculture within environmental limits. • A risk-based environmental impact assessment process being implemented. • All aquaculture has appropriate environmental monitoring requirements associate with licensing agreement.	• A sophisticated monitoring network for environment and animal health forecasts potential environmental (e.g., HAB) and disease risks and provides pre-emptive mitigation measures. • Environmental monitoring routine for private sector operations, supported by efficient and capable Government verification. • Spatial planning regularly reviewed to allow the cautious expansion of aquaculture where deemed as sustainable.
Business	• Low import tariffs allow high quality inputs (feeds, equipment and services) to be imported by innovative businesses. • The sector remains dominated by a small number of innovative farms, mainly on the lakes. • As is the trend worldwide, risk-based aquaculture insurance framework established by the private sector. • Some favourable government investment support (e.g., guarantee schemes) over the short-term	• The number of large cage farming operations increases substantially but stabilises as production capacity nears the limits of lake carrying capacity, esp. in Lake Kivu, and as market and industry dynamics stabilise as well. • Emergence of small-scale cage clusters supported by established, larger cage farmers with associated off-take agreements. • There is a steady revival in pond farming as skills and confidence improves, supported by the increasing availability of feed and fingerlings. • Commercial farms are insured against stock loss. • Government financial support phased out.	• The maturing aquaculture industry is dominated by a number of large, highly capable companies, sustainably farming mostly at semi-intensive / intensive levels. • Smaller operators, esp. of pond farms, tend to operate commercially in cooperative clusters, served by a network of competitive input suppliers and supplying a diverse and rewarding market. • All commercial farms, and groups of small-scale operators have aquaculture insurance. • Sector development financially self-sufficient.

Pillar	Time period		
	By 2025	By 2030	By 2035 and beyond
Knowledge	• Leading commercial farms have a core of trained and experienced managers and husbandry staff. • Multi-annual aquaculture research plan agreed between industry, academia and government, focusing mainly on short-term researchable constraints to sustainable aquaculture. • Aquaculture extension system established. • Graduate and training needs for the strategy period investigated and understood.	• All commercial farms have experienced managers and husbandry staff. SMEs have access to experienced extension officers and training. • Industry leading research planning, contributing via finance, expertise and demonstration. • Multi-annual research plans now include long-term programmes, led by the Government and conducted via local universities, likely with international cooperation. • Graduate and vocational training courses in place and operational.	• On-going, co-funded (public / private) multi-annual aquaculture research programmes routinely focus on researchable constraints identified via co-management groups. • Increasingly sophisticated research led by Rwandan institutions identifying and addressing emerging issues to sustainable aquaculture. • Deep and diverse pool of aquaculture teaching capacity across Rwanda. • All levels and scales of aquaculture have the skills for productive, adaptive and sustainable aquaculture and food production.

2.5 Anticipated outcomes of the Strategy

The outcomes of the Strategy are anticipated to be as follows:

- Aquaculture contributes to Rwanda's animal protein production and overall food security.
- The aquaculture sector is seen as an attractive and rewarding employment opportunity that contributes to the well-being and cohesion of Rwandan lakeside and rural communities.
- The continued emergence of an entrepreneurial, innovative and highly skilled private sector that drives sustainable growth in Rwanda's aquaculture.
- The current and emerging barriers to sustainable growth in aquaculture production are identified and reduced.
- Rwandan aquaculture maximises the use of technology and innovation to drive growth and improve its overall sustainability, in economic, social and environmental terms.

2.6 Pre-conditions and risks to the success of the Strategy

As with any sector strategy, there are a number of pre-conditions needed for – and risks to – achieving the outcomes described above. These have been identified over the evidence-gathering phase and the preparation of the Foundation Documents.

2.6.1 Pre-conditions and assumptions

The successful implementation of the strategy is based on a number of pre-conditions and assumptions. Essentially internal to Rwanda in nature, these include:

- Future Government planning (e.g., beyond NST 1 and PSTA 4, both which conclude in 2024) embrace and build upon this Strategy.
- The Government commits to providing sufficient staff to support the governance of the sector and that they are provided the skills and material needs to do so.
- The Government is open to co-management of the aquaculture sector with the private sector.
- Rwandan institutions responsible for the governance of aquaculture e.g., MINAGRI, REMA and the RWB continue to cooperate and are prepared to integrate licensing and monitoring systems in order to simplify and strengthen aquaculture administration.
- The Strategy and accompanying Action Plan provide sufficient confidence to leverage additional funding from donor and non-governmental sources.
- The private sector – especially in the form of larger aquaculture businesses – is sufficiently incentivised to drive growth and expand the value chain.

2.6.2 Risks

Annex B of the Strategy (the **Foundation Documents**) identified a number of largely external risks to the sustainable development of Rwanda's aquaculture sector and the expected outcomes of this Strategy including:

- The acceleration of climate change, accompanied by unexpected impacts on Rwanda's weather, hydrology and agricultural productivity.
- Regional fish diseases that threaten Rwandan aquaculture production and overwhelm the biosecurity planning included in this Strategy.
- Geo-political events e.g., war, pandemics, etc that impact on raw materials and energy costs, as well as the international seafood trade.
- Persistent competition from low-cost imports of small-pelagic and farmed fish (e.g., Vietnamese catfish) that undermines prices and the viability of Rwandan aquaculture production.

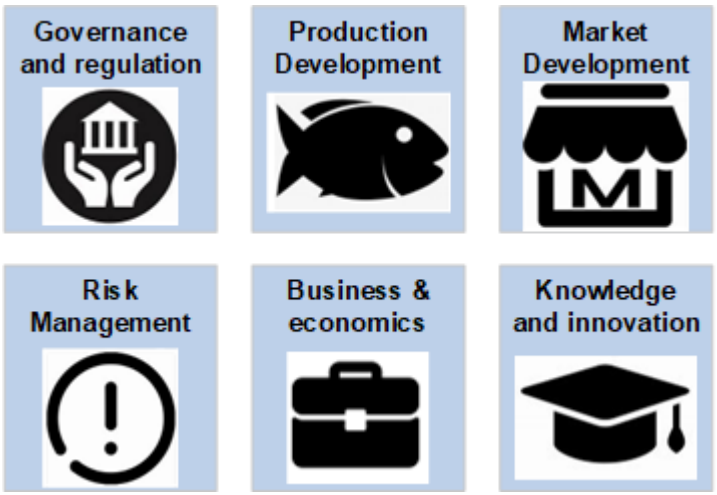
3. The Action Plan

3.1 Introduction to the NASR's Action Plan

This Strategy is outwardly ambitious and will be delivered over a medium-term timeline (e.g., to 2035) as Rwanda transitions to the state envisioned in its Vision 2050, moving from a low-income to an upper middle-income economy.

The Strategy will be implemented through the detailed time-bound, **Action Plan** that makes up **Annex A** of the NASR. This Action Plan uses the same six pillar framework as this Strategy (see **Section 1.3** and figure below).

Figure 3: Six 'pillar' framework for the sustainable development of the Rwandan aquaculture sector



3.2 Structure of the Action Plan

The **Action Plan** in **Annex A** of the NASR provides the following elements for each the six thematic pillars shown in the diagram above:

1. **Development Goal**: each of the six thematic pillars will have a single Development Goal (Goal or DG). Together these will combine to achieve the Vision of the sector as anticipated in 2035 (see **Section 2.2**).
2. **Development Objective**: each single thematic Development Goal will have a number of Development Objectives (Objectives or DOs) that need to be achieved in order to comprehensively reach the Goal.
3. **Key Actions**: each Objective will have a number of Key Actions that will need to be undertaken to achieve the Objective. These Key Actions are described in terms of:
    - ***Implementation Steps***: the activities that would need to be undertaken to complete an action.
    - ***Timeline and Milestones:*** the timeline in terms of (i) short (2023 - 2024), medium (2025 - 2029) and long-term (2030 - 2035) time periods and the key milestones in terms of outputs or milestones achieved.

