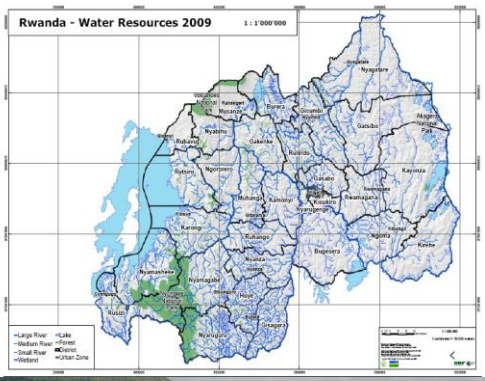
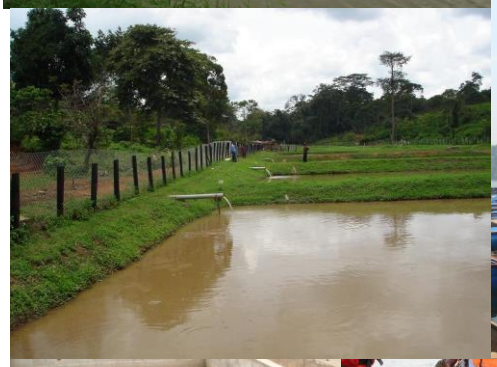
# MASTER PLAN FOR FISHERIES AND FISH FARMING IN RWANDA




## MINISTRY OF AGRICULTURE AND ANIMAL RESOURCES

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# Acronyms and Abbreviations

| | |
|---|---|
| **ANAF** | Aquaculture Network for Africa |
| **ADB** | African Development Bank |
| **ASARECA** | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| **APELAC** | Association des Pecheurs d'Isambaza du Lac Kivu |
| **BCEOM** | Bureau Central d'Etudes pour les Equippements d'Outre Mer |
| **CAADP** | Comprehensive Africa Agricultural Development Programme |
| **CBD** | Convention on Biodiversity |
| **CIFAA** | Committee for Inland Fisheries and Aquaculture of Africa |
| **KOADUNA** | Koperative y'Abarobyi Dusabane Nasho |
| **COFI** | Committee on Fisheries |
| **COOPILAC** | Cooperative des Pecheurs d'Isambaza du Lac Kivu |
| **CRF** | Code of Conduct for Responsible Fisheries |
| **EAC** | East African Community |
| **EDPRS** | Economic Development and Poverty Reduction Strategy |
| **ELADEP** | Empoisonnement des lacs du Pays et Développement de la Pêche |
| **FAIDP** | Fisheries and Aquaculture Institution Development Program |
| **FAPP** | Fisheries and Aquaculture Productivity Program |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FARA** | Forum for Agricultural Research in Africa |
| **GDP** | Gross Domestic Product |
| **GFARD** | General Authority for Fish Resources Development |
| **GoR** | Government of Rwanda |
| **HVLD** | High Volume Low Density |
| **ICLARM** | International Center for Living Aquatic Resources Management |
| **IISD** | International Institute for Sustainable Development |
| **ISAR** | Institut Superieur Agronomique du Rwanda |
| **LVFO** | Lake Victoria Fisheries Organisation |

| | |
|---|---|
| **LVHD** | Low Volume High Density |
| **MINAGRI** | Ministry of Agriculture and Animal Resources |
| **NARS** | National Agricultural Research Systems |
| **NEPAD** | New Partnership for Africa's Development |
| **NUR** | National University of Rwanda |
| **PAIGELAC** | Inland Lakes Integrated Development and Management Support Project |
| **PPN** | National Aquaculture Project |
| **RADA** | Rwanda Agricultural Development Authority |
| **RAFRI** | Rwanda Aquaculture and Fisheries Research Institute |
| **RARDA** | Rwanda Animal Resources Development Authority |
| **REMA** | Rwanda Environment Management Authority |
| **SPADA** | Special Programme for Aquaculture Development in Africa |
| **TCP** | Technical Cooperation Programme of the Food and Agriculture Organisation |
| **UNDP** | United Nations Development Programme |
| **USAID** | United States Agency for International Development |
| **VicRes** | Lake Victoria Research Initiatives |

# Executive Summary

A review of the fisheries and fish farming industry in Rwanda indicated inadequate management capacity in terms of organizational structure, technical capacity, and logistical support which has resulted in increased depletion and degradation of the fisheries resources as well as disjointed and unsustainable aquaculture development efforts. The capture fisheries production remains the major supply of fish locally but has reduced over years and currently provides about 1.28 kg of fish per capita annually. The diminished fish supply is a consequence of increased fishing pressure, heightened illegal, unregulated and unreported fishing, and increased unmonitored fish movements; all driven by increased fish demand and inadequate fisheries and aquaculture management framework.

Despite the enormous natural and socioeconomic potential, historical and current public sector interventions coupled with current overwhelming national and individual farmer interest for development of aquaculture, the sector remains extremely underdeveloped with minimal contribution to the national fish harvest. However, the country has fairly well distributed ample water resources, good physical and communication infrastructure, and very good national macroeconomic policies which if exploited can provide a very firm basis for rehabilitation and development of the Aquaculture and Fisheries sector for increased fish production. Fisheries and aquaculture can be undertaken in nearly all ecological zones of the country but different sites are suitable for different production systems depending on the site specific natural and socioeconomic conditions. There are several facilities and stations throughout the country for aquaculture extension, research and management which if rehabilitated and developed can be nuclei for fisheries and aquaculture development. Rwanda has in place a fair legal and policy framework for fisheries and aquaculture development and management but implementation of these statutory instruments has been slow and inadequate to spur the needed development.

The development of the Master Plan entailed review of the situation regarding fisheries and aquaculture taking into account historical perspective, current management, and the different cross cutting policies. It involved evaluation of past efforts and interventions in fisheries and aquaculture sectors, and presentation of best options for moving the country towards self reliance

and sustainable development in terms of fisheries and aquaculture production. Specifics of proposed interventions have been presented including cost estimates and any environmental or legal and policy issues associated with the transformation of the fisheries and aquaculture sector in Rwanda

The current plan calls for a paradigm shift in exploitation and management of the fisheries resources in order to cost-effectively utilise the country's economic and natural potential for increased and sustainable fish production. It calls for a shift from open access to controlled and commercialized fisheries production for efficient, sustainable, equitable and profitable capture fisheries and aquaculture sector in the country. It takes cognizant of the collapsed fisheries and the vast potential for aquaculture and advocates for knowledge based commercial fish culture that is private sector driven. It is feasible for Rwanda to achieve self reliance in fish and to turn into a regional fish producing and export hub through improved fisheries management and adoption of appropriate aquaculture and fisheries development framework as elaborated in this Master Plan.

# Chapter 1

## Overview of Fisheries and Aquaculture in Rwanda

### 1.1 Background

Rwanda is a land-locked country with an estimated population of 11 million and a surface area of 26,338 sq. km of which 1,390 is water surface. There are 24 lakes including three shared lakes (i.e. Kivu with the Democratic Republic of Congo (DRC) and Cyohoha and Rweru with Burundi). The national fish production is estimated at 13,000 tons of which capture fisheries contribute 9,000 tons and aquaculture 4,000 tons. Rwanda is currently by far a net importer of fish from neighboring Uganda and Tanzania. However, it is important to note that Rwanda also re-exports most of the imported fish to the DRC. Fisheries and Aquaculture sectors provide about 200,000 jobs (both direct and downstream jobs) though it is not a traditional enterprise (Mwanja et al. 2011). The sector which is managed largely through local governments and cooperatives falls under the Ministry of Agriculture and Animal Resources (MINAGRI). On the whole however, fishing in Rwanda has remained artisanal characterized by smallholder fishers and farmers. Therefore is a need to reorganize the fishers and farmers not only into cooperatives but viable fish production units with consideration for attaining economies of scale and accessing regional supply chains.

**The Policy Framework**

The Government of Rwanda (GoR) laid out a new Fisheries and Aquaculture Policy in 1998 aimed at ensuring food security, poverty eradication, and natural resources/environmental protection. The policy called for improvement in aquaculture production, coordination of fisheries and aquaculture activities with water resources management, development of fisheries and aquaculture management capacity, and review of the attendant legislations. A new fisheries law was enacted in 2008 to repeal the one which dated back in 1937. Along this was the establishment of a mega project, the Inland Lakes Integrated Development and Management Support Project (PAIGELAC) for development of fisheries and aquaculture funded by a loan facility from African Development Bank (ADB). During the medium term review, PAIGELAC was instructed to include the development of a National Aquaculture Management Plan.

Among key challenges are increased degradation of the lakes environment and poor management of the fisheries. Fisheries and Aquaculture are considered a decentralized activity with limited oversight from the MINAGRI under the Animal Production Unit of the Rwanda Animal Resources Development Authority (RARDA). However, local authorities do not have the capacity to manage the fisheries resources sustainably.

Rwanda has very good potential for increased fisheries productivity which if commercialized in approach and linked to sectors such as tourism together with an enabling policy can stimulate increased fish production for both local and regional markets. However, lack of a central fisheries management agency and limited private sector investment and participation has led to severe destruction of the resource to levels which are less than 10% of the estimated production potential.

Given the current state of the fisheries sector and the demand for fisheries resources there is need to put in place strategies and measures that will ensure that Rwanda can fully and sustainably utilize her resources to meet the high animal protein demand, while tapping the inherent nutritional security found only in fish. With the projected 16 million people by 2020, the country will need 112,000 tons of fish annually if the population is to catch up with the average fish consumption in Sub Sahara Africa. With growing elite and urban population, as well as increased health challenges, demand for fish is real and has to be addressed now before the water bodies completely lose their biological potential for fisheries production. There is need to halt the collapse and restore the natural fisheries productivity and production to sustainable and economic levels and grow the contribution of the fisheries sector to the national economy. The current plan calls for a new management dispensation and a paradigm shift from open common access with no clear responsibility and ownership for fisheries resources base to commercial fisheries and aquaculture business.

## 1.2 National fish demand

The level of per capita fish consumption in Rwanda estimated at 1.5 kg is the lowest in East Africa and falls far below the Sub Sahara Africa and global level estimated at 6.7 and 16.6 kg respectively. Clearly, the low level of fish consumption in Rwanda is of serious concern to

national development in terms of population health since fish provides high biological value proteins, vital vitamins, minerals, fatty acids and other micro-nutrients crucial to a healthy diet of the people. This is of particular concern given the limited alternative sources of animal protein and other related nutrients. If Rwanda's population growth continues as projected in the vision 2020, the country will need 112,000 tons just to attain the average Sub Sahara per capita consumption of 6.6 kg/person/year and 265,600 metric tons to reach the global average of 16.6.

## 1.3 Fish Production in Rwanda

### *1.3.1 Capture Fisheries in Rwanda*

Artisanal fishing has been practiced in Rwanda for decades since the colonial times although fisheries production has never been a major economic activity; a situation attributed to absence of a fishing tradition. Various donor supported projects have been undertaken since the 1970s to support capture fisheries but sustainability of the sub sector was not achieved. With increased value of fish over the years, there has been increase in fishing capacity along with fishing malpractices leading to overfishing in all the waters. All previous studies conducted since 1991 highlighted overfishing as the major obstacle to sustainability of the fisheries industry in Rwanda. *Etude Sectorielle de la Pêche et al pisciculture au Rwanda*, 1991 noted excessive overfishing in Rwanda lakes and observed too many fishermen, illegal fishing and use of destructive gears. The same observation was made in the BCEOM report (2008) which attributed the collapsed fisheries in the Eastern Province lakes to *Clarias gariepinus* (African catfish) and the alien *Protopterus aethiopicus* (Mamba). The latter was ironically introduced by a government and donor supported project in 1985-87 to boost fisheries production. As a result of that finding, the BCEOM report recommended target fishing of these two species which are referred to as predators. Currently, the PAIGELAC project is implementing this recommendation. However, the BCEOM recommendation does not suggest practical steps to address the problem of overfishing. Although the African catfish and Mamba are known to prey upon other fishes, they are not voracious predators as their diet is not exclusively fish. *P. eathiopicus* is basically molluscivorous while *C. gariepinus* is omnivorous. Even if these two species were to be exclusively piscivorous, they would not deplete the prey stocks as the predator/prey equilibrium would set in. Therefore, the only plausible cause for depletion of native stocks remains excessive fishing capacity and use of destructive gears in all the water

bodies. As a result of illegal, unregulated and unreported fishing over a long period, the natural fish stocks have been depleted. Fish stocks in most lakes have collapsed to the extent that our recent assessment of catch after 12 hours of fishing was only 2 kg of fish per boat.

### *1.3.2 Aquaculture*

**Historical perspective**

Fish farming is reported to have started in Rwanda at the end of the 1940s during the monarch and the Belgian colonial administration, promoted mainly as a government sponsored activity. The then administration constructed two main fingerling production centres at l'Ecole des Assistants Agricoles, Butare, in 1952 and the Kigembe Station in 1954. Direct support was provided to fish farmers in form of extension services, seed, and other inputs. The category of aquaculture that was promoted until recently by all previous governments since the 1940s was subsistence fish farming characterized by low input and low output, primarily based on pond fertilization from livestock wastes with inherent managerial weakness of public sector dependant on hand-outs to subsistence farmers.

During the period 1960- 1965, development of fish culture in Rwanda came to a standstill; many existing ponds were abandoned due to civil strife. From 1967 to 1973, the government undertook to revitalize fish farming through two UNDP/FAO projects. The projects reactivated the Kigembe Centre and carried out trials on culture of *Cyprinus carpio* (common carp), Tilapia species and *Clarias carsonii* /*liocephalus*. Tilapia fingerlings were produced and several ponds in rural areas were restocked. These projects were followed by several others that were all focused on small holder subsistence aquaculture. The common feature of these state interventions was always a boom during project times followed by declined production and abandoning of the ponds at the expiry of the projects, clearly demonstrating lack of sustainability. The current interventions under PAIGELAC project are not any different. Under the PAIGELAC project, fish farmers and fishermen have been organized under cooperatives and given various forms of support ranging from training, study tours to direct provision of inputs. The project has so far trained 3623 fish farmers and supported 118 fishing cooperatives across the country. However, the dynamics of these cooperatives, unlike other agricultural enterprises such as livestock, are complex and sustainability remains questionable.

**Previous projects and Development efforts**

Intervention to develop capture fisheries in Rwanda started in the 1970s on Lake Kivu with support from Rwanda Government and FAO (RWA/77/010; 1979-1983) for phase I. Support for phase II and III was obtained from Rwanda Government, the Netherlands and UNDP (RWA/77/010-GCP/RWA/008/NET (1984-86) and RWA/87/012 (1987-1991). The total support for the two phases was Rwf 252 million and USD 5.3 million. Other lake systems have also received various support including: Rwf 27 million study of fish poisoning on Lake Burera in 1989; Rwf 20 million for the development of Lake Muhazi fisheries project 1985-87. It was during this project that the seemingly dreaded Mamba ***P. aethiopius*** was introduced into Lake Muhazi; Rwf 10 million fisheries research and development in Lakes Mpanga, Cyambwe and Nasho; and various Technical Cooperation Programme (TCP) projects were obtained from FAO for fisheries development in Rwanda. A number of projects were also implemented in aquaculture including support from Centre de Recherches pour le Développement International, Ottawa, Canada which was designed to implement the Empoisonnement des lacs du Pays et Développement de la Pêche (ELADEP) Project. The headquarters of this project were at Ruganwa Fish Station in Kigali. ELADEP's main activities were to undertake experiments in growing different species in aquaria and ponds at Ruganwa Fish Station and the Kigembe Centre and the training of extension workers (*moniteurs piscicoles)* at Kigembe. Under ELADEP, technicians from Rwanda were trained in fish farming and fisheries at the Centre de Formation in Bouaké, Ivory Coast.

Before the crisis, the National Aquaculture Project (PPN) financed from 1983 to 1994 to the tune of US$52 million by United States Agency for International Development (USAID) had attempted to support fisheries sustainability. There were also interventions by USAID and FAO in 1999, which provided the logistical support to the Lake Kivu fisher' cooperatives (APELAC, COOPILAC). Financial support of about US$51.3 million was used to train and organize cooperatives, improve, increase and diversify fishing units, develop bays, undertake pilot cage fishing culture schemes and improve the lake surveillance capacity of the cooperatives. In addition, the cooperatives received about US$500,000 support from FAO in 2001 to procure fishing gear and to improve the management efficiency of artisanal fishing units.

It is clear from the above that substantial amounts of funds and other resources have been expended over the years to increase fish production through capture fisheries and aquaculture in Rwanda albeit with no reported or tangible increments. National fish production is currently estimated at 13,088 tons giving one of the region's lowest per capita fish supply (Table 1).

**Table 1:** *Fish production in some East African Countries*

| | Burundi | Kenya | Rwanda | Uganda |
|---|---|---|---|---|
| Population | ~9,200,000 | ~38,000,000 | ~10,200,000 | ~32,000,000 |
| Area ($km^2$) | 27,830 | 582,650 | 26,338 | 236,040 |
| Inland waters ($km^2$): | 2,180 | 13,400 | 1,390 | 36,330 |
| Inland Production | 14,000 | 167,605 | 9,050 | 576,000 |
| Land Aquaculture production | 200 | 1,012 | 4,038 | 83,200 |
| Level of Management of the Fisheries Agency | Department of Fisheries under the Ministry of Livestock and Fisheries | Ministry of Fisheries with directorates for inland fisheries management | Decentralized to local authorities with limited oversight by the Ministry of Agriculture, Animal Industry and Fisheries | Department within Ministry of Agriculture, Animal Industry and Fisheries |
| Level of Aquaculture Management | Under the Department of Fisheries in the Ministry of Livestock and Fisheries | Ministry of Fisheries with Aquaculture as a directorate | Decentralized to local authorities with limited oversight by the Ministry of Agriculture, Animal Industry and Fisheries | Under the Department of Fisheries |
| Production value (USD) | $783,000 | $160,000,000 | $25,000,000 | $700,000,000 |
| Value of Imported Fish | $104,000 | $8,300,000 | $10,000,000 | $1.600,000 |
| Capita supply kg | 1.5 | 4.40 | 1.28 | 20.60 |
| Consumption kg | >2.0 | 3.10 | 1.50 | >6.100 |
| Direct employment | 4,000 | 65,500 | 40,000 | 400,000 |
| Indirect employment | 120,000 | 800,000 | 200,000 | 700,000 |
| Number of livelihoods | 300,000 | ~2,400,000 | 1,000,000 | 2,800,000 |

## 1.4 State of Aquaculture Infrastructure

There are 17 aquaculture stations (Kigembe, Rwasave, Runyinya, Rushashi, Ruli, Rusumo, Ngarama, Cyamutara, Muko, Bwafu, Ndorwa, Kazabe, Mabanza, Kivumu, Karengera, Nkungu and Nyamishaba), many of which are dilapidated. Kigembe, Nkungu Rwasave and Rusumo have been rehabilitated by PAIGELAC project. Apart from Kigembe and Rwasave that can combine research and extension, the rest of the aquaculture stations are fish farms that can best serve as Technology Demonstration Centres. It was found that the capacity of these centers to

produce fish seed, on-farm feed and conduct research that is responsive to the ever changing farmer needs was lacking. The centres were grossly understaffed.

