Eritrea

National Aquaculture Development Strategy and Implementation Plan

2023-2027

Ministry of Marine Resources

Massawa

November, 2022

Vision (Drawn from the Draft Fisheries Policy)

To develop an ecologically healthy, economically viable and socially inclusive sustainable aquaculture sector towards economic prosperity, food and nutritional security, and wellbeing of the aquaculture communities and practitioners in Eritrea. The coastal areas of the Red Sea will be the beacon of a vibrant economic growth and development for Eritrea.

Mission

To establish and develop a sustainable aquaculture sector, taking advantage of long coastal line, the hundreds of existing inland water reservoirs, the rich marine biodiversity (genetic materials) for different production systems, and conducive climate to create a highly productive aquaculture sector best on aquaculture practices and continuous innovation. Create a sector that delivers quality and sufficient seafood, and significantly contributes to Eritrea's food security and brings substantial socio-economic benefits to coastal and inland aquaculture communities across the country.

Eritrea Government through Ministry of Marine Resources will pursue:

- Develop the capacity of MMR staff to train fisher communities and farmers to engage in and practice aquaculture sustainably.
- Demonstrate and promote inland and coastal aquaculture practice and support development of aquaculture production by working with coastal fishing communities and existing inland farmers cooperatives to establish aquaculture enterprises using sustainable practices
- Promote development of aquaculture for production of fish for food security, better livelihoods and youth employment.
- Support the development of an aquaculture industry that is supported and valued by the local fishing and farming communities
- Create an enabling and efficient regulatory environment that supports the uptake of aquaculture technologies and development of aquaculture industry and business
- Designate land for aquaculture and allow farmers to develop integrated aquaculture agriculture.
- Demonstrate commercial hatchery propagation technologies to private sector as target sources for seed for coastal mariculture and inland aquaculture.

As wild fisheries stocks approach the limits of sustainable seafood supply, the aquaculture industry will be positioned so as to play an an important role in meeting the national and regional demand for seafood products.

This strategy builds on current policy commitments and provides a blueprint to guide public, fishing communities and private sector investment for the industry.

Key Definitions:

Policy: A policy is a program of action adopted by a government based on a set of principles to attain specific goals on the macro and national levels for economic and social good. It is a deliberate plan of action to guide decisions and achieve rational outcome. Appropriate policy for the aquaculture sector requires political will and vision. Policies change with time and circumstances but remain overarching targets.

Development Strategy: This describes the ways and means to reach policy objectives. In here it is detailed description of the goal, priorities, objectives, purpose, outputs, key activities and key approaches to kick starting aquaculture development in Eritrea. It also spells out the roles and responsibilities of the various stakeholder, and review of proposed production systems, sustainability measures, risks and assumptions and mitigation measures. It details the pathway to achieving the NFPS objectives for aquaculture and provides the guidelines for development plan herein.

Implementation Plan: This is a more detailed framework of the strategy with specific activities, milestones, timeframe and responsibilities; going down the continuum from general to specific. It provides "where" and "when" the activities will be executed with estimated costs.

Aquaculture: This is the farming of aquatic organisms involving interventions in the rearing process to enhance production.

Inland Aquaculture: Culture of freshwater organisms either on land or in suitable freshwater water bodies under controlled environment.

Mariculture: This is a sub-sector of aquaculture specifically focused on the cultivation of marine organisms either on land in suitable systems or, in situ, in the marine environment.

Onshore Aquaculture: The use of land adjacent to sea or freshwater bodies to raise or condition seed/culture material for stocking in water body - based aquaculture production system, or that land adjacent to the water body used to grow aquatic species. This can be in ponds, tanks, cages/hapas within ponds, or in recirculation systems where filtration serves to remove waste and temperature is controlled.

Inshore Aquaculture practice: This involves setting up and doing aquaculture activities within the water body close to the land, at or in sites which are mostly sheltered from wave action, strong winds, water currents and any other extreme weather conditions. This includes areas such as small bays or in the shelter of a structure or island using suspended culture between fixed points. In mariculture such areas are commonly used for aquaculture production of species such as Pacific oysters, mud crab, mussels and seaweed, and or low volume high density culture of finfish.

Intertidal based Aquaculture: This uses the area between High and Low Water Spring tide marks to cultivate species such as Pacific oysters, seaweed and other typically intertidal dwelling organisms. Depending upon the species cultivated this can be achieved either on the seabed, on trestles or other similar structures.

Offshore Aquaculture: This involves aquaculture practice that is based at or in sites found in open waters or generally exposed areas of a water body with limited natural protection from wave

action, wind storms, and other extreme conditions, using suspended production systems requiring heavy anchoring and strong mooring technology.

Initially the focus of Eritrea Aquaculture will be along the coastline (inshore, intertidal and onshore), and freshwater/inland aquaculture.

The focus of National Aquaculture Development Strategy and Implementation Plan (NADSIP)

This NADSIP will be used to:

- Update and replace the existing NADSIP
- Provide an overview of the issues, challenges and opportunities for coastal and inland aquaculture development
- Seeks to contribute to introduction and guide the sustainable development of coastal mariculture
- Promote and guide the expansion of inland aquaculture including reservoir base fish culture, pond culture and cage aquaculture.
- Provide specific technical guidance on the different recommended production systems and opportunities available.
- Promote aquaculture as an alternative means of food fish production and other aquaculture products while tapping in the existing natural and socioeconomic potential of aquaculture practice.
- Provide key action points that explore and drive coastal mariculture and inland aquaculture development, especially in relation to community development and technology transfer and acquisition.
- Link to and support other key National strategies including the National Visions, National Economic Development Plan, National Fisheries Development Strategy, among others.

It is important to note: This strategy does not inform or influence any policies or regulations for the sector, and is not an endorsement of any operations which fall outside of current legislation.

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EXECUTIVE SUMMARY

Eritrea's has the sixth longest coastline in Africa, and as a result of historical efforts to develop the irrigation agriculture and water for livestock, has developed significant inland water resources, all of which have been assessed and found highly suitable for aquaculture production and development. Initial efforts by Eritrea Government with technical support from FAO to put in place a strategy and development plan for aquaculture resulted in a draft Aquaculture Strategy and Implementation Plan (NASDP) of 2008. This NASDP of 2008 was 5 years and has been overtaken by time and many events. The Government of Eritrea through the Ministry of Marine Resources (MMR) with technical support from FAO has decided to review and update the 2008 strategy, and restart the efforts to develop coastal mariculture and inland aquaculture anew with a focus on empowering communities and farmer cooperatives as well as interested private sector enterprises to engage in aquaculture production. This updated NADSIP is set for the next five years, 2023 to 2027, at an estimated cost of **Nakfa 72,660,000** (US$ 4,844,000). It is focused on developing the capacity of coastal communities and inland farmers cooperatives to adopt and engage in aquaculture production for food and nutrition security, income generation, and expanding opportunities for rural youth employment. The updated NADSIP promotes sustainable cultivation of a variety of marine species in the onshore, intertidally, and inshore areas; as well as inland aquaculture practice by using a variety of methods, including restocking and stocking, pond aquaculture, and cage aquaculture. Careful assessment and choice of appropriate methods will be required for each site in regards to the natural and socioeconomic factors, required inputs, market demand, available skilled labour and technical services, among others. The updating of this strategy was collated through engagement and consultation with aquaculture technical staff of MMR, key actors in the fisheries industry, and assessment of existing challenges, and potential opportunities that can be taken advantage of. Considerations were made as to the current aquaculture issues at regional and international levels that can support the development of the Eritrea aquaculture industry. From these consultations, four main strategic priorities were identified:

- Training and skilling of technical staff and development of demonstration and training infrastructure for MMR to be able to train coastal and inland communities in viable and sustainable aquaculture practice.
- Support to technology transfer through South-to-South cooperation and considerable long-time engagements that can allow for setting up and working with communities and private enterprises in aquaculture production.
- Research and Innovation – research and studies that support adoption and adaption of production systems appropriate for Eritrea coastal and inland communities, seed production and multiplication, and aquafeed development.
- Mobilizing and training of coastal and inland communities to engage in aquaculture production and marketing – ensuring that there is ample work force with production and management skills within the communities to drive the aquaculture industry development.

In line with the above set priorities, aquaculture will be restarted through a systematic approach with particular emphasis on building technical and farmer level capacity nearly at the same time through different approaches. In outline, the process begins with identifying possible capacity building approaches for both staff and communities, recognizes identified candidate species and

production systems upon which demonstration systems and infrastructure will be built to start the aquaculture production. This will be followed by pilot community/cooperatives and individual aquaculture projects trailblazing aquaculture practice in the implementation of the strategy and the expansion of the program. At all times communities and individual farmers will be given opportunity to learn through placements and or hands-on training. The development will be guided by active and locally driven science and technology research system, working together with extension, training and information system.

1. BACKGROUND TO AQUACULTURE DEVELOPMENT IN ERITREA

Eritrea's population was estimated at 3.29 million in 2012 by the Office of the Ministry of Local Government, with an annual growth rate of 2.9 percent. The population of Eritrea is currently estimated to about 5.8 million (Eritrea Baseline Final Report for ACliSAT Project, 2020). About 70 per cent of the population is under 35 years old. Women are thought to constitute 55 per cent of Eritrea's population and head 47.2 per cent of all households (EPHS, 2021). According to IFAD's Eritrea's Country Strategic Opportunities Programme 2020-2025 (COSOP, 2019), cultural factors are a leading course for unequal access to inputs and economic opportunities for women's socio-economic empowerment in rural areas. In general, the COSOP assessment also found that Eritrea's GDP is driven by services (58.9 percent) and industry (23.5 percent), with agriculture and fisheries contributing only 17.6 per cent. This so despite agriculture sector employing 65–70 percent of the population. COSOP also assessed Eritrea to be faced with prospects of severe food and nutrition security challenges with resultant malnutrition among children under 5 years old. This is projected to lead to stunting by an estimated 50.3% of these under 5 years children, 38.8% underweight, and 15.3% wasting away. These projections are based on the chronic under nutrition and micronutrient deficiency.

Eritrea's physical, natural, genetic and socioeconomic resources make aquaculture development of very high potential and realisable. Although several policy documents since the 1990s have raised the prospectus of aquaculture development and some pilot commercial effort undertaken, Eritrea has not had a systematic and planned role out of aquaculture development despite having a draft National Aquaculture Development Strategy and Plan (NADSP) by 2008. Certainly, there is no tradition, no experienced practitioners (aquaculturists) and no systems for aquaculture practice in Eritrea, as was the case for many African countries that are now steadily growing their aquaculture sectors. The situation is changing in these African countries as result of effective planning and deliberate efforts by governments to rollout aquaculture practice by promoting, demonstrating, piloting different production systems, attracting and incentivising farming communities with basic inputs, courting private sector actors to establish aquaculture business supporting services, and making fish markets formal and attractive for business. Eritrea will follow this path but starting from a much better position in terms of infrastructure, technical capacity, and past experience.

It is the view of this Technical Assistance and those in the recent part that, MMR will need to work with progressive individuals at community level to demonstrate simple and appropriate technologies for coastal mariculture and inland aquaculture for the general fishing, farming and entrepreneurial communities to adopt and engage in aquaculture practice. To this effect, MMR will initially need to conduct an in-depth survey to identify both sites and individuals that they can partner with to demonstrate successful aquaculture practice. Past assessment highlighted the following 3 key steps in undertaking this activity:

1. Survey and establish demonstration farms of key target aquaculture production systems, for both coastal mariculture and inland aquaculture practice. This demonstration sites will serve the purpose of skills development through practical training and creating of successful stories in aquaculture practice that will endear those engaged and attract other members of the target communities. The list of equipment, gadgets, apparatus, instruments, farm implements, supplies and materials needed for the construction, establishment, operation and maintenance

of selected production systems was already generated in 2018 and awaits identification of funds and procurement.

2. Hands-on training of staff by working in established fish farms and enterprises in countries that are already successful and are using the target production systems in the environment and climate as well socioeconomic setting similar to that of Eritrea. This exposure should be for a reasonable time of up to 3 months, and with some staff focused on mariculture systems while others should focus on inland aquaculture development. External exposure is critical because of non-availability of the supplies and materials locally, and yet the very MMR staff is needed in setting the demonstration systems for training and technology transfer for the target communities. This will shorten the time and allow for more effective acquisition and transfer of technologies, especially under a South-to-South cooperation arrangement.

3. With assistance of mid-level experts from successful countries in the South, especially in South-eastern Asia, the MMR staff after exposure and hands-on training, shall set up demonstration and training sites, and conduct training of carefully selected individuals at community level based on the established demonstration sites for the different types of aquaculture production systems. This should also include training of willing youth, such as the demobilized young soldiers in serving as Local Service Providers, fabricators of aquaculture implements using locally available materials, and trainers of farmers and fishers who pick interest after the demonstration phase. These youth and young adults should be given 3 months training and offered certificates in different aspects of a given production system, preferably under 'Technical and Vocational Education and Training (TVET)' system with involvement of Ministry responsible for Education. This will ensure that communities can access primary technical support and guidance from within the communities.

1.1. Fisheries sector performance

The Government's vision is reflected in the National Indicative Development Plan 2014-2018, with Agriculture sector as the leading employer and food production sector that includes fisheries. The fisheries subsector contributes about 3 per cent to GDP. Eritrea has substantial and relatively underexploited marine resources, with national fish catches estimated at below 10,000 tonnes per year. About 2,000 tonnes of the fish production is by small-scale fisher boats. The Government, with support from its partners, has established over 330 inland water reservoirs, of which only 70 have been stocked with different fish species in an effort to improve rural diets. The Government is the main provider of inputs and equipment for agriculture, livestock and fisheries, for which purpose it uses revolving funds distributed under cooperative principles. Farmers and fishers are organized into cooperatives, but are assessed as to their capacity building needs for enhancing their role and services to other members. Rural financial services are provided by a microcredit institution under the nationwide Savings and Microcredit Programme. The Ministry of Marine Resources (MMRs) policy framework is focused on (i) developing inland culture fisheries and coastal mariculture for food and nutrition security; and (ii) sustainable growth of marine fisheries for foreign exchange earnings. Aquaculture is inherent within and is part of the fisheries sector in Eritrea, and is therefore bound by existing National Fisheries Policy and Strategic Plan (NFPS) albeit drafts, as prepared by MMR (2021).

1.1.1. National Policy Framework

The NFPS recognizes the critical importance of aquaculture as a source for aquatic production, and aquaculture sector's natural and socioeconomic potential for coastal mariculture and inland aquaculture production in Eritrea. Clear provisions including objectives and measures have been captured in the draft NFPS, and as such, this updated NADSIP is grounded in NFPS and is an instrument for rolling out the implementation of NFPS provisions and measures for aquaculture development in Eritrea. The key policy objectives and measures relating to aquaculture development are as follows:

1) Optimally harness the capture and culture fisheries potential of the country by enhancing fish production and productivity in a responsible and sustainable manner;
2) To ensure food and nutritional security by increasing the per capita availability of safe, affordable and quality fish;
3) Promote Inland fisheries and aquaculture through standardized inputs and fish farming systems for sustainable and responsible culture and capture fisheries;
4) Promote community partnerships, private participation and effective cooperative movement in the fisheries sector;
5) Generate gainful employment and entrepreneurship opportunities along the value chain leading to higher income of fishers and fish farmers, improve their living standards and usher in economic prosperity.

Whereas the key policy measures and guidance for aquaculture development as stated in the draft NFPS are as follows:

1) MMR with partners encourage establishing a uniform, integrated and concerted regulatory framework for planned and sustained growth of cage culture in open-water resources and will promote development of scientific aquaculture in existing dams, reservoirs and ponds, new ponds in low-lying areas, lands with saline and alkaline soils, and lands not suitable for crop cultivation.
2) In order to ensure that the fish produced from aquaculture is safe, appropriate regulatory, management and precautionary measures will be put in place in coordination with relevant agencies.
3) MMR will work out Action Plans for expansion of Shrimp/prawn farming in inland saline/alkaline and freshwater areas under scientific guidance.
4) Promote, introduce and support culture of identified exotic species of high production and economic potential for inland aquaculture, with appropriate and adequate bio-security protocols and use of the Best Management Practices (BMPs) and Good Aquaculture Practices (GAPs).

The above policy objectives and measures, guided the framing of the NADSIP priorities and suggested approaches that have been put forward so as to guide the restarting of aquaculture development effort by MMR. The key objectives of the renewed effort basically contributed to two broad goals of fisheries sector, the socioeconomic and ecological goals. With the aiming of getting aquaculture practice on the ground, the main focus at operational level will be to support communities to produce aquaculture products for food and nutrition security, income generation and improved livelihoods, as well as create more jobs for youth in coastal fishing and inland

farming communities. This will be done in a manner that will use the coastal and inland environment and natural resources sustainably and aimed at ensuring ecological integrity of the aquatic ecosystems.

In summary, the desired outcomes and the rationale for the two objectives are:

1) **Socioeconomic objective**

   Promote adoption of aquaculture practice and production by at least 5% of the inland farmers and coastal fisher communities for production of food fish and increased household fish consumption, income, and rural employment.

   Rationale

   There exist simple and appropriate production systems with proven technology that can be readily adopted and used by communities to sustainably produce farmed aquatic products that contribute to improved food and nutrition security, income and livelihoods of practising fish farmers.

1.1.1.1. 'Land Tenure Use' Policy, and Access to Water Resources in lieu of Aquaculture needs

In Eritrea land can be said to be under Government stewardship on behalf of its citizens and use by its citizens for different socioeconomic activities of their choice within the overall national physical planning framework. Land tenure in Eritrea has been shaped by its history and aspirations of its people over time. Currently, Government manages the land principally to foster a modern technologically advanced and internationally competitive economy. This is aimed at encourage investments in productive sectors while ensuring that all citizens including women have right to access and use the land for socioeconomic activities in manner that is socially fair and equitable, and that ensures security of tenure, guards against political retribution, promotes economic growth and is just. In regards to aquaculture, this means identified suitable sites, most likely those that are currently not under any economic activity or which current activities can be changed with negatively impacting those using the land or the environment.

In promoting aquaculture practice and supporting aquaculture production, the Government of State of Eritrea will have to provide security of tenure for aquaculture investments and investors, and support the farmers engaged in aquaculture practice. This should be done without disfranchising those on the land but rather encouraging and building their capacity to also engage in aquaculture practice. Land acquisition and use in Eritrea is guided by elaborate provisions within the Land Proclamation no. 58/1994, and subsidiary legislation, Regulation for the distribution and administration of land, Legal Notice no. 31/1997. Under this law and regulation, land for aquaculture practice will be acquired on usufruct basis to those who express interest and willing to commit and be engaged in aquaculture practice for their livelihoods. All gender, especially women, will have equal rights to land resources. To guarantee tenure Government through land registration law no. 95/1997 which provides for registration and titling of land. The allocation of land to aquaculture practice will involve an extensive field survey. Since there is not yet in place a physical planning map for Eritrea, the is an opportunity for aquaculture to identify appropriate sites and areas for aquaculture production, and to engage relevant Government agencies so as to map and

gazette such areas, both on land and on water, as areas suitable for aquaculture practice and production.