3.3 The Action Plan

Table 2: The Action Plan – Governance and Regulation

Development Goal	Development Objectives	Actions
A well-regulated sector that ensures long-term sustainable aquaculture development and that contributes to national development objectives	**G1: A policy and regulatory framework for Rwandan aquaculture that provides both clear direction and support for the sustainable development of fish farming in Rwanda.**	• G1-1 Preparation of a clear Government policy providing direction on how aquaculture should develop up to 2035. • G1-2 Development of robust and supportive aquaculture legislation so that it covers the current and emerging aquaculture production systems over the planning period.
	G2: An active and capable administration that supports and manages the sustainable development of aquaculture in Rwanda.	• G2-1 Dedicated and well-trained unit for aquaculture administration in RAB with clear roles and responsibilities with adequate capability and resources for an expanding and diversifying aquaculture sector at both national and local levels. • G2-2 Integrated aquaculture planning, licensing and monitoring systems to facilitate, manage and inform sustainable aquaculture development via an online portal to improve investor experience and transparency. • G2-3 Collection, analysis and reporting of aquaculture production statistics.
	G3: Spatial planning of Rwandan aquaculture that allows the identification and sustainable management of aquaculture areas and their integration into the wider rural and lake economies.	• G3-1 National zoning to identify and manage designated aquaculture areas across the different ecozones in Rwanda. • G3-2 Local spatial planning and management for these designated aquaculture zones, including carrying-capacity related biomass limits in lakes.
	G4: A partnership approach between the public and private sectors involved in Rwandan aquaculture.	• G4-1 Founding a Rwanda aquaculture association structure. • G4-2 RAB / industry liaison and coordination initiatives.

Table 3: The Action Plan – Production Development

Development Goal	Development Objectives	Actions
A transition to large-scale commercial aquaculture operating alongside vibrant subsistence and small-scale fish farming, together maximising sustainable production in Rwanda's unique aquatic ecosystems	**P1: Increased production from Rwandan aquaculture to a sustainable circa 80,000 tonnes per annum by 2035.**	• P1-1 Develop a modern large-scale sustainable cage culture sector in deep water lakes. • P1-2 Develop an efficient and profitable SME coastal cage culture sector. • P1-3 Develop a small-scale pond culture sector supported by Government services.
	P2: A local fish feed industry producing quality species-specific and production system-specific feeds at affordable prices, using local ingredients where possible.	• P2-1 Specific feed formulations for age class and key production systems for key species. • P2-2 Efficient feed distribution and outlets in the main culture producing areas.
	P3: Hatchery production of high quality, well-performing and disease-free fry to support the expanding grow-out sector.	• P3-1 National broodstock management program to prevent inbreeding and select for fast growing strains. • P3-2 Hatchery good practice scheme (BMP / biosecurity). • P3-3 Sufficient fry availability and efficient distribution of fry to the main culture producing areas.

Table 4: The Action Plan – Market Development

Development Goal	Development Objectives	Actions
Sufficient supplies of farmed fish are available to meet increased fish consumption goals, supported by efficient and economic post-harvest systems	**M1: Respond to Rwanda's ambition to increase national wealth by ensuring this is matched by the availability of domestically reared or imported fish.**	• M1-1 Prioritise maximising contribution made by aquaculture. • M1-2 Accept that fish imports will be required & plan appropriately, in terms of government and commercial responses. • M1-3 Ensure that trade flows are not impeded unnecessarily.
	M2: Further develop Rwanda's regionally leading fish distribution system to extend supplies throughout Rwanda in order to maximise access to fish whilst minimising spoilage losses and hygiene risks.	• M2-1 Private sector investment in national cold chain infrastructure. • M2-2 Extend this to remote rural primary production locations where feasible. • M2-3 Coordinate systems to the wider benefit of perishable agriculture product distribution. • M2-4 Accept that infrastructural limits (e.g., power) exist, so develop appropriate distribution strategy. • M2-5 Provide support for distribution of traditional products (e.g., dried, smoked) where appropriate (i.e., where products are popular and practical).
	M3: Raise the profile of fish as a key component in Rwandan's diet and national food security.	• M3-1 Public awareness program to promote benefits of fish. • M3-2 Alert remote communities that *Ndagaa/Isambaza* is actually a fish. • M3-3 Mainstream fish within the national food policy dialogue. • M3-4 Segment fish consumption data collection, reporting and analysis into capture & culture monitoring and statistics.
	M4: Build upon the re-export fish trade to regional markets by facilitating and regularising this to maximise economic advantage to public and private interests whilst avoiding threats to the Rwandan domestic fish supply.	• M4-1 Assess the practicalities of formalising the re-export trade and risks that this could prove counterproductive. • M4-2 Upgrade cross border trade management, regulation and monitoring. • M4-3 If M4-1 positive, bring this trade into the formalised trade system. • M4-4 Seek opportunity for high-value export of Rwandan fish as an adjunct to domestic sales and provide appropriate support.

Development Goal	Development Objectives	Actions
	M5: Evaluate potential value of, and if positive, promote third party certification for sustainability covering environmental, social & governance (ESG) aspects to improve access to prime markets, encourage external investment and improve overall business performance.	• M5-1 Assess the potential benefits of third-party certification • M5-2 Realistic cost-benefit analysis to judge net advantage for Rwandan aquaculture • M5-3 Hold industry/government symposium to agree strategy • M5-4 If decision is positive, devise appropriate “RwandAqua” certification scheme or equivalence with established international schemes. • M5-5 Roll out scheme, starting with major commercial players

Table 5: The Action Plan – Risk management

Development Goal	Development Objectives	Actions
The biosecurity, food safety, environmental and socio-economic risks, both to and from Rwandan aquaculture production and its outputs, are identified and managed and where necessary mitigated	**R1: Rwandan aquaculture is resilient to existing and emerging biosecurity threats.**	• R1-1 Development of national biosecurity plan and strategy. • R1-2 Support the private sector to implement biosecurity measures. • R1-3 Support government responsibilities for biosecurity, inc. live import / export-related measures, disease diagnostics capability, farm surveillance and local / national / regional response mechanisms.
	R2: The produce from Rwandan aquaculture is nutritious and safe to eat across the value chain.	• R2-1 HACCP across value chain. • R2-2 Food safety standards for aquaculture products.
	R3: The environmental risks from Rwandan aquaculture are identified, monitored and managed where necessary to ensure the sector’s sustainable development.	• R3-1 Environmental impact assessment systems for Rwandan aquaculture operations. • R3-2 Environmental monitoring of Rwandan aquaculture. • R3-3 Impact of climate change assessed and included in sector planning and management. • R3-4 Climate change contribution of aquaculture mitigated through ‘green’ production systems.

Table 6: The Action Plan – Business & economics

Development Goal	Development Objectives	Actions
Improve the individual and overall performances of aquaculture businesses to increase production, profitability and employment opportunities for all Rwandans, thus contributing to the sustainable growth of the rural economy.	**B1: Aquaculture ventures, large and small in scale, are based upon sound business practice to ensure their commercial sustainability.**	• B1-1 In concert with educational institutions, commercial training for aquaculture production, processing and trading personnel the industry focuses on enhancing management skills. • B1-2 Restrict attribution of resources to projects with sufficient viability credentials. • B1-3 A net profit margin of at least 10% is seen as the minimal viable level. • B1-4 All actors of the aquaculture industry to be regularly assessed on their performances and – if necessary – advised to implement practices that provide better economic outcomes. • B1-5 Facilitation of investment for the culture of novel species/techniques dependent upon proven viability of the project
	B2: Economic and other forms of support available for promising aquaculture ventures including production, processing, distribution and marketing ventures.	• B2-1 Creation of an appraisal mechanism for evaluating viable schemes. • B2-2 Establishment of criteria for viable ventures in concert with research institutions or other appropriate bodies by the industry. • B2-3 The identification of funds / investors willing to invest in promising aquaculture ventures and facilitating of the negotiations between these funds / investors and the aquaculture investors is seen as a primarily matter for the industry.
	B3: Widening of the positive economic and socio-economic impact of viable aquaculture ventures achieved.	• B3-1 Promote equitable employment practices and monitor actual employment practices and resulting livelihood conditions, also responding to gender & diversity issues • B3.2 Support small holder and artisanal aquaculture through community-orientated planning, licensing & related decisions in disadvantaged rural communities.
	B4: Encouragement of ancillary activities and industry dependent upon aquaculture.	• B4-1 Rwandan feed mills include aquafeed in their offer and de novo specialist mills developing. • B4-2 Prospects for economic production of key raw materials (e.g., soy, other protein crops) investigated and where viable and sustainable, promoted.
	B5: Have insurance contracts implemented per year to cover business risks (2030) and technical risks (2035).	• B5-1 Monitoring of the risks level in the aquaculture sector. • B5-2 Piloting of insurance schemes.