The Rwasave Aquaculture Station is managed by the National University of Rwanda (NUR) at Butare. The center has had some rehabilitation works by PAIGELAC project. Rwasave has adequate water flow. With the existing infrastructure, the center can undertake applied aquaculture research that can benefit the farmers. Rushashi, Rusumo and Nkungu are managed by the cooperative societies.

### *1.4.1 Global and Regional Aquaculture Growth*

Whereas production from capture fisheries is generally on the decline globally, aquaculture has registered positive growth and is more likely to fill the gap caused by declining capture fisheries and increasing human population. A number of African Countries have made several folds increase in aquaculture production. Between 2004 and 2006, Uganda's aquaculture production increased from 5,539 mt to 32,392 mt while Nigeria's aquaculture production rose from 43, 950 mt to 84,578 mt. In the 2009/2010 Financial Year, Kenya government injected US$ 14 million to implement fish farming enterprise economic stimulus package. This unprecedented level of funding is likely to dramatically raise the country's aquaculture production. Egypt leads African countries with a total national fish production of 600,000 metric tons; 75% of which is generated from fish farms.

Fish production in the East African Community (EAC) grew steadily over the past decades till the 1990s, when growth started to slow down in the capture fisheries amidst indications that several fisheries are nearing production limits. Aquaculture, on the other hand, is gaining momentum, although production levels are still very low. In 2007, Rwanda's aquaculture production was recorded as 4,038 mt which is more than 10 fold the 386 mt produced in 2005. Clearly aquaculture production is increasing but production is not yet satisfactory. What is required is real production and not contentment with increasing trends. There is a need to part with the past, restructure the sector and set it on a well defined development trajectory that will dramatically increase output.

## 1.5 Rwanda's Aquatic Resource Base

Rwanda is endowed with an extensive hydrological system (Figure 1 and Figure 2) characterized by a dense network of lakes, rivers, and wetlands that feed into two major drainage basins: the Nile to the east and the Congo to the west. About eight percent of the entire country (210,000 ha) is covered by water. Lakes occupy about 128,000 ha, rivers about 7,260 ha, and water in wetlands and valleys occupies about 77,000 ha. The Congo basin covers 33% of Rwanda and includes 10% of all national waters. The Nile basin covers 67% and delivers 90% of the national waters. The forested area of Nyungwe National Park is Rwanda's major watershed for both the Nile and the Congo basins. The waters of the Nile basin flow out through the Akagera River System, which contributes 8 to 10% to the Nile drainage system.

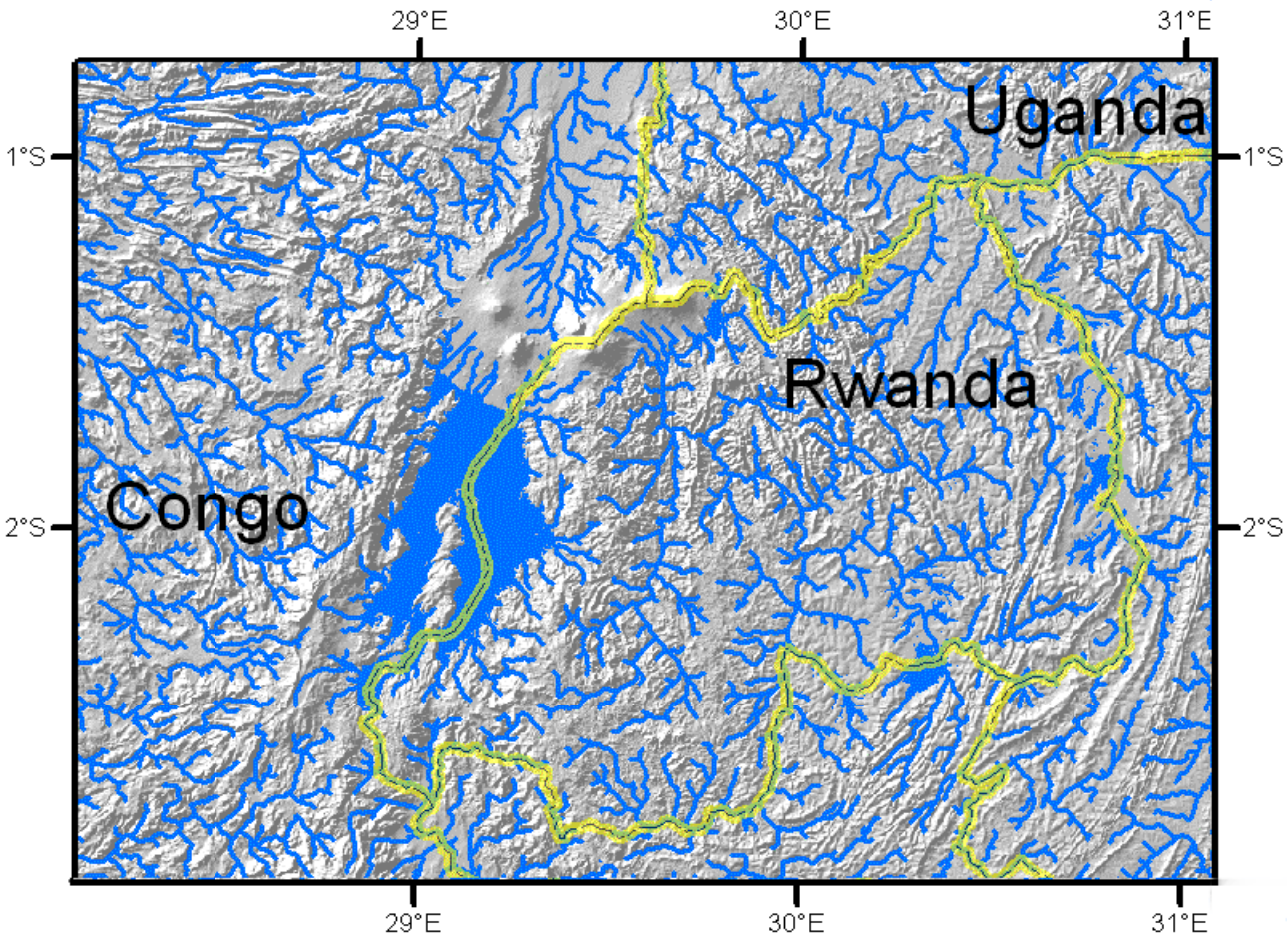


**Figure 1:** *Rwanda's extensive hydrological network*
Source: http://rocky.ess.washington.edu/areas/Rwanda/

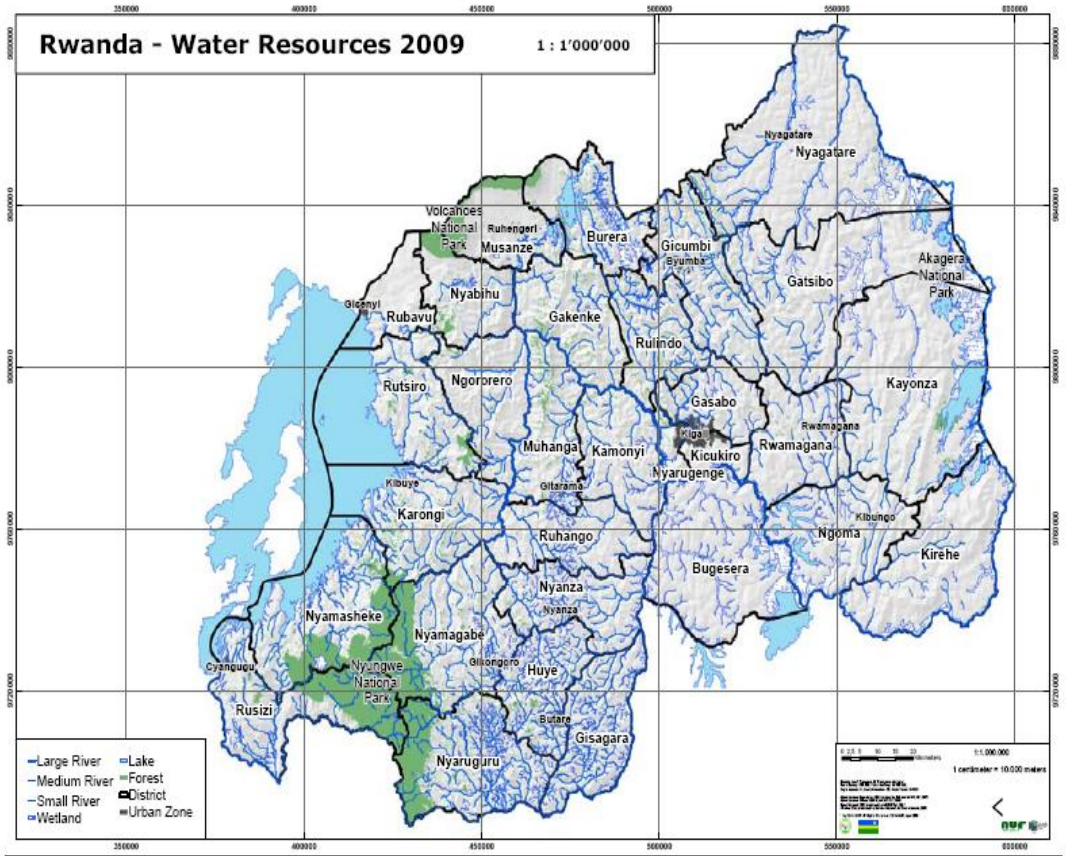


**Figure 2:** *Rwanda's Hydrological Network.*
Source: http://www.rema.gov.rw/soe/chap7.pdf

### *1.5.1 Lakes*

- The Northern Lakes of: Burera, Ruhondo
- The Central Lake: Muhazi
- The Bugesera Lakes: Cyohoha (North and South), Rweru, Rumira, Kidogo, Gaharwa, Kirimbi, Mirayi and Gashanga
- The Gisaka Lakes: Sake, Mugesera and Birira
- The Nasho Basin Lakes: Nasho, Mpanga, Kagese, Cyambwe, Rwakibare
- The Akagera National Park Lakes: Ihema, Mihindi, Kivumba, Hago, Rwanyakizinga

### *1.5.2 Rivers*

The major rivers are: Nyabarongo and Akanyaru whose confluence forms the Akagera. Others are the Ruhwa, Rusizi, Mukungwa, Kagitumba, and Muvumba. Associated with the rivers are water pools locally known as *ibidendezi*.

### *1.5.3 Underground Water*

According to the Rwanda Irrigation Master Plan (2010), the best aquifers are found in the quaternary volcanic formation of Birunga with a yield of 110 $m^3h^{-1}$. However, the eastern part of the country which is under some degree of water stress is characterized by granitic aquifers whose yield is low (1-5 $m^3h^{-1}$).

### *1.5.4 Water Resource Reserves*

According to USAID (2008), the total estimated withdrawal rate is 0.8 cu. km/year (equivalent to 141 $m^3$/person/year), which is approximately 22% of the total allowable withdrawal (IISD, 2005) indicating that there is presently little pressure on the water systems to meet national demands. The same observation was made in the Rwanda Irrigation Master Plan (2010) which observed that the country is characterized by high precipitation and large unexploited reserves of both surface and ground water. The country's water reserves exceed by far the expected demand.

### *1.5.5 Environmental Status of the Hydrological Network*

Rwanda is home to almost 11 million people and is the most densely populated country in Africa. The population is projected to grow to 16 million people by 2020. High population density exerts too much pressure on the land. Already most parts of the country have been cultivated exposing the soil to erosion. The situation is compounded by the country's relief which consists of mountains and hills with steep slopes and valleys. Water that flows from the hills into the water networks in the valleys erodes the soil into main rivers. As result, most rivers are heavily silted rendering would be potential aquaculture sites unsuitable. The waters of the Bugesera and Gisaka lakes in which the Akagera River traverses turn brown during rainy seasons due to heavy siltation. The extensive hydrological network in Rwanda is grossly affected by

unreliable rainfall. Prolonged droughts that are common in the country lead to decreased water levels in lakes and rivers which in turn disrupt fish spawning patterns and subsequently recruitment. On the other hand, climate variability often results in heavy rains and flooding in valleys with attendant increase in siltation of the water systems.

## 1.6 Fish Production Systems

Suitability of an area for aquaculture depends on various biophysical and socio-economic factors which include: the natural requirements of the species to be cultured, the production system of choice, availability of water in sufficient quantities and in good quality, topographical features, accessibility to markets, and connectivity to energy among others.

During the study, historical reports were reviewed and field observations undertaken across the country to collect information on the best aquaculture production systems for the various ecological regions. Information collected from the field was triangulated with secondary data to determine the most cost effective production system. Based on the factors stated above, districts were grouped into zones and assigned the most cost effective production system. However, the most suitable production system for any zone does not preclude others but is a ranking according to the available options. The following are the proposed production systems:

### *1.6.1 Cage production*

Cage fish culture is the raising of fish in containers enclosed on all sides and bottom with mesh material that secures the fish inside while allowing relatively free water exchange with the surrounding environment. The model type of cage culture system that is recommended for upstart aquaculture development is the low cost and Low Volume High Density (LVHD) cage fish culture (Schmittou et al. 1997). In this system, fish is raised in low cage water volumes of 1 $\leq 8m^3$ (typically $4m^3$ at optimum high stocking densities of 300 – 500 individuals or expected harvest weights from 150 – 250 kg of fish per $m^3$ of cage. LVHD has been tried in many developing countries including neighbouring Uganda where it was proved that; (i) The technology directly and indirectly satisfies the universal fundamental goals of producing high quality fish, (ii) It is relatively inexpensive and simple, therefore easily adaptable by small

holder farmers with limited resources, (iii) It is applicable in most existing water environments and does not require conversion of land into new bodies of water, (iv) There is less likelihood of off flavour fish than in ponds, (v) It is more adaptable than conventional aquaculture methods in meeting production to market size, (vi) It is not very capital intensive, and (vii) It is applicable in open waters with low capture fish yields. It is therefore the most likely major option to commercialise aquaculture in Rwanda in view of the pressure on land and terrain.

Cages can be made of nylon net meshes, bamboo, wire mesh, and any other material that can form a mesh enclosure. However, the commonly used material is nylon. The size at which fish is stocked in the cage depends on the mesh size. For small fish, smaller meshes are required to guard against escape. However, small cage meshes get easily clogged and consequently start bio-fouling. It is therefore advisable to start with small meshes and change to bigger sized meshes as the fish grows. In Lake Victoria, it has been demonstrated that tilapia can grow much faster in cages than ponds. For example, whereas it takes over 12 months to raise tilapia from 30 grams to 600 grams in ponds, it has been found to take only 6 months to attain the same weight in cages. For cage operation to be successful, a good quality feed in a pellet form and preferably floating has been shown to be cost-effective.

Good water quality is important in any type of aquaculture but particularly significant in cage culture because of confinement and density of fish. It is recommended that a cage should be sited where water depth is at least 3 metres. If however it is in a lake, the average depth should be more than 20 meters to provide nutrients sink and mitigate against eutrophication. If the water is too shallow and the bottom of the cage is very close to the water bottom, the exchange of water may be seriously affected thus resulting in poor growth of fish and/or even mortality. The bottom of the water body at the site where the cage is placed should be sandy or rocky. Muddy bottom surfaces are not good because of decomposition and possible emission of toxic gases from such areas. Waters with some currents e.g. in slow-flowing river stretches, are good sites for cage culture.

Given the biophysical features of Rwanda and the enterprise budgets generated in neighboring countries, the Low Volume High Density (LVHD) cage system is recommended as the most

suitable production system. The following zones were found to have moderate to high potential for cage culture.

**Lake Kivu Districts**

Lake Kivu (Figure 3) offers a great opportunity for cage culture in Rwanda. The lake is located in a mountainous region between 1°34' and 2° 30' South latitude and between 28°50' and 29°23' East longitude. This area is characterized by volcanic activity. The lake covers a surface area of 2,370 $km^2$ of which 42% is within Rwanda's border. Its average depth is 240 m with the maximum of 490 m, found in the north of the basin. Its total volume is estimated at 550 $km^3$. Lake Kivu is permanently stratified with an upper stratum (20-60 m), where there is some mixing by wind action. A thermocline is observed at 20–30 m. During the dry season (June-July), there is a partial movement of water in the first upper layer. Only 12% of the littoral area (shallow vegetated) of Lake Kivu has access to oxygenated waters. This has a limitation to fish culture. The deep layer is deoxygenated and is rich in dissolved gases, particularly Carbon dioxide ($CO_2$) and Methane ($CH_4$).

The climate around Lake Kivu is continental humid, characterized by a short dry season in December to January followed by a long rainy season from February to May, a long dry season from June to September and a short rainy season from October to November. The average annual rainfall is 1300 mm. As a consequence of high altitude (1463 m), the surface water temperatures vary between 22°C and 24°C. The pH of surface waters is 9.1.

Although possible release of a fraction of bottom layer gases triggered by a magma eruption within the lake, poses a big risk to flora and fauna of the lake, the current biophysical parameters stated above permit growth of fish in cages. Information from Rubavu Districts indicated that cage culture was already piloted on Lake Kivu with positive production results.