1.1.2. Ecological objective:

To survey and identify environmentally and ecologically appropriate sites and species for aquaculture practice, and support prospective farmers and fishers to develop and use the identified sites and species for aquaculture production in a manner that will ensure ecological and genetic resources integrity of Eritrea's aquatic biodiversity.

Rationale:

The natural ecological functioning and services, as well as the associated interactions, are a basis for productive aquaculture practice, without which the planned socioeconomic objective and outputs for coastal mariculture and inland aquaculture will not be achieved.

1.2. Geographical profile and Socioeconomic situation

Eritrea has a total land area of 124,320 sq. km, and a marine exclusive economic zone of 121,000 sq. km. It is located in Sub-Saharan Africa and between latitudes 12°45'N and 18°03'N and 37° 35'E and 43° 07'E, bordering the Red Sea with coastline that is about 1,300 km long, and a 56,000 sq. km continental shelf. Eritrea has about 356 small and medium-sized islands within the Red Sea, including the archipelagos of Dahlak Kebir and Hawakil and the Bay of Assab, which islands range from about 0.5 km to over 60 km in length, and 642 sq. km in area (MMR/NFPS, 2021).The geographical land and water extent, together with the rich marine biodiversity, combine to give Eritrea exceptional natural and socioeconomic potential for aquaculture development, with protected bays and enclaves that are readily accessible and of appropriate depth. Eritrea is principally a livestock region with limited fish-eating culture. The per capita fish consumption currently estimated at 1.2 kg (FAO, 2022), which is about 12% of the sub-Saharan national average per capita consumption of 10.1 kg (FAO, 2020). The national fish production is estimated to be less than 10,000 tonnes annually and is exclusively from capture fisheries.

1.3. Resources for aquaculture development

Eritrea's marine waters have a rich biodiversity with high levels of dynamic endemism, which resources are considered largely pristine and underexploited. The Eritrea marine environment includes several coral reefs, sea grasses, floras and faunas, varying sandy bottoms interspaced with lagoons with sheds of mangrove trees. Eritrean waters are also rich in small pelagics fishery comprised mainly of the sardines and anchovies. The small pelagics make a prime natural and biological resource base for aquaculture development as a source of fish meal for the aquafeed.

The long coast embedded with a number of bays, enclaves, and associated islands and archipelagos, coupled with largely pristine waters, offer established natural potential for coastal and offshore mariculture as well as onshore marine aquaculture production, intertidal and inshore mariculture production systems using ponds, tanks and floating and or suspended cages of naturally occurring candidate culture species with already proven and existing technology elsewhere.

The naturally occurring aquaculture genetics include a number of finfishes (mullet, milkfish, rabbitfish, grouper, snapper and seabream) as well as sea cucumbers, shrimp, mud crab, and oyster species. These have been recently assessed to have very potential for coastal mariculture in Eritrea under the IFAD Fisheries Management Programme. In terms of inland aquaculture in the highlands where the temperatures are relatively much lower than lowland areas, this strategy calls for use of subtropical species such as common carps, crucians and goldfish; while the relatively warmer and hot areas, this strategy will be promoting warm water culture species including tilapias and African catfish. Already a number of water reservoirs have been successfully stocked with tilapia fish, carps, and African catfish (*Clarias gariepinus*). The eels and catfish were also stocked during the Italian colonial period but the population of eel, being a catadromous species, has essentially disappeared. African catfish is also reported to occur in of some reservoirs.

In terms of technical expertise, MMR has diverse technical capacity from biologists, ICT, engineers and social scientists, in reasonable numbers to support the piloting and trail blazing of aquaculture production practice, both inland and coastal aquaculture development. The Ministry has a complete division for aquaculture management and development, which includes staff working in freshwater and marine in areas of research, training, extension and management/regulation. In addition, make in the other divisions have capacity to support the aquaculture division and agenda.

In terms of existing infrastructure and facilities, the MMR has a field station at Halibay that is being used for salt production and trials for extensive pond culture of milkfish as complementary or integrated activity of the salt production. The site also has dilapidated cold storage and reverse osmosis infrastructure that needs serious repair to function.

There is an operational research station for freshwater aquaculture, the Mai-Serwa Freshwater Station (MSFS) which currently serves as a research centre for inland aquaculture research and training.

The Ministry Headquarters currently has ample office space to support the management and coordination of aquaculture development nationally.

Although the facilities of the defunct shrimp farm in Massawa (SFE) are still existing, available information indicates that local authorities may have changed the plan for the area from aquaculture development to recreation and tourism. The available facilities the culture ponds, buildings, and the feed production unit. With renewed MMR effort to promote aquaculture practice, there is however now a case to be made to local authorities to reconsider the change in use of the SFE site so as to attract aquaculture investment that can re-engage the site for coastal mariculture development. The existing fish feed production unit includes a mill which is current focused on processing and producing of fish meal only.

In terms of post-harvest facilities, there exists six fish processing factories located at Assab (EMPC Assab Fish Factory), Asmara (EMPC Fish Processing Plant), Massawa (Erifish), Gellalu, Tio and Eddi, that process and supply fish to a number of established fish markets, especially in the larger population centres of Asmara, Massawa, and Assab. These together with the Port of Massawa are seen as providing reasonable infrastructure for handling, processing and marketing of aquaculture products; while the port will also facilitate acquisition of aquaculture inputs.

As indicated above there is a feed manufacturing plant in Massawa that was set up for the Seawater Shrimp Farming Project. During the project it was producing about 20 tons of feed per day. It is however thought to have a higher installed capacity. It remains operational and currently focused on producing fish meal. There also exists a number of poultry and livestock feed manufacturing plants in different parts of the country that can be engaged to set up lines for production of aquafeed as the demand for feed grows. Of course, consideration can be made for importation from neighbouring countries for importing of aquafeed if needed.

As to seed, the species prioritized here for mariculture including mullet, milkfish, sea cucumber and groupers, initial practice can start with wild seed which is readily available and abundant in Eritrean waters; as the hatcheries, which technology is readily available, are planned and put in place through public, private sector partnership (PPP) arrangement. Government will provide the technical expertise, sites and required machinery, while private sector entities will provide the financial and business management services for execution of the venture. The defunct facility of the SFE project is a very good starting place to lure new investment in commercial on-shore mariculture in Eritrea through the PPP arrangement. Engagement with local authorities will be required to ensure the use of this area does not change from aquaculture to recreational or tourism development.

In regards to inland aquaculture, seed for stocking reservoirs for cold highland areas can use the Mai Serwa Research Station; and another site in relative warmer area should be chosen to set up a tilapia and catfish hatchery. These technologies are currently widely available and not that costly. Set up of such facilities will be considered under the proposed South-to-South Cooperation projects.

All of the geographical, socioeconomic, natural and genetic resources of Eritrea, make the country's aspiration for improved food and nutrition security as well as employment and income for livelihoods enhancement through development of coastal mariculture and inland aquaculture achievable and well placed. The role of this strategy is therefore to guide MMR and other actors toward achieving the set policy objectives and tasks for aquaculture development in a manner that is sustainable, gender responsive, environmentally responsible and climate smart.

1.3.1. Freshwater reservoirs and inland aquaculture development potential

Historically and up to today, Government of Eritrea has been emphatic on ensuring that freshwater is harnessed and provided for the different domestic, industrial and production requirements. This has been largely through erecting of dams and reservoirs in different areas across the country. To this effect there are currently 781 inland man-made freshwater reservoirs that have been established, of which 25 are considered major reservoirs with a combined area of nearly 540 hectares, with hundreds of medium to small sized ones established for purposes of serving small communities or settlements. These waters are open to aquaculture practice, especially as aquaculture is non-consumptive and does not pollute the water once practised in environmentally responsible manner. At present 70 of these reservoirs have been assessed and are stocked with mix species of fish including tilapia, African catfish, and carps. It is initial assessment that actually all the existing 781 reservoirs are suitable for aquaculture development purposes. Another 300 freshwater reservoirs are planned for construction over the medium term. All large reservoirs are thought to be mostly amenable for culture-based fishery/stock enhancement, while all reservoirs with more than 2 m depth on average, can be used for low volume high density cage

aquaculture establishments without compromising their other functions as source of potable water and irrigation development. In some few cases, the reservoirs can be used to provide water for pond aquaculture integrated with irrigation farming.

2) ROLE OF DIFFERENT ACTORS IN PROMOTION AND DEVELOPMENT OF AQUACULTURE

There is essentially no existing aquaculture practice apart from the reservoir culture fisheries production in a few of the freshwater reservoirs. Aquaculture development will be starting essentially from scratch, and will be driven and led by MMR by promoting and demonstrating different mariculture and inland aquaculture production systems to the fisher communities and inland farming cooperatives and individuals. MMR will therefore be responsible for identified appropriate technologies, starting with most basic and simple to adopt practice, and through hands-on training and skills development assist the communities in adopting and practicing aquaculture production. MMR will also at the same time be carrying out adaptive or action research to optimize the different culture practices and technologies, develop solutions against the challenges identified, and make the practices climate smart and environmentally sustainable.

It will also be prudent that interest youth are identified and skilled in providing technical services such as setting up culture systems for shellfish, pond construction, making of cage aquaculture facilities, harvesting and collecting of seed, feeding and managing of production systems, and harvesting and handling of harvested fish. These youth and young adults, who should be residing in the fishing and farming communities, will complement and work with the MMR staff in promote aquaculture practice. Initially they will be supported by MMR but as aquaculture takes root, the farmers will responsible for paying for the services or taking them on to manage their aquaculture enterprises.

The fish feed facility as part of the defunct Shrimps and Fish Enterprise (SFE), and existing feed factories for other livestock are seen as crucial in production of aquafeed. These existing livestock feed factors as well as SFE facility, for the start can be presented with the business opportunity to produce fish feed for the emerging coastal mariculture and inland aquaculture producers by establishing separate production lines for the fish feed. The plan is that as the volume of fish feed grows, other specialised fish feed mills will be established. The strategy here also includes setting up mechanisms such as farmer-feed producer-market linkage, which eliminate the need for cash transactions by feed producers supplying the required feed to farmers and being paid once the farmed products are sold to established markets. MMR however will also have to equip farmers with on-farm fish feed production technologies so as to cut down on cost of commercial feed. It is also advisable that initially the focus should be on more of the herbivorous species that can be feed on algae within the ponds or the water body.

Existing fish processing and marketing facilities will be critical offering the pull end of sector by creating demand for the farmed products. MMR will need to formally engage and work with the existing processing factories on minimum standards for which the communities can produce and sell the fish to the established processing and marketing centres.

Commercial banks, microfinance institutions and group saving and credit associations, will have to be brought on board and taken through the coastal mariculture and inland aquaculture needs

and practices that require credit, so that they grow with the sector. This is such that as MMR pulls out of production after the initial few years, it will be critical that financing institutions can step in to support farmers with credit for inputs.

MMR will also have to play its monitoring and regulatory role including ensuring that farmers are adhering to the sustainability measures and practices put in place, that the sourcing of material for seeding is not destructive and is well guided, the ponds are well located and not adding to the salination problem, manage in conflicts between farmers and fishers, and ensure that safety and quality of the products for marketing are not compromised. Therefore, MMR will also have a regulatory role in development of aquaculture.

3) MECHANISMS FOR FOSTERING SUSTAINABLE AQUACULTURE DEVELOPMENT

While the socioeconomic potential for aquaculture in Eritrea is assessed as high, a sustainable and responsible approach to development of aquaculture is paramount. The influences of aquaculture on the environment need to be considered and monitored so that aquaculture can be established in an ecologically harmonious way and environmentally responsible manner. MMR will need to monitor and work to manage any potential effects of different farming methods on different habitats by promoting appropriate practices and discouraging destructive ones. To this effect MMR will have to put the following in place right from the start:

1) Link all established aquaculture production enterprises to viable and organized markets;
2) Put in place mechanisms to ensure adoption and use of highly productive systems;
3) Build capacity of farmers through demonstrating to and supporting them in setting up and operating efficient and highly productive aquaculture systems;
4) Conduct a survey to identify and gazette appropriate locations for aquaculture practice;
5) Identify and promote use of appropriate genetics using locally available species and strains while ensuring ecological and genetic integrity of wild stocks are protected;
6) Put in place appropriate measures to ensure fish health, while ensuring that biosafety and biosecurity measures are included in all aquaculture establishments with appropriate records management and monitoring;
7) Encourage and promote production and use of quality feed that has negligible and reversible environmental impacts;
8) Develop the human resource capacity for management and provision of extension services through hands-on training, exposure and placement opportunities in more successful countries with similar environmental, climate and socioeconomic conditions;
9) Review and update policy and public investment support for aquaculture management and business support services;
10) Put in place a rigorous but supportive system for data collection, monitoring and reporting on aquaculture production and development activities across the country.
11) Put in place measures to protect biodiversity, reduce pressure on wild stocks, and improve water quality in watersheds with aquaculture production systems.
12) In areas that are water stressed, MMR will need to demonstrate and promote use of water recycling production systems and other related appropriate technologies that can ensure efficient use of water whilst containing and treating effluents.

4) AQUACULTURE DEVELOPMENT STRATEGY

This strategy is based on the assessed aquaculture development opportunities for environmentally responsible Eritrea coastal mariculture and inland aquaculture practice and development, conducted through a series of technical studies carried out from 2008 and as recent as 2021, an in-depth stakeholders (appendix IV) field observations and consultations with different stakeholders (appendix VI), as well as review of existing literature. The existing aquaculture development potential is thus summarised here as follows:

4.1. Established aquaculture development opportunities

There are currently a wide and diverse array of aquaculture development opportunities across Eritrea, which if properly identified, planned, promoted, and managed will lead to successful establishment of vibrant aquaculture sector in Eritrea, for both mariculture and inland aquaculture practice and production. These opportunities were highlighted and discussed by the different stakeholders encountered during the development of this Strategy. It is though important to note the following:

- Only a few initial assessments have been carried out, and detailed assessments and feasibility studies may be required for each case.
- There is generally need of a Strategic environmental and socioeconomic assessment of the planned coastal mariculture and inland aquaculture development to guide the roll out of aquaculture production activities.
- Commercial mariculture and inland aquaculture developments will need specific EIA studies so as to put in place mitigation measures against any plausible impacts. This includes the investigating of the impact on provision of ecosystems services against the different farming techniques proposed for commercial ventures, as well as ensuring that resource use is sustainable, with minimal and reversible negative impacts on the marine environment.
- The available opportunities may be limited or enhanced by the circumstances in which the planned coastal mariculture and inland aquaculture are practiced. For example, the regulatory and policy framework, climate and coastal change, national development policies and other related resource management policies, changes to marine and coastal and inland habitats, new technology, and new research findings and breakthroughs as well as the economic feasibility.
- Eritrea is gate to significant amount of ocean traffic including significant fishing activity, and has very high potential for tourism and recreation activities. As such, the relationships of these aspects to the planned aquaculture development must be taken in consideration in any effort to realise the identified aquaculture potential opportunity.

4.1.1. List of available aquaculture development opportunities

Table 1: General aquaculture development opportunities

Resource and type of development	**Particulars**	**Opportunity for Eritrea**

Long coastal line of approximately 1,300 km; large continental shelf of 52,000 sq. miles; sheltered bays, 356 islands and archipelagos, and largely pristine marine environment.	Eritrea has a rich and wide variety of natural habitats that are suitable for practice and development of mariculture including offshore, near shore, inter-tidal and onshore for different culture organisms.	Eritrea needs to conduct a detailed survey, identify and map and gazette locations for mariculture practice and development in a manner that guarantees tenure and secures investment while ensuring sustainable and socioeconomically equitable aquaculture development.
Currently there 781 established freshwater reservoirs that are located across Eritrea, with most of them being suitable for culture fisheries and development of pond and cage inland aquaculture practice and production.	Reservoirs have been created across Eritrea for domestic, industrial and agricultural production water supply.	The evidence so far on promotion of inland aquaculture points to very high interest among the farming communities and cooperatives. Clear planning and appropriate technologies need to be piloted with appropriate choice of species between cold and warm areas.
Eritrea marine waters are rich in marine and diverse genetic resources that are prime candidates for aquaculture development and production, with already proven existing and simple production technologies.	Demonstration and piloting of different appropriate production systems and expansion of existing or trial sites will ensure engagement of local farmers and cooperatives, and uptake of aquaculture practice.	There is need to have carefully selection of sites, lead/pilot farmers, with involvement of local leaders and administrations to secure buy-in from the target farmers across the country and appropriate selection of candidate species.
In terms of stocking materials, multi species hatchery development sites and candidate species for mariculture and specialised tilapia and mirror carp hatchery development have been identified and proposed. This includes mullets, milkfish, groupers, mud crabs, oysters, shrimp and sea cucumber.	Sites for the hatcheries have been identified and draft plans in place but there is generally no technical experience in hatchery propagation.	The development of hatcheries locally is crucial for uptake and sustainable engagement in production by the target farmers. This will unlock the potential for different identified species to be cultured. A multi species mariculture hatchery is more appropriate initially, and can be through a public, private partnership arrangement.
Integrated Multitrophic Aquaculture (IMTA) is feasible and relatively simple to adopt already existing and proven technologies. For example, groupers and sea cucumber in floating cages; tilapia and mirror	IMTA is cultivation of complementary species at differing trophic (food web) levels in close proximity. The concept is that each species helps to reduce waste products or environmental impacts at one trophic level whilst obtaining some form of benefit, generally nutritional, at the same time. Further	In theory, IMTA could be carried out onshore, within sheltered inshore waters initially. This can be the case where multispecies seed is collected from the wild and farmed as such.

carps in ponds; African catfish and tilapia in ponds; mullets, milkfish and sea cucumbers in cages or ponds.	research on the economic and environmental value is needed. Greenwave8 is a US example where success has been achieved.	
There are a number of landing sites with appropriate facilities for launching and facilitating marine aquaculture practice, and up to fish processing facilities linked to several established markets across Eritrea that can handle aquaculture produce.	Development of coastal cage and pond-based mariculture whether it is for finfish, shellfish or seaweed will require that vessels can access the sites, land load and offload as may be required, and processing capacity to handle the additional products. It will be important that the vessels can quickly access offshore sites for feeding, maintenance and harvesting etc, and the processing facilities can receive and handled farmed products. As such, local dockside facilities for the vessels and landing facilities for harvested product will be crucial.	The existence of landing and processing facilities in Eritrea is quite significant and will support farmers and attract private investment. Eritrea has ports that can accommodate additional mariculture support vessels. With the promotion of mariculture practice and production there is need to engage existing processing facilities so that they can receive farmed products.