Development Goal	Development Objectives	Actions
	B6: Set up and operationalise a Business Development Service entity (by 2025) to support the implementation of capable and sustainable aquaculture enterprises and gather valuable data about the sector.	• B6-1 Monitoring and benchmarking of aquaculture success factors and promotion of best practices. • B6-2 Small-scale farmers trained in basic business management e.g., financial planning, accounting and record keeping.
	B7: Clustering of small-scale farms to provide support services and encourage coordination for the bulk purchase of inputs and sales of products.	• B7-1 Clustering of small-scale producers into geographical zones for support services. • B7-2 Promote cluster models that provide services and inputs needed by small farmers. • B7-3 Support farmers for the creation of organisations to coordinate the bulk purchase of inputs and coordinated processing, sales and marketing.

Table 7: The Action Plan – Knowledge and Research

Development Goal	Development Objectives	Actions
Widely accessible vocational training with an efficient and widespread transfer of technologies to benefit farmers and improve overall aquaculture productivity in Rwanda, supported by a coordinated national aquaculture research and development programme	**K1: A well-functioning and Vocational Training programme for aquaculture technicians in farm operation and business managers for farm development and management.**	• K1-1 A well-functioning and Vocational Training programme for aquaculture technicians in farm operation and business managers for farm development and management. • K1-2 Vocational training needs assessment. • K1-3 Develop a vocational training program. • K1-4 Enhance private sector training.
	K2: A wide spread and effective extension service aimed at small scale and SME at the district level across the country.	• K2-1 Undertake regular extension needs analysis in terms of scope, location and farm numbers. • K2-2 Develop extension materials in the form of best practice manuals and videos in Rwandan language for the key species, culture systems, operation and management. • K2-3 Build capacity within RAB and train extension officers to undertake regular visits to key small scale and SME production areas to provide information and advice/aimed at small scale and SME at the district level across the country.
	K3: A well-functioning graduate and postgraduate education program by coordinated institutions in sustainable and responsible aquaculture production, planning and management.	• K3-1 Develop a full degree curriculum and postgraduate program. • K3-2 Develop a Department of Fisheries and Aquaculture within the University of Rwanda as a national Centre of Excellence.
	K4: A National Aquaculture Research program that is based on farmer needs and the development of new species and efficient culture systems.	• K4-1 Develop a coordinated research and development plan. • K4-2 Undertake appropriate research and development. • K4-3 Transfer knowledge to the farmers.

3.4 Key milestones of the NASR

Based on the anticipated production of 80,620 t of fish by 2035, we have prepared the following sets of scenarios:

1. Past (2010 - 2020) and anticipated (2025 - 2035) fish production, fry & aquafeed needs (see **Table 8**)
2. Past (2010 - 2020) and anticipated (2025 - 2035) capital expenditure (**Table 9)** and turnover (in USD 1,000 per annum) (Table 10)
3. Past (2010 - 2020) and anticipated (2025 - 2035) livelihoods, direct employment and indirect employment (**Table 11**)

These scenarios are based on a large number of assumptions and therefore must be taken as a possible illustration of the way the sector will change, rather than any detailed forecasts.

The main assumptions are provided in **Appendix A: Assumptions for anticipated milestones**.

Table 8: Past (2010 - 2020) and anticipated (2025 - 2035) fish production, fry & aquafeed needs

Subsistence pond farms

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	40	810	1,073	1,071	1,428	1,312
Production (t)	80	1,296	1,716	2,142	2,856	2,624
Production - tilapia (t)	*48*	*778*	*1,030*	*1,285*	*1,713*	*1,575*
Production - other spp. (t)	*32*	*518*	*686*	*857*	*1,142*	*1,050*
Fry requirements (no.)	534,933	8,641,067	11,440,000	14,280,390	19,038,599	17,495,237
Fertiliser requirement (t)	40	648	858	1,071	1,428	1,312

Semi-intensive pond farms

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	4	65	86	107	343	735
Production (t)	20	324	429	536	1,713	3,674
Production - tilapia (t)	*14*	*227*	*300*	*375*	*1,199*	*2,572*
Production - other spp. (t)	*6*	*97*	*129*	*161*	*514*	*1,102*
Fry requirements (no.)	66,867	270,033	1,251,250	1,785,049	5,711,580	12,246,666
On-farm fry production (no.)	11,702	189,023	875,875	446,262	1,427,895	3,061,666
Fertiliser requirement (t)	10	162	215	268	857	1,837
Supplementary feed requirement (t)	25	405	536	669	2,142	4,592

Intensive pond farms

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	-	-	-	-	57	210
Production (t)	-	-	-	-	1,142	4,199
Production - tilapia (t)	-	-	-	-	*571*	*3,359*
Production - other spp. (t)	-	-	-	-	*914*	*840*
Fry requirements (no.)	-	-	-	-	1,631,880	5,998,367
On-farm fry production (no.)	-	-	-	-	1,631,880	5,998,367
Feed requirement (t)	-	-	-	-	800	7,138

Intensive tanks, raceways & RAS

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	-	-	-	4	25	50
Production (t)	-	-	-	200	1,250	2,500
Production - tilapia (t)	-	-	-	*160*	*1,000*	*2,000*
Production - other spp. (t)	-	-	-	*40*	*250*	*500*
On-farm fry production (no.)	-	-	-	533,333	2,666,667	1,333,333
Feed requirement (t)	-	-	-	320	2,000	4,000

Small cage farm

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	-	-	7	11	21	30
Production (t)	-	-	1,653	2,779	5,128	7,623
Fry requirements (no.)	-	-	2,755,000	4,631,494	8,547,301	12,705,570
On-farm fry production (no.)	-	-	2,755,000	4,631,494	8,547,301	12,705,570
Feed requirement (t)	-	-	2,975	5,002	9,231	13,722

Large cage farms

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	-	-	1	2	10	12
Production (t)	-	-	500	9,000	52,000	60,000
On-farm fry production (no.)	-	-	1,428,571	25,714,286	148,571,429	171,428,571
Feed requirement (t)	-	-	850	15,300	88,400	102,000

All types

Characteristic	Past (estimates)			Future (forecast)		
	2010	2015	2020	2025	2030	2035
No. of farms	44	875	1,166	1,195	1,884	2,349
Production (t)	100	1,620	4,298	14,656	64,090	80,620
Production - tilapia (t)	62	1,005	3,483	13,599	61,612	77,129
Production - other spp. (t)	38	616	815	1,057	2,820	3,492
Fry requirements (no.)	601,800	8,911,100	15,446,250	20,696,934	34,929,360	48,445,839
On-farm fry production (no.)	11,702	189,023	5,059,446	31,325,376	162,845,171	194,527,508
Feed requirement (t)	65	1,053	5,220	22,362	104,000	132,765

Table 9: Past (2010 - 2020) and anticipated (2025 - 2035) capital expenditure (in USD 1,000 per annum)