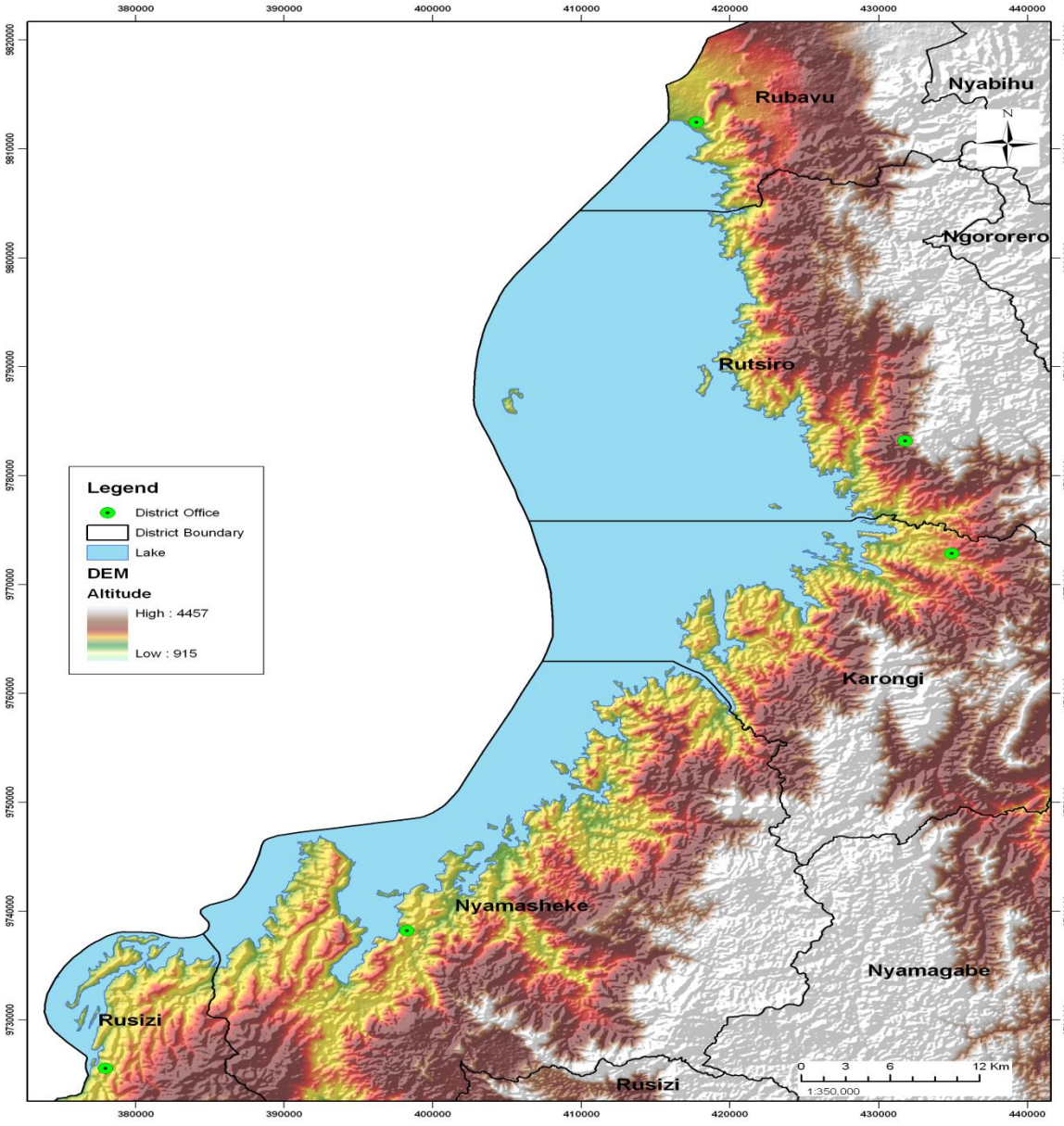


**Figure 3:** *Map of Lake Kivu; the entire shoreline with its bays have high potential for Fish Cage Culture*

### Lakes Burera and Ruhondo

Lake Burera (Figure 4) situated on the southern slopes of Mt. Muhabura in Northern Rwanda at 1°23'4 °30' S/29°45'-29°49'E and 1862 m above sea level, is 12 km long and 8 km wide. It contains two small islands and is fed by 6 streams. The lake has a maximum depth of 173 m and an open water surface of approximately 3500 ha. It drains from its southwestern extremity to

Lake Ruhondo (1°28 '-1°33 ' S/29°42 '-29°46 'E), 1764 m above sea level. The V shaped Lake Ruhondo (Figure 4) is 9 km long, 3 km wide and 65 m deep. The lake has an area of 2800 ha. In addition to the overflow from Lake Burera, it receives water from four other streams, of which Gasura is the most important. There is a 500 ha swamp at the northern end of the lake i.e. at the apex of the 'V'. It drains to the southwest via the Mukungwa River, a tributary of the Nyabarongo. Formation of Lakes Burera and Ruhondo is associated with volcanic activity of the Birunga volcano which caused outpouring of larva across a river valley that cooled and solidified. The following limnological parameters for the two lakes were reported by the BCEOM report (2008):

**Table 2:** *Physicochemical of Lakes Burera and Ruhondo*

| **Lakes** | **Depth (m)** | **Temperature ($^oC$)** | **Oxygen (mg/l)** | **pH** | **Conductivity (S)** | **$NO_2$ (mg/l)** |
|---|---|---|---|---|---|---|
| Burera | 0 | 21.4 | 6.4 | 9.8 | 102.1 | 0.0004 |
| | 15 | 20.6 | 4.2 | 9.2 | 101.9 | |
| | 50 | 20.3 | 0.1 | 8.8 | 104.5 | |
| Ruhondo | 0 | 23.1 | 7.2 | 10.5 | 253.5 | 0.013 |
| | 5 | 21.6 | 3.3 | 9.9 | 258.5 | 0.014 |
| | 11 | 21 | 0.1 | 9.4 | 269 | |

According to the parameters summarized in Table 2 above, Lakes Burera and Ruhondo can support cage culture of cold tolerant species like the Blue Tilapia (*Oreochromis aureaus*) which has been reported to tolerate temperature as low as $9^oC$ while the lethal temperature for Nile Tilapia (*Oreochromis niloticus*) is $10^oC$. Nile tilapia would also grow but at a much slower rate because of the temperatures that are in the lower 20s. The optimum temperature of Nile Tilapia growth is 25 – $30^oC$. Demonstration of cage culture of Nile Tilapia in Ruhondo has already started but will require technical guidance especially on raising fish cost-effectively at low temperatures.

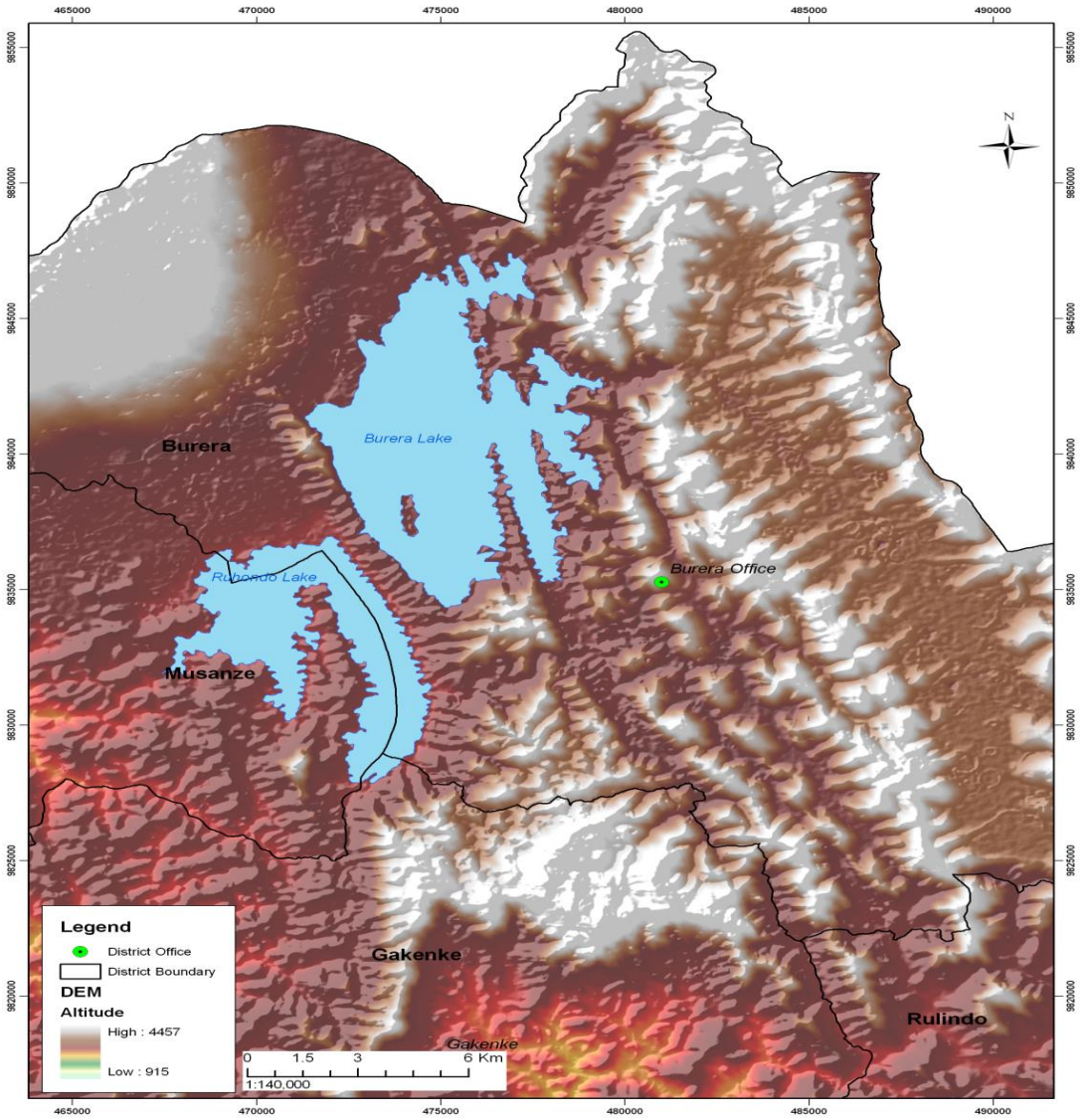


**Figure 4:** *Map of Lakes Burera and Ruhondo that are deep enough to support Cage Culture*

**Districts with Dams**

It was noted during the field visit that a number of districts in Rwanda have dams, valley tanks, pools or ibidendezi (Figure 5) that are more than 5 metres deep. Some of these water bodies are associated with irrigation while others are not. Most of the dams in Rwanda are deeper than 3 metres (Table 3) and offer opportunities for cage culture. Experience with LVHD cages in reservoirs in Uganda, most of which were much smaller than the dams in Rwanda recorded yields ranging from 150 – 189 $kgm^{-3}$. The dams could therefore be used to support a profitable cage culture industry in several parts of the country.

**Figure 5:** *Dams such as Cyadisha dam between Huye and Gisagara Districts can support Cage Culture*

**Table 3:** *Some of the dams/reservoirs in Rwanda*

| No. | DISTRICT | SECTOR | NAME OF THE DAM | SURFACE ($m^2$) | AVERAGE DEPTH (metre) |
|---|---|---|---|---|---|
| 1 | NYANZA | BUSASAMANA | E.B NYAMAGANA | 63,000 | 6 |
| 2 | NYANZA | KIBILIZI | E.B AGASASA | 65,250 | 6,5 |
| 3 | NYANZA | KIBILIZI | E.B NYARUBOGO | 60,000 | 5,9 |
| 4 | MUHANGA | SHYOGWE | E.B MISIZI | 60,000 | 6,4 |
| 5 | MUHANGA | SHYOGWE | E.B AIDR | 60,000 | 6 |
| 6 | MUHANGA | SHYOGWE | E.B RUGERAMIGOZI | 60,000 | 6,8 |
| 7 | RUHANGO | BWERAMANA (Base) | E.B .BASE | 60,000 | 6,3 |
| 8 | NYAMASHEKE | BUSHEKERI | MPAKANIYE Martin (Owner) | 1000 | 2 |
| 9 | NYABIHU | KARAGO | BOMA | 1,000 | 3,5 |
| | | KARAGO | KARAGO | 1,000 | 5,5 |
| | | MUKAMIRA | CYUNYU | 400 | 5,5 |
| | | MUKAMIRA | BIHINGA | 500 | 5,5 |
| | | NGORORERO | GATUMBA | 500 | 10 |
| 10 | KIREHE | MUSAZA | SAGATARE | 20,000 | 3,5 |
| | | MUSHIKIRI | CYUNUZI | 20,000 | 3,5 |
| 11 | KAYONZA | KABALE-RWINKWAVU | GISHANDA | 40,000 | 3 |
| 12 | | GAHINI | KABIGABIRO | 45,000 | 4 |
| 13 | | RUKARA | CYABATANZI | 25,000 | 3 |
| 14 | NYAGATARE | NYAGATARE | CYABAYAGA | 38,000 | 6 |
| 15 | GATSIBO | REMERA | KANYONYOMBA | 16,000 | 4 |

### *1.6.2 Tank based Aquaculture production*

Raising fish in tanks is commonly employed in recirculation systems also known as "Closed Systems". In tank-based culture systems, fish is raised in tanks that are supplied with clean water. The tanks can be made using various materials ranging from concrete, fibre glass, metals to high density poly-fibre supported by wooden or metallic frames. Fish rearing tanks can be square, rectangular, circular or oval. Raising fish in tanks can be by water flow-through or recirculation systems. These systems are especially recommended where there is established infrastructure for supply of water for production and are appropriate for peri-urban and urban aquaculture production. Due to adequate rainfall in Rwanda, rain harvesting supplemented by springs or municipal water in peri-urban and urban areas can support tank-based aquaculture production using water reuse.

### a) Water flow through system

In a flow through system, water is drawn from the supply, used in the rearing tanks and discharged into the natural drainage system. Effluent water should be filtered before it is discharged in fulfilment of environmental management requirements. Water could be diverted from a river source, used to rear fish in the tanks and discharged back into the main river through a constructed wetland or a water treatment system. An example of a tank-based water flow through system is Dan Fish Farm at Kibbutz Dan in Israel. At this farm, water is obtained at an elevated point on River Dan, used to raise fish at the farm and purified before release into River Dan which flows into the Sea of Galilee. Similar fish tank-based enterprises in Nigeria have increased yields of African catfish by several folds and Rwanda could develop similar systems.

### b) Recirculation/Water Re-Use Aquaculture System

In recirculation systems also referred to as water reuse systems, water from the rearing units is filtered and re-used. Since fish live in water, obtain feed from water and discharge wastes into the same water, it is important that the quality of water is continuously purified and monitored to ensure that adequate water standards are maintained. This can only be achieved in recirculation systems if efficient filtration components are installed. Water filtration entails removal of particles and dissolved compounds such as ammonia from the water. In some operations, filtration includes degassing, aeration and disinfection mainly with UV radiation. For these systems, availability of a reliable energy source is a prerequisite.

**Why re-circulated systems?**

Aquaculture production requires availability of clean water with respect to dissolved oxygen, pH and conductivity. With the increasing human population, water requirements in Rwanda for domestic use and livestock are likely to rise. The situation is compounded by destruction of forests and wetlands along water catchments. As a result, many natural water bodies dry up or their water volumes reduce drastically during dry seasons. Removal of water retention vegetation along catchment areas leads to heavy silted runoffs that pollute waters and make them unsuitable for aquaculture. Rwanda Environment Management Authority (REMA) regulations require that water effluents from fish farms are filtered before discharge into the natural drainage system. All these factors combined justify the need for water re-use. Although water

recirculation systems are capital intensive, they are efficient and easily controlled production systems. Disease causing organisms, predators and other unwanted organisms do not easily find access into the farm. In recirculation systems, water quality is easily regulated and efficient water use allows for production that is independent of fluctuations in weather conditions. The following are potential sites for tank based aquaculture.

**The North-South Chain of Highlands along the rim of the Rift Valley**

From field observations, it was noted that several rivers flowing from hills in the districts of: Nyaruguru, Nyamagabe, Ngororero, Musanze, and Gicumbi (Figure 6) offer great opportunities for tank aquaculture based on water flow through systems. A number of these rivers are not silted at the source and could therefore be tapped, used to grow fish in tanks and the effluent water discharged into the natural flow. Suitability of tank culture in these districts is further made possible by the high water yielding aquifers (up to 110 $m^3h^{-1}$) at relatively low depth of 30 – 90 meters in the North and North-Western region. The point of concern however, is that these regions are characterized by high altitude, above 1800m above sea level which correspondingly translates into low water temperatures. It will therefore be necessary to consider culture of cold tolerant fish species such as trout or water heating in a re-circulation system where possible.

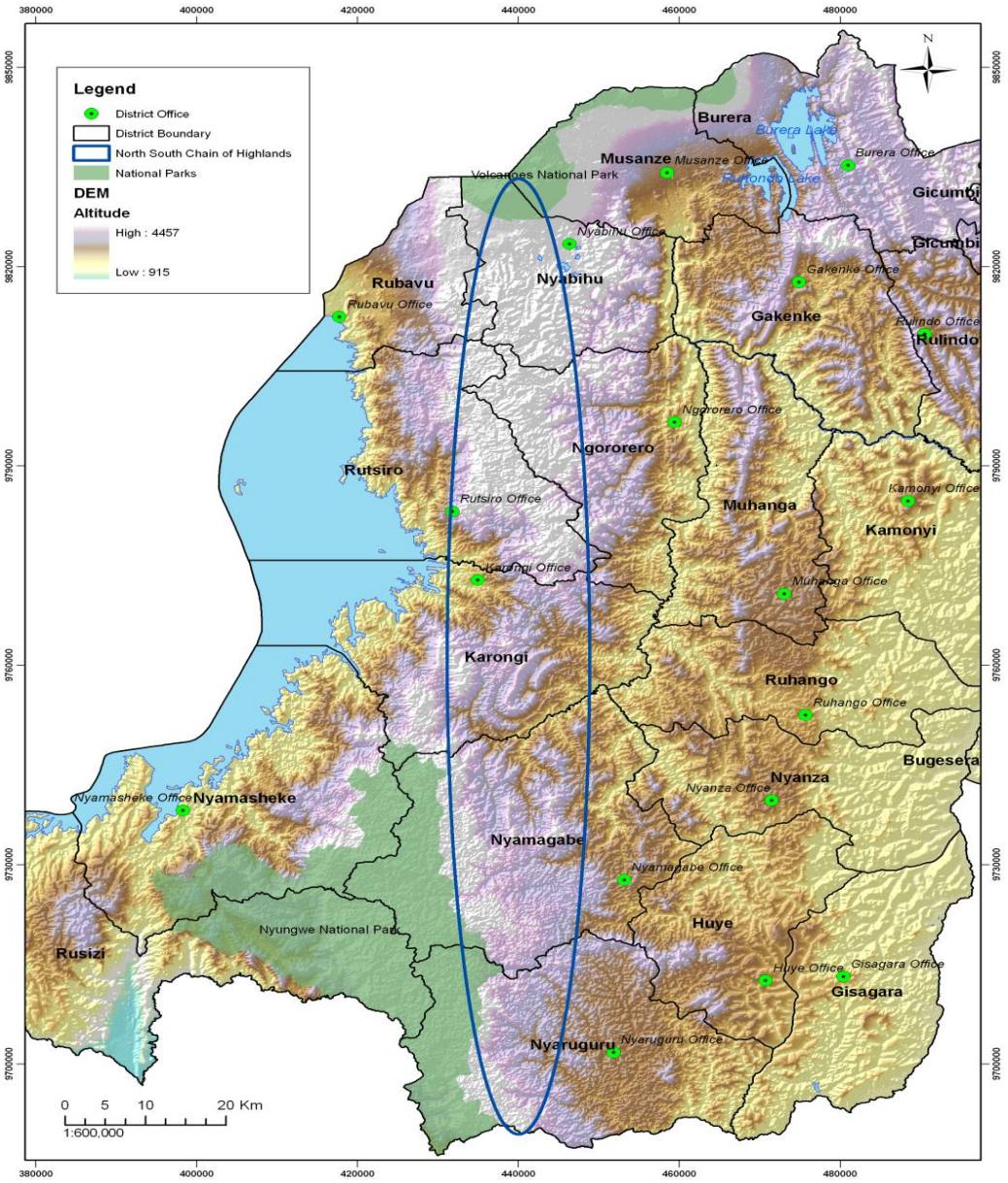


**Figure 6:** *Map showing the North-South Chain of Highlands that are suitable for tank culture of cold tolerant fish species*

**The Rwesero and Cyabayaga sites**

The Rwesero site at the point where Nyabugogo River leaves Lake Muhazi 01 º79'23.3"S° 30 º15'50.6" E and 1430m (Figure 7) was found suitable for tank culture of fish in flow through or recirculation system. The river leaves at a good height (Figure 8) that can provide for gravity flow of water into fish rearing tanks.