Table 2: Onshore mariculture opportunities

Resource and type of development	**Particulars**	**Opportunity for Eritrea**
Unsettled coastal land with many potential sites for onshore aquaculture establishments.	The open spaces even within urban areas in Eritrea provide good opportunities for aquaculture establishments that can readily be serviced.	Proper planning and engagement with communities is critical to ensuring that the spaces can be used for aquaculture production. It is also crucial that the communities buy-in and are involved in aquaculture development implementation.
There are number of existing facilities for MMR to initiate aquaculture development. There also facilities under local administrations such as the defunct SFE project facilities that can be re-engaged for aquaculture development.	The MMR facilities offer ready solutions for piloting, demonstration and training of interested farmers and communities.	These facilities need to be identified, assessed, and adjusted to suit the planned aquaculture activities.
Identified sites for field trials and research. Halibay has been identified for integrated salt-aquaculture production, while Mai Serwa can be enhanced to	The two centres have been established and are currently active but limited in scope. These centres have room for expansion and or modification to suit the different mariculture	There will be need for proper assessment and refocusing the Halibay and Mai Serwa centres so that the planned research activities to support onshore mariculture and inland aquaculture can be effectively carried out. Another site close to or within

serve as inland aquaculture research station.	and inland aquaculture research activities.	Massawa needs to be identified for mariculture research and practical training.
Pond culture of milkfish/mullets has ready and simple technology. These fish species though relatively low in economic value, provide ready source of protein to fishing communities as they can be reared on complete algal diet or natural feed without need for artificial feed.	Recent technical assessments found high potential for culture of milkfish and mullets in ponds using seed sourced from the wild.	Culture of these herbivorous species onshore in ponds is very promising but needs to piloted with support to farmers given that aquaculture is a new enterprise in Eritrea, and target farmers have no experience.
Sea cucumber coastal mariculture production has potential high and lucrative market across in Yemen that was already tested with harvest from the wild until the Government placed a ban on fishing sea cucumber due to overfishing.	Sea cucumber was target for coastal fishing communities prior to the Government ban. Sea cucumber from the wild had established market in Yemen. Aquaculture of sea cucumbers is now feasible through hatchery propagation and production technologies that are simple and appropriate for Eritrea coastal fisher communities.	MMR will need to formally establish markets for sea cucumber in Yemen, working with coastal authorities and Government in Yemen to ensure formal supply and trade for sea cucumbers. Cooperation with JICA is required for transfer of sea cucumber technology to Eritrea as Japan is one of the two leading sea cucumber producers under mariculture.
Pond culture of mud crabs is of great potential. The mud crabs are naturally occurring in Eritrea waters and have established markets especially in Europe and Asia.	The recent technical assessment of pond-based production of mud crab found the venture to be of high potential in terms of productivity. Unfortunately, there is no local market for the mud crab.	There is need for starting at the market end, so that any production including trials or piloting are linked to and are an attempt to address the market requirements for mud crab.
Production of seed for milkfish, mullets and groupers, and seed for sea cucumbers in mini-hatchery has been assessed to be feasible at the old aquaculture processing unit at Tiwalet in Massawa	The old processing unit for export of aquarium fish at Tiwalet in Massawa was assessed by previous technical assistant missions to be suitable for establishment of multi-species mini-hatchery. The site is by the sea, has aquarium facilities that can used, has access to the national power grid, is accessible by road and water, and a design for the mini-hatchery has been produced.	This may require re-engaging of the Philippine TAs so as to guide in establishing and operationalising of the mini-hatchery. It should be done hand in hand with the roll out of the demonstrations which will initially depend on wild seed. The actually uptake and engagement in coastal mariculture should be dependent largely on seed from the mini-hatchery.

Table 3: Intertidal, Inshore and Offshore Mariculture Opportunities

Resource and type of development	**Particulars**	**Opportunity for Eritrea**
Many good sites and a number of existing facilities to support the launching and use of floating cage technology for culture of milkfish, mullets, groupers and sea cucumbers.	Assessment cage aquaculture of five (05) different species: milkfish floating fish cage farming, mullet fish cage farming, grouper fish cage farming, and potential polyculture with sea cucumbers in cage farming has been assessed to have very good potential in many inshore areas.	Given ready availability of fish meal, there is need for engaging of local animal feed factories and the existing SFE facility to formulate and produce complete fish feed especially for the carnivorous fishes, for cage aquaculture to be successful. More practical training and hands-on management by staff and farmers will be required.
Oyster culture based on existing genetics is of high potential especially if the market linkage is secured.	Assessed recently to have very good potential based on locally occurring species. There are no known diseases of oysters in Eritrea, which allows for a clean slate limiting investment in disease control. A number of staff were given initial training for setting up of oyster farms, but mostly theoretical without practical training.	This again will require linkage to ready international market prior to investment, so that the culture and investment is guided by the market availability and specifications. Need deliberate efforts to secure EU and Asian markets for oysters, and putting in place the regulatory, and requisite quality control and assurance system.
Seaweed Cultivation is of great potential in Eritrea using either locally available genetics or importation of Eucheuma species since sister species were found to be available locally. There is also existence of red algae and other types that can be considered for agar production and other products used in pharmaceuticals industries.	*Eucheuma* seaweed farming has been assessed to be high potential in terms of ease of culture and shelf life after processing (drying). It has a wide array of production systems, that are mostly economical and easy to establish, maintain, expand and adaptable to the poor community people. It has a short culture period, does not need big capital, can be dried and stored for a longer period of time while waiting for a good market price before selling. It is a potential source for foreign currency being an export commodity that can help the country's economy, in general,	There is potential for commercial cultivation in Eritrea has been found to be very high based on field trials conducted with guidance of the TAs. There is of course still need to review the local species available and cultivation techniques specific to Eritrea. This needs to be done along with the market analysis for seaweed products from Eritrea and how to grow these markets along with consumer familiarisation with seaweed products would help

	and enhance the farmer's family income, in particular.	drive sales and industry growth.
Diversification of livelihoods and sources of income for coastal fishing communities.	Adoption and promotion of coastal mariculture will provide alternative livelihoods to the coastal fishing communities.	The tradition of the coastal communities is inshore fishing due to the limitation of boat sizes and resources for offshore fishing. Mariculture will support coastal communities to expand their sources of income and livelihoods. Unfortunately, there will be need for a lot of mobilization, sensitization and promotion of mariculture. This should include demonstrations and piloting in partnership with carefully selected individuals. Generally, mariculture will also create employment as other skills beyond operating facilities will be required in practice of mariculture including boat builders, charter boats etc. This increase jobs and address issues of high unemployment rates and a seasonal workforce in coastal communities. Development of mariculture will also require more dedicated vessels for routine husbandry, maintenance and harvesting.

Table 4: Inland Aquaculture Development Opportunities

Resource and type of development	**Particulars**	**Opportunity for Eritrea**
Cold water and warm water species.	There exists both warm-water species, the tilapiines, and cold-water species, a number of crucians which can actually do well in cold and warm waters typical of the highlands.	Reservoirs need to be monitored for water quality parameters on monthly basis and if possible daily basis for a period of two or more years. This will inform the

		choice of species for the different freshwater reservoirs.
Existing fish feed materials and potential aquafeed producing factories. Also key aquafeed ingredients are locally available including fish meal from the sardines, anchovies and fishing by-catch; sesame and peanut cake; and potential for use of seaweed to replace the scarce grain as the starch component.	Eritrea has advantage of locally produced fish meal from the abundant naturally occurring anchovies, sardines and other small pelagics as well as by-catch, that can be processed into fish meal. There are also a number of existing animal feed producing factories around the country as well as the feed mill set up for production of aquafeed in the 1990s for the SFE project. The existing large animal feed factories include 1) Massawa Poultry Feed Factory, 2) Dubarwa Livestock Feed Factory, 3) Asmara General Animal Feed Factory, 4) Alebu Animal Feed Factory, 5) a new one under establishment in Asmara that is double the average capacity of existing ones, 6) Smaller fish feed factories in different towns and cities of Eritrea(per. Comm. Director PCCO, MMR)	There is need for assessment of local available materials especially grain which is still a challenge in Eritrea. However, having the more costly protein ingredient is significant advantage, which fish meal can be marketed in the region while importing the required grain for aquafeed production. The potential of producing and using seaweed as an alternative starch component is also high. Mostly importantly, from the start farmers have to be given practical skills in on-farm aquafeed production and management as a stop-gap measure.
Cage aquaculture within reservoirs.	Most of the reservoirs are on average more than four metres deep and of good expanse. As inland communities get used to fish, the reservoir culture fisheries may not be sufficient to sustain the demand. Therefore, there will need for consideration of use of LVHD cage aquaculture fish production systems as alternative systems for supply of fish to inland communities.	There is need for systematic technical and socioeconomic assessment of carrying capacities, potential conflicts with other users of the reservoirs, and participatory planning to ensure that when introduced the cage aquaculture is accepted by all stakeholders.
Happa-based tilapia seed production	In warm waters and reservoirs with gentle shores, happa based tilapia seed production can result in significant increase in seed production and productivity with significantly lower cost and labour than the indoor system.	There is need to identify two to three reservoirs for use in happa-based tilapia seed production. This will involve assessing of the water quality parameters, and ability to fix happas and

		manipulate fish in the happas for seed production.
Indoor tilapia hatchery for SRT production, and African catfish hatchery	At Mai Serwa there is an opportunity to produce SRT tilapia seed, which is needed in case of cage aquaculture adoption. Alongside this, a greenhouse can be put up for establishment of African catfish seed production with nursing done in rehabilitated earthen ponds or plastic/canvas ponds.	The facilities at Mai Serwa will have to be developed to handled indoor hatchery capacity for both tilapia and African catfish including air and water temperature control, recycling and treating of water to avoid fungal and bacterial infestations in the eggs and fly; and live feed culture for African catfish fry nursing and fingerling raising.
Diversification of reservoir fish culture to include pond and cage aquaculture production	The technologies are readily available and can be deployed within the reservoirs (cages) with minimal impact on other users and reservoir fisheries, and outside selected reservoirs for pond culture as people get used to fish inland.	Detailed survey will be required for all reservoirs so as to identify those appropriate for different production systems.

Key activities and tasks envisaged for tapping into the above potential opportunities including the following:

1) Set up of demonstration and piloting establishments for the different mariculture and inland aquaculture production systems
2) Initially establish a system for collecting, conditioning, holding and sorting of wild seed for the four target coastal mariculture species (mullets, milkfish, sea cucumber and groupers.
3) Construction of coastal cage mariculture units and establishment of demonstration sites for growout of mullets, milkfish, sea cucumber and groupers
4) Identification of appropriate sites, pond design and laying, and construction of ponds for mullet and milkfish culture at 5 different sites.
5) Carefully identify and select individuals that are progressive and willing to work with MMR for a long period.
6) The pond and cages design for coastal mariculture production were provided as part of the TAs activity and output reports for MMR.

4.2. Proposed Governance Structure for the Strategy

The lead agency shall be the Aquaculture Division of MMR. It shall have primary responsibility for the management, implementation and evaluation of the NADSIP. Implementation of NADSIP will utilize existing mechanisms for aquaculture governance and management within MMR. The implementation structure is illustrated in Figure --- below and described below.

The following principles will guide the implementation process:

- Each government unit and partner shall remain accountable to its jurisdiction;
- Zoba/Regional Administrative Units will enter into aquaculture development Memorandum of Understanding (MOU) Management with MMR. This will prioritize actions, set timeframes, roles and responsibilities, and coordination of implementation efforts;
- Implementation will occur in accordance with the resources available within each jurisdiction were agreed upon, i.e., the process is intended to help direct resources toward areas of need and priority within each province/territory; and
- Performance measurement will facilitate implementation by helping to keep the plan(s) current and identifying constraints.

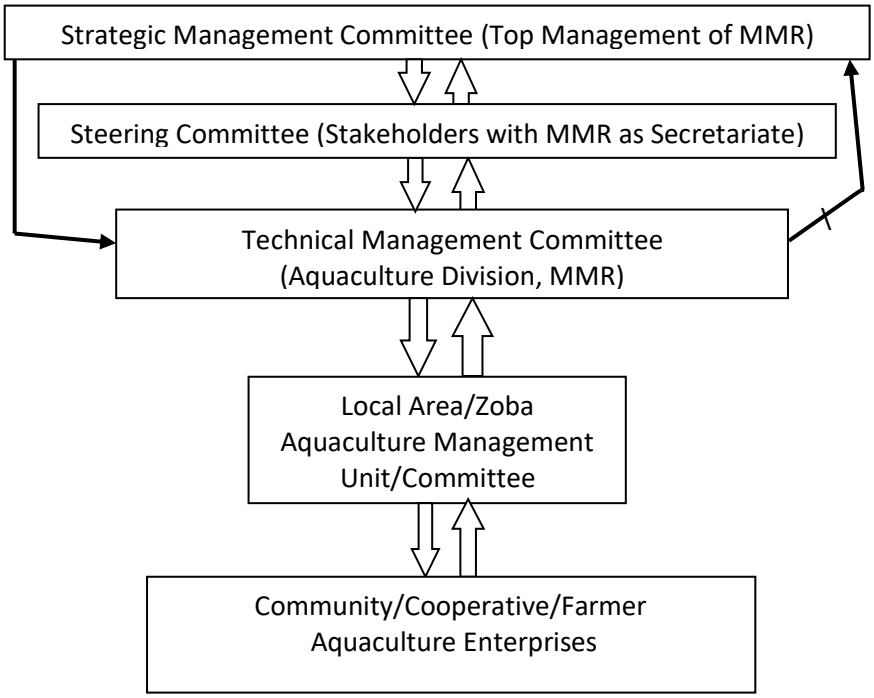

Figure 1: Illustration of the management of Implementation of NADSIP

Figure 2 provides a graphic illustration of the implementation structure for the NADSIP. At the very top is the Strategic Management Committee (SMC) comprised of the Top Management of MMR chaired by H.E Minister for Marine Resources, and the Head of Aquaculture Division should be co-opted to inform of Top Management of technical issues of the NADSIP implementation. Below that will be a Steering Committee (ST) of 12 to 15 persons, comprising of key stakeholders from different agencies, fishing communities, inland farmers cooperatives, and entrepreneurs (private sectors), and experts. It should be chaired by non-MMR staff, with MMR as the secretary. Below the Steering Committee is the Technical Management Committee comprised of seven persons, three (03) technical managers from coastal mariculture unit, two (02) from inland aquaculture, and two (02) technical persons from outside MMR but in relevant fields. The TMC will be chaired by the Head of Head of Aquaculture Division. The SMC will be responsible for National Coordination and Implementation of the NADSIP, while the TMC will

be responsible for technical implementation and day-to-day operations of NADSIP at national level actions. Below the TMC will be the Regional or Zoba Aquaculture Management Committees that will be comprised of heads of the relevant departments including fisheries, water, environment, community development and chaired by the Regional Administrative Head. This Unit will be responsible for mobilizing the farmers and fishers, and to assist MMR in promotion of Aquaculture practice, resolve non-technical conflicts and oversee the distribution of inputs to the farmers and fishers. The unit will report to the TMC. Below that will be the enterprise level management, which may be communal, cooperative or individual farmer.

4.2.1. SMC - Roles and Responsibilities

The Top Management of MMR will serve as the key means for coordinating government efforts to advance the objectives of NADSIP. The TOP Management is typically considered as the political leadership of MMR and Director Generals of the different departments that regularly meet to take policy and strategic decisions on implementation of programmes and projects in MMR. The Top Management of MMR will be responsible for prioritizing and approving the NADSIP implementation actions.

Time frames for completion of the action items will be reviewed and agreed upon by Top Management of MMR annually. Additionally, the Top Management will determine which of the potential contributing partners will participate in implementation, including which partner should take the lead and which will play supporting roles.

4.2.2. NADSIP Steering Committee (NSC) - Roles and Responsibilities

The NSC will give general guidance and set operational policies for the implementation of the NADSIP. This should also give opportunity to the development partners to be included and given their views on planned activities and implementation. It should also be where progress reports and implementation plans are presented and shared for stakeholders' suggestions and guidance to the TMC. The NSC can ask to interact with the SMC so as to ensure that sticking issues are resolved and acted on in timely manner by MMR and other stakeholders. The NSC should meet once every six months.

4.2.3. Regional and Zonal Administrators, Technical Managers and Extension workers

At the local or Zoba level, the administrators will take lead in ensuring that the responsible technical support is availed during implementation, and follow up the measures passed by MMR in respect to aquaculture development. Most critically, they will have to ensure that crosscutting issues including gender, climate change, health and occupational safety of workers among others, and taken in consideration during implementation. Technical Managers and Extension Offices at Zoba level will ensure that the planned activities are implemented in line with guidance from MMR.

4.3. Anticipated challenges and solutions to implementation of the Strategy

Challenge 1: Lack of local capacity to produce and supply required aquaculture supplies and implements, and having to relying for most part on importation.

- **Suggested solution:** Purposively work with local firms and entrepreneurs to build their capacity to fabricate and manufacture of aquaculture implements and gears. This should include training and exposing interested youth in local fabrication of required implements.

Challenge 2: Typical bureaucratic delays of import-based procurements and supplies. This is because such import-based procurements by Government require clearance by different layers and offices of government including offices responsible for financing, trade and tax offices by implication.

- **Suggested solution:** MMR will have to invest in forward and comprehensive planning, and increase the technical capacity within the procurement unit of the ministry. This will also require prioritizing of activities, and building capacity to make and or fabricate some of the supplies and implements locally.

Challenge 3: Acquiring and ensuring sustainable funding and support through the implementation period of the NADSIP.

- **Suggestion solutions:** MMR led by H.E. Minister for Marine Resources will need to engage the development partners and the Ministry responsible for Finance to secure funding over the planned 5 years of implementation of NADSIP.

Challenge 4: Limited access to international public goods for aquaculture practice and development, and lack of access to international markets needed for marketing of high value mariculture products, due to an extended period of international isolation.

- **Suggested solution:** MMR will need to re-engage related agencies in other successful aquaculture practicing countries, as well as international agencies so as to source and acquire the needed technologies and establish the export market for Eritrea high value mariculture products such as mud crabs, oysters, sea cucumbers and others.