Farm category	Past (estimates) 1,000 USD			Future (forecast) 1,000 USD		
	2010	2015	2020	2025	2030	2035
Subsistence pond farms	$ 80	$ 1,620	$ 2,145	$ 2,142	$ 2,856	$ 2,624
Semi-intensive pond farms	$ 30	$ 119	$ 266	$ 711	$ 2,570	$ 5,511
Intensive pond farms	$ -	$ -	$ -	$ -	$ 8,496	$ 18,895
Intensive tanks, raceways & RAS	$ -	$ -	$ -	$ 1,000	$ 6,250	$ 12,500
Small cage farm	$ -	$ -	$ 2,066	$ 3,474	$ 6,410	$ 9,529
Large cage farms	$ -	$ -	$ 1,250	$ 22,500	$ 130,000	$ 150,000
TOTALS	**$ 110**	**$ 1,740**	**$ 5,727**	**$ 29,827**	**$ 156,582**	**$ 199,059**

Table 10: Past (2010 - 2020) and anticipated (2025 - 2035) farm turnover by species (in USD 1,000 per annum)

Turnover - tilapia production

Farm category	Past (estimates) 1,000 USD			Future (forecast) 1,000 USD		
	2010	2015	2020	2025	2030	2035
Subsistence pond farms	$ 144	$ 2,916	$ 3,861	$ 3,856	$ 5,140	$ 4,724
Semi-intensive pond farms	$ 42	$ 167	$ 372	$ 996	$ 3,598	$ 7,715
Intensive pond farms	$ -	$ -	$ -	$ -	$ 2,832	$ 10,077
Intensive tanks, raceways & RAS	$ -	$ -	$ -	$ 560	$ 3,500	$ 7,000
Small cage farm	$ -	$ -	$ -	$ 9,726	$ 17,949	$ 26,682
Large cage farms	$ -	$ -	$ 1,750	$ 31,500	$ 182,000	$ 210,000
TOTALS	**$ 187**	**$ 3,084**	**$ 5,983**	**$ 46,638**	**$ 215,020**	**$ 266,198**

Turnover - other species production

Farm category	Past (estimates) 1,000 USD			Future (forecast) 1,000 USD		
	2010	2015	2020	2025	2030	2035
Subsistence pond farms	$ 80	$ 1,620	$ 2,145	$ 2,142	$ 2,856	$ 2,624
Semi-intensive pond farms	$ 15	$ 60	$ 133	$ 356	$ 1,285	$ 2,755
Intensive pond farms	$ -	$ -	$ -	$ -	$ 3,776	$ 2,099
Intensive tanks, raceways & RAS	$ -	$ -	$ -	$ 120	$ 750	$ 1,500
Small cage farm	$ -	$ -	$ -	$ -	$ -	$ -
Large cage farms	$ -	$ -	$ -	$ -	$ -	$ -
TOTALS	**$ 95**	**$ 1,680**	**$ 2,278**	**$ 2,618**	**$ 8,667**	**$ 8,979**

Table 11: Past (2010 - 2020) and anticipated (2025 - 2035) livelihoods, direct employment and indirect employment

Livelihoods

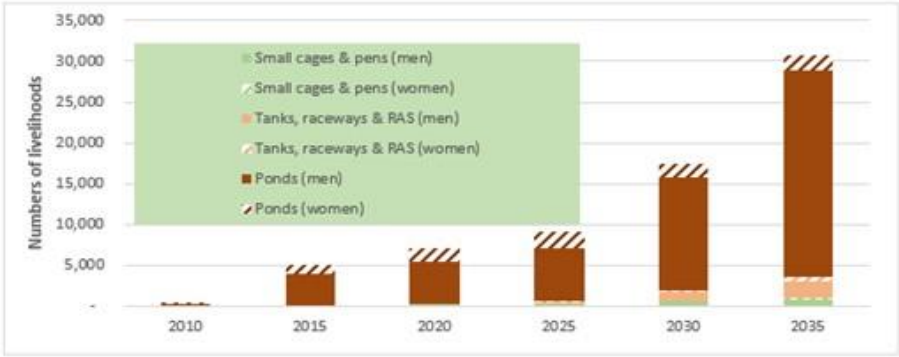
System type (gender)	2010	2015	2020	2025	2030	2035
Small cages & pens (men)	-	-	198	333	615	915
Small cages & pens (women)	-	-	44	37	68	102
Tanks, raceways & RAS (men)	-	-	-	160	1,000	2,000
Tanks, raceways & RAS (women)	-	-	-	40	250	500
Ponds (men)	227	3,928	5,200	6,491	13,846	25,448
Ponds (women)	76	1,227	1,625	2,028	1,711	1,753
Total (men)	***227***	***3,928***	***5,398***	***6,985***	***15,462***	***28,362***
Total (women)	***76***	***1,227***	***1,669***	***2,106***	***2,029***	***2,355***
Grand total	**303**	**5,155**	**7,067**	**9,090**	**17,491**	**30,717**

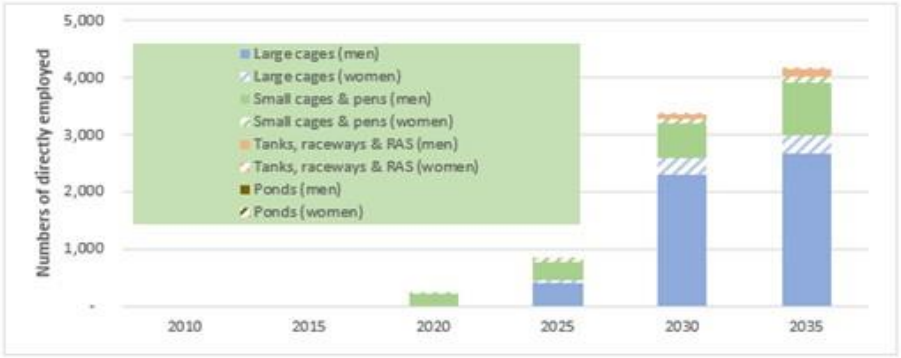
Direct employment

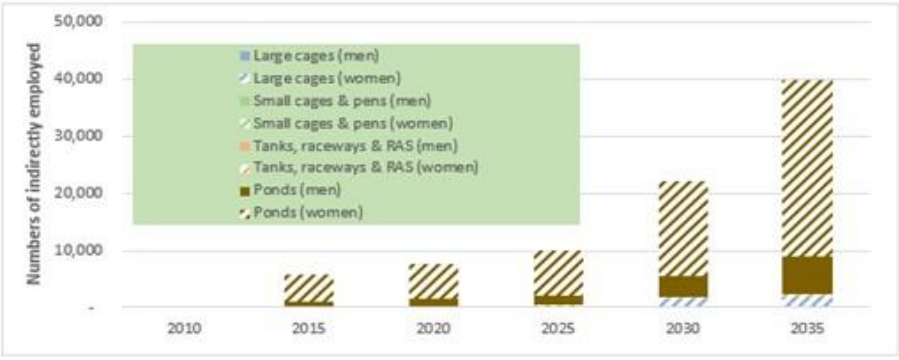
System type (gender)	2010	2015	2020	2025	2030	2035
Large cages (men)	-	-	22	401	2,314	2,670
Large cages (women)	-	-	3	50	286	330
Small cages & pens (men)	-	-	198	333	615	915
Small cages & pens (women)	-	-	22	37	68	102
Tanks, raceways & RAS (men)	-	-	-	11	67	133
Tanks, raceways & RAS (women)	-	-	-	3	17	33
Ponds (men)	-	-	-	-	-	-
Ponds (women)	-	-	-	-	-	-
Total (men)	-	-	***198***	***344***	***682***	***1,048***
Total (women)	-	-	***22***	***40***	***85***	***135***
Grand total	-	-	**220**	**384**	**767**	**1,183**