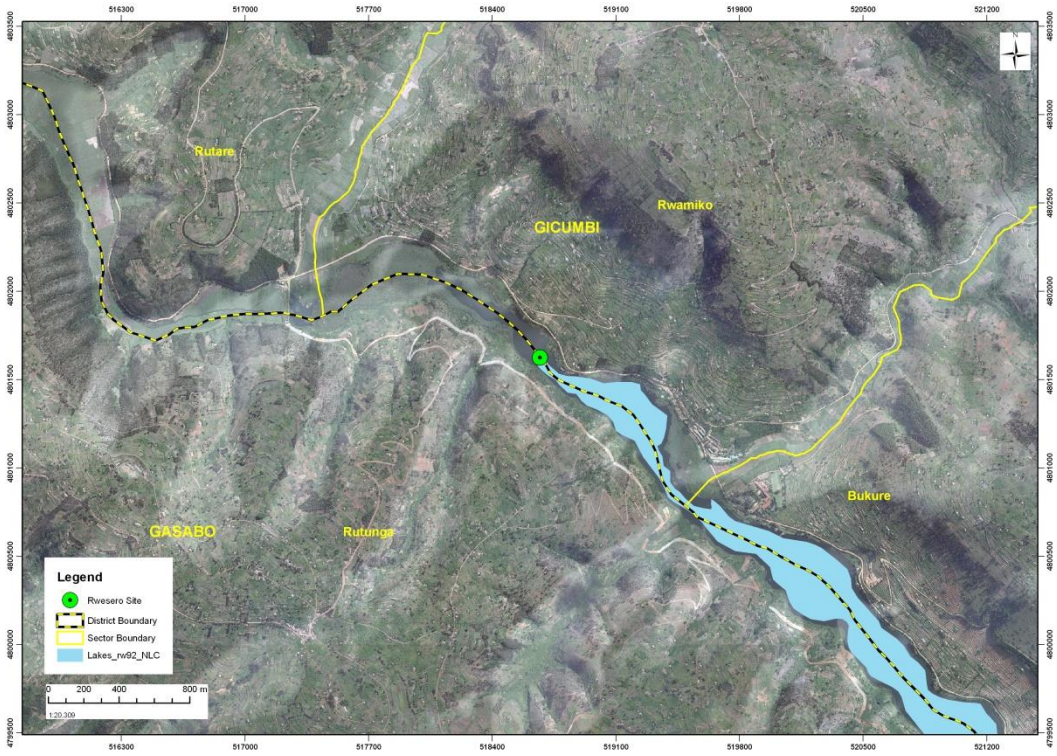


**Figure 7:** *Location of the Rwesero Site*

**Figure 8:** *Pictorial View of the Rwesero Site*

Conditions similar to those at Rwesero site were observed at Cyabayaga 01º 41’08.9S E 30º.28'50.6"E and 1357m in Nyagatare District (Figure 9 and Figure 10). The warm ambient temperatures of Nyagatare provide an opportunity for fast growth of warm water fish while the adjoining rice scheme will offer a potential market for table fish. This site should be considered for development of tank based aquaculture. There are many other areas with potential for cage culture around the country that require detailed investigations.

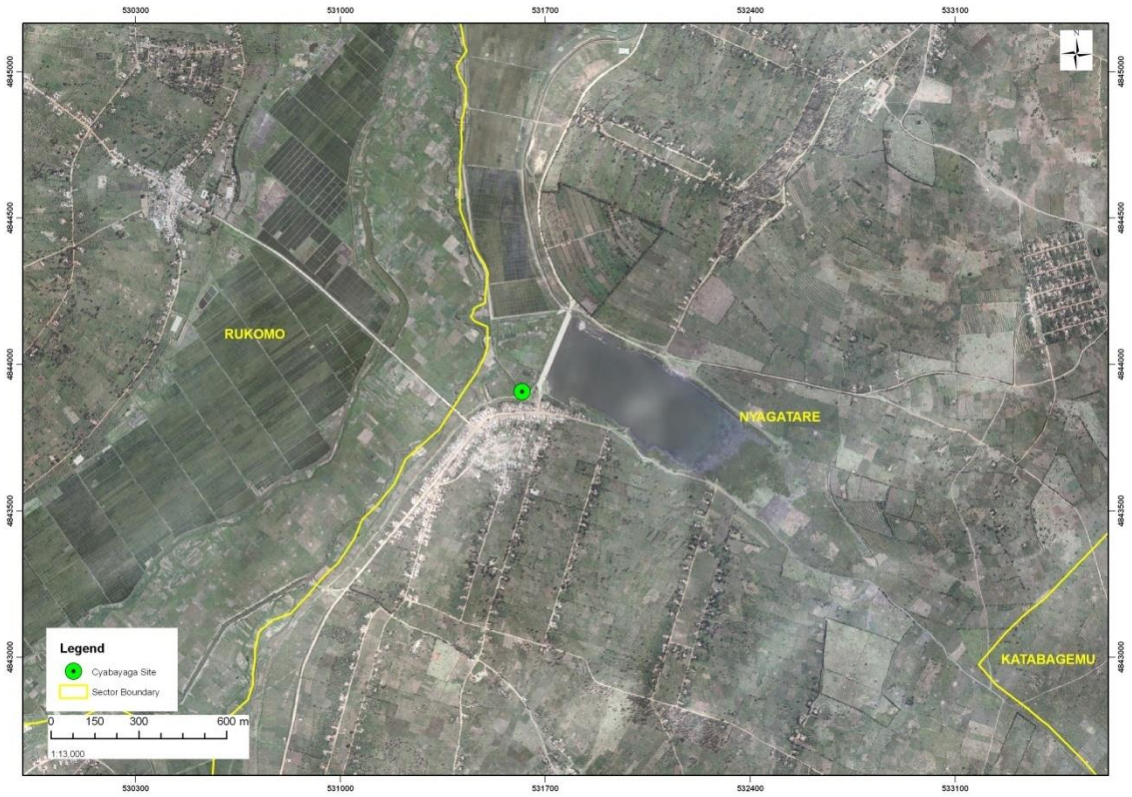


**Figure 8:** *Location of the Cyabayaga Site Close to the Rice Scheme.*

**Figure 9:** *Water from Muvumba River Flows at Cyabayaga at an Elevation that Permits Tanks Based Aquaculture*

**The Lakes of Bugesera, Gisaka and Nasho Basin**

The lakes of the Nile basin in the districts of: Bugesera, Ngoma, Kirehe, Rwamagana, (Figures 11 and 12), Kayonza, Gatsibo, and part of Gicumbi were found to be very shallow with muddy bottoms making them largely unsuitable for cage culture. Only lakes Rwampanga and Rwakibare were reported by KOADUNA to have sections with sandy bottoms. The most feasible option for utilizing these water bodies is drawing the water from the lakes and using it to support land based aquaculture in tanks and raceways. These lakes are surrounded by extensive wetlands running along the shores. Water from land based aquaculture facilities can be treated and discharged into the wetland for natural filtration before entering the main lake. Water temperature in most of these lakes is in the mid 20s. Besides, the lakes along the Akagera River provide several suitable sites for tanks based culture along its course. One such site is the Karuruma area (02 º17'94.0"S 030 º26 º 91.0"E at 1334m above sea level) in Bugesera District. At this point, the Akagera River water is at surface and at a head that can allow gravity flow to the nearby fields where a large aquaculture facility can be established. Due to adequate rainfall in

Rwanda, rain harvesting supplemented by springs or municipal water in peri-urban and urban areas can support tank based aquaculture production using water reuse systems.

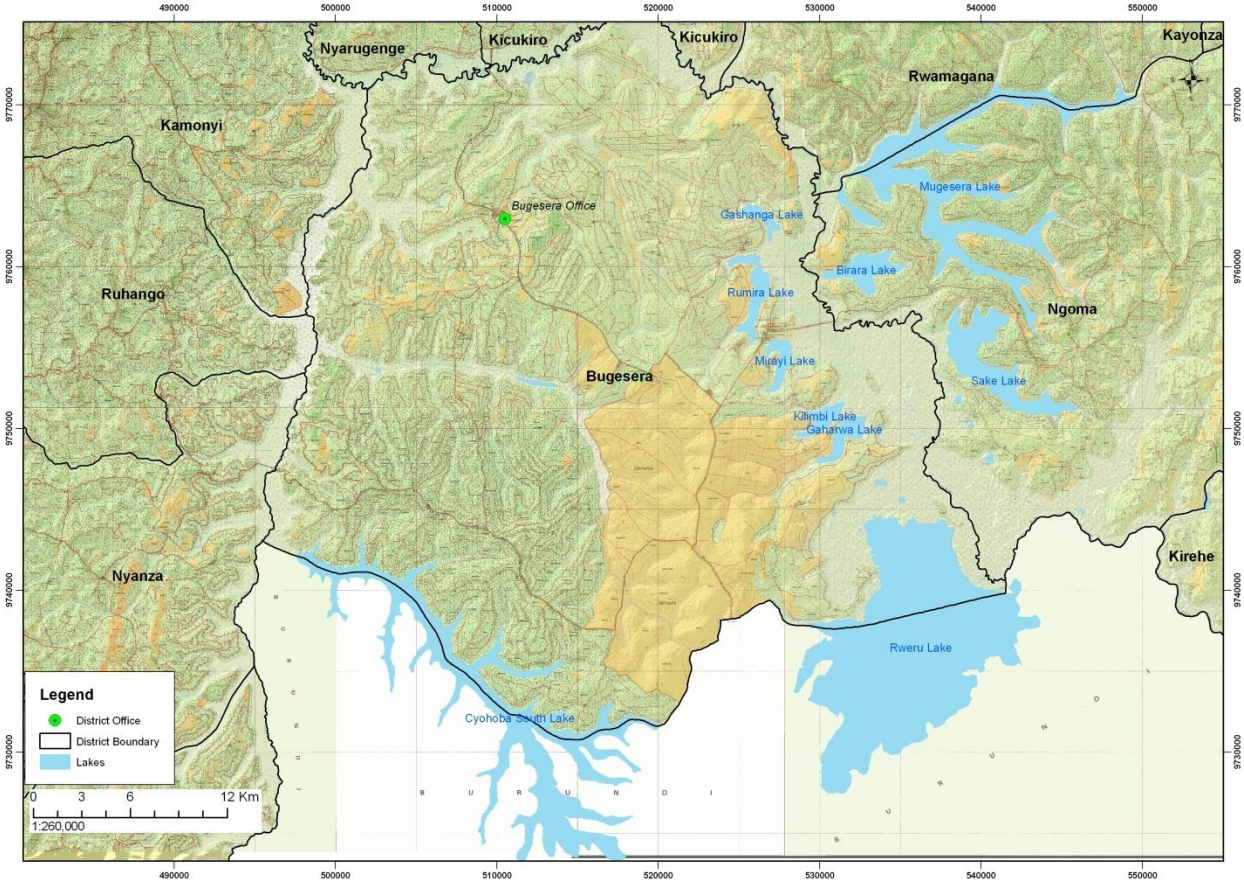


**Figure 10:** *Lakes of Bugesera and Ngoma Districts can support Land Based Tank/Raceways Fish Culture*

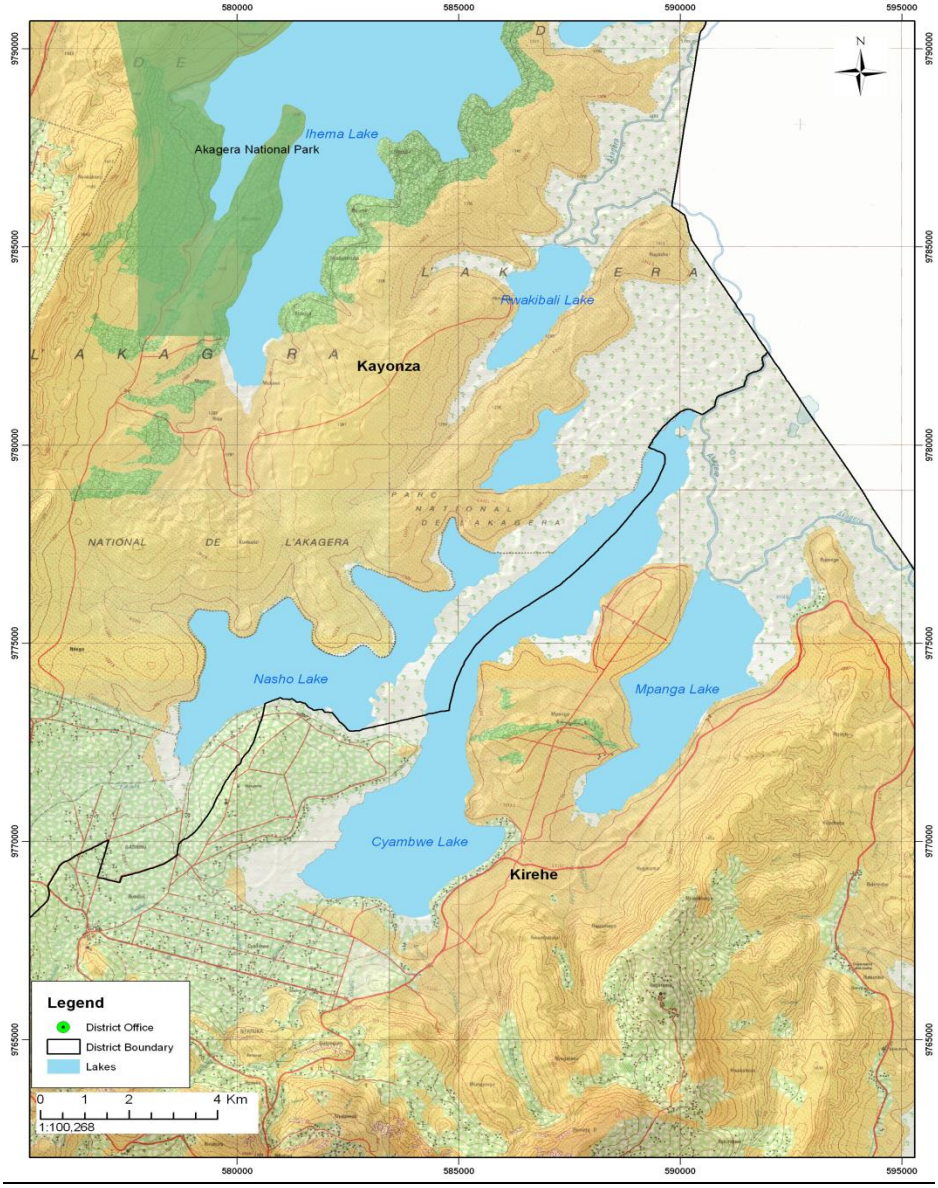


**Figure 10:** *The Nasho Basin Lakes in Kirehe and Kayonza Districts can Support Land Based Tanks/Raceways Fish Culture Systems*

### *1.6.3 Aquaculture Parks*

Aquaculture parks are concentrations of fish production units in suitable watersheds that are well supplied with water; with appropriate environmental conditions for culture of the target species in terms of temperature, soil types, and terrain/topography. Aquaculture parks are planned akin to the industrial parks concept. Fish farms in an aquaculture park which can be ponds, tanks, raceways, pens, cages are owned individually with a common management approach and leadership. An aquaculture park concentrates fish farmers in one area making it easy to access

utilities, credit and advisory services so as to take advantage of the economies of scale. Production from aquaculture parks is planned according to market demands through phased out harvest throughout the year. Aquaculture parks concept can work to transform small holder subsistence farmers into profitable aquaculture enterprises. In this system, traditional practices such as integration of fish with other farming practises can be undertaken although the focus should be feed based aquaculture. Sites such as: Nyagisenyi, Mushishito, Rufuha, Masizi around Muhura stream and around Rukarara River in Nyamagabe district have potential for aquaculture parks. Others sites suitable for aquaculture parks were found in Gakenke, Bugarama in Rusizi, several areas along the main river catchments and the Bugesera and Gisaka lakes. The Karuruma area in Bugesera along the Akagera already mentioned above is particularly suitable for aquaculture parks.

### *1.6.4 Capture Fisheries*

Currently Rwanda's water bodies produce an estimated 9,050 mt per year. The fisheries sub-sector contributed 0.33% to the Gross Domestic Product (GDP) in 2009. Rwanda is experiencing declining fish stocks amidst increased fishing pressure, growing fishing malpractices, and increasingly costly fisheries management demands. Lack of a central fisheries management agency and limited private sector investment has led to severe destruction of the resource to levels which are less than 10% of the estimated production potential.

There are 24 lakes including three shared lakes; Lake Kivu with DRC and Lakes Cyohoha and Rweru with Burundi. Forty species are reported in Rwandan waters of which only four; *Limnothrissa miodon* (locally called Isambaza), the Nile tilapia *Oreochromis niloticus*, the African catfish, *Clarias gariepinus*, and *Haplochromis sp* are of economic importance. All the Rwanda lakes apart from those within the National Parks have been subjected to fishing malpractices for a long time including use of under size mesh nets, striking of water surface (typhooning), use of chemical attractants, poison fishing, and beach seining. Prolonged use of illegal gears that is unregulated and unreported for several years has now reached a level where the fisheries have collapsed. The lakes' environment including fisheries resource base are not regularly monitored and researched to provide technical data on which management can base to make decisions. For example, there is paucity of data on limnology of several lakes, stocks and

ichthyologic information. In absence of such data, it is difficult to recommend sustainable levels of exploitation. For instance, it was reported that *Rastrineobola argentea* (indagala) was introduced into Lake Burera and has since become established. In spite of this, the country still imports the same fish for use as fish meal. In absence of stock assessment data, it cannot be ascertained whether the deficit is due to inadequate stocks or poor fishing technology. There have also been fish introductions in Lake Kivu starting with *L. miodon* in 1959 and most recently with *Lamprichthys tanganicanus* (locally known as *Rwanda rushya*). The continued introductions of new species of fish seems not to follow well detailed studies as required and provided for in the Convention on Biodiversity (CBD) and FAO Code of Conduct for Responsible Fisheries (CRF).

Given the high level of fish stock depletion in all the lakes in Rwanda and introductions, there is need to review the BCEOM report and implement more realistic measures including shifting from open access to concessionary fishing. Some of the stock deficient lakes are more or less large ponds that should be managed in that perspective. There is need to halt the collapse and restore the natural fisheries productivity to sustainable levels. The current exploitation levels and fisheries management system is unsustainable. Continued fishing as it has been in the past will in the near future lead to total collapse of the natural fisheries production.

Capture fisheries has dwindled at a time when demand from the increasing human population is rising. It is widely accepted that it will be difficult to increase fish production much above its current level based only on improvement in management of capture fisheries in Rwanda. Like elsewhere, the solution lies in the country adopting aquaculture as means for production of fish, this though not as a livelihood measure as was the case throughout Africa at introduction of aquaculture in 1950s, but as enterprise based on doing aquaculture as business.

## 1.7 Inputs, Processing and Marketing

### *1.7.1 Inputs Supply*

It has been established that the critical factors of aquaculture are mainly: seed, feed, technology, capital and market. Currently, Rwanda's capacity to produce seed is limited while the rest of the above factors have not yet been addressed. Seed and feed are imported from neighbouring

countries while technology remains a glaring gap. It was noted that there are no established input suppliers on the local market and the few emerging commercial fish farmers have to source all the inputs from outside the country. Unavailability of inputs makes aquaculture unattractive for investments. Such a situation typifies a budding aquaculture industry and calls for public intervention to facilitate emergence of strong private sector input supply businesses.