4.4. Strategy Development

The existing draft NADSIP was based on a consultative and technical assessment processes involving a wide array of stakeholders. The current effort though being facilitated by Technical Assistant, the information and suggestions for areas of focus and objectives of updated version have come from MMR staff and other key stakeholders consulted. This is especially so that the strategy and plan can be rolled out with minimum need for external leadership or technical guidance. The key stakeholders within the fisheries and aquaculture sector, all recognised aquaculture as key focus of Government and that must start from basic socioeconomic and ecological principles, that is, participatory, gainful and ecologically sustainable. The previous version was very elaborate technically but assumed aquaculture could be driven economically with private sector which not yet in place. This strategy focuses on serving the communities in terms of food and nutrition security while putting in place infrastructure to support eventual commercial aquaculture development. To this effect the stakeholders identified the key actions that will start the aquaculture development, and suggested key priorities and action points, that were reviewed and confirmed in the workshop held in Massawa in MMR. It also identified the role that MMR, coastal communities, rural inland farming communities and the few existing private sector actors could play in getting aquaculture started in Eritrea. Throughout the process there was continuous engagement, site visits and interviews with a range of different actors. The updated Eritrea Aquaculture Strategy and Development Implementation Plan is intended to cover cultivation of marine species onshore, intertidally and inshore; and inland waters; and will be reviewed in the

next 5 years. A Stakeholders analysis and a SWOT analysis of the Eritrean Coastal mariculture and Inland aquaculture sectors were undertaken through an iterative process with MMR staff, and during the workshop held in Massawa in October, 2022. This can be found in Appendix III and IV.

4.5. Setting priorities

The three processes, namely;1) consultation with wide array of stakeholders (appendix VII); 2) review of prior technical assessments of Eritrea's potential and opportunities for aquaculture development and practice including candidate species and systems that were recently undertaken, referenced herein; and 3) logical framework analysis, were used to provide an indicative set of priority activities for the updated NADSIP for Eritrea (appendix II). Following the consultations with different stakeholders and review of the available information, key areas of focus, issues, opportunities and issues were synthesised with participation of the MMR Aquaculture Division technical staff using the tool developed by the Consultant (appendix IX). Outcome of the synthesis was used to identify the priorities and develop the strategies and activities for delivery of set outputs of the strategy.

Overall, the stakeholders chose to focus on getting aquaculture started in the country through emphasis on engaging fishing and farming communities in aquaculture production for food and nutrition security, income generation and rural employment, using basic and simple to adopt technologies that are socioeconomically, ecologically and technically feasible and appropriate for Eritrea, and with focus on products that can locally be consumed and marketed.

4.6. Strategy Action Points

4.6.1. Priority Areas

To this effect the following priority areas were agreed to for the next five years (2023 – 2027):

PRIORITY AREA 1: Development of capacity for MMR technical staff in demonstrating, training and supporting target communities in aquaculture adoption and practice.

1) **Strategic Action 1-1:** Develop the capacity of MMR technical staff through exposure, hands-on training and placement opportunities in countries of similar socioeconomic status and close climatic and environmental conditions but successful in coastal mariculture and inland aquaculture.

Strategy Elaboration: Build MMR internal technical and managerial capacity necessary to guide the piloting, demonstration and supporting farmers in establishing and managing aquaculture production systems. This will be through exposure and hands-on practical training in coastal and inland aquaculture production systems management in aquaculture successful countries in the South with similar socioeconomic, environmental and climatic conditions. Having the right skills in place is crucial and necessary for training local farmers and entrepreneurs in aquaculture practice so as to avoid 'reinventing the will' and to save resources and time. There are number of countries with similar socioeconomic, environmental and climatic conditions and yet very successful in aquaculture, such as Philippines, Bangladesh, Indonesia, Thailand, Vietnam and India, which could offer the necessary exposure and placement opportunity for MMR technical staff to quickly

appraise their technical skills in setting up, operating and demonstrating appropriate technologies to the target communities and farmers.

Desired Outcome: 18 MMR staff provided with requisite practical skills and knowledge in setting up and managing different mariculture (12 staff) and inland aquaculture (06 staff) production systems.

2) **Strategic Action 1-2:** Establishment of appropriate infrastructure for demonstration, training and piloting of aquaculture practice for target communities

Strategy Elaboration: For the sector to develop there needs to be the right infrastructure and facilities in place in suitable areas. There are potential sites and buildings available, but work needs to be done to ensure that these buildings are suitable for mariculture operations. This would need investment from operators, funders, investors or landowners.

Desired Outcome: 40 for mariculture, i.e., 5 per each of the 8 identified potential production systems; and 40 for inland aquaculture, i.e., 02 hapa-based tilapia seed production units, 01 indoor SRT tilapia hatchery unit, 01 indoor (greenhouse)/outdoor African catfish seed production unit, 01 pond based mirror carp seed production unit, 15 tilapia LVHD cage aquaculture units based in 5 warm water reservoirs using all male tilapia and commercial feed, 03 medium sized ponds (1,000 sq. m of 20m by 50m) for monoculture of all male tilapia; 02 medium sized ponds (1,000 sq. m – 20m by 50m) for poly culture of mixed tilapia and African catfish, 12 reservoirs stocked directly with mixed sex tilapia and mirror carp, and 03 integrated fish/vegetable/poultry production units) established and operated jointly with progressive members of the fishing communities, individual entrepreneurs and or farmer cooperatives to facilitate uptake and commencement of mariculture and inland aquaculture practice.

3) **Strategic Action 1-3**: Provide resources, exposure, logistics and infrastructure to MMR to enhance the capacity of staff to support and follow up farmers and entrepreneurs in aquaculture practice and business.

Strategy Elaboration: There is going to be need for MMR staff to constantly engage and support farmers, fishers and entrepreneurs that are interested and or engaged in aquaculture practice and business, in and outside the MMR premises. There will be numerous field visits, travel inland and abroad, participation in regional meetings and aquaculture symposia locally and internationally, as well as several study tours and exchange visits. This will require financial resources, vehicle operation and maintenance, travel allowances, ICT (computers and other related gadgets, and more versatile internet in all centres of MMR), field work stations and stores, and hire of consultants and experts for different activities where MMR may not have the established capacity.

Desired outcome: This is estimated at 15% of the total implementation budget over the five years. Detailed plans and needs will be made by different units of MMR involved with the project.

PRIORITY AREA 2: Technology transfer and acquisition for coastal mariculture and inland aquaculture development

1) **Strategic Action 2-1:** Survey, map and gazette areas for aquaculture development including specific sites for farmers, both along the coastline and by inland freshwater reservoirs, as well as carry out a socioeconomic survey as to the needs, challenges and

suggested solution for adopting aquaculture for the target communities. A broad technical feasibility study should also be conducted to cover the different production systems.

Strategy Elaboration: Given the lack of tradition, and the need from the start to ensure aquaculture does not conflict with other uses of coastal areas and inland water, it is crucial that MMR technical staff, after undergoing technical capacity building, and with the support of TAs, survey and map appropriate areas for aquaculture to guide communities and farmers in locating aquaculture establishments. The sites identified shall be in such a way that the aquaculture practice does not have spatial conflicts with other users, and does not lead to undesirable ecological and environmental impacts.

Desired Outcome: 40 sites for mariculture and 20 reservoirs for inland aquaculture identified and gazetted to guide interested farmers and entrepreneurs in locating their aquaculture establishments; One (01) socioeconomic survey, and one (01) broad feasibility survey.

2) **Strategic Action 2-2:** Recruit mid-level technical persons (experts) to facilitate acquisition and transfer of coastal mariculture and inland aquaculture technology through South-to-South Cooperation arrangement.

Strategy Elaboration: This will include recruiting and working with mid-level and farm level experienced managers from countries in the South of similar socioeconomic and climatic conditions to Eritrea that have successfully established and practice coastal mariculture and inland aquaculture, such as Bangladesh, Philippines, Vietnam, Thailand and Indonesia. The technical persons should be willing to spend a good amount of time in Eritrea so as to support MMR establish demonstration facilities and work with farmers in setting up and operating pilot aquaculture establishments through at least 2 to 3 production cycles. The experts will assist MMR staff in promoting and establishing the different production systems using working with identified progressive local farmers and or interested private entrepreneurs.

Desired Outcome: Six (06) foreign mid-level experts, three (03) for mariculture and three for inland aquaculture, for 24 months.

3) **Strategic Action 2-3**: Identify and partner with lead farmers and or cooperatives to establish and operate pilot aquaculture production systems for the eight potential feasible aquaculture systems including:
    1. Grouper floating net cage aquaculture production
    2. Milkfish/mullets floating net cage aquaculture production
    3. Small-scale milkfish hatchery propagation
    4. Sea cucumber pond-based production
    5. Milkfish earthen ponds production
    6. Mud crabs' earthen ponds production
    7. Seaweed production using *Euchema sp.* or local sister species or red algae
    8. Oyster production using hanging method.

Strategy Elaboration: MMR to identify and select 5 progressive individuals and or farm/fishermen cooperative/organizations for piloting each of the 8 identified coastal mariculture production systems; and 30 persons and or organizations/farmer cooperatives identified for piloting or

trailblazing the different proposed inland aquaculture systems. The inland aquaculture will include persons or organizations to manage the 20 cage aquaculture establishments within the reservoirs, three (03) to manage the integrated aquaculture production establishments, and 12 farmer cooperatives to manage the newly stocked reservoirs. The selected individuals and organizations will work with MMR in establishing and operating pilot production systems. The MMR staff will be technically assisted by the recruited foreign technicians.

Desired Outcome: 40 persons and or cooperatives identified for piloting coastal mariculture; 35 persons and or cooperatives identified and supported for piloting inland aquaculture production technologies.

PRIORITY AREA 3: Mobilizing and train coastal and inland communities to engage in gainful aquaculture production and marketing based on the demonstrated results under **Priority area 2, strategic Action 2-3.**

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1) **Strategic Action 3-1:** Form strategic partnerships with individuals, groups or cooperatives of fishers or farmers/cooperatives, so as to commit to and receive training and engage in coastal mariculture and inland aquaculture practice.

Strategy elaboration: Identify progressive and resourced individuals, groups or cooperatives within the coastal fishing and inland farming communities, and establish strategic partnerships with them so as to establish and operate aquaculture production systems for demonstration and training farmers. The engagement of lead farmers and target communities should be from setting up of production system through to management of production and marketing of the products. The production and marketing should run for at least two cycles before MMR turns over the ownership and operations to the individuals /groups /cooperatives within the target communities. The individual farmer, fisher or cooperative chosen should be willing to serve and assist in training of other farmers/groups/cooperatives. The individuals, groups and cooperatives should be convinced to contribute at least 10 to 15% of the cost, either in kind or as funds in addition to time they have to put in managing the production system.

Desired outcome(s): 1,850 persons (20 persons for each of the 40 identified coastal mariculture production system demonstration site; and 30 per each of the 35 inland aquaculture production system demonstration site) exposed and trained in process of setting up, operating, harvesting and handling, and marketing of the proceeds from the aquaculture production systems.

2) **Strategic Action 3-2:** Building Skills for Aquaculture Jobs (BSAJ) for youth and young adults to engage and act as Local Service Providers (LSPs) for coastal mariculture and inland aquaculture practice.

Strategy elaboration: Identify and build aquaculture skills and knowledge into willing and vulnerable youth and young adults from target communities, comprising of at least 55% females and 45% males, to serve as 'Local Service Providers'. Key areas of focus should be construction and set up of production systems, management of aquaculture facilities, hatchery propagation, collecting of seed from the wild and transporting it to the intended sites, stocking of production systems, feeding of the farmed organisms, harvesting and handling of farmed products, and on-

farm feed production and management. The idea is to build ample work force with appropriate production and management skills of youth and young adults living within the communities so as to drive and support the nascent aquaculture industry as Local Service Providers (LSPs). This is certainly a means of creating employment for the youth, that can either engage in doing aquaculture production as business of their own, or be employed by cooperatives and individuals to manage the established aquaculture enterprises or work as LSPs in respective communities with guidance and oversight of MMR. The training shall be conducted by MMR staff, and it shall be formal with mandatory attendance of all lectures, demonstrations and practical course work moderated for persons with primary or secondary education, running for a duration of up to 2 to 3 months, with 2 months placement at one of the demonstration sites. The trained youth and young adults will be issued with certificates specifying the areas they have mastered according to the assessment by the MMR trainers. MMR will liaise with Ministry of Education to ensure that the certificates issued are credible and authenticated as level I and or level II TVET (Technical and Vocational Education and Training) certificates.

Desired outcome(s):1,500 youth and young adults (150 for each of the eight (08) identified mariculture systems; and 300 for inland aquaculture production systems) trained and imparted with skills in different aspects of inland aquaculture and coastal mariculture. The knowledge and skills shall be documented and transferrable.

3) **Strategic Action 3-3:** Development of sources of wild and hatchery propagated seed; support to existing factories to produce aquafeed; and building local capacity to fabricate farming and harvesting gears /implements

Strategy elaboration: A two-pronged approach will be undertaken for seed supply for both coastal mariculture and inland aquaculture. One source will be appropriately designed sourcing from the wild, grading, conditioning and transporting of the seed to farmers. This will have to be strictly monitored and managed by skilled persons. Second source will be setting up a hatchery for key leading coastal mariculture species and inland aquaculture species using either existing infrastructure or establishing new sites operated jointly by MMR and progressive or lead farmers. Similarly, the feed will be done through a two-pronged approach; 1) will be engaging the SFE facility and other existing animal feed manufacturing factories to commence production of commercial fish feed for different species. MMR will have to provide formulations of the required feed to the factories; 2) will be to skill farmers in use of locally available materials to produce feed on-farm with technical guidance from extension workers and local service providers. In terms of farm implements, whereas importation is sure means it is expensive and it is still highly regulated causing delays that may hinder uptake and expansion of aquaculture. To this effect, MMR working with foreign technicians will have to build local capacity of extension workers and LSPs to make the production systems and implements on-site. This will include working with established local engineering companies and fabricators to give them models of the production systems and implements for them to design and manufacture.

Desired outcome(s): Identify 8 locations for collection of seed from the wild; set up one multi-species mini-hatchery at the old processing unit for export of aquarium species in Tiwalet for coastal mariculture; support development of 3 aquafeed production lines in existing animal feed factories; and develop capacity of 40 extension workers and LSPs to fabricate mariculture and inland aquaculture implements.

PRIORITY AREA 4: Research and Innovation for coastal mariculture and inland aquaculture adoption and development

1) **Strategic Action 4-1:** Improve and equip the existing research facilities for coastal mariculture and inland aquaculture research.

Strategy elaboration: This will involve rehabilitation and setting up additional facilities, equipment and personnel for coastal mariculture and inland aquaculture. Two (2) research stations that are strategically located for access by the aquaculture producers. They will also in addition serve as training and demonstration centres especially for local service providers and lead or progressive producers. Technical infrastructure includes establishment of laboratory space for weighing, preparing and manipulating experimental materials; provision of basic laboratory equipment; water temperature regulators and controllers; cold chain for storage of temperature sensitive materials; weighing and volumetric instruments; heating and cooling instruments; glassware; and others. The outdoor facilities include earthen, concrete, plastic and canvas ponds and tanks; water supply and drainage systems; earth moving machinery; alternative sources of energy, especially solar power; and waste management system.

Desired outcome(s): Two (2) active research stations, one fish pathology laboratory, and one (01) integrated salt-aquaculture field station, equipped and serviced for scientific work and or production with indoor and outdoor facilities and infrastructure for research and production respectively. Mair Serwa station was assessed to be appropriate for inland aquaculture research, but there is need for identification of an appropriately serviced site close to Massawa for coastal mariculture research, which should also house the fish pathology laboratory for mariculture. The Halibay site is way out and not particularly serviced, but found was assessed and found appropriate as a field site for integrated salt-mariculture production.

2) **Strategic Option 4-2:** Conduct adaptive research for potential identified eight production systems appropriate for Eritrea coastal and inland communities.

Strategy elaboration: To guide aquaculture uptake and technology transfer, public research in aquaculture will have to focus on adaptive research working mainly through on-farm trials by engaging progressive or lead farmers as partners in research. Key areas of focus according to the systems identified include the following:

1. Feed formulation and development
2. On-farm feed production and management
3. Harvesting seed from the wild and conditioning, transporting and stocking of seed for different species harvested from the wild.
4. Hatchery propagation of key coastal and inland aquaculture species including use of SRT seed for inland cage aquaculture development.
5. Feeding and management of water quality in production system
6. Controlling and management salinization and acidification for coastal production system

Desired outcome(s): Two (2) active research stations actively engaged in six sets of adaptive research studies above in both mariculture and inland aquaculture, based largely on on-farm based trials with participation of farmers.

4.7. Key Outputs, Activities and Budgets

The above strategies shall be implemented through a series of activities and that shall lead to attainment of the associated and elaborated purposes and outputs, under each priority area and strategic option. The outputs in this NADSIP are limited in focus to getting aquaculture practice going in Eritrea so as to enhance its contribution to food and nutrition security, youth employment and income generation. The activities and budgets for proposed interventions are modest and required to promote and support uptake of aquaculture by farming and fishing communities as well as private entrepreneurs. Details of the outputs, activities and associated budgets are provided in Development Implementation Plan of this Strategy, that given below.

4.8. Crossing Cutting Issues

Deliberate efforts will be made by MMR to equip MMR and local government technical and administrative staff involved with implementing of this strategy with tools for mainstreaming Gender, socially disadvantage segments of the population, Environment, Climate Change, and Community Development in aquaculture planning and development. 10% of the estimated budget will be set aside for these aspects to be taken on board. Key areas of focus will be the following:

1. Promotion of gender inclusive and sustainable aquaculture development.
2. Increase the contribution across gender from aquaculture production and productivity.
3. Fostering a healthy and sustainable environment for aquaculture production and development.
4. Suitable and affordable aquaculture practices for socially disadvantaged households identified and integrated in the programmes and projects of aquaculture.
5. Integrating of Climate Change in the planning and implementation of aquaculture policies and projects.
6. Support to community development through promotion of profitable and market driven aquaculture.
7. Engage and train young demobilized soldiers in doing aquaculture as a business and or trained as Government or private sector paid Local Service Providers to assist communities and practitioners in doing aquaculture.

4.9. Monitoring and Evaluation of NADSIP

1. **Key indicators** of the achievement of outputs include level of aquaculture practice, productivity of different systems (yields per unit area), per capita consumption of fish, amounts of products marketed, incomes of farm households, number of farmers and farms, area under culture.

2. **Time frame**: NADSIP is planned for a period of five years starting from 2023 and ending in 2027, when it will be again updated. Evaluation of achievements and necessary adjustments in the NADSIP shall be carried out in the fourth year of the plan period in 2027 and at the end of the plan period in 2027.