Indirect employment

System type (gender)	2010	2015	2020	2025	2030	2035
Large cages (men)	-	-	3	49	285	329
Large cages (women)	-	-	13	225	1,300	1,500
Small cages & pens (men)	-	-	14	24	44	65
Small cages & pens (women)	-	-	65	109	200	298
Tanks, raceways & RAS (men)	-	-	-	2	11	21
Tanks, raceways & RAS (women)	-	-	-	8	49	98
Ponds (men)	64	1,040	1,376	1,718	3,665	6,736
Ponds (women)	292	4,736	6,271	7,827	16,697	30,687
Total (men)	***64***	***1,040***	***1,391***	***1,744***	***3,720***	***6,823***
Total (women)	***292***	***4,736***	***6,335***	***7,944***	***16,946***	***31,082***
Grand total	**357**	**5,776**	**7,726**	**9,688**	**20,666**	**37,905**







4. Implementation of the NASR

4.1 Roles and Responsibilities

4.1.1 Main participants

The Action Plan recommends a large number of actions that need to be implemented before 2035, with many over the short-term e.g., the three year period 2023 to 2025. These will need to be led by a variety of different actors in the aquaculture sector, including the following:

- **Private sector**: the private sector will provide a pivotal role in implementing the Strategy, as they will both drive growth and demand improvements to governance, research and the value chain performance. The Strategy assumes much of this drive will come from the larger, more commercially experienced companies as they bring in experience from elsewhere and become established in Rwandan conditions. It is essential – and indeed an acknowledged pre-condition (see **Section 2.6.1**) that private sector experience and expertise is fully leveraged by RAB though a co-management approach (see Development Objective G4 in the Action Plan).
- **Government (MINAGRI/RAB)**: aquaculture planning and administration is under the Ministry of Agriculture and Natural Resources (MINAGRI) and the Rwanda Agriculture and Animal Resources Development Board (RAB). The Action Plan includes an action (G2-1) to establish a dedicated aquaculture department in RAB with clear roles and capabilities, which would be ultimately responsible for leading many of the governance-related tasks in the Action Plan. Over the short-term, it is recommended that particular support is provided to MINAGRI/RAB to guide delivery of the Strategy until RAB's aquaculture unit is fully established and operational (see **Section 4.2** below for more details of the NASR Delivery Unit).
- **Government (other)**: there is a role for other Government bodies and agencies to assist with the delivery of this Strategy. In particular the Rwanda Environmental Management Authority (REMA), Rwanda Water Board (RWB), the Rwanda Food and Drugs Authority (RFDA), the Rwanda Land Management and Use Authority (RLMUA), the Rwanda Standards Board (RSB) and the Rwanda Development Board (RDB) will be key participants in different areas of the Strategy. In addition the budgeting and planning of the strategy will be conducted in coordination with the Ministry of Finance and Economic Planning.
- **Academia**: the University of Rwanda, together with other academic institutes in such as INATEK (Institute of Agriculture, Technology and Education of Kibungo), Rwanda Polytechnic and IPRC (Integrated Polytechnic Regional Centre) located in each Rwandan province will key partners in the Strategy through both (i) participating in the multi-annual aquaculture research programme (see Development Objective K1 in the Action Plan) and (ii) in training young Rwandans in the science, technology and economics of modern aquaculture.

4.1.2 Roll out

The first few years of the Strategy roll out will very much be government-led, putting in the basic regulatory building blocks for sustainable aquaculture development, in order to support private sector growth. It is important that the private sector is regularly consulted over this formative period as they coalesce into a representative and competent co-management partner.

As the Strategy matures, the private sector will increasingly drive aquaculture production in Rwanda, co-funding need-based research, and diversifying and expanding production as the markets develop. They will be supported through a valued co-management approach by a capable and focused

aquaculture administration that facilitates responsible investment and ensures the sector meets environmental, economic and social obligations as the country moves towards 2050.

4.2 Delivery planning, delivery and oversight

4.2.1 Overview

Whilst the expected growth in the aquaculture sector will be largely driven by an entrepreneurial private sector, MINAGRI / RAB will be responsible for overseeing the implementation of the Strategy. An important short-term Development Objective is "*An active and capable administration that supports and manages the sustainable development of aquaculture in Rwanda*" (G2).

In order to bridge the transition to this point, it there are a number of options. These include:

1. **Rapid development of RAB's planning and management capacity** as envisaged by Development Objective G2. This could be supported by a temporary working group or committee formed from MINAGRI, RAB and private sector co-managers.
2. **Formation of a short-term delivery unit in RAB** to assist in the initial implementation of the Strategy. The first two to three years of the Strategy's timeline (see **Section 4.3**, next) will be highly formative, containing the bulk of the actions, many of which are essential pre-cursors to the longer-term roll-out of the outputs from the Action Plan. Once the RAB Aquaculture Unit has been fully established, staffed and where necessary capabilities developed, RAB will assume the responsibilities for overseeing the implementation of the strategy over the medium and longer-term.
3. **Formation of a Rwanda Aquaculture Development Agency** to oversee and coordinate the implementation of this strategy and the associated Action Plan. This agency could evolve from the short-term delivery unit in RAB suggested above, remaining at arm's length from RAB to assist MINAGRI guide, monitor and evaluate the implementation of the Strategy. This approach has been successfully undertaken in a number of countries, such as Australia and the Seychelles.

4.2.2 Implementation support

Support will need to be provided to RAB over the first few years of the strategy's implementation. In particular the capacity of the staffing will need to be built in both numbers and skill to ensure adequate capability to support the private sector as it drives development of the aquaculture sector. Where these skills are not able to be built in-house, short-term consultancies or contracts should be considered e.g., in specialist areas such as IT, GIS and monitoring and evaluation. It is important that RAB's capacity to deliver is regularly evaluated and additional capacity added where and when necessary.

4.2.3 Embedding of the NASR into national planning and budgeting

Irrespective of who leads delivery of the Strategy (e.g., RAB, or RAB with the assistance of a short-term delivery unit, or a semi-independent Rwanda Aquaculture Development Agency), its implementation will need to be carefully planned.

The Action Plan provided in **Annex A** is comprehensive and wide-reaching. The main budgeting vehicle will be the forthcoming PSTA-5 (2025 – 2029) and subsequent PSTA 6 & 7 five-year funding cycles. This mapping process will inevitably suggest that further prioritisation and compromises might have to be made. It is essential that the co-management approach with the private sector strongly advocated in the Strategy starts at this point, with the industry providing robust and representative views on where

the main funding priorities are and what key administrative or technical bottlenecks need to be addressed first.

4.2.4 Implications for RAB staffing and budget

The anticipated twenty-fold expansion in aquaculture production over about 15 years will require a considerable strengthening of RAB's capacity and capability. This is specifically supported in the Action Plan through Development Objective G2 '*An active and capable administration that supports and manages the sustainable development of aquaculture in Rwanda'*, where the formation of a 'Department of Aquaculture and Fisheries' is envisioned, both within MINAGRI (for policy direction) and RAB (for implementation and operational management).

The structure of this Department will be determined over the first two key actions of G2:

- G2-1: Dedicated and well-trained unit for aquaculture administration in RAB with clear roles and responsibilities with adequate capability and resources for an expanding and diversifying aquaculture sector at both national and local levels.
- G2-2: Integrated aquaculture planning, licensing and monitoring systems to facilitate, manage and inform sustainable aquaculture development via an online portal to improve investor experience and transparency.

In anticipation of this, we would suggest that MINAGRI / RAB's specialist aquaculture staff contingent might look as follows.