### *1.7.2 Fishery Products, Processing and Marketing*

Modern and appropriate fish processing and product development is not yet visible in Rwanda. The only fish processing methods in use are traditional smoking and sun drying on lake beaches. Small scale smoking was mainly practiced on the Nasho basin lakes while sun drying of *L. miodon* was observed on Lake Kivu. The low level of fish processing and products development could be attributed to the artisanal nature of the fisheries and lack of fish to process. The small amount of fish caught on the lake is all sold right at the lake side with nothing is left to sell in urban centres. In Kibuye, there was competition between Projet peché (Private Fish Trading and Processing Company) and fish traders. The fishers through their cooperatives preferred to sell to other buyers other than Projet Peché due to lower prices offered by the Project. It was found that the small quantities of Isamabaza (*L. miodon*) landed in Cyangungu were weighed and immediately bought by small traders who packed them in basins (Figure 13) and carried to sale in Bukavu across the border in DRC. The same scenario prevailed in Gisenyi where most of the fish caught on the Rwanda side is sold in Goma. This kind of undefined marketing can be a loophole for loss of revenue if there were substantial quantities of fish. But it is also an indication of availability of a regional market for fish.

**Figure 11:** *Packaging and Marketing of Isambaza from Lake Kivu*

A market value chain analysis in Kimironko and other markets in Kigali indicated high prices of fish. Prices of fish have been on the increase in Rwanda (Table 4) and the trend is unlikely to reverse given the fast increasing demand.

**Table 4:** *Price (RWF/kg) of fish in 1991 and 2011*

| **Species** | **1991** | **2011** |
|---|---|---|
| Fresh Tilapia | 110 | 2000 |
| Tilapia fillet | - | 4500 |
| Fresh African catfish | 80 | 1500 |
| Nile perch fillet***** | - | 3500 |
| Immature Nile perch***** | - | 2000 |
| Isambaza | 80 | 2100 |
| Ndagala (dried) | 120 | 100 |

*From Uganda and Tanzania

One of the most significant constraints is the high level of post harvest losses. Post harvest losses as a result of poor handling and lack of cold chain implementation in the industry have been reported to be as high as 20% from the primary producer to retail outlets. There is no well established cold chain system for transporting fish from the country's lakes to the markets. The few traders who manage to get fish from the lakes transport it without ice and arrive when the fish is at varying levels of deterioration. Imported fish however has established cold chain system which enables transportation of the frozen fish to all the major urban centers in the country. Lack of the cold chain system for local fish could again be attributed to very small quantities of landed fish that do not justify investment in the cold chain infrastructure.

## 1.8 Institutional and Organizational Capacity

### *1.8.1 Administration and Regulation*

Management and implementation of fisheries policies and aquaculture is a mandate of Rwanda Animal Resources Development Authority (RARDA) which is one of the agencies of the Ministry of Agriculture and Animal Resources (MINAGRI). Under RARDA, the Fisheries and Aquaculture section is headed by a desk officer at a level of a technician who is the only fisheries staff in RARDA. Prior to the formation of RARDA, Fisheries and Aquaculture was under the Department of Animal Husbandry which also included Animal Production, Veterinary Services, and Fisheries and Aquaculture divisions. This structure was reduced to a desk and transferred to RARDA in 2006.

At local government level, Fisheries and Aquaculture is the responsibility of the Veterinary or Agricultural Officers. The District Veterinary Officer is in charge of livestock activities, including extension work and implementation of the Fishery and Aquaculture policy. The only fisheries officers at the local level are the 11 staff of PAIGELAC. There is a conspicuously weak administrative structure for Fisheries and Aquaculture. The sector is managed by staff whose training is not directly related to fisheries discipline. As a result of the obscure Fisheries and Aquaculture structure with no Chief Fisheries Officer, Rwanda is not represented at FAO fora such as the CIFAA, COFI and others. As such, serious decisions that collectively bind Rwanda as a member of the United Nations are taken in her absence.

### *1.8.2 Research Institution*

Aquaculture is a relatively new agricultural practice compared to crop and livestock husbandry. It remains unfamiliar to several stakeholders including advisory service providers. In many aspects, aquaculture is a technology-driven sector that requires farmer responsive research. Presently, there are no institutions mandated to undertake Fisheries and Aquaculture research and training in Rwanda. Limited research aspects of Fisheries and Aquaculture are undertaken by the National University of Rwanda (NUR) at Butare. NUR has one of the well maintained aquaculture research stations at Rwasave used for training and teaching aquaculture. The station covers an area of 20 hectares with a hatchery and several ponds. Agriculture research in the country is under the Institut Superieur Agronomique du Rwanda (ISAR) which undertakes research in crops and livestock. ISAR is however not responsible for fisheries and aquaculture research and does not have any structure and function for that purpose in spite of the fact that its station in Bugesera extends to lake shores.

Absence of research institutional capacity underlies the paucity of information on the water quality environment, ecology, fish stocks, reproductive and fish ecology, fish migrations, gear technology, aquaculture technologies such as induced spawning, feeding, genetics and selective breeding, production systems design, post harvest processing, value addition, product development, socio economics and others. Currently, most of the available information is from research components of some of the projects above that were undertaken by foreign experts with assistance from local team members over very limited periods. There is need for well planned research, focussed on addressing national challenges in Fisheries and Aquaculture.

### *1.8.3 Training*

Currently, there is no institution offering professional training in the domain of aquaculture and fisheries in Rwanda. However, some colleges and NUR offer some aspects of aquaculture and fisheries as modules or course units. On the whole however, training in Fisheries and Aquaculture is weak and does not produce manpower that is responsive to the changing needs of stakeholders in the sub sector. The limited training offered by some tertiary institutions produces half baked manpower which compounds the technology question through wrong advice to the resource managers, fishers and farmers. The shortage of trained staff in aquaculture and fisheries

is evident at districts and lower levels where the sector is a responsibility of professionals of other disciplines.

### *1.8.4 Advisory Services*

The fisheries desk officer at RARDA is responsible for advisory services in Aquaculture and fisheries in the whole country. Presently, PAIGELAC project offers technical support to a number of cooperatives and fishers. The capacity for both RARDA and PAIGELAC to offer advisory services to the stakeholders is limited by manpower, logistical support, skill and infrastructure. There are a few private consultants but they are also unable to meet demand from increasing numbers of people interested in fish farming. While building capacity to deliver advisory services, there will be need to consider establishing regulatory mechanisms so that farmers are protected from quacks and inexperienced service providers.

### *1.8.5 Policy and Legal Framework*

Development of Fisheries and Aquaculture in Rwanda is guided by the Fishery and Aquaculture Development Policy. The goals of this Policy are to:

i. Contribute to the food security of the communities.
ii. Contribute to poverty reduction through increased incomes of rural dwellers.
iii. Contribute to aquatic environmental protection.

The policy addresses technical and institutional guidelines for management and development of aquaculture and fisheries sectors. At the technical level, the policy spells out:

- Increasing productivity of fishing environments through the formulation and implementation of integrated development plans for water bodies and their catchment areas.
- Intensifying aquaculture production through the use of high yield aquaculture techniques.

At the institutional level, it highlights:

- Building national capacities in technical supervision, extension and research.
- Reforming the regulatory framework in order to encourage private investment in fishery and aquaculture.
- Promoting rural credit in the sub-sector.

- Improving marketing of fish products.

The policy forms the basis for the new law that regulates management and development of aquaculture and fisheries in Rwanda.

**Legal Instrument**

The Rwandan fisheries legal framework of the 1937 and 1950s relating to Game and Fishing was repealed and replaced by Law No. 58/2008 of 10/09/2008 determining the organisation and management of Aquaculture and Fisheries in Rwanda. The new legislation covers various aspects of the industry such as: restrictions in fishing, introduction of aquatic species, aquaculture practices, and grounds for refusal of an aquaculture concession, protection of aquatic organisms, fishing licenses, hygiene and quality of aquaculture and fishery products. The new law provides for acquisition of aquaculture concessions in natural water bodies which is vital for transformation of aquaculture and fisheries industry.

## 1.9 Summary of Constraints to Development of Fisheries and Aquaculture Sector in Rwanda

The study identified a number of constraints to the development of the sector in Rwanda. These include:

- Lack of a fish eating tradition that did not consider fish as a high value commodity.
- Poor regulatory framework of the fishing effort and fishing methods.
- Uncoordinated and unfocussed development projects leading to unsustainable outputs.
- Environmental pollution of water systems by excessive erosion of farmlands.
- Almost total depletion of natural fish stocks through overfishing.
- Fishing cooperatives that are geared towards harvesting with no inputs into the fisheries.
- Lack of private sector investments in the sub-sector.
- Lack of interest in fisheries and aquaculture at the district level hence low rating of the sector. There is very little local leadership support to fisheries and aquaculture development in almost all the districts.
- Lack of institutions for management of research and advisory services.
- There is no reliable data on the size of the fish stocks to guide management decisions.

- There are species introduction without adequate studies in contravention to CBD and FAO code for responsible fisheries.
- Lack of clear sector leadership and representation at national, regional bodies and international fora such as the CIFAA of FAO.
- Poor linkage of aquaculture and other agriculture production systems.
- Insufficient human resource to steer the sector.
- Significant high post harvest losses of the little fish harvested from the lakes.
- Lack of aquaculture technologies and innovations.
- Insufficient advisory services.
- Lack of fisheries and aquaculture inputs including seed, feed, gear, equipments and others on the local market.

# Chapter 2

## The Master Plan for Development of Fisheries and Aquaculture in Rwanda 2011 – 2020

### 2.1 Preamble

The development of the Master Plan entailed review of the situation regarding Fisheries and Aquaculture taking into account historical perspective, current management, and the different cross cutting policies. It involved evaluation of past efforts and interventions in Fisheries and Aquaculture sectors, and presentation of best options for moving the country towards self reliance and sustainable development in terms of fisheries and aquaculture production. Specifics of proposed interventions have been presented including cost estimates and any environmental or legal and policy issues associated with the transformation of the fisheries and aquaculture sector in Rwanda.

The plan is based on the analysis of the resources base, historical developments in the fisheries sector, the current operational environment framework within the country and the region. The operation environment hereby refers to factors that are not within the realms to the sector but influence its performance. These include, cross cutting policies, economic strategies, market dynamics as well geopolitical developments. The master plan calls for concerted actions along a well thought out pathway that will lead Rwanda from fish insufficiency to fish surplus. The driver is the conviction by Rwandans that it can be done and the determination to do it.

### 2.2 The guiding principle

The Master Plan draws from NEPAD Action Plan for African Fisheries and Aquaculture (NEPAD 2005) which anticipates substantial growth in sustainable production from aquaculture. For inland fisheries, the Action Plan emphasizes; promoting enterprise development through enabling institutions and policy frameworks, strengthening consideration of inland fisheries in national and regional policies and actions on food security and improving market access, particularly for small-scale producers, processors and traders. The NEPAD Action Plan calls for urgent need to develop guidelines and policies that create conducive aquaculture investment

climate while providing safeguards against environmental and social risks. It further outlines the following investment areas:

- Developing sector-wide strategies at national level for expansion and intensification of aquaculture.
- Supporting priority Aquaculture Zones which in this Master plan are the aquaculture parks.
- Encouraging private sector investment across the sector.
- Applying proven technologies to increase production.
- Maintaining the competitive advantage for aquaculture production.
- Supporting the emerging regional trade in aquaculture products.
- Harnessing the opportunity of expanding export markets for high-value products to increase investment in African Aquaculture Production and Processing.
- Exploiting the potential of Aquaculture Production to contribute to food security programs

It was noted that the investment areas described for development for Africa's Fisheries and Aquaculture are in congruency with the Rwanda Vision 2020 on which this Master plan is based.

The Master Plan delineates the specific roles and responsibilities of the private and public sectors. All these issues are addressed within the context of prevailing macro and micro-economic, social and cultural conditions involving a wide range of partners in the public and private sectors. The Master Plan is in line with region-wide efforts to adopt similar approaches to the development of the sub-sector as articulated by the Aquaculture Network for Africa (ANAF) and the FAO Special Programme for Aquaculture Development in Africa (SPADA).

The aspirations of Rwandans and the development trajectory are clearly defined in the Vision 2020 and the Economic Development and Poverty Reduction Strategy (EDPRS) 2008 – 2012. Both the Vision 2020 and the EDPRS 2008 – 2012 point to transformation of agriculture from subsistence into a productive high value, market oriented sector. These will be realized through; intensification of sustainable production systems, building the technical and organizational

capacity of farmers, promoting commodity chains and agribusiness, and strengthening the institutional framework of the sector at central and local level. Central to this transformation is the emergence of a vibrant private sector. One of the pillars identified in Vision 2020 is development of an efficient private sector spearheaded by competitiveness and entrepreneurship while EDPRS 2008 – 2012 calls for heavy investment in "hard infrastructure" by the GoR to create strong incentives for the private sector to increase its investment rate. The contribution of the Aquaculture and Fisheries sector to the envisaged national goals are described in the National Fishery and Aquaculture Development policy as:

- Contribute to the food security of the communities.
- Contribute to poverty reduction through increased incomes of rural dwellers.
- Contribute to aquatic environmental protection.
- Increasing productivity of fishing environments.
- Intensifying aquaculture production through the use of high yield aquaculture techniques.
- Building national capacities in technical supervision, extension and research.
- Reforming the regulatory framework in order to encourage private investment in fishery and aquaculture.
- Promoting rural credit in the sub-sector; and
- Improving marketing of fish products.

In order to achieve the above, the master plan is guided by three main themes namely:

i) Developing knowledge based aquaculture and fisheries systems.
ii) Creating institutional capacity to manage and develop fisheries resources in Rwanda.
iii) Creating enabling environment for the private sector to play their role in increased fish production.

**Vision for the Plan** is in accordance with Vision 2020 which advocates for transformation of agriculture into a productive, high value and market oriented sector with forward linkages to other sectors. The vision is thus to create a vibrant, market oriented and private sector led

Fisheries and Aquaculture sector that meets the country's animal nutritional security and contributes to the equitable development of the country.

**Mission**

Fisheries and Aquaculture sector contributing at least 10% to the Agricultural GDP and meeting 40% to household animal protein intake.

**Purpose of the Plan**: To identify high priority options for strategic investment in Fisheries and Aquaculture and to lay out a realistic and achievable targets.

**Goals**

- To establish profitable and competitive aquaculture industry in Rwanda.
- To revamp and restore the productivity and production capacity of natural fisheries resources.
- Eliminate fisheries trade deficit and initiate exports of Rwanda aquaculture products.
- Enhance job creation, food and nutritional security as well as contribute to economic growth.
- Ensure sustainability and compatibility with the environment.
- Provide Rwanda consumers with domestically produced, high quality, safe, competitively priced, and nutritious aquaculture products.

*The objectives of the Master plan are:*

- Developing institutional capacity.

The Aquaculture and Fisheries institutional capacity in Rwanda is currently too undefined and mixed up. There is need to create institutional capacity in the following areas: i) Management and Regulation; ii) Research, technological development and innovations; iii)Training; iv) Advisory services.

- Building a private sector driven Aquaculture and Fisheries industry.

In order for Aquaculture and Fisheries to transform into a vibrant industry of major significance to the national economy, the private sector has to play a central role. The Master Plan therefore

seeks to: i) Facilitate emergence of a strong private sector; and ii) Create linkages between the public and private sector.

- Creating knowledge based Aquaculture and Fisheries industry.

Although Rwanda is endowed with abundant water resources and relatively favourable climate for fisheries, the water bodies have been depleted of the natural fish stocks and aquaculture in the country is not yet developed to utilize this resource to meet the national fish demand. The Master Plan prescribes the roadmap and mechanisms required to tap into this natural potential and exploit it for Fisheries and Aquaculture development through:

a) Presentation of knowledge-based Fisheries and Aquaculture development and management options.
b) Description and design of requisite management and fish production technological infrastructure.
c) Identification and elaboration of the existing policy options and strategies necessary for fisheries and aquaculture development.
d) Maintenance of aquatic environmental health.

*Expected outcomes*

- Rwanda is self reliant in fish production and exporting.
- Increased fish contribution to the agricultural and national GDP.
- Increased income and food nutrition security amongst aquaculture producers and the population.
- Increased public investments in strategic areas in the sub-sector.
- Improved adherence to quality standards in the sub-sector.
- Improved relationship between the public and private sector stakeholders.

## 2.3 Productions and Targets

**(What is the current status and what level should be achieved by 2020?)**

Rwanda produced 13,088mt of fish in 2007 of which the contribution from capture Fisheries and Aquaculture was 9,050mt and 4,038mt respectively (Mwanja et al. 2011). According to the Vision 2020, Rwanda's human population is estimated to reach 16 million by 2020. Rwanda should strive to attain Sub Sahara per capita fish supply of 6.6 kg by 2017 and thereafter build

capacity for export. In order to attain Sub Sahara fish consumption level, Rwanda will have to produce 112,000 tons per annum; an 8.5 fold increase of the current production. Whereas this seems astronomical, it can be achieved with logical and guided private and public sector investment given the vast natural potential and prevailing socioeconomic policy environment.

Several countries that have taken note of the global fish demand and focussed their resources to development of aquaculture have achieved tremendous results and Rwanda can make it as well. In Africa, a good example is Egypt, where aquaculture production increased from 29,244 tons in 1984 to 471,535 tons in 2004 representing 25% and 54.5% of total annual fish production respectively. The target is 1.7 million tons of fish by 2017 with 1.0 million tons coming from aquaculture. It is clear from this that aquaculture production alone in Egypt surpasses by far the total fish production (both capture fisheries and aquaculture) from any of the East African Countries in spite of the endowment with plentiful water resources in East Africa. Given the case of Egypt, it is not impossible for Rwanda to produce 200,000 tons of fish by 2017 if this Master Plan is implemented. *How will it be achieved*?

## 2.4 Need for paradigm shift

In order to realise the above targets, there is need for appreciation that it can be done by all players along the value chain. It therefore calls for a paradigm shift in fish production steered by well elaborated policy options through a National Fisheries and Aquaculture Strategy as well as a Fisheries and Aquaculture Plan. A critical review of aquaculture in Rwanda will reveal that it was introduced as a subsistence earthen pond backyard activity with no economic aspirations. Government and donor funds were expended to start up fish farmers who were supported with extension services, seed, feed, and other handouts. This approach provided a weak foundation and a dependency syndrome that could not support sustainable fish farming as profit driven enterprise. Stemming from the subsistence conceptual framework under which aquaculture was introduced in Rwanda, the sub sector is still characterised by small scale earthen ponds with farmers scattered over the country. Of recent however, there have been a few private sector initiatives and attempts at investment in commercial fish farming.