5) CONCLUSION

In summary, the National Aquaculture Development Strategy and Implementation Plan (NADSIP) sets out a vision for promotion, uptake/adoption and sustainable development of aquaculture practice in Eritrea. It describes a number of selected actions needed to achieve the set vision. It is expected that successful implementation of the various actions will, taken together, lead to adoption and practice of aquaculture in Eritrea, and foster sustainable aquaculture development throughout the country. The NADSIP inculcates from the start idea of proper and participatory planning, socioeconomically equitable and gender responsive practice, and ecological sustainable and environmentally responsible practice. The NADSIP requires that aquaculture is carried out in appropriately located sites with established potential for aquaculture production. The ten (10) specific Strategies present a comprehensive list of actions identified as a result of a wide range of information received through extensive stakeholder consultation and input as well as extensive expert analysis of the various opportunities and challenges for the sector. The action items target specific issues intended to get aquaculture started and developed sustainably. The strategies present an opportunity to promote and encourage adoption and practice of aquaculture in the most strategic manner possible. The Strategies are directional, living documents that are both flexible and adaptive. They are guided by the National Development Plans and overall national economic and social policies, based on existing national policies and plans and implementation mechanisms within MMR and other relevant agencies. The strategies also reflect varied geographical, environmental and social circumstances and priorities, providing for both coastal and inland farming communities, warm and cold areas, and highlands and lowlands. Through regular reviews, the plans should be updated to reflect those initiatives that have been completed and to accommodate new issues that emerge.

6) AQUACULTURE DEVELOPMENT IMPLEMENTATION PLAN

1) **THEME:** AQUACULTURE PRODUCTION AND MANAGEMENT CAPACITY DEVELOPMENT:

   Objective: To build capacity of MMR staff in planning, constructing, managing and maintaining selected aquaculture production systems through practical, hands-on and on-site training.

   Action: Training and skilling of MMR technical staff and establishment of community/farmer demonstration and training infrastructure for MMR

   Strategic Action 1-1: Develop the capacity of MMR technical staff through exposure, hands-on training and placement opportunities in countries of similar socioeconomic status and especially those that have environmental and climatic conditions close or similar to those of Eritrea, and are successful in coastal mariculture and inland aquaculture practice.

   Duration: Within six (06) months. MMR will be given opportunity to train for 3 months

over the first six months of implementation of NADSIP, through hands-on training and placement in active aquaculture establishments in countries considered successful in aquaculture practice

Table 5: Key cost areas and unit cost estimates for capacity development

SN	Cost area (key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Charges in host farm for 3 months.	Person	18,000	12	216,000
02	Basic farm ware and kits	Person	2,250	12	27,000
03	Flight charges	Tickets	30,000	12	360,000
04	Visa, health certificates and insurance	Person	6,000	12	72,000
05	Upkeep for MMR staff on placement	Person-Months	27,000	36	972,000
	Total				**1,647,000**

Strategic Action 1-2: Establishment of appropriate infrastructure for demonstration, training and piloting of aquaculture practice for target communities.

Duration: Within the first 24 months of implementation of the NADSIP.

Table 6: Key cost areas and cost estimates – Coastal mariculture facilities

SN	Cost area (key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Cage mariculture units (6m by 6m by 6m) for milkfish &mullets production	Cage sets	72,000	5	360,000
02	Pond mariculture units (30 m by 70m by 1.2m) for milkfish and millets production	Ponds	216,000	5	1,080,000
03	Cage mariculture units (6m by 6m by 6m) for grouper production	Cage sets	72,000	5	360,000
04	Cage mariculture of sea cucumber (6m by 6m by 6m)	Cage sets	72,000	5	360,000
05	Pond mariculture of mud crabs (20m by 50m by 1.2m)	Ponds	108,000	5	540,000
06	Establish a multi-species mini-hatchery.	Mini-hatchery set	600,000	5	3,000,000
07	Oyster production establishments	Establishments	60,000	5	300,000
08	Seaweed production units	Establishments	45,000	5	225,000
09	Sea cucumber production ponds	Establishments	108,000	5	540,000
	Total				**6,765,000**

Table 7: Key cost areas and cost estimates – Inland Aquaculture facilities

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Set up of happa-based tilapia seed production units (30 happas, 120 pegs, 30 broods, feed)	Happa-based tilapia hatchery	75,000	3	225,000
02	Setup and operation of on indoor tilapia hatchery unit with feed mediated SRT	Indoor tilapia hatchery	180,000	1	180,000
03	Mirror carp hatchery (03 Breeding ponds, 01 indoor incubation unit, and 12 nursing happas within 3 ponds)	Mirror carp hatchery	600,000	1	600,000

04	Reservoir based cage aquaculture production units (20 cages of 5m by 5m by 3m)	Cages	32,000	20	640,000
05	Commercially formulated and produced feed	Kg	25,600	15	384,000
06	Stocking material for 12 reservoirs of 400,000 sq. m each (tilapia and mirror carp seed) including transport costs	Seed	2	960,000	1,920,000
07	Specialised truck for fish seed transport	Specialized seed transport truck	800,000	1	800,000
08	Management costs (field travel allowances and fuel)	Months	16,000	24	384,000
	Total				**5,133,000**

Table 8: Key cost areas and unit cost estimates for supportive services and infrastructure

SN	Cost area (key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Support services and infrastructure	Year	1,200,000	5	6,000,000
	Total				**6,000,000**

2) **THEME:** SUSTAINABLE COASTAL MARICULTURE AND INLAND AQUACULTURE PROMOTION AND ADOPTION

Objective: To ensure that coastal mariculture and inland aquaculture are introduced and practiced in socioeconomically and environmentally responsible manner that shall facilitate wide and fast uptake of the technology.

Strategic Action 2-1: Survey, map and gazette areas for aquaculture development including specific sites for farmers, both along the coastline and by inland freshwater reservoirs.

Duration: Six (06) months

Table 9: Key cost areas and estimated costs for aquaculture promotion and adoption

SN	Cost area (key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Field travel costs – fuel and vehicle servicing	Field trip	5,250	24	126,000
02	Field travel costs – field allowances for 8days/pxn/mnth*8pxns*6mnths	Days	350	288	100,800
03	Water quality assessment kits	Probe	300,000	1	300,000
04	GIS and mapping field gadgets	Sets	2,500	3	7,500
05	Water body area marking buoys	Buoys	60	240	14,400
06	ICT (computers and associated software)	Sets	67,500	2	135,000
07	Socioeconomic survey of needs, challenges and solutions for adoption of aquaculture by target communities	Consultancy Study	247,500	1	247,500
08	A broad feasibility study for different culture	Consultancy			

	systems within target communities	study	450,000	1	450,000
	Total				**1,381,200**

Strategic Action 2-2: Recruit mid-level technical persons (experts) to facilitate acquisition and transfer of coastal mariculture and inland aquaculture technology through South-to-South Cooperation arrangement.
Duration: 24 months

Table 10: Key cost areas and estimated costs for transfer of aquaculture technology

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Proposal development and related processes for South-to-South Cooperation	Consultant	108,000	1	108,000
02	Search costs for recruiting of experts	Fees	54,000	1	54,000
03	Flight charges for six (06) experts* 2 trips@	Tickets	30,000	12	360,000
04	Visa, health certificates & insurance* 2 trips	Person	6,000	12	72,000
05	Upkeep and fees for experts for 2 years =, 6 6experts*2yrs*12mths	Man-Months	45,000	144	6,480,000
06	Field gear and kits/materials	L/sum	1,500,000	1	1,500,000
	Total				**8,466,000**

Strategic Action 2-3: Identify and partner with lead farmers and or cooperatives to establish and operate pilot aquaculture production systems for the eight potential identified aquaculture systems.
Duration: 03 months

Table 11: Key cost areas and estimated costs identifying lead farmers

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Survey, search and consultations for interested progressive persons for coastal mariculture				-
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	6	31,500
b.	- Field travel – travel allowances for 4 pxns = 4pxns*12days/mnth*3mnths	Days	350	144	50,400
c.	- Airtime for 4 pxns - =4pxns*3mnths	Months	400	12	4,800
02	Survey, search and consultations for interested progressive persons for inland aquaculture				-
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	6	31,500
b.	- Field travel – travel allowances for 4 pxns - =4pxns*12days/mnth*3mths	Days	350	144	50,400
c.	- Airtime for 4 pxns - =4pxns*3	Months	400	12	4,800
	Total				**173,400**

3) **THEME:** AQUACULTURE EXTENSION AND TRAINING

Objective: To promote adoption of aquaculture practice and production as means of food and nutrition security, income generation and improving livelihoods of coastal fishing and inland rural farming communities.

Strategic Option 3-1: Form strategic partnerships with individuals, groups or cooperatives of fishers or farmers/cooperatives, so as to commit to and receive training and engage in coastal mariculture and inland aquaculture practice

Duration: 24 months

Table 12: Key cost areas and estimated costs for aquaculture extension training

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Training of 800 individuals and organisations in coastal mariculture				
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	48	252,000
b.	- Field all.12 pxns*6 days/mnth*24 mnths	Days	350	1,728	604,800
c.	- Airtime for 12 pxns for 24 mnths	Months	350	288	172,800
d.	- Training kits (bag, measuring tape, apron, pen, pencil, notepad)	Kits	450	800	360,000
e.	- ToT and training modules preparation	Days	1,500	6	9,000
02	Training of 1,050 individuals and organisations in inland aquaculture practice				
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	48	252,000
b.	- Field all. 12 pxns, 6 days/mnth, 24 mnths	Days	350	1,728	604,800
c.	- Airtime for 12 pxns for 24 mnths	Months	350	288	100,800
d.	- Training kits (bag, measuring tape, apron, pen, pencil, notepad)	Kits	450	1,050	472,500
e.	- ToT and training modules preparation	Days	1,500	6	9,000
	Total				**2,828,700**

Strategic Action 3-2: Building Skills for Aquaculture Jobs (BSAJ) for youth and young adults to engage and act as Local Service Providers (LSPs) for coastal mariculture and inland aquaculture practice.

Duration: 12 months

Table 13: Key cost areas and estimated costs for building skills among youth and young adults for aquaculture jobs.

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	**Training of 1,200 youth and young adults to service as LSPs in coastal mariculture**				
a.	- Design and approval of curriculum for TVET in coastal mariculture	W/shop	12,000	3	36,000
b.	- ToT and training modules preparation	Days	1,500	6	9,000
c.	- Selection and establishment of training centres – TVETs by demo sites	TVETs	45,000	8	360,000
d.	- Field travel – vehicle fuel and servicing	Trips	5,250	96	504,000

e.	- Field all. 12 pxns, 6 days/mnth, 24 mnths	Days	350	1,728	604,800
f.	- Airtime for 12 pxns for 24 mnths	Months	350	288	100,800
g.	- Training kits (bag, measuring tape, apron, pen, pencil, notepad)	Kits	450	1,200	540,000
h.	- Refreshments during training for 1,215 pxns for 12 days/mnth for 3 mnths	Days	60	43,740	2,624,400
i.	- Training materials, hoes, wheelbarrows, bundles of strings, shovels, spades, etc.	Pxn	1,250	1,200	1,500,000
02	**Training of 300youth and young adults to serve as LSPs in inland aquaculture practice**				
a.	- Design and approval of curriculum for TVET in inland aquaculture	W/shop	12,000	3	36,000
b.	- ToT and training modules preparation	Days	1,500	6	9,000
c.	- Selection and establishment of training centres – TVETs at established demo sites	TVETs	45,000	8	360,000
d.	- Field travel – vehicle fuel and servicing	Trips	5,250	96	504,000
e.	- Field all. 12 pxns, 6 days/mnth, 24 mnths	Days	350	1,728	604,800
f.	- Airtime for 12 pxns for 24 mnths	Months	350	288	100,800
g.	- Training kits (bag, measuring tape, apron, pen, pencil, notepad)	Kits	450	300	135,000
h.	- Refreshments during training for 310 pxns for 12 days/mnth for 3 mnths	Days	60	11,160	669,600
i.	- Training materials, hoes, wheelbarrows, bundles of strings, shovels, spades, etc.	Pxn	1,250	300	375,000
	Total				**9,037,200**

Strategic Option 3-3: Development of sources of wild and hatchery propagated seed; support to existing factories to produce aquafeed; and building local capacity to fabricate farming and harvesting gears /implements
Duration: 12 months

Table 14: Key cost areas and estimated costs developing sources of inputs and implements for aquaculture production

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
1.	**Survey and map 8 locations on the coastal line to serve as sources of seed for mariculture species**				
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	12	63,000
b.	- Allowances 4 pxns, 6 days/mnth, 12 mnths	Days	350	288	100,800
d.	- Seine nets for sampling	Nets	15,000	3	45,000
e.	- Conditioning tanks and aerators	Sets	25,000	3	75,000
2.	**Development of 3 aquafeed commercial production lines.**				
a.	- Development of appropriate formulations for different farmed species	Consultant	180,000	2	360,000
b.	- TA to existing feed factories to adopt and set up aquafeed production lines	Days	60	4,500	270,000
c.	- Validation of produced fish feed with on-				

	farm trials.	Trial sets	135,000	2	270,000
03	**Training of 40 LSPs in fabrication of implements for coastal mariculture inland aquaculture**				
a.	- Field travel – vehicle fuel and servicing	Trips	5,250	12	63,000
b.	- Field all. 8 pxns, 5 days/mnth, 12 mnths	Days	350	480	168,000
d.	- Training kits (bag, measuring tape, apron, pen, pencil, notepad and tool box)	Kits	5,250	40	210,000
	Total				**1,624,000**

4) **THEME:** RESEARCH LED AQUACULTURE DEVELOPMENT

Objective: To promote use of appropriate and environmentally suitable aquaculture production systems and species that will ensure the ecological and genetic resources integrity while enhancing the aquaculture productivity and environmentally sound use of land, water and other associated resources.

Strategic Action 4-1: Improve and equip the existing research facilities for coastal mariculture and inland aquaculture research.
Duration: 36 months

Table 15: Key cost areas and estimated costs developing aquaculture research capacity

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Identification of appropriate site and establishment of Coastal Mariculture Research Station in Massawa	Buildings, ponds, tanks, machines, implements, lab equipment, ICT, water supply and drainage system	3,187,500	1	3,187,500
02	Equipping of Halibay Station for integrated salt-aquaculture production	Ponds and water supply and drainage system	220,000	10	2,220,000
03	Redesign of ponds and addition of appropriate outdoor facilities at Mai Serwa	Works & facilities	90,000	8	720,000
04	Acquire canvas and plastic ponds for research and nursing of fry for Mai Serwa Centre	Canvas and plastic ponds with water supply system	60,000	8	480,000
05	Equipping of Mai Serwa Station to serve as an inland aquaculture research Centre	Equipment, ICT, remodelling indoor and outdoor facilities	1,350,000	1	1,350,000
06	Fish pathology laboratory	Set up a fish pathology unit at Massawa Coastal Aquaculture Research Centre	480,000	1	480,000
	Total				**8,437,500**

Strategic Action 4-2: Conduct adaptive research for the potential identified eight production systems appropriate for Eritrea coastal and inland communities.
Duration: 36 months

Table 16: Key cost areas and estimated costs for conduct critical research studies

SN	Cost area (Key inputs)	Unit	Unit cost (Nakfa)	Qty	Amount (Nakfa)
01	Development of a research plan and programme for each of the two centres	W/shops	12,000	6	72,000
02	Implementation of coastal mariculture research	Studies	900,000	4	3,600,000
03	Implementation of inland aquaculture research	Studies	900,000	2	1,800,000
04	Dissemination of research results (demos, publications and open days)	Sets	40,000	4	160,000
05	Training of LSPs and lead farmers in uptake of key research outputs and findings.	Sets	40,000	2	80,000
	Total				**5,712,000**

Table 17: Activity matrix including priority areas, strategies, outputs, activities and budgets

Priority Area	Strategies	Outputs	Activities	Targets	Budget (Nakfa)
Aquaculture Strategy Coordination and Management: Promote aquaculture for food and nutrition security, income generation and rural employment, through use of best management practices and creating transparent management systems with significant reduction in encumbrances in doing aquaculture in Eritrea	Oversee, coordinate and manage the implementation of the NADSIP	The NADSIP passed by Government, rolled out and implemented	1. Consideration and approval of draft NADSIP by MMR Top Management, and launch of NADSIP	Approval and launch of NADSIP	220,000
		Regular meetings for guiding implementation of NADSIP.	2. Top Management of MMR and SMC conduct regular meetings to coordinate and support the implementation of the NADSIP	Minimum 4 Top Management and 12 SMC meetings annually	1,440,000
		Aquaculture Management structure enhanced to support implementation of NADSIP	3. Review the existing staff establishment structures for aquaculture management at central and local government	HR Review of sector in line with NADSIP requirements	30,000
			4. Fill the existing vacant placements for aquaculture management for MMR staff so as to address the NADSIP personnel requirements	4 mariculture and 6 inland technical staff.	120,000
	Staffing, community participation and technical support provided as planned.	Planned activities manned and implemented as per the NADSIP.	5. Survey and conduct consultations so as to identify the progressive individuals/lead farmers to work with in piloting of aquaculture production systems	300 lead farmers identified.	300,000
			6. Provide long term technical assistance to aquaculture management including conducting regular staff performance appraisal	TA in implementing of NADSIP	2,700,000
			7. Put in place appropriate infrastructure, logistics and technology to support the implementation of the NADSIP	Offices, cars, internet etc.	4,500,000
	Monitoring and evaluation of the performance of the NADSIP	Quarterly, annual, mid-term (2026) and end of NADSIP era (2027) performance monitored and evaluated	8. Periodic review of progress of implementation of the NADSIP	27 missions by MMR and independent experts	750,000
Capacity development: Training and skilling of MMR technical staff and development of demonstration and	Develop the capacity of MMR technical staff through exposure, hands-on training and placement opportunities in countries of similar socioeconomic status and	18 MMR staff provided with requisite practical skills and knowledge in setting up and managing different mariculture (12 staff) and inland aquaculture (06 staff)	9. Training and skilling of MMR technical staff	18 MMR staff trained	1,647,000
			10. Establishment farmer/community / cooperatives demos and training infrastructure.	40 facilities for coastal mariculture	6,765,000

training infrastructure for MMR	have environmental and climate conditions near or similar to Eritrea, and successful in coastal mariculture and inland aquaculture.	production systems.	11. Establishment farmer/community / cooperatives demos and training infrastructure.	40 facilities for inland aquaculture	5,133,000
	Provide support services and operational and technological infrastructure to MMR to support target communities in adopting aquaculture practice	Operations, services and support of MMR accessible and deployed to promote adoption and practice of aquaculture by target communities	12. Conduct the following: travel inland and abroad; local and international meeting; aquaculture workshops and symposia; study tours and exchange visits; acquire, operate and maintain vehicles, motorcycles and bicycles; acquire ICT (computers and other related gadgets, and more versatile internet in all centres of MMR);set up field work stations and stores, and hire of consultants and experts for different activities where MMR may not have the established capacity.	5 years	6,000,000
Aquaculture promotion and adoption: Technology transfer and acquisition for coastal mariculture and inland aquaculture development	Survey, map and gazette areas for aquaculture development including specific sites for farmers, both along the coastline and by inland freshwater reservoirs.	Areas of high aquaculture production potential mapped based on set and generally agreed criteria	13. Conduct field survey, identify, map and gazette sites for mariculture and inland aquaculture piloting.	40 sites for mariculture and 20 reservoirs for inland aquaculture	**1,381,200**
	Recruit foreign mid-level technical persons (experts) to facilitate acquisition and transfer of coastal mariculture and inland aquaculture technology through South-to-South Cooperation arrangement.	Experts from countries in the South with socioeconomically similar and near or similar environmental and climate conditions, and with well-functioning farmer level coastal and inland aquaculture practice, recruited to support the aquaculture development in Eritrea.	14. Preparation and development of a South-to-South Cooperation project for FAO or IFAD consideration and support.	South-to-South GCP project	8,466,000
			15. Recruitment and hire of mid-level experienced technical experts	Six (06) experts	
			16. Facilitation of the work of the experts including remunerations and provisions for the planned activities	Funding and support for 24 months work.	
	Identify and partner with lead farmers and or cooperatives to establish and operate pilot aquaculture production systems for the eight potential identified aquaculture	Progressive individuals/lead farmers or entrepreneurs engaged to pilot aquaculture production in Eritrea.	17. Survey and consultations with communities, local leaders and farmer organizations	40 persons coastal mariculture; 35 persons for inland aquaculture.	