Table 12: Illustrative view on MINAGRI / RAB staffing and budget over 2025, 2030 & 2035

Organisation	Position	Grade range	Positions (FTE)			Cost (USD)		
			2025	2030	2035	2025	2030	2035
MINAGRI	DG: Aquaculture	2	0.5	1	1	$ 6,197	$ 12,394	$ 12,394
MINAGRI	Technical adviser: Aquaculture	4	1	1	1	$ 7,324	$ 7,324	$ 7,324
MINAGRI	Technical adviser: M&E	4	0.5	1	1	$ 3,662	$ 7,324	$ 7,324
RAB	Director - Aquaculture	3	1	1	1	$ 9,577	$ 9,577	$ 9,577
RAB	Deputy-Director: Aquaculture	4		1	1	$ -	$ 7,324	$ 7,324
RAB	Head: Aquaculture licensing	4	1	1	1	$ 7,324	$ 7,324	$ 7,324
RAB	Head: Aquaculture research	4	0.5	0.75	1	$ 3,662	$ 5,493	$ 7,324
RAB	Technical officer: Markets	5	0.5	1	1	$ 3,099	$ 6,197	$ 6,197
RAB	Technical officer: Extension	5	1	2	3	$ 6,197	$ 12,394	$ 18,592
RAB	Technical officer: Biosecurity	5	1	2	2	$ 6,197	$ 12,394	$ 12,394
RAB	Technical officer: Environment	5	1	1	2	$ 6,197	$ 6,197	$ 12,394
RAB	Technical officer: Industry liaison	5	1	1	1	$ 6,197	$ 6,197	$ 6,197
RAB	Technical officer: GIS	5	1	1	1	$ 6,197	$ 6,197	$ 6,197
RAB	Technical officer: IT	5	1	1	1	$ 6,197	$ 6,197	$ 6,197
RAB	Technical officer: Statistics	5	0.5	1	1	$ 3,099	$ 6,197	$ 6,197
RAB	Technical officer: Procurement	5	0.5	0.25	0.25	$ 3,099	$ 1,549	$ 1,549
RAB	Assistant: IT	7	1	1	1	$ 4,282	$ 4,282	$ 4,282
RAB	Assistant: Licensing	7	1	2	3	$ 4,282	$ 8,563	$ 12,845
RAB	Assistant: Procurement	7	0.5	0.5	0.5	$ 2,141	$ 2,141	$ 2,141
TOTALS			**14.5**	**20.5**	**23.75**	**$ 94,930**	**$ 135,268**	**$ 153,775**

Source: FTEs Poseidon estimates. Salaries based on 2020 government salary grades (approximated).

The full-time equivalent (FTE) staffing levels and associated salary costs in the table above are for illustration only but provide an image of how MINAGRI and RAB's staffing and associated costs might change of the three key time points in the Strategy's timeline. It suggests that RAB will develop a cadre of specialist technical officers across a wider range of disciplines with an FTE by 2035 of around 12 persons.

4.3 Timeline

The Strategy is expected to be realised over the period from 2023 to 2035. The 2035 planning horizon has been chosen as it is the proposed mid-point for Rwanda's Vison 2050 and where a mid-term review will take place. As a result, various national planning targets for Rwanda have been sent, including becoming an upper-middle income country by 2035 and a GDP per capita of over USD 4,036.

The timeline has been divided into three periods as follows:

Short-term 2023 - 2024		Medium-term 2025 - 2029					Long-term 2029 - 3035					
PSTA-4		PSTA-5					PSTA-6					PSTA-7
2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

The first two years of the Strategy will fall under the last part of the current five-year Strategic Plan for Agriculture Transformation (PSTA) 2018 – 2024. This will mainly serve as a mobilisation period before the mina first phase of the Strategy's implementation under PSTA-5 (2025 – 2029). It will then be consolidated over the longer-term through PSTA-6 (2030 – 2034) and then PSTA-7 (2035 – 2039).

5. Budget and Funding

5.1 General principles

A key principle of the Strategy (see **Section 2.1**) is that funding of the Strategy's implementation must be a national responsibility. The governance costs must be from recurrent Government funding, and the private sector is expected to pay for applied research, innovation and capacity-building. It is also expected that some external funding will be required to kick-start critical activities where appropriate.

A detailed budget will be prepared for (i) immediate short-term funding under the remainder PSTA-4 and the main implementation period under PSTA-5 (2025 – 2029)

5.2 Budget

Costing a detailed Action Plan such as found in Annex A is a complex task. In order to guide the Government of Rwanda, a provisional budget has been provided in below. This simple analysis provides some costs to demonstrate the incremental budget requirements to fund the Strategy. This is based on actions undertaken by government to put in place a number of plans and structures necessary to underpin future sustainable expansion of the aquaculture sector in Rwanda, such as spatial planning, biosecurity planning and research. Please note it excludes the following:

1. Incremental government staff costs (provisional estimates are provide in **Section 4.2.4** above).
2. Government capital costs for aquaculture-related infrastructure.
3. Capital costs for cold chain development.
4. Private sector development costs (note some capital cost and turnover estimates are provided in the M&E section in **Section 6**).

The outline budget is included in **Table 13** overleaf. It amounts to just under USD 5.5 million over the period 2023 – 2025, or around USD 42,000 per annum. Whilst this sounds a considerable sum, it is relatively small compared to an industry that is projected to turnover nearly USD 9 million per annum by 2035 (see Table 16 on 45). on page 45).

The majority of the budget (66%) is mainly targeted at capacity-building (35%) and governance support (31%). The balance is across risk management, production support, market development an investment proposition. In terms of the main recipients, RAB is by far the biggest (85%), with MINAGRI (4%) and academia (8%) other important recipients.

Figure 4: Budget by area and lead recipient

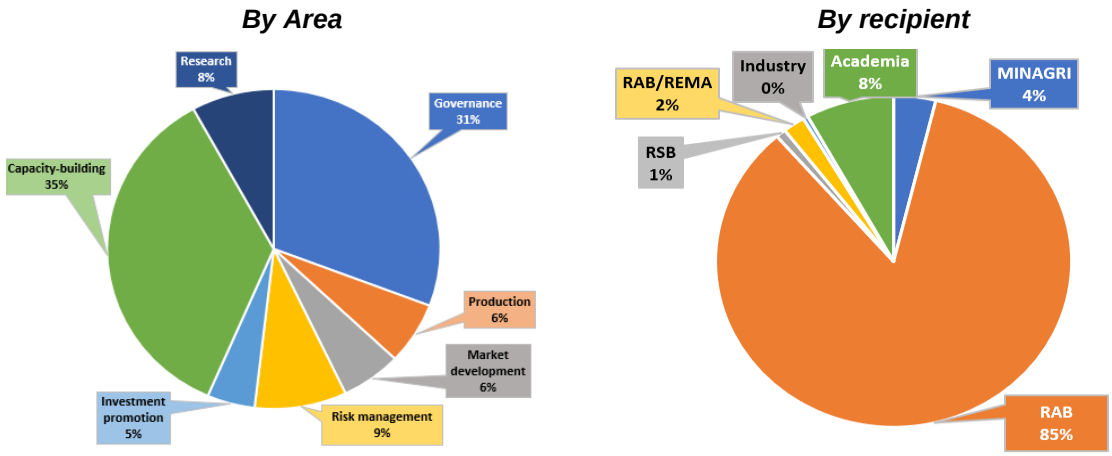


Table 13: Outline budget for strategy implementation (excludes staffing, infrastructure and private sector costs)