Commercial producers can be small, medium or large-scale, but with active participation in the market. Commercially oriented farmers purchase inputs (including capital and labour) and engage in off-farm sales of the fish produced. For these investors, aquaculture is a principal economic activity. Non-commercial producers may also purchase inputs, mainly seed and feed, but rely chiefly on family labour and on-farm sales of the produce. In brief, commercial aquaculture can be defined as the farming of aquatic organisms, with the goal of maximizing profits. Thus, the distinction between commercial and non-commercial aquaculture operations relies primarily on the existence or absence of a business orientation and on how factors of production will be paid. Small scale producers should not be equated to subsistence farmers as the former can make profit no matter the size of the business. In breaking with the past as alluded to in EDPRS 2008 - 2012, there will be an effort to move away from state sponsored farmers to facilitation of the real private sector's bid to transform fisheries and aquaculture into a lucrative industry. This will be done along the identified themes:

# Chapter 3

## Thematic Area One

## Proposed Production Systems, Sport Fishing, Inputs, Markets and Product Development

### 3.1 Developing Knowledge Based Aquaculture and Fisheries Systems

Rwanda's aquatic resource base is potentially sufficient to support production of fish and other aquatic products for national consumption and export. This will however only be possible if the sector is transformed from subsistence low input-low output aquaculture and artisanal fishing to knowledge and technology driven systems. In this respect, a quick scan of the aquatic resources base has been made and the following production options recommended based on the identified potentials and the requisite inputs.

#### *3.1.1 Cage Production Systems*

The cage system (Figure 14) will be practiced in the bays of Lakes: Kivu, Burera, Ruhondo, valley dams and ibidendezi. The conservative estimate of the section of the surface area of a lake that can be used for cage culture is 2%. The Rwanda part of Lake Kivu is 1,000 $km^2$ or 100,000 ha, therefore 2% of which is 2,000 ha. Assuming a low production of 500 tons/ha, the total production from this lake alone would be 1,000,000 tons of fish. Lake Burera's surface area is 3,500 ha. The projected production from this lake is 35,000 tons from only 70 ha. Lake Ruhondo is 2,800 ha with allowable cage area of 56 ha and projected production from cage culture of 28,000 tons. The total production from the three deep lakes would be 1,063,000 tons at a low stocking density of 50 $kg/m^3$. Note that the average stocking density of LVHD cages in use currently is 150 $kg/m^3$.

Rwanda has over 15 dams with a surface area of 636,650 $m^2$ and cage area of 13,000 $m^2$. At a ratio of 1:50, the estimated fish production from cage culture in these dams at 150 $Kgm^{-3}$ would be 487.5 metric tons.

**Figure 12:** *Cages Culture and Harvesting in East Africa*

**Estimated production from cages**

Cage culture will adopt the system of lake based parks. Suitable bays will be identified and selected for cage culture. Low Density High Volume Cages of 8 $m^3$ i.e. with dimensions of each section (2X2X2) metres will be used. At a stocking density of 150 $Kg/m^3$, each cage is expected to produce 1.2 tons of fish. A conservative estimate of 1 ton per cage is used. The smallest unit of production for each park is 10 cages. Ownership of less than 10 cages will not be allowed in the park. Each park will be comprised of a maximum number of 500 members. In cases where a member owns more than one unit of 10 cages, membership of the park will be less than 500. Total production from the park will therefore be: 500 x 10 = 5,000 tones with a total area of cage surface being 4 x 5,000 = 20 ha. Total area of a lake based aquaculture park should at least be 40 ha on the lake to cater for spacing and rafts. In addition, there should be adjoining land to accommodate parks buildings and other infrastructure.

*Lake Based Cage Aquaculture Parks will be established as follows*:

Lake Kivu: Each of the 5 districts (i.e. Rusizi, Nyamasheke, Karongi, Rutsiro and Rubavu) should have a minimum of 5 lake based cage parks by 2017 = 25 parks

Lake Burera = 02 parks

Lake Ruhondo = 01 park

Total Lake Based Aquaculture Parks will be 28 with an estimated production of 5,000 tons each = 140,000 metric tons.

**How will cage culture be developed in Rwanda?**

In order to develop cage culture in Rwanda, the following activities are proposed.

i. Creating awareness on cage culture as a viable fish production system. This will be achieved through:
    a) Demonstration of the technology as has already started on Lake Ruhondo.
    b) Hands-on training for potential investors and farm managers.
    c) Production and distribution of leaflets in Kinyarwanda on cage culture.
    d) Demonstration of cage culture profitability based on data collected from the region given that inputs that will be used will be more or less the same.
ii. Detailed characterization of all potential sites within the above potential areas in terms of; physical characteristics, limnology and related seasonal influences, accessibility to utilities for value addition and markets.
iii. Putting in place cage investment support packages to investors including: shared grants, technological support, availability of a cold chain system and access to markets
iv. Support of input supply business to enable pioneer investors access essential inputs such as: feed, cage nets and accessories, life jackets, boats /dinghies and others.

The above will be undertaken within the broader framework of sectoral transformation which will include other components.

### *3.1.2 Tanks Based Aquaculture.*

Tank based aquaculture makes substantial contribution to the national fish catch as has been the case with the African Catfish in Nigeria. A tank based unit (Figure 15) with dimensions of each

section (30x10x1) metres at a stocking density of 50 Kg/$m^3$ and a turnover rate of Two (2) Productions per year can reach 30 tons of fish annually. This estimate is on the lower side given that catfish tanks in Nigeria can hold as high as 360 Kg/$m^3$. With the suitable sites in Rwanda, 100 farms can be established if the other factors required to set up a commercial fish farm such as access to affordable credit are addressed. Assuming 100 farmers in Rwanda with an average of 3 units, total fish production can be 30X3X100 = 9,000 tons annually.

**Figure 13:** *Simple Tank Based Facilities*

**Starting tank/raceways based aquaculture in Rwanda**

Tank culture of fish is a fast growing branch of aquaculture with several servicing disciplines such as; engineering, chemistry, economics, environmental management and others. Fish production in tanks is a move towards intensification and will therefore need some level of investments in technology and management. Central to successful production in this system is water quality management which is closely related to quality feeding and water treatment. In

order to kick-start this type of production in Rwanda where most of the basic inputs and technology are currently non-existent, it will be necessary to create a technology uptake pathway that is modeled on public-private partnerships. The following strategic interventions are therefore proposed.

i. Acquisition of Technical Assistance (TA) on tanks and raceways to provide advisory services to pioneer investors in the system.
ii. Setting up a tank based production unit in each province of the country.
iii. Setting a pilot raceways project around the shallow lakes of Bugesera and Gisaka.
iv. Demonstrating production of fish in tanks; starting with the two common species of Tilapia and African catfish.
v. Computing and availing productivity and profitability data of the system to the private sector.
vi. Promoting tank based aquaculture and emphasizing the point that it can be done in many places with clean water including urban and peri-urban centers.
vii. Accessibility to investment support incentives.

### *3.1.3 Aquaculture Parks*

The aquaculture park system can be a model for transformation of small scale subsistence fish farms that are scattered all over the country into commercial units which collectively make substantial fish production. For example, an aquaculture park consisting of up to 150 commercial fish farming units each is envisaged to be established alongside or in close vicinity of each of the 17 existing aquaculture stations in the country within the first five years at sites with adequate water utility supply. Each interested farmer or household can own at least one production unit, and farmers can associate as a group and manage corresponding number of units as a group. The idea is to effectively transform the majority of existing fish farmers who are largely rural and remote into viable commercial production entities that are easy to service and attract the required market for the produced fish. Bringing smallholder fish farmers under viable spatial production units shall also serve to attract entrepreneurs into the aquaculture inputs production/supply industry. The systems of production will be dependent on the suitability as described above.

Government and development partners shall support the construction and establishment of the production units and rent them out to individual producers at a nominal fee. The aquaculture

parks shall also attract good technical service providers and reduce operation costs for extension and guidance to farmers. The linkage to markets shall allow farmers to get the required inputs on credit linked to the marketing of the produced fish. As an illustration, if on average each aquaculture park has 100 ponds of 1000 $m^2$ each stocked at 5 $Kg/m^3$, production for each park would be 500 tons. For 17 such parks in the country, total production would be 8,500 tons.

It can be deciphered from the above estimations that aquaculture has a potential to generate the required fish and a wide range of benefits such as: employment, food and income. However, it is a pre requisite that Government of Rwanda puts in place mechanisms for sustainable aquaculture development. Whilst aquaculture in Rwanda has significant strengths and opportunities (e.g. good sites for aquaculture development with adequate water resources, high fish prices, expanding markets for fish regionally), it also has some challenges and faces some threats including: lack of supportive institutional capacity, limited access to quality and appropriate technologies; limited access to credit; barriers to trade of farmed fish, rising costs of external imports, access to quality and affordable inputs for production. A sustainable aquaculture industry in Africa's non-traditional fish farming areas, including Rwanda, has to include the systematic development of skills for research, and advisory service. The private sector as the major force for investment in aquaculture requires innovations that are generated from research.

**Kick starting aquaculture parks in Rwanda**

The notion of aquaculture parks is new in most of Africa but has proved effective in Asian countries. The concept is aimed at organizing rural aquaculture production to overcome the inherent technical and economic limitations of smallholder rural aquaculture. Aquaculture is currently characterised by small holder farmers scattered all over the country producing barely enough to feed on. They do not have ready access to technology and capital while there is no organised market into which to feed. It is for this reason that aquaculture is ranked low as its contribution to the GDP is too small to be determined. The aquaculture park concept is meant to turn around the situation by having clusters of farmers in a given geographical location operating at a small to medium scale but collectively attaining a critical mass of production and tapping into an organised market. Being a new concept, it will be important to explain the aquaculture park to various important stakeholders including: the farmers, local and central leaders,

government officials and development partners with an aim of buy in. A general acceptance by stakeholders will pave way for the following activities:

i. Marking out river catchments or lake area where the park can be established.
ii. Explaining the concept to the local communities.
iii. Physical planning of the area to permit organised production.
iv. Developing infrastructure (roads, canals, farm enclosures, holding facilities, cold chain, and value addition) and extending utilities.
v. Developing a management plan for each park zone.
vi. Tendering for the farm units to private sector /farmers at a modest fee.
vii. Establishing a national unit with machinery and equipment to excavate ponds and reservoirs.
viii. Supporting investors within the framework of sector-wide incentives to attract private sector investments.

### *3.1.4 Ornamental Fish Rearing*

Rwanda is endowed with various *Haplochromine* species and the newly introduced Rwanda *rushya* which display various colour shades in an impressively beautiful pattern can be explored for ornamental culture. Keeping of fish for pleasure will become increasingly important as more and more Rwandans join the middle class. It is therefore important that technologies to harness this suitable fish stocks are adopted and the private sector attracted to the industry. The following interventions are proposed to start ornamental industry in Rwanda;

- Set a national fish aquarium not only for beauty but for education purposes as well.
- Undertake research to produce an inventory of fish species suitable for ornamental industry.
- Demonstrate ornamental fish culture.
- Provide support services to ornamental fish trade.

### *3.1.5 Development of Sustainable Capture Fisheries*

**a) Concession fishing**

Nearly all the fisheries in the country can be classified as commercially collapsed. The open access to fisheries resources, the use of illegal gears, and excessive fishing capacity have been

the major driving forces behind degradation of the fisheries resources base. With no central fisheries management agency, enforcement of law has been nearly absent with many rules and measures going obsolete. There is therefore need for a more cost effective regulatory framework under a new management dispensation. There is a need for immediate management measure to forestall biological collapse and to initiate cost effective approaches for restoration and revitalization of the production potential of these fisheries. As part of the commercialization drive, there will be need for adoption of a fish quality and safety management regime that can demonstrate not only the quality of their product, but also the sustainable management of their fish stocks.

Currently fisheries in Rwanda have been organized under cooperatives. There are a total of 113 cooperatives involved in fisheries directly or in related services. The catches from the lakes are however disappointing. The reality is that the fish stocks have been depleted and can longer support commercial fishery. Fishing has been done on lakes for decades without scientific guidance to sustainability of the harvests. There is no data on stock, size and important fish biology information as spawning patterns and length-at-50% sexual maturity which would guide in regulation of fishing effort and practices. However, fisheries of *Isambaza* and *Indagala* have not yet completely collapsed and can be restored with good fisheries management. Various reports have reported overfishing on Rwanda lakes for more than 20 years and recommended organization of farmers, closed season fishing and others.

The current state of capture fisheries in Rwanda again calls for a paradigm shift; breaking with the past and doing things anew. Of particular importance is to shift from open access and common resource principles to concessionaire fishing. This new management strategy is made possible by the law on organization and management of aquaculture and fishing in Rwanda 2008. Article 18-21 of the law provides for concession fishing and aquaculture. Concession fishing where an investor maintains a sustainable stock by harvesting what is scientifically acceptable should replace general public fishing whether individually or in cooperatives. The concessionaire will not only operate a profitable capture fisheries business but will also create jobs for fishers, handlers, processors as well as stimulate organized trade in fish and fish products. It may be possible for a concessionaire to engage in both capture fisheries and

aquaculture on the same water body. The overall impact should be improvement of living standards of the communities around the lakes which currently is characterized by very low catches and poverty (Figure 16).

**Figure 14:** *Fisher folks and craft on Lake Sake, Ngoma District*

The fisheries sector cannot be managed using the tools of the past if the country is to adopt and commit to sustainable fisheries that support strong commercial and recreational fishing sectors. However, there is need to moderate the requisite interventions in terms of cost. The financial cost of management to taxpayers can be defrayed by adoption of concessionary fisheries management and commercialization of the fishing activities which could be through organizing and retraining fisher folks or invitation of private investors.

Under the concession arrangement, the public sector shall still undertake research and inspection of the system to ensure that it complies with responsible fishing practices as stipulated in the FAO code of practice. Research on stock assessment, limnology and ichthyology, monitoring of the resource and socioeconomic studies will remain a mandate of the GoR. For the lakes in Bugesera, Gisaka and Nasho basin which are shallow, the concessionaire may consider ranching as an option for sustainable fish production. The current fishing cooperatives should be encouraged to bid for concession on the lakes where they operate without precluding individual investors. Concessionaire management promotes alternative management measures which not only involves private sector but also attracts resources needed for development and commercialization of fisheries exploitation. Concessions should be made to communities,

individuals or firms in turn for private sector investment in the development and management of fisheries resources in the country. This will follow thorough stock assessment and restoration needs. Such concessions should include defining of user rights, ownership of resources, access and management of water bodies, and concessions for effective development and management of the fisheries resources in the lake. Estimate production from fish concession by 2020 is 70,000mt although the estimated potential from the currently fished lakes is 106,000mt.

**b) Fish species**

The main fish species caught in the lakes are the Isambaza (*Limnothrissa miodon*), Nile Tilapia (*Oreochromis niloticus*), Inkube or African Catfish (*Clarias gariepinus*) and *Haplochromis sp*. There is also an emerging fishery of Indagala (*Rastrineobola argentea*). Other species in Rwanda water bodies include: Common carp (*Cyprinus carpio*), Mamba (*Protopterus aethiopicus*), Ningu (*Labeo victorianus*), *Schlibe mystus*, Nkolongo (*Synodontis sp*) *Lamprichthys tanganicanus* "Msiha (Swahili), *Rwanda rushya* (Kinyarwanda)*"* etc. Of these, only the Nile Tilapia and the African Catfish are cultured. Although the widely cultured common carp was introduced in Rwanda presumably for aquaculture, it only exists in wild stocks in the rivers and lakes of the Nasho basin. This array of indigenous fish species and those that have already adapted to the local conditions without detrimental effects provides a sound base for launching a vibrant aquaculture industry without importation of new species as proposed in the Vietnamese report. What constraints aquaculture in Rwanda is not lack of commercial species but other factors discussed in this Master Plan. Rwanda is a small country with a fragile aquatic ecosystem which should be protected from any changes that would upset it. Introductions should only be considered for species that are tolerant to cold waters such as the blue tilapia and trout whose biology is well known and no reported undesirable effects to ecosystems.

**The common carp** was introduced already in the lake and river systems in Rwanda with no registered negative impacts. In the neighboring Kisoro District of Uganda, Common Carp was introduced in the crater lakes where it supported artisanal fishery till its populations were depleted by overfishing without restocking. The common carp is therefore one of the species that should be multiplied to culture in pools, reservoirs and minor lakes after thorough Environmental Impact Assessment. The species ability to tolerate low temperatures makes it suitable for culture

in the cold mountainous areas of the country such as: Nyaruguru, Nyamagabe, Ngororero and Musanze. As a start up measure, Kigembe should start induced spawning and supply of common carp seed to farmers while the private sector is attracted to invest in its production.

**Trout** is the name given to fresh water and marine water fishes belonging to the family Salmonidae. The rainbow trout is a hardy fish that is easy to spawn; fast growing, tolerant to a wide range of environments and handling, and the large fry can be easily weaned on to an artificial diet (usually feeding on zooplankton). The species is capable of occupying many different habitats and growing in fresh water to attain a weight of 4.5 kg in 3 years. The species can withstand vast ranges of temperature variation (0-27°C), but spawning and growth occurs in a narrower range (9-14°C). The optimum water temperature for rainbow trout culture is below 21°C. Trout farming is practiced on the slopes of Mt. Kenya where temperatures are similar to those prevailing in the Birunga of Rwanda. In Kenya, the species has become quite important in terms of value with a kilogram costing US$ 4-16 depending on where it is sold. Trout fishing in Mountain Rivers is a popular sport that supports tourism industry. In India, trout hatcheries are located in areas that are at altitude of 2280 metres. Detailed investigations should be undertaken to identify specific areas within the high altitude ranges that are suitable of trout farming in Rwanda.

Detailed and precise site locations for the various fish production systems indicating multilevel utilization should be undertaken across the country to further guide initiation of development projects. This should be undertaken with full participation of the local authorities who should integrate fish production and water use in their development plans and targets (*imihigo*). It is projected that over 250,000 mt will be produced from the proposed systems (Table 5).

**Table 5:** *Summary of Projected Production*

| **Production System** | **Projected Yield (mt)** | **Value US$ (million)** |
|---|---|---|
| Cage | 140,000 | 420,000 |
| River Fed Aquaculture Parks | 8,500 | 25,500 |
| Tanks | 9,000 | 27,000 |
| Concessionary Fishing | 70,000 | 210,000 |
| **TOTAL** | **227,500** | **682,500** |

### *3.1.6 Sport fishing – Lake Muhazi*

Sport fishing if well organized can be a big source for national revenue as well as creation of jobs. In 2008, sport fishing created 63,000 jobs in Costa Rica and earned the country US $599 million. In Rwanda, sporting fishing should be developed on Lake Muhazi. This lake is 40 km long and has a mean width close to 1 km, with a maximum width of 2 km. It occupies the floor of a system of valleys, with 13 narrow arms (Figure 17). Much of the lake shore is swampy and there are swamps at the heads of all the 13 arms. The lake is fed by the Mohagumbo River at the eastern end, and by 13 other small streams, and drains from the western end via the Nyabugogo River that flows to the Nyabarongo River. The lake which is 77 Km from Kigali city is unpolluted. A number of resorts have sprung up on this lake; a fact that points to an already identified tourist sector on the lake. The growth in the tourism sector in Rwanda also presents a very good opportunity for development of recreational fishing.