	systems.				173,400
Aquaculture Extension and Training: Mobilizing and train coastal and inland communities to engage in gainful aquaculture production and marketing	Form strategic partnerships with individuals, groups or cooperatives of fishers or farmers/cooperatives, so as to commit to and receive training and engage in coastal mariculture and inland aquaculture practice	Communities exposed and trained in process of setting up, operating, harvesting and handling, and marketing of the proceeds from the aquaculture production systems.	18. Field survey and consultations with communities and local leaders to establish interested individuals who can commit to being trained in aquaculture practice.	1,850 individuals identified and committed to adoption of aquaculture practice	
			19. Training of the identified individuals in different systems of mariculture and inland aquaculture production.	1,850 individuals trained.	2,828,700
	Building Skills for Aquaculture Jobs (BSAJ) for rural youth and young adults to engage and act as Local Service Providers (LSPs) for coastal mariculture and inland aquaculture practice.	Rural youth and young adults identified, trained and imparted with transferable documented skills in different aspects of inland aquaculture and coastal mariculture.	20. Training of vulnerable youth and young adults to serve as Local Aquaculture Service Providers (LSPs)	1,500 youth and young adults	9,037,200
	Development of sources of wild and hatchery propagated seed; support to existing factories to produce aquafeed; and building local capacity to fabricate farming and harvesting gears /implements	Supply of culture/stocking materials, aquafeed, and implements and gears for aquaculture established and assured.	21. Survey, identifying and mapping of suitable locations on the coastal with stocking/seed for mariculture, and putting in place a mechanism and guidelines for collecting seed from the wild	8 sites and systems	
			22. Construction, establishing and operationalising of a multispecies mini-hatchery	01 mini-hatchery	
			23. Technical assistance and support to existing feed factories to establish commercial aquafeed production lines.	3 commercial lines/factories.	
			24. Training of LSPs in fabrication of implements for coastal mariculture and inland aquaculture	40 LSPs	1,624,000
Aquaculture Socioeconomics and marketing: Expanding the local, national and regional markets for aquaculture fish and fishery products	Identify, engage and link coastal mariculture and inland aquaculture producers to key markets for aquaculture products.	Produced mariculture and inland aquaculture products marketed locally and in the region.	25. Establish a taskforce within MMR for generating and providing to farmers with feasible market linkages, and support for engaging and entering into contractual production for aquaculture products for the identified markets.	One (01) marketing unit/taskforce	450,000
			26. Set up a platform where farmers can meet 3 to 4 times a year with prospective buyers or market mobilized by MMR an ICT mobile platform for linking producers and traders	Three (03) B2B Conferences each year.	1,200,000
			27. Establish and operate a facility to proactively identify, prepare and support aquaculture producers to enter in		

			contracts with large local and regional aquaculture products off-takers	One (01) facility	150,000
	Promote, advertise and develop markets for Eritrea aquaculture products	Coastal mariculture and inland aquaculture products differentiated and marketed in specialized aquaculture markets.	28. Develop, operate and maintain a virtual coastal mariculture and inland aquaculture products market platform linking producers to restaurants, hotels, markets, institutions and large off-takers		260,000
			29. Establish at least 4 aquaculture products marketing centres in identified and gazetted 'high aquaculture potential zones (HPAZs).	Four (4) specialized markets for mariculture and aquaculture products	1,440,000
	Promote processing and marketing of quality aquaculture products using existing infrastructure	50% of aquaculture products processed and marketed as valued added products by year 2027.	30. Engage existing processing facilities and support them to process and marketed coastal mariculture and inland aquaculture products.	3 MoUs and facilities established and supported	180,000
	Promotion of cross-border and regional aquaculture products trade	Cross-border and regional trade in Uganda aquaculture products increased by 50% by year five.	31. Set up and develop capacity of up to 12 cottage enterprises at farmer or cooperative level to process and value add aquaculture produce, including setting up of the basic standards to guide the handling, processing, value adding and marketing of aquaculture products	12 cottage aquaculture processing facilities.	750,000
Research led aquaculture development: Research and innovation for aquaculture adoption and development	Improve and equip the existing research facilities for coastal mariculture and inland aquaculture research.	Aquaculture adoption and development in Eritrea guided by science and locally proven technologies.	32. Establishing a functional mariculture research centre at Halibay field station, and uplifting Mair Serwa for inland aquaculture research.	Two (2) active research stations, for mariculture & inland aquaculture	8,437,500
	Conduct adaptive research for potential identified eight production systems appropriate for Eritrea coastal and inland communities.	Key critical areas of mariculture and inland aquaculture practice scientifically investigated.	33. Undertake critical research for adoption and practice of both mariculture and inland aquaculture, based largely on on-farm based trials with participation of farmers.	six (06) sets of adaptive research studies	5,712,000
Crossing Cutting Issues: Equipping central and local government technical and administrative staff with tools for mainstreaming Gender, (Socially	Support to gender inclusion in sustainable aquaculture development	All aquaculture plans, projects, and activities to deliberately include provisions for empowerment of rural women and youth	34. Conduct a baseline study for gender issues that may prohibit full participation of women in aquaculture development	National Consultant	150,000
			35. Formulate gender responsive targets, indicators and promote collection, maintenance and use of sex-disaggregated data and qualitative information to address and monitor differential needs, roles, challenges and opportunities of women and youth involved/interested in aquaculture.	National Consultant and MMR	150,000

disadvantages), Environment, Climate Change, and Community Development in aquaculture planning and development.		Ensure that all planned NADSIP activities have gender considerations and/or the empowerment of women.	36. Train and sensitize Central and local government aquaculture managers in gender mainstreaming	At least 50% of the aquaculture project outputs including aspects of gender inclusion and mainstreaming	120,000
			37. Establish aquaculture gender focal persons in all aquaculture administrative units		
	Fostering a healthy and sustainable environment for aquaculture production and development	Aquaculture ventures and enterprises established and operated in socially equitable and ecologically sound manner	38. Conduct a Strategic Environmental and Social Assessment (SESA) for aquaculture adoption and practice in line with the NADSIP	National Consultant	180,000
			39. Put in place measures and guidelines for socially equitable and ecologically sound aquaculture practice; and train lead farmers on doing aquaculture in a manner that is compatible to social, economic and cultural interests of the attendant communities	National Consultant (2 sets of guidelines)	120,000
			40. Develop and operationalize guidelines to assist with the inclusion of BMP strategies into existing and new aquaculture ventures		
	Integrating of Climate Change in the planning and implementation of aquaculture policies and projects	Priority adaptation; technologies, barrier analysis and enabling framework for the deployment and diffusion of the technologies for integration adaptation to climate change in aquaculture production systems popularized	41. Assess the vulnerabilities and put in place mitigation measures of aquaculture production systems and the human population that depends on aquaculture to climate change in HPAZs		
			42. Identify barriers that may hinder the acquisition, deployment, and diffusion of prioritized technologies; and develop a Technology Action Plan (TAP) specifying activities and enabling frameworks required to overcome the barriers to the transfer, adoption, and diffusion of selected technologies in the region	Consultant	245,000
	Grand Total				**72,660,000**

Sources of Information

1) FAO (2008). The National Aquaculture Development Strategy and Plan for Eritrea: Recommendations.

2) FAO (2019). Eritrea GlobleFish Market Profiles. Available online at: https://www.fao.org/3/cb9703en/cb9703en.pdf

3) Godardo L. Juanich and Dionisio D. Colantro (2018). Joint TA Mission Report, Ministry of Marine Resources, Marine Resources Research DivisionAquaculture Research Unit, Massawa, Eritrea.

4) Habtemicael Weldegiorgis (2015). Land tenure in Eritrea. Available online at: https://www.fig.net/resources/proceedings/fig_proceedings/fig2015/papers/ts01c/TS01C_weldegiorgis_7442_abs.pdf

5) Ministry for Agriculture Newsletter (2012): Micro-dams promoting development and transforming communities. Asmara, Eritrea.

6) Ministry of Marine Resources (2021). National Fisheries Policy for Eritrea.

7) Ministry of Marine Resources ((2018). Joint Mission Report for Aquaculture Technical Assistants. Marine Resources Research Division, Aquaculture Research Unit Massawa, Eritrea

8) State of Eritrea. National Coastal Policy. Ministry of Marine Resources, Asmara, Eritrea.

9) State of Eritrea. Fisheries Sector Policies and Strategies: Five-Year Plan of the Fisheries Development Programme (2021-2025). Ministry of Marine Resources, Massawa, Eritrea.

Appendices

Annex I: Development Objectives, Purposes and Outputs

1. Socioeconomic objective:

Promote adoption of aquaculture practice and production as means of food and nutrition security, income generation and improving livelihoods of coastal fishing and inland rural farming communities.

Rationale

There exist simple and appropriate production systems with proven technology that can be readily adopted and used by communities to sustainably produce farmed aquatic products that contribute to improved food and nutrition security, income and livelihoods of practising fish farmers.

Purpose

1.1. Provide exposure, hands-on training and placement opportunities to aquaculture technical managers, researchers, specialists, and extension workers so as to equip them with practical professional and technical skills for promoting and demonstrating of coastal mariculture and inland aquaculture practice.
1.2. Conduct adaptive research for identified candidate species and systems suitable for coastal and inland rural communities to engage in gainful aquaculture practice.
1.3. Establish demonstration and training infrastructure for coastal mariculture and inland aquaculture practice using the identified suitable species and production systems.
1.4. Develop the technical support services for development of broodstock, production of fish and shrimp seed, production and/or supply of feed, and for extension, disease prevention and control, processing and marketing.
1.5. Design and implement appropriate incentives for individuals or cooperatives from target communities to engage in aquaculture and culture-based fishery.

Outputs for Purpose 1.1:

1.1.1. A capacity development program for aquaculture managers, researchers, technicians, extension personnel and lead fishers/farmers (interested in mariculture) formulated.
1.1.2. Hands-on and placement programs for MMR staff, active representatives of community or cooperative producers/fishers/farmers and private farmers.
1.1.3. Technical and financial assistance and incentives to private sector enterprises to commercially produce quality fish feed and seed developed

Outputs for Purpose 1.2:

6.1.1. Hatchery, nursery, broodstock development, and growout facilities and infrastructure for coastal mariculture research established at a site to be identified following the planned suitability survey and study for coastal aquaculture.
6.1.2. Existing facilities of cold freshwater fishes at Mai Serwa upgraded for research, training and production for inland and reservoir aquaculture.
6.1.3. A hatchery, nursery, broodstock development, and growout facility for warm water species research, training and production established

6.1.4. Tilapia and African Catfish (warm water), and carps (cold water) broodstock for freshwater aquaculture species developed or imported.

6.1.5. Assess locally available potential ingredients and develop appropriate formulations for local fish feed production.

Outputs for Purpose 1.3:

1.3.1. Policy and operational guidelines of public-community partnerships and public private partnerships (PPP) for piloting aquaculture established.

1.3.2. South-to-South facilitated coastal mariculture and inland aquaculture (pond and cage fish farming) facilities and operations established and conducted with participation of MMR staff, fishing and inland farming communities.

1.3.3. Public – Community partnerships and Public Private Partnerships (PPP) formed and used to establish pilot aquaculture production facilities for both coastal mariculture and inland aquaculture under a participatory "Build, Operate and Transfer" model of aquaculture development.

Outputs for Purpose 1.4:

1.4.1. Same as for purpose 1.2.

Outputs for Purpose 1.5:

1.5.1. Suitable mariculture and land-based coastal aquaculture sites identified, zoned, and guidelines and conditions and terms for access, use and tenure defined.

1.5.2. Linkage with existing fish processing and marketing companies and corporations established and offtake of aquaculture product defined.

1.5.3. A programme to promote the consumption of freshwater fish developed.

1.5.4. Credit and insurances, initially public schemes, for aquaculture developed.

2. Ecological

Objective:

To promote use of appropriate and environmentally suitable aquaculture production systems and species that will ensure the ecological and genetic resources integrity while enhancing the aquaculture productivity and environmentally sound use of land, water and other associated resources.

Rationale:

The natural ecological functioning and services, as well as the associated interactions are a basis for productive aquaculture ventures, without which the planned socioeconomic objective and outputs for coastal mariculture and inland aquaculture will not be achieved.

Purposes

2.1. Survey and map out clearly areas suitable for aquaculture practice and put in measures to guide establishment and operation of production systems.

2.2. Generate the necessary information and develop guidelines for accessing and use of the existing marine biological resources for coastal mariculture.

Outputs for Purpose 2.1:

2.1.1. Review the TA assessment, conduct confirmatory/discovery survey, and formally map out and designated aquaculture production zones/areas along the coastline and inland.

2.1.2. Coordinate with Ministry of Agriculture and develop a water resources and reservoir use plan/scheme that provides for aquaculture practice and management.

2.1.3. Aquaculture monitoring and reporting system that includes production statistics, ecological performance, environmental management, gender concerns and climate change adaptations and mitigations, established

2.1.4. Periodic monitoring of aquaculture performance conducted and reported upon as per established system.

Annex II: Logical Framework for the Strategic Plan

Objectives	Indicators of success	Means of verification (sources of data)	Assumptions and risks
Socioeconomic: 1) Alleviate poverty and assure food security; and improve livelihoods in rural areas; improve health and nutrition of the people.	More people employed in fishery sector, more fish consumption per capita, higher household incomes.	Household survey reports, employment figures in the sector, Ministry of Health reports, Survey reports	More jobs are generated, wages are attractive in the sector; quality and affordable fish products are produced and sold. Risks include lack of incentives for expansion and entrepreneurship, poor quality and highly priced fish.
2) Generate income, with economically viable and sustainable projects, for the poor communities and for the country and catalyse other economically rewarding activities in rural and urban areas	Farms being established, more fish being produced and marketed, higher farm incomes and national revenues.	Economic surveys and reports from government, export volumes and earnings from export	Well-managed aquaculture projects are needed to demonstrate economic viability Risks include market failures, inadequate support to sector, inappropriate technology, poor farming and management skills, and high costs of inputs.
Ecological Protection, maintenance and improvement of the productivity of land, water and genetic resources.	Water resources are not polluted and remain suitable for fishery and aquaculture; native fish species are not threatened	Reports of analyses of soil and water quality of different water bodies; Reports of the MOF and the Ministry of Land, Water and Environment (MOLWE)	Poaching, overharvesting (from reservoirs); deteriorated water quality of reservoirs; neglect of environmental aspects in aquaculture planning and development

2. Logical Framework: Purposes

Purposes **2. Socioeconomic objective**	Indicators of success	Means of verification (sources of data)	Assumptions and risks
1.1. Develop appropriate aquaculture species and systems that meet the requirements of economic viability and social and	Number and types of training and study tours carried out, number and type of personnel trained.	Training reports Training manuals produced Lack of or inappropriate training materials and capable trainers.	Lack of or inappropriate training materials and capable trainers. Lack of support for training. A training needs

environmental responsibility.			assessment is required and high-quality training manuals need to be developed.
1.2. Train researchers, specialists, and technicians and improve their professional and technical skills for research, extension and the management of aquaculture and culture based fishery.	Number and types of training and study tours carried out, number and type of personnel trained. Proficiency assessment of trained personnel	Reports of training activities Training manuals produced	Lack of or inappropriate training materials and lack of capable trainers. Lack of support for training. A training needs assessment is required and good quality training manuals need to be developed.
1.3. Develop the technical support services for development of broodstock, production of fish and shrimp seed, production and/or supply of feed, and for extension, disease prevention and control, credit, processing, and marketing and trade	Facilities developed and technical advisory teams by MMR (Aquaculture Division), Eritrean Institute of Technology (EIT), College of Science, formed to provide technical services to farmers; a "one-stop shop" program to streamline provision of information, technology and credit services shall be in place by Year 3.	Number of inquiries and requests for technical advice as contained in reports	Difficulty in obtaining advice on different problems from different sources. A one-stop shop would make it easy and less time consuming for farmers and others to obtain advice, information and technical services.
1.5. Develop appropriate economic incentives for farmers, investors, and the communities to engage in aquaculture and culture-based fishery, as well as to wholesalers and retailers.	Increased number of businesses related to fish processing, handling and selling established in urban and rural areas.	Surveys and reports from MOF and/or the Ministry of Commerce	Coordination between concerned ministries will facilitate the formulation of appropriate incentives.
1.6 Develop more livelihood activities that are based on aquaculture in the countryside and urban centres.	Number of fish farms established, number of value-addition activities started in rural communities; greater volume of business related to fish production, processing and distribution.	Surveys and reports from MOF and/or the Ministry of Commerce	Supply of fish is reliable and the product form is acceptable to consumers on-farm value-addition activities by farmers and women are economically rewarding. The risk is an erratic supply and poor quality of fish and fish products.