Key area	Cost item	Description	Period	Main recipient	2023-2025	2026-2030	2031-2035	Total	DO link
Governance	Aquaculture policy - development	External policy assistance	One-off	MINAGRI	$ 10,000	$ -	$ -	$ 10,000	G1-1
Governance	Aquaculture policy - periodic review	External policy assistance	10-years	MINAGRI	$ -	$ -	$ 10,000	$ 10,000	G1-1
Governance	Aquaculture regulation MO - development	International legal assistance	One-off	MINAGRI	$ 100,000	$ -	$ -	$ 100,000	G1-2
Governance	Aquaculture regulation MO - review	International legal assistance	5-years	MINAGRI	$ -	$ 25,000	$ 25,000	$ 50,000	G1-2
Governance	Administration functional review	External institutional specialist	One-off	RAB	$ 25,000	$ -	$ -	$ 25,000	G2-1
Governance	One stop shop establishment, inc. GIS	GIS / IT specialist assistance	One-off	RAB	$ 150,000	$ -	$ -	$ 150,000	G2-2
Governance	One stop shop development	GIS / IT specialist assistance	Annual	RAB	$ 25,000	$ 75,000	$ 75,000	$ 175,000	G2-2
Governance	Establish Statistical capability	Statistics development expertise	One-off	RAB	$ 150,000	$ -	$ -	$ 150,000	G2-3
Governance	Statistical data collection	Statistics development expertise	Annual	RAB	$ 100,000	$ 100,000	$ 150,000	$ 350,000	G2-3
Governance	Rwanda Aquaculture Atlas	GIS / IT specialist assistance	One-off	RAB	$ 75,000	$ -	$ -	$ 75,000	G3-1
Governance	Rwanda Aquaculture Atlas - update	GIS / IT specialist assistance	Annual	RAB	$ 25,000	$ 40,000	$ 40,000	$ 105,000	G3-1
Governance	Aquaculture area management planning	External spatial planning assistance	Annual	RAB	$ 50,000	$ 25,000	$ 25,000	$ 100,000	G3-2
Governance	Establishing co-management structures	External assistance	One-off	RAB	$ 25,000	$ -	$ -	$ 25,000	G4-1
Governance	Operate co-management mechanisms	Stakeholder meetings & communication	Annual	RAB	$ 75,000	$ 125,000	$ 125,000	$ 325,000	G4-2
Production support	Support to small-scale pond planning	GIS / IT specialist assistance	5-years	RAB	$ 10,000	$ 5,000	$ 5,000	$ 20,000	P1-3
Production support	Support specialist aquafeed development	Specialist support	One-off	RAB	$ 40,000	$ -	$ -	$ 40,000	P2-1
Production support	Support to broodstock certification	Specialist support	One-off	RAB	$ 10,000	$ 40,000	$ -	$ 50,000	P3-1
Production support	Support to hatchery certification	Specialist support	One-off	RAB	$ 40,000	$ -	$ -	$ 40,000	P3-2
Production support	Support to improving farm productivity & circularity	Specialist support	Annual	RAB	$ 45,000	$ 75,000	$ 75,000	$ 195,000	P4
Market development	Support to market intelligence	Specialist support	Annual	RAB	$ 45,000	$ 50,000	$ 50,000	$ 145,000	M1
Market development	Promoting farmed fish consumption in Rwanda	Specialist support	Annual	RAB	$ 22,500	$ 50,000	$ 50,000	$ 122,500	M3
Market development	Trade studies	Specialist support	One-off	RAB	$ -	$ 20,000	$ -	$ 20,000	M4
Market development	Support ecolabelling & brand development	Specialist support	5-years	RAB	$ 15,000	$ 10,000	$ 10,000	$ 35,000	M5
Risk management	Prepare national biosecurity plan	Specialist support	One-off	RAB	$ 150,000	$ -	$ -	$ 150,000	R1
Risk management	Ongoing support to biosecurity planning & response	Specialist support	Annual	RAB	$ 30,000	$ 75,000	$ 75,000	$ 180,000	R1
Risk management	Develop specific standards for aquaculture	Specialist support	One-off	RSB	$ 25,000	$ 15,000	$ 10,000	$ 50,000	R2
Risk management	Develop ESIA framework	Specialist support	One-off	RAB/REMA	$ 30,000	$ 10,000	$ 10,000	$ 50,000	F3-1
Risk management	Establish environmental monitoring capability in RAB	Specialist support	One-off	RAB/REMA	$ 20,000	$ 10,000	$ 10,000	$ 40,000	R3-2
Risk management	Develop climate change adaptation plan for aquaculture	Specialist support	One-off	RAB/REMA	$ 20,000	$ -	$ -	$ 20,000	R3-3
Governance	Support benchmarking technical / economic performance	Specialist support	Annual	MINAGRI	$ 30,000	$ 5,000	$ 5,000	$ 40,000	B1
Investment promotion	Support RAB investment appraisal capability	Specialist support	5-years	RAB	$ 15,000	$ 5,000	$ 5,000	$ 25,000	B2
Investment promotion	Support 'good employment' in the aquaculture sector	Specialist support	One-off	Industry	$ 15,000	$ 5,000	$ 5,000	$ 25,000	B3
Investment promotion	Support aquaculture insurance development in Rwanda	Specialist support	5-years	RAB	$ 25,000	$ 10,000	$ 15,000	$ 50,000	B5
Investment promotion	Establish Business Development Service	Specialist support	5-years	RAB	$ 15,000	$ 5,000	$ 5,000	$ 25,000	B6
Investment promotion	Support SME aquaculture clusters	General support	Annual	RAB	$ 30,000	$ 50,000	$ 50,000	$ 130,000	B7
Capacity-building	Vocational training needs analysis	Specialist support & training	Annual	RAB	$ 150,000	$ 250,000	$ 250,000	$ 650,000	K1
Capacity-building	install and run aquaculture extension service	Specialist support & training	Annual	RAB	$ 225,000	$ 375,000	$ 375,000	$ 975,000	K2
Capacity-building	Support aquaculture graduate and post-graduate programs	Specialist support & training	Annual	Academia	$ 75,000	$ 125,000	$ 125,000	$ 325,000	K3
Research	Develop annual research planning capability	Research planning expertise	5-years	Academia	$ 75,000	$ 20,000	$ 20,000	$ 115,000	K4-1
Research	On-going support to aquaculture research	Specialist support	Annual	RAB	$ 75,000	$ 125,000	$ 125,000	$ 325,000	K4-2
					$ 2,042,500	$ 1,725,000	$ 1,725,000	$ 5,492,500	

5.3 Cost recovery

With co-management comes responsibility, including for the funding of sector support and research. It is therefore important that cost-recovery opportunities are included in the long-term budgeting of sector support, including:

- Aquaculture licenses and permits.
- Environmental permits.
- Applied research (it is expected that research plans will be demand driven).
- Specialist technical support.
- Pollution mitigation and clean up.

Experience shows that the private sector is prepared to co-fund actions so long as they are clear and transparent, pre-planned in consultation with industry and provide a clear benefit to sustainable development of the sector.

5.4 Role of external funding

As discussed above, the general principle is for sustained national funding of the Strategy, both from Government recurrent funding as well as through cost-recovery from the private sector as it benefits from the development of the sector. However, there is potentially a role for external funding agencies such as international development agencies, bilateral donors and non-governmental philanthropic sources to provide short-term, highly directed financial and technical assistance to assist the Government implement this Strategy.

This source of funding would likely be targeted at the following:

- Short-term technical studies that would benefit from external expertise
- Capacity-building e.g., in-country and external training.
- Longer-term research, again probably where external expertise might be appropriate.
- Governance support e.g., technical or financial assistance to RAB.
- Monitoring and evaluation of the NASR's implementation.

6. Monitoring and Evaluation of the Strategy's Implementation and Impact

Given its long-term nature (e.g., up to 2035) and the wide range of actions envisaged, as well as the level of government budgetary support, the implementation, outcomes and impacts of the NASR need to be carefully monitored and periodically evaluated.

6.1 Monitoring

As part of the process of embedding of the NASR into national planning and budgeting processes (see **Section 4.2.3** on page 36 above) an appropriate monitoring framework needs to be established. A key component of this will be the identification of objectively verifiable SMART[2] indicators (OVIs) at different levels e.g., *process* (e.g., whether the activities and actions are being undertaken as planned), *outcome* (e.g., whether the Development Objectives have been realised and *impact* (whether the Development Goals have been realised). These should be a mixture of production (e.g. FCRs, growth rates), economic and consumer data (e.g. PCC).

Whilst these indicators will need to be developed by MINAGRI and RAB as part of their multi-annual sector planning processes (again, see **Section 4.2.3**), a number of high level *key performance indicators* (KPIs) have been identified, based on the production forecasts provided in **Section 3.4** and are provided in the table below.