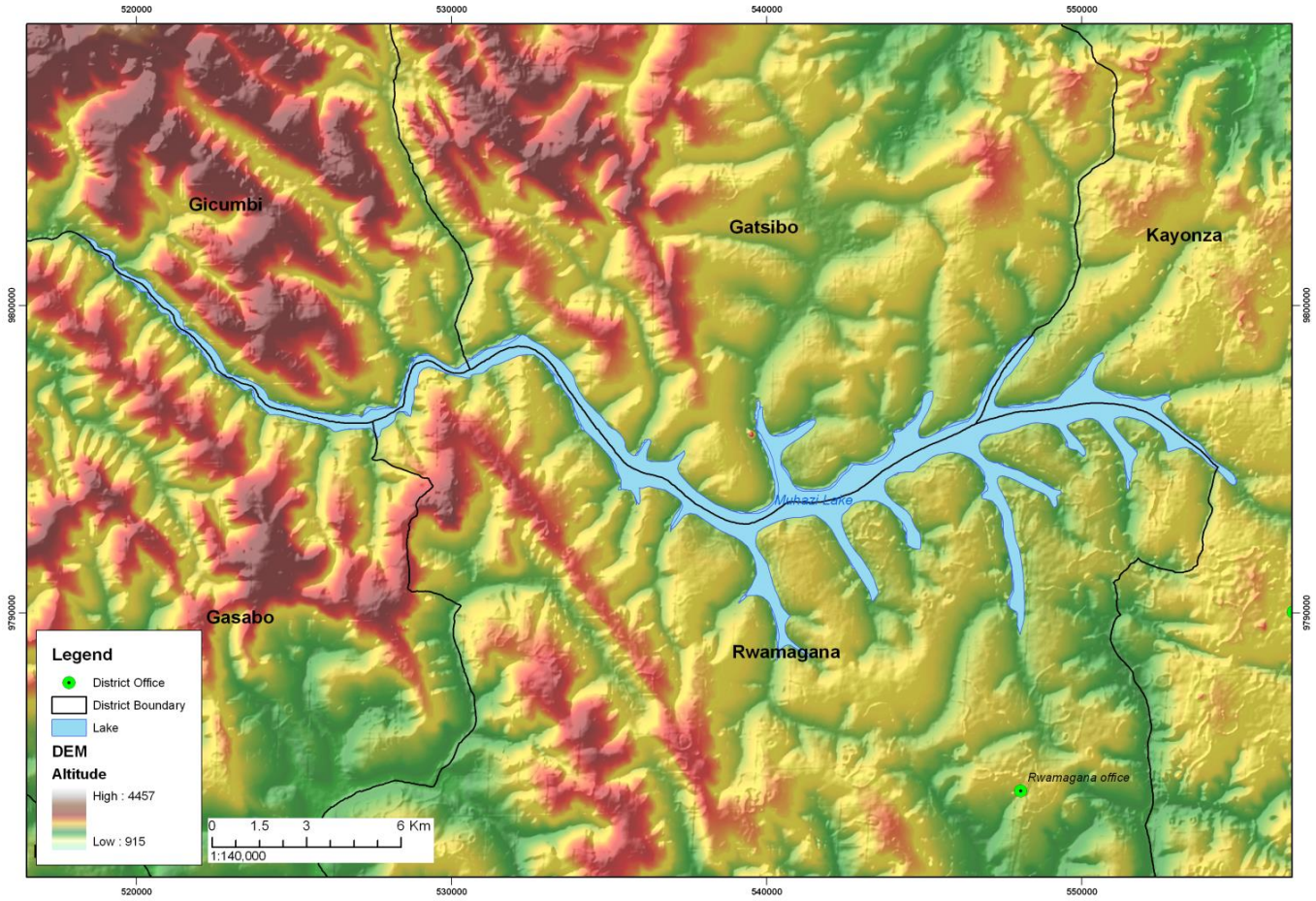


**Figure 15:** *Map showing Lake Muhazi with its arms. The lake is suitable for sport fishing*

It is proposed that Lake Muhazi be set aside to support sport fishing due to its proximity to the fast expanding city of Kigali and nearby towns of Rwamagana, Kayonza and Nyagatare. The recreation fishing can be a big industry with various actors including manufacturers and retailers of fishing tackles, fishing boats, hire of equipment and tour guides. Packages such as pay to fish and fishing competitions can be developed.

The following interventions should be undertaken to develop sport fishing on Lake Muhazi:

- Reserve the lake for sport fishing, water drives and related leisure activities. Cage culture or any other activity that will cause nutrient loading, eutrophication and associated offensive odors should be banned on the lake.
- Protect the catchment and the entire environment of the lake to avoid siltation and pollution.

- Stock indigenous fishes with a high sport value such as *Labeos*, *Barbus*, and others.
- Train and establish services of guides, boat operators, and hotels taking into account that for some people, scenery, accommodations, food, comfort and other attributes are just as important as the fishing itself.
- Recruit trainers in angling, and water sport while locals are apprentice guides.
- Amend the fishing law to include sport fishing emphasizing catch-and-release as the guiding principle.
- Attract private investors in the fishing and water sport industry.

## 3.2 Input supply for commercial aquaculture

It has been established that the critical factors of aquaculture are mainly: seed, feed, technology, capital and market. Whereas capital and markets cut across the agriculture sector, seed, feed and technology in aquaculture require specific considerations as they are applied to aquatic environments.

### *3.2.1 Seed*

Availability of good quality seed is a key to development of aquaculture industry. Fish farming in Rwanda is constrained by lack of reliable sources of quality seed. The national aquaculture stations such as Kigembe that used to produce tilapia seed for supply to small holder farmers are not in production. As a short term measure, GoR through the PAIGELAC project has imported tilapia seed from neighboring Uganda to restock lakes and supply to farmers. In the medium to long term, there is need to develop capacity to produce sufficient quantities of good quality seed. A two pronged approach should be employed based on public private synergism. The private sector should take a lead in mass production of seed. It is anticipated that seed production will be identified as a lucrative investment area in aquaculture and thus attract the private sector to set up hatcheries for commercial fish species such as Nile Tilapia and African catfish fish. The public sector should provide supportive research and technology to improve the quality of the already cultured species as well as domestication of new species of commercial importance. Procedures of establishing seed quality and certification should be put in place to protect the industry from inferior seed. Public institutions should not get into direct competition with the private sector as seed producers but can backstop the process.

Large quantities of clean water are required for successful operation of a fish hatchery. A number of sites in Rwanda were found suitable for establishment of commercial fish hatchery projects in Rwanda. The Rwesero site at the point where Nyabugogo River flows out of Lake Muhazi is a good site for a fish hatchery. At this point, the Nyabugogo water is unsilted as it flows in cascades from a gradient created by the dam. The head between the site and the adjoining low lying land (1.5–2m) offers an advantage for gravity flow of large quantities of clean water that can supply larval rearing units and brood stock ponds. However, the site is about 20 km from the national hydro power grid. The Vietnamese report proposes investment in mini hydropower production at this site. This should be explored as well as extension of a power line to the nearby Rwesero trading center. Power will be required for heating water to raise it to optimum temperatures for warm water fish species. It was established during the field work that the land at the site is owned privately by an individual. The land owner should be interested to invest in hatchery business alone or in partnership with government. Due to the importance of this site in the projected National fish production above (Table 5), it is important that this site is put to this purpose.

A similar site but with less water quality and quantity exists at Cyabayaga where water diverted from Muvumba river flows to fill a reservoir. This site is particularly suitable for a catfish hatchery given the high ambient temperatures and the surrounding human population who relish the species. This site is owned by a Rice Scheme and the Nyagatare District Authority. These bodies could invest in a catfish hatchery project or hire it out to a private investor. The other area suitable for Tilapia and catfish seed production business is around the Bugesera, Gisaka and Nasho lakes. Clean water can be pumped from these lakes and used to run fish hatcheries based on water recirculation or flow through systems. Such a business would be less impacted by decreasing water levels that are frequent during prolonged dry seasons. The following strategic interventions are proposed for boosting seed production in Rwanda;

i. Demonstrate profitability of fish seed business.
ii. Continue the rehabilitation efforts at Kigembe and equip the centre for seed production.
iii. Restructure Kigembe into various functional units and improve on the level of staffing.
iv. Negotiate with the owner of the land at Rwesero for establishment of a private commercial fish hatchery.

v. Extend power to Rwesero.
vi. Establish an African catfish hatchery at Cyabayaga following a PPP approach.
vii. Establish at least two hatcheries in the Nasho Valley.
viii. Attract investment for establishment of a hatchery for cold water fishes in the Birunga area.
ix. Develop criteria for certification of hatcheries and fish seed.
x. Develop disease control protocols for fish hatcheries.
xi. Support research in seed production.
xii. Support input supply for fish seed production.

### *3.2.2 Feed*

There is need to adopt feed based aquaculture in line with the paradigm shift from low–input, low-output based on pond fertilization alone to feed based aquaculture. Feed is a major input in aquaculture production, accounting for up to 60% of production costs. The overall benefit of using a good quality feed is in low Food Conversation Ratios (FCR) with no fouling of the environment. Cheap food is not always cheap since more kilograms may be used to produce one kilogram of fish as compared to a good quality feed. Currently Fish Feed Technology is one of the least developed in Rwanda. There is no industrial manufacture of fish feeds and farmers do not make on-farm made feeds. The industry depends on feed imported from Uganda.

The fish feed industry in Rwanda is currently at cross roads. Whereas good feed is needed to stimulate commercial aquaculture, the demand is too low to justify heavy investment in feed making equipment especially the extruder. Ironically, there can be no commercial aquaculture without availability of quality feed; the kind of egg and the chick as who came first scenario. Given the capital investment in manufacturing of floating fish feeds, availability of raw material and little demand from the pioneering farmers, it does not make economic sense to manufacture fish feeds in Rwanda in the short term. Therefore, in the short to medium term, feed importation of floating pellets from neighboring countries should continue. Small feed making machines (grinders, mixers and pelleters) can be imported for improvement of on-farm made sinking pellets. However, plans should be made to produce fish feeds in Rwanda as the quantities of fish produced increase. In order to break the impasse and jump start the sector, there will be need for

government intervention in the feed industry for the public good. Because of the large investment in this important sector of the industry, GoR should consider awarding soft loans to the private sector or establish a fish feed factory and later privatize it. These and others could be considered but ultimately a good feed is a perquisite for a profitable aquaculture industry. Assuming the upper limit of FCR of 2, twice the amount of feed will be required for the amount of fish produced.

**Strategic Interventions in feed production**

i. Support to fish feed suppliers/importers.
ii. Developing capacity for on-farm made feeds.
iii. Provide stimulus feed to the pioneer aquaculture enterprise.
iv. Training on fish handling and feeding regimes.
v. Agreeing on government special support to the fish feed industry.
vi. Identifying potential feed manufacturers in Rwanda.
vii. Construction of the fish feed factory under public-private sector partnership.
viii. Determining biological and economic performance of the feed.
ix. Establishing distribution networks.

## 3.3 Input supply other than feed and seed

Aquaculture requires several inputs ranging from chemical compounds to equipment such as aerators, graders, water and air pumps, diffusers, various types of hapas, cage nets, feeders, and packing materials, among others. As the aquaculture transformation process evolves, availability of the required inputs will become crucial. Whereas inputs are available for crop and livestock production, there are no suppliers of aquaculture inputs on the local markets. The private sector should be attracted into the Fisheries and Aquaculture input trade under the general framework of attracting investments into Fisheries and Aquaculture. There should be at least one national aqua-shop with both capture fisheries and aquaculture inputs by 2013.

## 3.4 Fish Marketing, Processing and Product Development

Sound marketing and international trade strategies will be crucial to the orderly and progressive development of the Rwanda aquaculture industry. Fish marketing and processing with the

associated Quality and Safety Assurance and Management systems for fish shall be pivotal in the transformation of Fisheries and Aquaculture sectors in the country. As fish production increases, there will be need to increase and develop a fish marketing system as well as build capacity for processing and developing fish products. Currently, market of fish is driven by high prices which can be as high as 2,500 RWF per kg of Tilapia. Although demand is likely to remain high due to increasing human population, large quantities of fish from the proposed production systems will necessitate processing to avoid post harvest losses. Consumers have increasingly recognized the health and nutritional benefits of eating fish. Fish is comparatively low in calories, fat, and harmful forms of cholesterol, and comparatively high biological value protein, vitamins, and Omega-3 fatty acids which are implicated in the prevention of heart disease and others. The most immediate aspect of this plan shall be to make fisheries production in the country market led based on ensuring and guaranteeing the quality and safety of the fish and fishery products traded locally or regionally. Given that the country is a major route for fish to the Eastern DRC, measures should be put in a place to provide a good platform for support to fish exports.

In the short term, the following measures should be put in place to streamline fish value addition and marketing in Rwanda to attract investment in fish filleting and production of products such as fish ball, fingers, soups and others;

- The current fish market under construction by PAIGELAC should be modified to include a section for holding live fish. Fish from aquaculture can be harvested and sold live and wholesome in contrast to fish from capture fisheries which are landed at various levels of deterioration.
- Marketing of Isambaza from Lake Kivu through basins and baskets should be banned.
- Develop an industry to process all fish wastes into animal feeds or fertilizers.
- Introduce the concept of open air fish eating places at social gatherings not only for marketing fish but for health reasons as well.
- Research can lead to new techniques to improve the freshness, colour, flavour, texture, taste, nutritional characteristics, and shelf-life of cultivated fish as well as new or improved value-added products.
- Research and technology development can also improve packaging, accessibility, and ease of preparation of fish products for consumers.

- There should be development and adoption of uniform quality standards throughout the aquaculture industry and assurance of product safety. This will improve consumer confidence.
- Improve and expand market information for producers, processors and consumers related to characteristics and handling of aquaculture/fish products.
- There should be an effort to develop programs to educate consumers and retailers about the safety, quality and handling of aquaculture products, and to educate the Fisheries and Aquaculture industry about quality assurance practices for production and processing of these products.
- As aquaculture industry in Rwanda grows, the PPP should identify and develop new domestic and international markets, including specialty markets, import replacement and export development.
- Support export enhancement programs and international trade missions for aquaculture products. The government can also help identify and resolve trade barriers for live and food fish.
- The government should foster harmonization of EAC policies and regulations for trade of fisheries and aquaculture products.
- Improve marketing education for producers, processors, and consumers related to characteristics and handling of aquaculture products.
- Review national standards on quality.

## 3.5 Environmental Health

As Rwanda aquaculture continues to expand, it must be sustainable and environmentally compatible. There is need for better knowledge about possible interactions between aquaculture and natural environments to minimize the potential for habitat degradation, disease transmission, genetic dilution of wild stocks through interbreeding with cultivated strains, introduction of non-indigenous species into natural waters, and discharge of wastes, toxins, and excess nutrients.

Water resources which are the base of aquaculture and fisheries are threatened by silting resulting from excessive erosion and degradation of wetlands along the main water bodies. Pollution with human wastes and industrial wastes cannot be ruled out. However, various

government programs at local and national level should have projects geared towards environmental restoration. The results of these initiatives are expected to lead to clean waters free from silt. If this is achieved, opportunities for undertaking commercial aquaculture in Rwanda will be widened. This being a cross cutting issue, there is need for linkages with public institutions, the private sectors, civil society and local communities involved in environment management.The government should encourage and support programs that improve management of water resources and aquaculture wastes, increase understanding of environmental risks associated with aquaculture and foster development of environmentally sound designs and operating guidelines.

# Chapter 4

## Thematic Area Two

## Creating Institutional Capacity to Manage and Develop Fisheries and Aquaculture Resources in Rwanda

### 4.1 Fisheries and Aquaculture Management

Aquaculture and Fisheries Management in Rwanda is currently an inconspicuous section in RARDA under MINAGRI. Currently, there is a fragmented and uncertain regulatory framework for fisheries which is a deterrent to the development of a profitable and competitive industry. The sector is accorded low level at the centre and low ratings among the agro sectors in all districts. Fish is not one of the commodities being promoted in any of the districts as can be deduced from the Districts Development Plans and *imihigo*. In fact, even small sectors such as apiary are rated higher than fish in a number of districts. As a result, the few staff in the fisheries is not motivated as they are seen to work in a sector on the periphery of government development agenda. This situation must be reversed and indeed the reversal process has started as exemplified by the recent ministerial statement to the effect that Rwanda will be self sufficient in fish supply by 2013. This is a positive step and can be achieved if proper reforms are undertaken followed by a well defined development path for the sector.

Institution reforms should entail reorganization and strengthening of the management sector. In this respect, it is proposed that a Directorate of Aquaculture and Fisheries be created with its head as the Chief Aquaculture and Fisheries Officer of the country. Under the Directorate, there will be three departments namely; Aquaculture, Fisheries and Regulation/Inspectorate. Correspondingly, an effort should be made to post skilled personnel in aquaculture and/or fisheries at local levels starting with those districts with the highest potential. This structure is central to establishment of well coordinated and regulated sector. It is noted that the proposed structural reforms have budgetary implications. In order to minimize public expenditure, the structure could start with lean staff that can be reviewed as the sector grows to become a major economic activity. By comparison, countries in the region have a much higher level of fisheries

management at political and technical levels. Uganda, Kenya and Tanzania all have Directors for fisheries with its head as the Chief Fisheries Officer. Kenya has a full Cabinet Minister for fisheries; Uganda has a Minister of State for fisheries; while Tanzania has a Deputy Minister responsible for fisheries under the Ministry of Livestock and Fisheries. Whereas Rwanda should not abruptly move to those levels, there should be an effort to create administrative and management structures that can facilitate growth of the sector. The following functions are therefore proposed:

- Review and recommend improvements to the regulatory framework for permits, monitoring, fish health inspection, transport and export of live aquaculture products; research, culture of genetically altered aquatic organisms; fish inspection and safety, cultivation of "non-indigenous" species, testing and approval of aquatic animal drugs and vaccines.
- Develop simplified and uniform standards for review procedures, siting standards, monitoring protocols, and reporting requirements for aquaculture in public waters

## 4.2 Research and Advisory Services

It is a strategy of the GoR to transform agriculture into a productive, high value, market oriented sector, with forward linkages to other sectors. Research innovations, technology development and transfer are key to agricultural transformation. This is especially true in aquaculture which is a technology driven sector. Client responsive research, efficient packaging and transfer of cost-effective technologies to the users are an important lubricant of an aquaculture and fisheries development process. As a process of facilitating the private sector in the industry, the public sector has the obligation to provide research services and provide the required technologies.

The competitiveness and profitability of the Rwanda Aquaculture and Fisheries industry will be directly related to public investments in management, research and technology development and attraction of the private sector. It should be pointed out here that the major research needs and opportunities for aquaculture are related to those of other agricultural technologies but are not similar. The diversity of species cultured, the aquatic environment and production systems employed present added challenges. Research and Technology development priorities for

aquaculture must be practically-based, foster sustainability and be developed cooperatively with industry.