1.7. Develop species and systems that are appropriate for the environment (coastal aquaculture, reservoir culture) in order to create new jobs, meet the demand for fish products in local, national and export markets.	A greater diversity of species farmed under various culture systems. More farms being established and more local labour being hired.	Reports of MOF (requests for licensing); Reports of the Ministry of Labour	The economic viability of a culture system should be clear and the technical support for farms and for value addition enterprises are in place.
1.8. Promote the consumption of fish particularly freshwater fish in highland communities.	Volume of freshwater fish sold, caught or produced for home consumption	Surveys, Reports of IFD	The promotion campaign is sustained and with multi-agency cooperation. Fish is affordable.
2. Purposes under the ecological objective	**Indicators**	**Means of verification (sources of data)**	**Assumptions and risks**
2.1. Strengthen management skills to implement national laws, international codes of responsible fisheries (particularly the Code's aquaculture and culture-based fisheries provision) and conservation of biodiversity.	Best practice guidelines produced and personnel trained in their implementation.	Best practice manuals published, report on the training activities conducted and number of trained personnel.	There would be need for cooperation among agencies and users/communities in developing guidelines and complying with the codes and better practices
2.2. Ensure the protection and management of reservoirs, the marine fishery resources and the coastal environment by strengthening the control and implementation of environmental regulations on land and water use for aquaculture/culture-based fishery.	No violation of rules reported. Water quality of reservoir is according to ministry of health standards.	A compendium and published sets of relevant rules and regulations; Survey and analytical reports of water body and community problems	A compendium and published sets of relevant rules and regulations; Survey and analytical reports of water body and community problems A surveillance and monitoring system is crucial to the achievement of this objective. Regulations are clearly understood by the users; clear

3. Logical framework: Outputs

Outputs under the socioeconomic Objective	**Indicators of success**	**Means of verification (sources of data)**	**Assumptions and risks**

Output 1.1.1: Feasibility studies of recommended species and systems, as listed in Annex 2, are conducted.	Field trials, research projects initiated by Year 1 and completed in Year 2.	Project feasibility reports.	Ill-designed and inadequately supported projects are a risk.
Output1.1.2.Demonstration and pilot projects established, as described in Annex 2	Pilot projects in selected sites, research staff and resources applied to projects initiated in Year 2 and completed in Years 2/3.	Project reports	Same as above
Output 1.2.1. A comprehensive national human resources development program for aquaculture researchers, technicians, and extension personnel formulated	Qualitative and quantitative assessment of manpower needs; staff and resources to conduct this activity are mobilized. Conducted in Year 1	A published national aquaculture manpower development plan; s	Lack of interest and low priority accorded to training.
Output 1.2.2. Local training courses and foreign study tour programs for researchers, technicians and prospective aquaculturists on fish farming technologies conducted.	These components are included in the National Manpower training program; study tours are planned and participants are selected; resources allocated; planned and implemented in Year1- 3.	Reports of training and study tour activities; feedback reports from participants	Same as above
Output 1.2.3. Local training in culture-based fishery particularly on stocking and stock enhancement for researchers, technicians and communities around the reservoirs conducted.	Demonstrated knowledge and skill in the techniques of stock enhancement; actual stock enhancement of all major reservoirs done by Year 3; reservoir fish populations are higher and fish growth is better.	Report of stock assessment; catch data.	Expertise is needed to plan, organize and conduct the training.
Output 1.3.1. Facilities of the Inland Fisheries Division in Mai Serwa upgraded for research, training and production for reservoir aquaculture.	More and higher quality applied research, and extension and training and activities implemented by year 2-3.	Research reports; extension manuals; reports of training activities.	Resources are inadequate.
Output1.3.2. Hatchery and nursery facility for research, training and seed production established at an appropriate site for coastal mariculture of shellfish and finfish.	More seed being produced and distributed.	Distribution or sale reports; Seed production reports	Appropriate technology exists for targeted species, or is ease to modified to suit target species and production systems.

Output 1.3.3 Broodstock for freshwater aquaculture species developed or introduced	Number of broodstock developed and held.	Stations brood stock records.	Responsible research stations facilities can be improved to hold significant number of brood stock.
Output 1.3.4. Breeding program to produce quality broodstock and fry/fingerlings for culture and stocking in reservoirs developed	Number of fingerlings for different target species stocked in the different reservoirs	Hatchery Records and field survey reports.	There is in place sufficient propagation space to allow for production of sufficient number of fingerlings.
Output 1.3.5. An aquaculture feed programme with emphasis on low-cost, simple and practical feed formulation, allowing the private sector to import or manufacture, developed and implement	Technical report on feed formulae for different species and ages/stages of the farmed organisms. Amount of feed produced on-farm and commercially.	Technical reports Survey reports.	Required materials (ingredients) can be readily found or imported for formulation and production of feed.
Output 1.3.6. Fish health regulations and control on the introduction of live fish established and enforced.	Set of guidelines and or regulations/proclamation for coastal mariculture and inland aquaculture health management.	Rules and Regulations for coastal and inland aquaculture	There guidelines and regulations are majorly precautionary as there is no known disease for coastal or inland aquaculture in Eritrea currently.
Output 1.3.7. Technical and financial assistance and incentives to the private sector in establishing and operating commercial hatcheries developed.	Number of investors and practitioners from private sector supported technically and financially.	Aquaculture performance reports.	There are willing private entrepreneurs interested in coastal and inland aquaculture in Eritrea.
Output 1.4.1. Same as Output 1.1.1			
Output 1.4.2. Collection and dissemination of information from internal and external sources developed or strengthened.	Coastal and inland aquaculture management information systems established and operated.	Technical reports and management records of aquaculture development and production.	There is in place the required personnel and hardware to support establishment of

			the Management Information Systems for aquaculture.
Output 1.4.3. A collaborative arrangement among research and educational institutions and private sector institutionalized.	Memoranda of University and Letters of Agreement for collaborative work and projects in aquaculture.	MoUs; Technical and Management reports on outputs of collaborative engagements	There is in place a number of education institutes that offer aquaculture training in Eritrea.
Output 1.4.4. Linkages with other countries and aquaculture organizations for information and expert exchange established.	Memoranda for collaboration in aquaculture development. Specific project engagements.	MoUs, LoAs; Project Reports etc.	Eritrea shall actively seek partnerships for aquaculture development especially through South-to-South cooperation.
Output 1.5.1. Suitable mariculture and land-based coastal aquaculture sites identified, zoned.	Sites identified and gazzetted for coastal and inland aquaculture practice.	Survey reports	Eritrea has very high potential and many suitable sites for coastal and inland aquaculture practice.
Output 1.5.2. A programme to improve market facilities, refrigeration, processing, and development of product forms and quality formulated.	Number of facilities established or rehabilitated for support to aquaculture products marketing value chain.	Technical and Project Reports.	A number of sites and facilities exist that can be developed or enhanced for healthy, quality and safe marketing of cultured products.
Output 1.5.3. A programme to promote the consumption of freshwater fish developed.	Proportion of households consuming fish; Per capita fish consumption.	Annual fisheries and aquaculture status reports for Eritrea.	Increased accessibility to fishery products through aquaculture will increase fish consumption in Eritrea.
Output 1.5.4. A programme in culture based fishery to enable communities near or around reservoirs to earn income from fishing and selling the fish developed.	Number of reservoir attendant communities and community members mobilized to engage in commercial aquaculture.	Inland aquaculture status and survey reports.	Doing aquaculture as a business will attract more members of reservoir attendant communities to

			join aquaculture practice
Output 1.5.5. Credit and insurance scheme for aquaculture developed.	Number of commercial aquaculture enterprises with aquaculture insurance.	Aquaculture status reports.	There are insurance companies in Eritrea that offer aquaculture.
Output 1.5.6. Infrastructure support services, regulations and incentives for investments in coastal aquaculture developed (for example designation and establishment of mariculture parks in areas identified and zoned for coastal aquaculture projects).	Number of public and private aquaculture business support services providers in the field of financing and credit; inputs supply chain; infrastructure development; business management; and	Aquaculture Business Support Services Survey Report.	Business Support Services Providers will emerging with take-off of commercial aquaculture in Eritrea.
Output 1.5.7. A programme that creates more employment in aquaculture and culture-based fishery is developed. It could include segmentation and specializations in the various stages of production (i.e. hatchery, nursery, grow-out), supply of feed and fry/fingerlings, processing, transportation, and marketing	Business and technical guidelines for segmented aquaculture production value chain.	Aquaculture production status report.	Segmented production value chain will spread the risk and reduce failure rate while increasing employment opportunities through lengthened value chains.
Output 1.5.8.: Same as Output 1.1.1 and 1.1.2			
Output 1.5.9. An education campaign that highlights the health benefits of consuming fish is developed and launched in cooperation with Ministry of Education.	Awareness level for health benefits of aquatic products;	Revised school curricular; Technical survey and assessment reports.	General public is not aware of the benefits of fishery products for their health.
Output 1.5.10. A pilot program to market freshwater fish in major population centres is launched preferably with the Ministry of Health.	Number of markets accessing fishery products in different parts of the country.	Market survey reports.	There markets ready to receive and sell aquaculture products.
Output 1.5.11. Low-cost and highly efficient production and processing technologies and an efficient marketing system are applied	Number and systems for aquaculture products processing technologies;	Aquaculture production and processing survey reports.	Technology for processing of aquaculture products is readily

(developed or borrowed and adapted to national situation).			accessible in Eritrea.
Output 1.5.12. An appropriate pricing system for fish products is implemented.	Aquaculture products price index.	Aquaculture products market survey reports.	Market forces will lead to emergence of fair aquaculture products prices.
Outputs under the ecological objective			
Output 2.1.1. A unified inspection, quarantine and control of introduction or movement of species with the Ministry of Land, Water and Environment and Ministry of Fisheries is developed.	Systematically compiled and published sets of laws, rules, and regulations. Gaps in the regulations to be studied and filled.	Publication	Lack of interest and institutional collaboration in the review is a risk. Expertise in epidemiology will be needed in developing the output
Output 2.1.2. Statistical and information system for aquaculture established.	A well-staffed and well-resourced (with funds and information management facilities and equipment) is operating by Year 2	An information and statistical office is established; up-to-date statistical and information reports	Lack of support and interest and lack of cooperation among agencies would jeopardize this objective
Output 2.1.3. Aquaculture-related issues included in the regional agreements on fishery conservation	Technical guidelines to implementing codes and agreements are adopted or developed by Year 2	Published guidelines	
Output 2.2.1. A program to maintain the water quality in the reservoirs is integrated into reservoir aquaculture.	Regulations, guidelines and best practices to ensure maintenance of water quality form part of the reservoir management.	Reports of water analyses.	Uncontrolled density and poor management of the cages poses water pollution; Cooperation with the Health Ministry and the MLWE is required.
Output 2.2.2 The community management scheme for reservoir aquaculture is developed that includes conservation.	Organized projects by year 3; 50% of all reservoirs with community management schemes by year 4.	Report of user groups, report of Aquaculture Division.	Poor managerial skills, ill-conceived management schemes and "free-riding" by some irresponsible members of the users' group are risks. Lessons

			from other resource management schemes i.e., forestry would be helpful.

Appendix III: SWOT analysis of the Eritrea's Inland and Marine Mariculture sector

STRENGTHS	WEAKNESSES
General Coastal Mariculture System • Long coastal line with many sites that are ecological good and or good landscape for coastal mariculture. • Generally good seawater quality and pristine environmental conditions. • Political will and commitment to start coastal aquaculture and address challenges and explore opportunities • Presence of very good genetic material for coastal aquaculture (parental stock, or supply of seed from the wild). • Trained staff with qualifications to guide coastal aquaculture development. • There is a framework for quality assurance and control system for high end markets.	• Lack of experience and knowhow for farmers and technical managers. • Lack of success stories and model mariculture systems. • Low demand on the home market for high value seafood • Lack of Aquaculture Regulatory framework • Lack of aquaculture environment management and planning. • No clear access to finance or capital for aquaculture practice by farmers and entrepreneurs • No skilled labour force to manage the ventures • No integrated strategy on utilization of water and land for agriculture, aquaculture and other uses • Lack of experience and success stories in aquaculture and mariculture
Onshore • Ample land onshore for mariculture facilities • Availability of existing facilities such as buildings, ponds, stores, laboratories that can be used during aquaculture practice • Availability of shoreside areas w with associated building	• Lack of examples and mature aquaculture businesses • Lack of existing onshore facilities for production and supply of mariculture inputs and implements • Lack of adequate facilities to demonstrate and train communities.
INSHORE and INTERTIDAL • Availability of several protected areas along the vast coastline • Parental stock and wild seed for key valuable species oysters, mud crabs, clams, mullet, milkfish, groupers, shrimps are abundant and readily available • No recorded natural occurrence of diseases for key mariculture species apart from that which came with imported shrimp in the 1990s under SFE project.	• Lack of examples and mature aquaculture businesses • Lack of establish markets for high potential production systems, that is, oysters, mud crabs, clams, shrimps and others. • History of white spot disease brought about by importation of stocking materials in failed shrimp projects of the 1990's.

• No major threats to marine environment and biodiversity recorded. • Pristine water quality. • No competition for space with other marine users. • Ample space for establishment and expansion. • There is an established regulatory system for coastal mariculture	• No clear demarcation for intertidal mariculture yet. • No established system for monitoring and managing disease agents and disease outbreaks. • Poorly understood economics of large-scale seaweed farming • Lack of quality and health assurance and control system in respect to seaweeds and other food mariculture products.
INLAND AQUACULTURE – RESTOCKING/STOCKING OF RESERVIORS • Availability of several inland freshwater reservoirs found naturally suitable for restocking and fish farming. •	• Inadequate and under-developed infrastructure e.g., hatcheries and multiplication centres.
POND AQUACULTURE • Relatively easier technology to execute	• No model or demonstration systems yet

OPPORTUNITIES	**THREATS**
COASTAL MARICULTURE SYSTEM • Start aquaculture aimed at producing for local and regional markets without much market restrictions • Encourage consumption within Eritrea e.g., through meals in public institutions • Ease of farming locally available species • Raise awareness of how aquaculture can significantly contribute to food security and nutrition, local and regional trade, and develop sustainably whilst meeting conservation objectives in the marine environment • Work to have a positive synergy between aquaculture and the marine environment by aiming to provide ecosystem services such as carbon sinks, habitat restoration, increased resilience and biodiversity and reducing pressure on wild stocks	• Relatively high water temperatures and high salinity • High technology for some production systems may limit their adoption. • Limited local knowledge and skills for the different aquaculture production systems. • Long history of exclusion from reginal and international markets. • Limited local markets for commercial aquaculture development. • Dependency on importing for key production infrastructure requirements • Competition from coastal capture fisheries for the same species landed and limited local market. • Growth in commercial shipping and water vessel traffic may pose a risk to aquaculture infrastructure. • Intermittent power supply. • Urbanization

	• Competition with other sectors for land and water resources. • The pastoral and nomadic life style may imperil the programme, especially inland low areas.
ONSHORE • Facilitate planning for change of use of existing buildings and infrastructure for mariculture • Diversification for fisheries sector/industry • High potential for Foreign Direct Investment (FDI) through mechanisms such as the HPO • Mobilization for new local investment through cooperatives and private investment sources	• Global climatic change (Increase in sea levels impacting aquaculture infrastructure, rising water temperatures affecting performance of culture organisms.) • Uncontrolled and unplanned expansion of the mariculture production systems • Lack of ready market entry points for different farmed products. • Public sector driven mariculture production without regard for source of financing and technical support for communities and private investors.
INSHORE AND INTERTIDAL • Creation of properly cited and managed coastal mariculture systems • Use coastal mariculture systems and processes to improve and maintain water quality, • Proper balance and development of certain farming methods can be used to offset effects of, for example nitrogen and phosphorus.	• Climate change and warming waters could lead to new hygiene threats e.g., from Vibrio species bacteria. • Water quality effected by agricultural and stormwater and agricultural runoff from the highlands without adequate water treatment processes.
INLAND AQUACULTURE • Expanding irrigation system has created numerous water reservoirs that can be used for fish culture. • Increasing recognition of fish as a health food by generally youth population. • Un-exploited aquaculture potential sites. • Unexploited local, regional and international markets • Availability of new bio-technologies. • Advancement of information and communication technologies	• Global climatic change (Warming of waters affecting the culture organisms, shrinking and drying of water bodies, low precipitation) • Low consumption of fish among inland communities.