Table 14: Key Performance Indicators for Strategy performance in 2025, 2030 & 2035

Key Performance indicator (KPI)		Milestone year		
		2025	2030	2035
KPI 1	Pond & tank production (t)	2,500	6,500	12,000
KPI 2	Cage production (t)	10,000	50,000	60,000
KPI 3	Juvenile production (million)	45	175	210
KPI 4	Feed used (t)	19,000	90,000	120,000
KPI 5	Men employed in value chain	9,000	18,000	35,000
KPI 6	Women employed in value chain	10,000	18,000	32,000
KPI 7	Fish per per capita consumption (kg/person/yr)	7.2	9.0	9.8

Source: Author's estimates.

It is suggested assistance is provided to RAB for the design and establishment of an M&E system, which would be transferred over to MINAGRI / RAB over the duration of its temporary existence. After that, NASR M&E should be integrated into recurrent MINAGRI/RAB planning and appraisal.

[2] SMART: Specific, Measurable, Achievable, Relevant and Time-Bound

6.2 Evaluation

It is important that periodic evaluations take place. These will allow the inevitable adjustments to the Action Plan to be made, and to ensure the NASR remains relevant, efficient and effective. We suggest formal evaluations take place at the following intervals:

- Mid-term evaluation: will take place towards the end of the first half of the NASR time line e.g., in 2027 (at the end of Year 5)
- Terminal evaluation: to take place one year before the Strategy timeline ends e.g., in 2034. This will allow an effective evaluation of the whole programme and to assist develop an exit strategy, possibly leading to the design of a new strategy over 2036 – 2050.

Appendix A: Assumptions for anticipated milestones and KPIs

Table 15: Assumptions - Production

System	Description	Productivity (t/yr)	FCR (kg feed/fertiliser per kg fish			Fry source (%)		Species mix (%)		Survival (%)	Harvest size (g)
			30% protein feed	*20% protein feed*	*Fertiliser*	*Bought*	*Own produce*	*Tilapia*	*Other*		
Subsistence pond farms	Subsistence level pond farming without feeds, only fertilised primary production.	2	n/a	n/a	0.5	100%	0%	60%	40%	50%	300g
Semi-intensive ponds	Fertilised ponds with supplementary feeding.	5	n/a	1.25	0.5	80%	20%	70%	30%	60%	400g
Intensive ponds	Fully fed ponds	20	1.7	n/a	n/a	50%	50%	80%	20%	70%	500g
Tanks, raceways & RAS	Intensive flow-through systems.	50	1.6	n/a	n/a	n/a	100%	80%	20%	75%	500g
Small-scale cages & pens	<500 t cages and pens	250	1.8	n/a	n/a	50%	50%	100%	n/a	60%	500g
Large-scale cages	>500 t cages	5,000	1.7	n/a	n/a	n/a	100%	100%	n/a	70%	500g

Sources:

Attribute	Source
Productivity	Poseidon estimates based on regional statistics
FCRs	Poseidon estimates based on regional statistics
Fry source	Poseidon estimates
Species mix	Poseidon estimates, based on anticipated demand and current production patterns.
Survival	Poseidon estimates based on regional statistics
Harvest size	Data collected over strategy preparation

Table 16: Assumptions – CAPEX and turnover

Capital cost (CAPEX)

System	Capital cost per tonne of production per annum (USD)
Subsistence pond farms	1,000
Semi-intensive ponds	1,500
Intensive ponds	4,500
Tanks, raceways & RAS	5,000
Small-scale cages & pens	1,250
Large-scale cages	2,500

Source: Regional data accumulated by Poseidon

Turnover

Species (system)	Farm gate price per kilogram (USD/kg)
Tilapia (ponds)	$ 3.00
Tilapia (cage)	$ 3.50
Catfish / carp (all systems) – local sales	$ 2.50
Catfish / carp (all systems) – export sales	$ 3.00

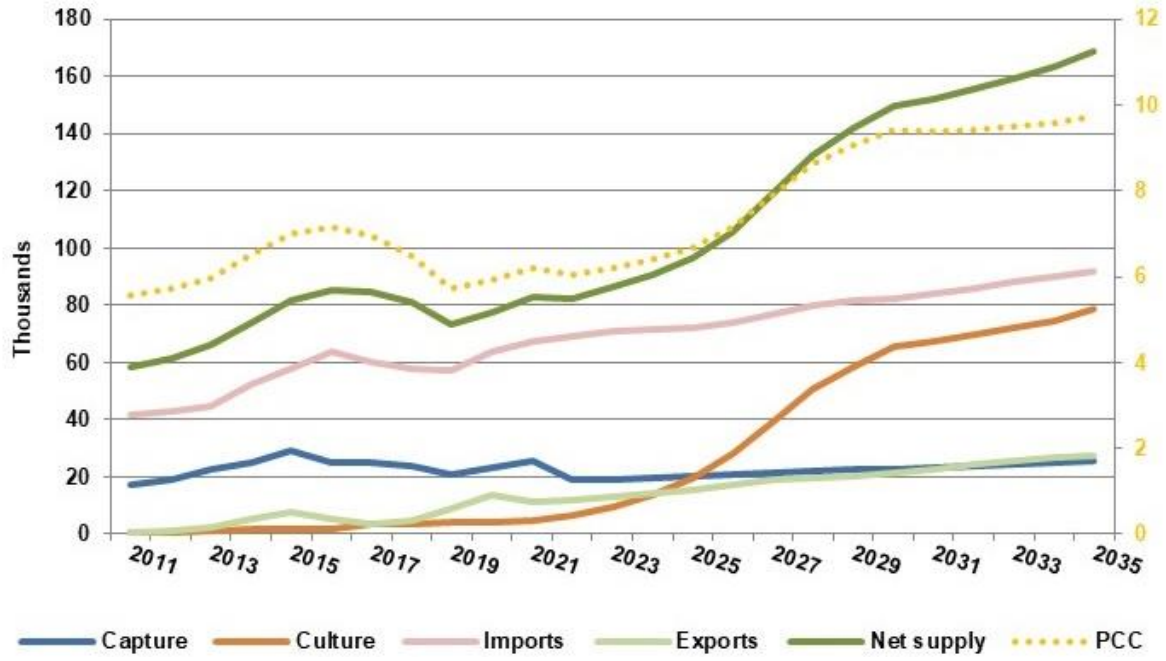
Source: Poseidon estimates, based on data collected over strategy preparation

Table 17: Assumptions – Employment

Type	System	Gender ratio (%)		FTE per tonne			Indirect multipliers (FTE per tonne)
		Men	Women	Livelihood	Direct	Total	
Livelihoods	Subsistence pond farms	72.5%	27.5%	0.3	0	0.3	0.28
	Semi-intensive ponds	75%	25%	0.3	0	0.3	0.28
Direct employment	Small-scale cages & pens	90%	10%	7.5	7.5	15	21
	Raceway, tanks & RAS	90%	10%	n/a	15	15	21
	Large-scale cages	89%	11%	n/a	20	20	32.8
Indirect employment	Fish sales outlets	11%	89%				
	Fish street sellers	18%	82%				

Attribute	Source
Gender ratios	Consultant estimates based on local information
FTEs	Consultant estimates based on regional information

Figure 5: Overall fish production and per capita consumption forecast up to 2035 ('000 tonnes / kg PCC)



Source: NASR Foundation Report (Section 4.2.2)

Using the forecast for growth in aquaculture over the next 15 years, trend line projections of growth in imports and exports are combined with the forecast growth in aquaculture output. The outcome suggests that if (i) trade performs as past trends suggest and (ii) the anticipated growth in aquaculture is achieved (i.e. proposed plans are fully implemented), then total supply will rise to around 170,000 tonnes annually. This would then allow fish consumption, as defined by PCC, to rise to close to 10kg per person per year.