• Strong linkages with regional and international organizations in finance, trade, research and training • Favourable climate. • Existence of regional trade blocks	
POND AQUACULTURE • Ponds are constructed as a means for tapping water for irrigation and can be engaged for multiple uses including fish farming. • Water recycling and re-use	• Lack of tradition of fish farming • Global climate change making ponds prone to drying up or being flooded out. • Permeable soils leading to excessive leaking of ponds
CAGE AQUACULTURE • Availability of numerous permanent underutilized water reservoirs which can be used for Cage Aquaculture • Non consumption use of water without risk of interfering with the primary plan for use of water for irrigation.	• Lack of local cage production knowledge. • Biofouling
INTEGRATED AQUACULTURE • Many Potential sites for integrated inland aquaculture	• Application and use of biocides

Appendix IV: Stakeholder Analysis

Stakeholder	Function	Competitive advantage	Target	Assistance to the Aquaculture subsector
MMR	Management and development of Aquaculture Sector including, planning and coordinating national and local aquaculture activities, research, training of communities and farmers, and provision of inputs.	Management experience Research Capacity Training and Extension Experience	Acquire practical skills through hands-on training and placement so as to effective guide the adoption of aquaculture production practices by the communities. Put in place a management regime to promote adoption of aquaculture practice and support communities	Training of aquaculture producers Adaptive and Action Research for establishing and operationalization of aquaculture production at farmer level. Generation of technologies and appropriate practices for aquaculture production. Coordinating national and regional aquaculture production activities.
NGOs	Micro financing, capacity building and advocacy. Support producers in technology transfer and acquisition	Financial resources and networks Advocacy Community mobilization	Complement government effort	Provide tools, equipment and support operations
Community Based Organizations and Cooperatives	Production, extension, community mobilization, processing value addition and marketing.	Better linkages at grassroots level Collective effort Bargaining power	Community development through combining efforts and putting resources for a common	Complement government effort Promote aquaculture practice as viable economic and

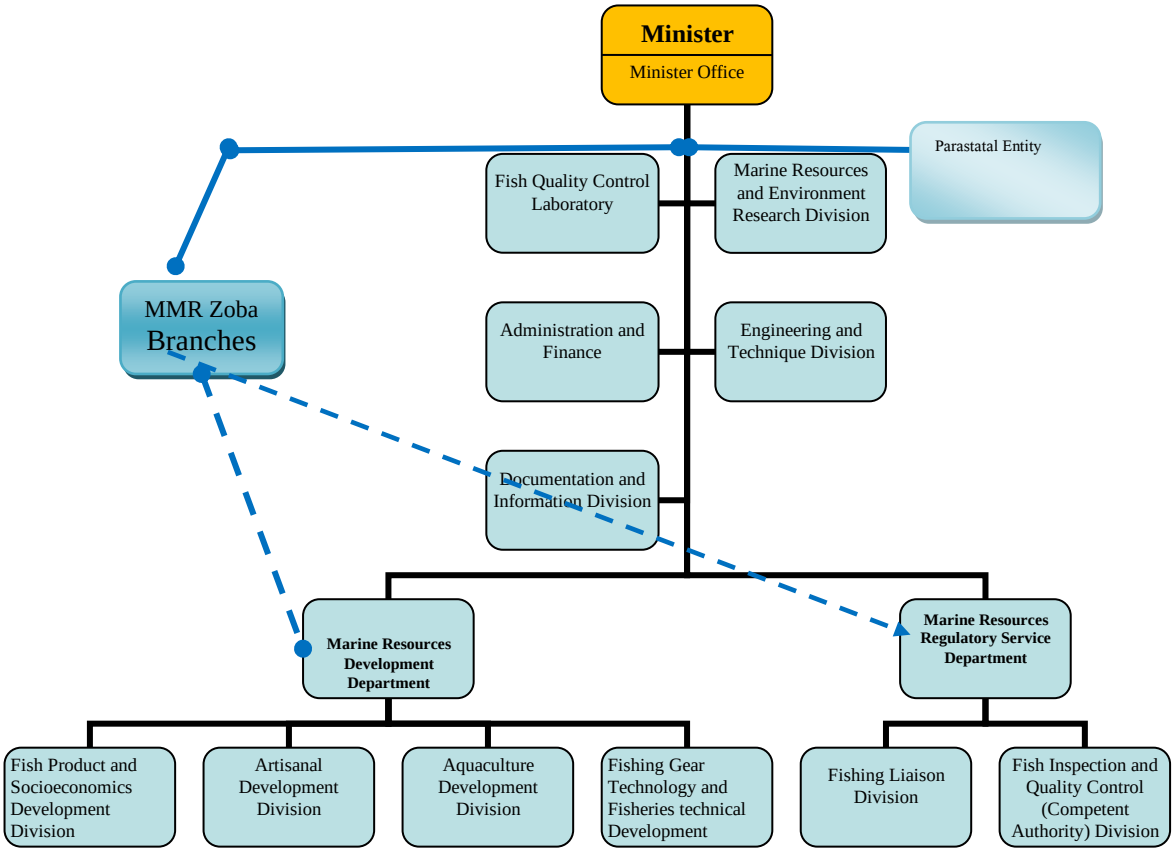
			profitable cause (income generation)	livelihoods activity.
Private sector	Production, support to aquaculture practice in terms of inputs, implements, financing and marketing of products.	Commercial transactions, and delivery of services and goods.	Importation of aquaculture equipment and supplies, Production and supply of aquaculture inputs. Marketing of the aquaculture products.	Commercialisation of aquaculture development.
Financial institutions	Supply credit	Financial resources and investment advice	Positive return on investment	Financial literacy Improve credit accessibility
Training institutions	Capacity building, research and consultancy	Capacity, facility and technical knowledge	Transfer of knowledge and technology	Human resource development and research
Regional authorities	Accelerate development in regions	Address specific regional issues	Enhance development through multi sectoral programs	Provide supplementary services to the subsector Local conflict resolution and management
Other Government agencies	Collaboration in service provision	Specific mandates	Improved service delivery and resources management	Offer complementary services to the subsector
Regional and International Organizations	Coordination of Aquaculture management	Capacity to lobby, develop linkages and mobile resources	Improve Aquaculture development	Enhance capacity to formulate policy, lobby and develop human resource
Development partners	Give financial and technical support	Availability of resources and technical expertise	Budgetary support and capacity building	Complement financial support and technical support

Appendix V: Risk Assessment and Management Matrix

Risks	Impact - rating	Likelihood of impact	Mitigation measures
Political/governance	High	• High	• Projects will be mainstreamed in Government structures, at national and Zoba levels. Project institutional anchoring and implementation will not change fundamentally, as the range of private service providers is very limited. To enhance local ownership, focus on empowering cooperatives by strengthening business planning capacity and promoting strong member ownership.
Past failed efforts being held against new action	High	• High	• Start with non-complex easier to adopt systems that do not require hi-tech and yet effective and highly productive. Right from the start farmers and communities need to urged to contribute to and own the process. • Build capacity within the communities to setup, operate, manage and service the production systems including on-farm feed production, fish harvesting, fish processing and marketing.
Limited exposure and technical capacity within MMR	Medium/High	• High	• Hands-on training on aquaculture establishments in successful countries with similar socioeconomic, climatic and environmental conditions, preferably in Asia. • Use of South-to-South Cooperation for technology transfer and demonstration • Provision of specialized international and national technical assistance; institutional capacity development at all levels; training of young staff.
Environmental and climate related impacts	High	• High	• Adopt climate-smart interventions and systematically integrate climate adaptation into demonstration and investment projects.
Low participation of women and youth	Medium	• High	• Enhance targeting of vulnerable people, in particular women and youth. • Design appropriate packages to suit poor women and youth's involvement in adoption of aquaculture practice.

			• Provide specialized training and skilling among able women and youth to act local service providers.
Conflicts between different users of the water bodies and resources	High	• High for inland aquaculture • Low for coastal mariculture	• Participatory planning and dialogue with all users right from the designing process. • Locate and set the aquaculture production systems and activities so that they do not interfere with other uses of the water bodies. • Survey and designate particular areas and sites for aquaculture development that are clearly promoted and popularised as such.

Appendix VI: Structure of MMR in regards to Aquaculture Development and Management



Appendix VII. Persons consulted

1. FAO

1) H.E. Dr. Esther Lusepani, FAO.R Eritrea
2) Mr. Asghedom, Assistant FAO.R Programme, Eritrea
3) Ms. Ghenet, Assistant FAO.R Administration, Eritrea
4) Dr. Deiva Oswin Stanley, Fisheries Technical Advisor, FAO, Eritrea; oswinstanley@gmail.com
5) Mr. Tedros, Zerai, Project Manager, FAO, Eritrea; Tedros.Zerai@fao.org

2. MMR

1) H.E. Mr. Tewelde Kelati, Minister Ministry of Marine Resources, Eritrea
2) Mr. Adonay Heruy, Director, Projects and Commissions Coordination Office
3) Eng. Idrisi Saleh, Head Department of Marine Resources Development,
4) Mr. Yonas Kiflay, Acting Director of Fish Inspection and Quality Control Division
5) Mr. Ismael Mohammedsaid – Director Aquaculture Development Division
6) Mr. FitsumberhanHarnet – Head Inland Aquaculture Development Unit – Fitsumberhan.Harnet@gmail.com
7) Mr. Tesfamikael Okbazghi– Head Mariculture Development Unit and Project Coordinator
8) Mr. Biniam Kaleab, MDU – binaiam5042@yahoo.com
9) Mr. Simon Michael, IADU – simonmichael@yahoo.com
10) Mr. Bereket Goitom, IADU – Bereketgoitom@gmail.com
11) Mr. Nuredin Ahmed, IADU – Nurie-Ahmed02@yahoo.com
12) Mr. Teklu Goitom, IADU – tec91Ue@gmail.com
13) Mr. Aman Abraham – amanabraham92@gmail.com
14) Mr. Saleh Mussa, SalehMussa599@gmail.com
15) Mr. Kiflom Debesai, IADU – kiflomdebesai2022@gmail.com
16) Mr. Mohammed Abdunur Ibrahim, MDU – mohammedabdunur27@gmail.com
17) Mr. Abdella Osman, MDU – Abd0577@gmail.com
18) .Mr Hadgu Eyesab–Halibay Station
19) Mr Misgnina Tesfu, Head Artisanal Fisheries Development Division
20) AdiamAbrham, PCCO
21) Huruy Tekile, CA Division
22) Senay Gebru, Research Division
23) Selomon Brhane, Research Division
24) (13),
25) ,Mokonen Girmay, Director Gash Barka Branch Inland Fisheries
26) Mahmud Selim Head documentation and Information Division
27) (11)
28) Atakhti Nguse, Minister's Office
29) Abdela Mahamed, MRDD
30) Bettel G/Meskel, MRDD
31) Mr Solomon Tsegey – Manager Halibay Station
32) Mr. Asghedom, FAO Technical Officer
33) Mr. Redaegzy Gebrenedhin, Owner of Mai Noh Ram farm

34) Mr. Merhawi Misghina – MRDD
35) Mr. Abraham Hadgu – Administrator, Mai Serwa Research Station
36) Mr. Essaw Tuku, Director of Zoba Makel Branch, Inland Fisheries
37) Mr. Efrem Testay, Head Zoba Makel Branch Cooperatives Support Unit
38) Mr. Habtom Eyob, Secretary of Segumu Cooperative
39) Ms. Meskela H.Monirisa, Member of the Segumu Cooperative known as 'Doctor'
40) Leake Desta, MRDD
41) Nguse Keflu, Director Fish Product and Socioeconomics Development Division
42) Melat Fesshay
43) Natnael
44) Tekle Mengetu, Director of Minister's Office
45) Selam Afewerki, MRDD
46) Ahmed Ibrahim, Head Extension unit
47) KibromTekeste, NFC

3. IFAD

1) Mr. Yisehak Kiflay Naizghi, Coordinator, IFAD

Annex VIII: Tailor made training programme for MMR staff and selected entrepreneurs from the inland farmers and coastal fishers' communities

Programme: A study tour of 3 months involving intensive short hands-on training courses, placement and exposure to different coastal mariculture and inland aquaculture production systems, to select Asian countries including Thailand, Philippines and Bangladesh.

Lead Institute will be the Asian Institute of Technology for Aquaculture in Bangkok, Thailand.

Contact person: Professor Ram Bhujel

Courses of focus:

1) Coastal mariculture seed production and growout production systems including design and planning of production systems, set up of growout production system, and production operations and management,
2) Inland aquaculture hatchery propagation and growout production systems for tilapia and African catfishes including use of both ponds and cage culture system, and indoor hatcheries and happa based tilapia seed production systems.
3) On-farm fish feed formulation, production and management.
4) Placement of staff on active coastal mariculture and inland aquaculture establishments in selected Asian countries.

Targeted persons for training:

1) 12 MMR staff from the Mariculture Unit of Aquaculture Division
2) 06 MMR staff from the Inland Aquaculture Unit of Aquaculture Division
3) 12 lead prospective mariculture practitioners selected from the coastal fisher communities
4) 12 lead prospective inland aquaculture practitioners from inland farming communities.

Timeframe:

This training will be carried out over a period of six months but in two sets of 3 months each for each group of trainees.

Appendix IX: NADSIP Development Tool: Key questions and issues for discussion with technical teams

1) Which policy is the Strategy and Development Plan rolling out?
    a. Do we agree that it the Draft Policy and Strategy for Fisheries Sector by MMR
    b. If not, are there any overarching or broad statements from political leaders in Central Government that are documented regarding aquaculture development that we can take as policy?
    c. What does the National Development Plan say about fisheries or aquaculture sector that we need the strategy to roll out?
2) Of the following aspects, which do you consider as a priority for meeting the policy objectives, directives or perceived intentions?
    a. Setting up Government managed commercial aquaculture production enterprises.
    b. Setting up facilities for aquaculture demonstration and training of fisher communities and farming communities.
    c. Building aquaculture research facilities.
    d. Training of fisher and farmer cooperatives to engage in gainful or productive aquaculture.
    e. Working with private individuals and cooperatives to support them to own, manage and operate aquaculture production infrastructure including hatcheries, feed mills and production units.
    f. Practical or hands-on training of MMR staff as 'trainers" of farmers and demonstrators of aquaculture production.
    g. Inviting experienced farmers and investors to own and operate aquaculture production enterprises/infrastructure from whom communities and local interested persons can learn.
3) For quick and firm transfer of technology, what do you suppose is the best approach knowing the local situation?
    a. South to South Cooperation, where through Government and FAO/UNDP, teams from successful Aquaculture countries in Asia such as Bangladesh, Philippines, Indonesia of Vietnam, are facilitated to set up and operate aquaculture production facilities and units while working with MMR staff and communities here in Eritrea.
    b. Identifying willing country or countries among those successful in coastal mariculture such as Bangladesh, Philippines or Indonesia; and inland aquaculture such as Egypt, Thailand, Uganda, where staff and farmers are facilitated for placement on farms for 3 to 6 weeks, under the South-to-South Cooperation arrangement,
    c. Hiring experienced technical persons to set up aquaculture production facilities for local investors and or coastal fisher and or inland farming communities.
4) Of the following which should be our priority – put in consideration ease of access to and operating of the technology, availability of inputs, and market for the products – at present and in the future?

a. Continue with inland aquaculture programme for stocking of freshwater dams and reservoirs, training of inland farming communities in fish farming and utilization of fish, etc.
b. Setting up and operate demonstrations for coastal aquaculture development including the following:
    i. Production ponds for mullet and milkfish using seed from the wild.
    ii. Setting up floating cages for production of mullet, milkfish and groupers using seed from the wild.
    iii. Setting up systems for farming of oysters, mud crab and clams
c. Surveying and mapping areas for aquaculture development, to which communities or investors (local and foreign) can be assigned if willing to invest.
d. Complete the construction and use of Halibay Aquaculture Research Centre for research.
e. Build the capacity of the MMR unit for training of fishers, farmers and interested local investors in aquaculture production and management.
f. Rehabilitate and enhance the capacity of Maisirwa Freshwater Research Centre in terms of construction of hatcheries to produce stocking materials, and facilities for training of farmers and communities in the highlands.

5) What is the system of funding and support for coastal aquaculture development
    a. Public Private Partnerships
    b. Public – Community Partnerships
    c. Cooperatives
    d. Private investment
6) Where is the market, and how much is the market demanding of the products that Eritrea can produce? Under what conditions and terms?
    a. Have a firm commitment, marketing system, understanding of the requirements of the target markets of the expected aquaculture products.
    b. MMR to establish agreements/understanding with prospective markets for the aquaculture products – can use existing fisheries markets, or expand to regional and international markets by putting the market specifications and requirements in place.
7) Whom should we target as most interested persons/entities likely to invest in aquaculture production at this time
    a. Are there community-based organisations and cooperatives willing to invest in aquaculture production?
    b. Are fishermen open or willing to consider aquaculture as an alternative source of livelihoods
    c. Are there any existing coastal communities engaged in any aquaculture?
    d. What are the systems of production used by the existing freshwater fish farmers?
    e. Can we set up public owned commercial aquaculture production facilities? – Any example of successful public fisheries or related enterprise?
8) Structure of MMR for implementation of the ADSIP?
    a. Capacity of staff in terms of numbers, training and experience
    b. What particular support is needed to get the staff ready?
        i. Formal academic training

ii. Exposure/study tours in successful countries.
iii. Hands-on training/placement on commercial aquaculture establishments in successful countries.

9) Are there any existing/on-going or planned (near future) National or Regional Fisheries and Aquaculture Development Programmes, Projects or Undertakings? And what are they for and what cost?
    a. National level
    b. Zoba level or otherwise.

Other identified issues for your review and suggestions:

1. Public sector managed input system **vs** farmer owned and managed system **vs** cooperatives owned and managed system, **vs** private investors owned and managed system **vs** public facilitated private investor owned and managed inputs production and supply system? i.e., (seed, feed and implements)
    a. Hatcheries for coastal aquaculture
    b. Hatcheries for stocking materials for inland aquaculture
    c. Commercially formulated and produced feed
        i. Can initially support and work with an importer of feed from Egypt, Saudi Arabia, Vietnam
        ii. Set up a public managed facility.
        iii. PPP
        iv. Public/Community partnerships
    d. Supply of aquaculture inputs
        i. Public vs Private commercial entities?

2. Need for supply of basic materials for making floating cages
    a. Start with train local fabricators to make and produce floating cages using stainless steel
    b. Can start with importing of complete cages from Italy, China or Thailand.
3. Build local capacity for pond construction
    a. Set up and build technical capacity of youth groups or cooperative groups in pond construction and maintenance
    b. Acquire basic machinery that can be leased out to farmers during pond construction for short periods.
4. What is the state of the aquaculture research Centre, and if left as is, what can we use it for in the aquaculture support services?
    a. Training of farmers
    b. Construction of hatchery and production units doe research and or demonstration.
    c. Offices and laboratories, while another appropriate site(s) to be used for ponds construction and hatchery are elsewhere
5. Training Centre
    a. Need for a unit focussed on training of communities in different aquaculture practices and systems within MMR
    b. Does Maisirwa Freshwater Research Centre have a training unit?

    c. Will need facilities for demonstration and training in Massawa
6. The high potential aquaculture zones/areas have been identified:
    a. Massawa and Zula bays
7. Appropriate production systems have been identified as follows:
    a. Floating cages for:
        i. Milkfish based on hatchery propagated seed
        ii. Groupers based on seed collected from the wild
        iii. Rabbitfishes based on seed collect from the wild
    b. Ponds for:
        i. Shrimps
        ii. Milkfish based on hatchery propagated seed
        iii. Mullet based on hatchery propagated seed
        iv. Groupers based on seed collected from the wild.
    c. Special production systems:
        i. Mud crabs
        ii. Oysters
        iii. Clams
8. Construction and establishment of hatcheries managed by fishing community or fish farmers cooperative
    a. Milkfish
    b. Mullets
    c. Mud crabs
9. Market for the aquaculture products
    a. This should be a top priority to secure contractual agreements / memorandum of understanding with urban fish markets and traders to produce for them.
    b. Need to secure external markets for the following species:
        i. Mud crab
        ii. Clams
        iii. Oysters
        iv. Eucheuma seaweed
10. Will need to carry out a Strategic Environmental and Social Assessment for aquaculture development and practices, especially in the high aquaculture potential zones
11. Systems of funding and support for coastal aquaculture development
    a. Public Private Partnerships
    b. Public – Community Partnerships
    c. Cooperatives
    d. Private investment
12. Why has there been excessive delay in getting aquaculture going despite the MMR capacity
    a. Solutions have to come from within
    b. Use south-to-south cooperation model for setting up demonstrations and building community level capacity
        i. As a follow up to FAO support
            1. Setting up hatcheries and performing hatchery propagation of selected key species

2. Construction and operation of both cage and pond-based production systems for key selected species.
3. Set up and demonstrate the culture of clams, mud crabs, oysters, and seaweed (Eucheuma sp.)

c. Work with cooperatives/coastal communities to demonstrate viability of aquaculture
    i. One-month hands-on training of MMR staff in different coastal aquaculture production systems and management
        1. Staff will need to travel and work practically in coastal aquaculture facilities to gain the requisite practice.