A coordinated national investment in aquaculture research and technology development, closely linked to the private sector, would be a strong stimulus to the developing of Rwanda aquaculture and fisheries industry. There are opportunities to substantially improve production efficiency and reduce costs through research in the areas of; water environment, stock enhancement, genetics, aquatic animal health, reproduction and early development, growth biology and nutrition. Research is also needed on improving management of water and wastes, development of sustainable systems and practices, economics and marketing, and improving quality, safety, and variety of aquaculture products. Rwanda can also benefit from research and technologies generated elsewhere or those already adopted in neighbouring countries through scientific exchange programs and stakeholder visits. An example is the proposed LVHD cage culture system that has already been proved profitable in Uganda.

Research in the country should be strengthened and restructured. Government development programs cannot continue to rely on donor funded projects with components of research or university research which is mainly for academic purposes. It is hereby proposed that Rwanda Aquaculture and Fisheries Research Institute (RAFRI) be created to spearhead client responsive and development oriented research. The most suitable site for the headquarters of RAFRI is in Bugesera District around Gashora. This is because of the several lakes in Bugesera and Gisaka as well as the network of rivers that traverse the area offering immense opportunities for developing concession fisheries and land based aquaculture. Gashora is easily accessed from Kigali and is connected to the national hydropower grid. It is proposed that RAFRI develops or establishes research centres on Lake Ruhondo in Musanze District, Kigembe in Gisagara District and Kibuye in Karongi districts. Lake Ruhondo centre which can be housed in the HELPAGE buildings will undertake research in cold water fishes in addition to other research and extension services in the Northern part of the country.

The Kigembe center will spearhead research in all aspects of aquaculture research as well as provide advisory services to farmers in Southern and South Western parts of the country. The Kibuye Research Centre will spearhead research on natural fisheries stocks with particular focus

on Lake Kivu including development of cage culture on this lake. The RAFRI Headquarters in Bugesera will be mandated with all aspects of research in aquaculture and fisheries and backstops the regional centers as well as establish linkages into national and regional National Agricultural Research Systems (NARS). Advisory services in aquaculture and fisheries will also be the responsibility of RAFRI. Whereas it could be urged that ISAR should be strengthened to take on Fisheries and Aquaculture research, the rate of development to service the desired transformation in the aquaculture and fisheries industry will most likely not be achieved in crop and livestock research institutional set up. This is mainly due to the fundamentally different requirement for conducting research in water and rearing aquatic organisms under controlled conditions as opposed to land based research.

RAFRI will also be responsible for information and data collection and dissemination. For maximum impact, aquaculture research and development programs should constitute a continuum, from basic and applied research to ultimate commercial adoption. Knowledge must be harnessed and effectively transferred to the private sector if its benefits are to be fully realized. There is a need to provide accurate, objective, and realistic information about aquaculture to the general public, consumers, and policy makers. Fast advances in knowledge and a rapidly increasing global aquaculture industry necessitate that the Rwanda private sector has immediate and continuous access to a variety of information sources to compete effectively in a global marketplace. Research findings, technology, and marketing information must be readily available to the industry. It is proposed that a unit responsible for information and outreach be created at high level in RAFRI and charged with the responsibility of regularly informing stakeholders and all Rwandans on the state of aquaculture and Fisheries. This is important for planning along the value chain on fish production and marketing. There should be support for a national investment in aquaculture R&D in areas that will enhance the international competitiveness of Rwanda aquaculture. There should be an effort to link up with researchers in the region through the sub regional research and management organizations such as ASARECA, LVFO, VicRES, FARA, CAADP and others. For technology dissemination the following are proposed;

- Foster commercialization of promising research and technology through support of demonstration projects and commercial field trials.

- Encourage partnerships, including joint ventures, between the private sector and scientists/laboratories in research/technology development and transfer activities.
- Support collaboration between extension and the aquaculture industry in technology transfer activities.
- Initiate international scientific exchange programs with countries having advanced aquaculture expertise, to enable Rwandans learn more about relevant technological advances.

## 4.3 Training

Lack of skilled manpower has been highlighted as one of the constraints in the aquaculture and fisheries sector in Rwanda. Of the current 12 staff working in aquaculture and fisheries sector in RARDA and PAIGELAC, none has a PhD, 2 have Masters while none has BSc. in Aquaculture and Fisheries. Scarcity of post graduate degree holders was also noted in higher institutions of learning. It is therefore clear that there isn't enough manpower with the requisite technical skills to ensure quality technical supervision, advisory support to communities, effective monitoring of the aquatic resources and the protection of fishing environments. Given the urgent need of this human resource to propel to the sector, it is proposed that this constraint is addressed in the short/immediate, medium and long term. As Rwanda aquaculture continues to develop, its success will depend, in part, on a reliable supply of skilled manpower to perform the technically challenging tasks required for advanced aquaculture systems

### *4.3.1 The Short Term*

As start up measures, low level but skilled managers should be sourced from neighboring countries and placed at private farms to guide entrepreneurs and small scale farmers who are embracing aquaculture as an agribusiness. These can be complimented by a few Technical Assistance (TA's) or management consortia to oversee the process of kick-starting commercialization of the industry. The short term phase should also include:

- Hands-on skills enhancement on commercial fish farms in the region.
- Identify high priority education and training needs, including in-service training, to support the industry's development and recommend actions to address these needs.

- Support aquaculture-related public education programs. Target audiences should include producers, processors, retailers, environmental interest groups, policy-makers, consumers, and the public at large.

Given the proposed paradigm shift in this Master Plan, it is necessary for the; the private sector/farmers, managers, political leaders/legislators to appreciate the transformation process by visiting countries where aquaculture has moved from subsistence to a vibrant commercial industry. One good example within the Nile Basin is Egypt. It is recommended that study tours within the Nile Basin Initiatives be arranged for the above category of people. In the same framework, Egyptian government can be requested to facilitate the transformation process through the General Authority for Fish Resources Development (GFARD) of the Ministry of Agriculture and Rural Development and various departments in the Ministry of Water and Irrigation.

### *4.3.2 The Medium Term*

Simultaneous with the short term activities, will be building capacity for the medium term which will entail training at Certificate and Diploma level. Candidates can be selected based on agreed criteria and sent for training in the region. The Fisheries Training Institute at Entebbe in Uganda and Mwanza Fisheries Training Institute in Tanzania are some of the tertiary institutions that can build capacity of this mid level technical staff. Medium term plans should also include; support to linkage of aquaculture education programs to the aquaculture industry through the use of internships, international exchange programs and fostering work-study opportunities.

### *4.3.3 The Long Term*

For long term capacity building, it will be necessary to start a program for training of trainers in aquaculture and fisheries. Candidates from universities and research institutions should be immediately selected and sent for training at postgraduate level (MSc and PhD). Simultaneous with training of trainers should be establishment for training a few but very practical staff at Certificate, Diploma and BSc. levels. The caution here is to avoid mass production of degree holders in the sector as it has proved counterproductive in some countries where there are many graduates who have never touched fish but masquerade as consultants. These so called consultants have misadvised farmers leading to heavy loss of investments which is a disincentive

to the nascent industry. Transformation of the sector can be properly managed by a few skilled and well motivated staff.

For continuity, aquaculture and fisheries education and training programs should be conducted in close cooperation with the industry and allow opportunities for practical, hands-on experience. The government should expand agricultural learning to include aquaculture and fisheries at lower levels of education and secondary schools. This should generate greater public support for aquaculture development and should contribute to an improved fisheries regulatory framework. By working with the industry and other stakeholders, the government has an opportunity to identify and support education and training programs for future human resource.

# Chapter 5

## Thematic Area Three

## Creating Enabling Environment for the Private Sector to Play a Pivotal Role in Increased Fish Production

While addressing these issues, the major emphasis will be placed on aquaculture as a business, providing attractive investment opportunities in order to generate the anticipated livelihoods and economic growth benefits in line with Vision 2020 and EDPRS 2008 - 2012. Lack of a commercial or business approach to aquaculture production is now acknowledged as one of the principal gaps confronting the expansion of the sub-sector in Africa. Early assumptions based on readily available and cheap inputs (land, labour, capital) certainly did not take into consideration the real economic and financial costs required to produce profitable yields. Much of this early effort targeted integrated subsistence fish farming (e.g. farm ponds versus fish ponds) which, whilst possibly contributing to household and even community incomes, made little if any significant impact on national fish supply or economic growth in Rwanda. These low-input family systems are still in practice in rural Rwanda. The aforementioned new paradigms now focus on socio-economically and technologically viable and sustainable aquaculture enterprises (aqua-businesses, with a focus on micro - small and medium enterprises). Aquaculture has to be operated as a business no matter how small the enterprise as long as it is market and profit oriented.

### 5.1 Attracting the Private Sector into Fisheries and Aquaculture

According to NEPAD (2005), African aquaculture development will require strengthening of private sector investments. These investments would be directed towards assessing fish supply and demand trends, developing conducive fish trade policies, improving market infrastructure, and building capacity among fish producers and processors for continued technical innovation, market exploration and self-regulation. However, the establishment of a new aquaculture technology is by definition based upon research and development activity, including the transfer and adaptation of technology to local conditions and markets. Global experience has shown that it is unrealistic to expect pioneer entrepreneurs to shoulder the full burden of Research and

Development (R&D) cost of establishing a new aquaculture technology. The risk and uncertainty involved in establishing a new technology without state assistance is simply too great for most entrepreneurs thus calling for public-private partnerships. The most successful aquaculture industries have emerged where the state, in partnership with the private sector, has shared the initial risk of sector establishment, particularly with respect to technology development.

A viable plan has to include means and ways of attracting an efficient service and inputs supply industry as well private led production sectors. It should be recognised that the decision to invest is based on appraisal of risk and return relative to competing opportunities. While fundamental conditions such as suitable environment, fish species and market for bait and table fish may stimulate investor interest in aquaculture, the very real constraints to private sector entry into the industry should not be underestimated.

Currently, financing is difficult to obtain and the principal obstacle is the real or perceived high risk associated with aquaculture businesses. This is further compounded by the lack of understanding of basic aspects of the aquaculture industry by lending and financial institutions in the public and private sector, and the paucity of good data on aquaculture loan histories. There are many constraints to the budding aquaculture industry in Rwanda including the following:

- Investors are unable to appraise the risk of investment in fish farming because there is lack of the required information and a record of sectoral performance benchmarks.
- There is lack of locally evaluated fish farming technologies. One can hardly find information even on simple practices such as stocking densities of various indigenous fish species with corresponding output.
- There is inadequate technical guidance on fisheries and pioneer investments are compelled to undertake vertical integration of activities including seed production; grow-out, feed production, product processing, marketing and manpower training. This has tended to increase the minimum viable size of operational unit and investment placing aquaculture out of reach of small and medium size entrepreneurs. As a result, there is no “critical mass” in aquaculture sector to reduce transaction costs and promote economies of scale. For example, the private sector is reluctant to invest in fish feed line because of

few potential buyers yet fish farming cannot easily take off if there is no supply of quality feed.

- Supplies and services required such as feeds, fish health management, hardware such as; air blowers, hatching tanks, feeders, pumps etc are non-existent or scarce at best.
- Aqua-business is relatively new compared to other agribusinesses.

Given the above, the following measures are proposed to attract private sector Into Aquaculture and Fisheries in Rwanda:

- Provide suitably packaged information for Fisheries and Aquaculture entrepreneurs or investors.
- Demonstrate viability of different production systems.
- Define areas according to the prioritised aquaculture production systems as well as other investment opportunities in the sector and publish them.
- Create a stimulus package for investment in fisheries and aquaculture akin to those in several developing countries.
- Establish a one stop centre for investors where they can acquire technology, and get assistance to register their businesses.
- Hold private sector sensitisation workshops/meetings.
- Provide interested potential investors with fact finding visits to successful aquaculture countries in Africa and South East Asia.
- Educate financial institutions about the aquaculture industry, including realistic assessments of risks and returns.
- Create awareness on risk analysis management for investments. Support education of public and private financial institutions about aquaculture, including realistic assessments of risks and returns.
- Mount public promotion initiatives to promote fish consumption.
- Thoroughly review current government financial assistance programs to determine their applicability to aquaculture. Consider and recommend additional financial services and incentives as appropriate to Fisheries and Aquaculture.
- Consider initial public investments in high risk areas and divesture upon realisation of profits.

# Chapter 6

## Proposed Follow up Projects (10 Years)

Analysis of the past and present state of fisheries and aquaculture in Rwanda indicates a potentially important industry that has never been organized for increased and sustainable productivity. With increasing human population, trade opportunities and appreciation of fish as a healthy food product, it would be costly to ignore the socioeconomic potential held in the country's aquatic resource base. There is need to structure the sector and unlock it for increased productivity. The preceding chapters have highlighted several aspects that should be addressed so as to create a vibrant aquatic based industry in Rwanda. It is therefore proposed that two major programs be initiated with various projects addressing pertinent components of the industry namely;

- Fisheries and Aquaculture Institution Development Program (FAIDP)
- Fisheries and Aquaculture Productivity Program (FAPP)

The Fisheries and Aquaculture Institution Development Program (FAIDP) will address issues relating to creation of institutions to support, manage and regulate the industry while the Fisheries and Aquaculture Productivity Program (FAPP) will facilitate attainment of the set levels of production. The two programs will work synergistically to achieve the sector goals. These programs should build on the foundation laid by the PAIGELAC project and facilitate emergency of a well coordinated and suitable fisheries and aquaculture industry.

### 6.1 The Fisheries and Aquaculture Institution Development Program (FAIDP)

This program will streamline management of aquaculture and fisheries within MINAGRI and at the various levels of local administration. The program will create platforms for planning, coordination and cross-linkages with other actors at national, regional and international levels. Through the program, a directorate or authority for fisheries and aquaculture will be created to oversee the emergency of the industry. The open access to fisheries resources, the use of illegal gears, and excessive capacity have been the major driving forces behind degradation of the fisheries resources base. With no central fisheries management agency, enforcement of law has been nearly absent with many rules and measures going obsolete. There is therefore need for a

more cost effective regulatory framework under a new management dispensation. As part of the commercialization drive, there will be need for adoption of fish quality and safety management regime that can demonstrate not only the quality of their product, but also the sustainable management of their fish stocks.

The proposed RAFRI will also be set to generate the prerequisite information and technologies. A component will be included in the program to link national human resource needs with training institutions so as to address the current acute human resource shortage. The following are the proposed major components/projects of the program.

- Support to Fisheries and Aquaculture Authority/Directorate.
- Research Institutions Development Project.
- Fisheries and Aquaculture Training Project.
- Advisory services/extension project.
- Quality Assurance and Market Development Project.

## 6.2 The Fisheries and Aquaculture Productivity Program (FAPP)

The gist of the sector is to transform fish production from subsistence or artisanal fishing to commercial capture fisheries or intensified and profitable aquaculture. This will be achieved through the various options elaborated in this plan. The program will oversee realization of the production systems and set targets. It should demonstrate the viability of the sector and open it up for private investments. The ultimate goal should be an industry run by the private sector with the government's main role being regulatory. The following components/projects are proposed for the program:

i. Detailed resource base analysis and mapping.
ii. Fisheries concession and management.
iii. Aquaculture systems, demonstration, information and promotions.
iv. Value addition, product development and marketing.
v. Aquaculture and aquaculture shared investments grants for: seed, feed and general inputs.
vi. Farmer skills enhancement and in-service training.

# Chapter 7

# Fund Mobilization and Implementation and Socioeconomic Benefits

## 7.1 Funding

Initially, the development of the sector will depend on government budget allocations and development funded projects. Subsequently, various options should be explored for generating funds from the industry for sustainability. The following are some of the possible income generating avenues;

- Fishing concession levy.
- Fees from hire of public infrastructure such as landings, holding facilities, markets and others already set up by the PAIGELAC project.
- Fees from hire of cage sites and farms within aquaculture parks.
- Sport fishing levy.

## 7.2 Implementation and Continuation from PAIGELAC

The successful development of a sustainable and competitive aquaculture and fisheries industry will depend on integration of this plan in a development process with effective coordination of the various actors to maximize value for money of the follow-on programs.

Fisheries and aquaculture activities have been reinvigorated by the PAIGELAC which is a project under MINAGRI. Through the project, fishers have been organised into cooperatives and basic infrastructure for fish production e.g. rehabilitation of 227 ponds and installation of 370 cages in lakes have been done.

The master plan takes cognizant of the fact that PIAGELAC is a project whose initial time span already expired on 31/06/2010. The project is now in an extension period ending on 31/12/2011. In order to avoid a situation where development activities undertaken through the PAIGELAC loan facility are laid to waste, it is recommended that preparations for the proposed follow on projects start immediately with in the current extension period. It is important to ensure continuity of the PAIGELAC developments and smooth transition from a project mode to

functional structures and operating systems. The following measures are therefore recommended:

- Set up a Master Plan Implementation Committee with clear Terms of Reference.
- Expeditiously review the draft master plan and adopt it as a government document.
- Set up a committee to draft the follow-on projects.
- Engage possible Development Partners to support follow-on projects

## 7.3 Socioeconomic and Environmental Benefits Resulting from Implementation of the Master Plan

Implementation of this plan will stimulate fisheries development and lead to increased fish production with the following socioeconomic benefits:

- Job creation and contribution to long-term economic growth.
- Alternative, but compatible (Integrated) agribusiness opportunities for the rural communities and the private sector.
- Expansion of domestic and export markets for Rwanda aquaculture products.
- Decreased pressure on threatened capture fisheries and creation of a sustainable fisheries industry.
- Redeeming the cost of fish imports and that can be used for other development activities.
- Assurance of high quality, safe, competitively priced, and nutritious fish to the Rwandan people.

The integration of aquaculture with other forms of agriculture or with commercial fishing activities can have economic and environmental benefits. Aquaculture effluents and solid wastes can fertilize agricultural crops. Conversely, aquaculture can take advantage of farm by-products "waste" materials. Agricultural and fisheries processing wastes can be incorporated into aquaculture feeds; nutrients from manures can stimulate primary productivity in aquaculture parks. Private sector production of eggs, fry, and juveniles to enhance fish stocks in public waters can contribute to stock enhancement in natural water bodies as well as help to preserve biodiversity through programs to raise and stock threatened or endangered fish species. Details of the projected socioeconomic benefits are summarized in Table 6.

**Table 6:** *Socio-economic and Environmental Management Impacts of the Master Plan*

| **Verifiable Indicators** | **Current Level in tonnes** | **Level By (2020) in tonnes** | **Change %** |
|---|---|---|---|
| 1.0 Economic growth and Balance of Payments (BOP) | | | |
| 1.1 Fish Production (mt/pa) | 13,088 | 227,500 | 1638 |
| 1.2 Official Exports (Value) – US$ million | 12,000,000 | 346,500,000* | 2787.5 |
| 1.3 Post harvest losses | ~40% | ~10% | 75 |
| 2.0 Employment and Poverty | | | |
| 2.1 Gainfully employed (No) | 240,000 | 1,200,000 | 400 |
| 2.2 Average fishermen's earnings/month (US$) | 55 | 500 | 809 |
| 3.0 Fisheries resources Management | | | |
| 3.1 Lakes with conservation reserves | 0 | 24 | 100 |
| 3.2 Co-management committees | 4 | 30 | 750 |
| 3.3 Water quality monitoring | rarely | Monthly | |
| 4.0 Social /Institutional Capacity | | | |
| 4.1 Landings with Modern infrastructure | 0 | 25 | 100 |
| 4.2 Organized landing sites (%) | 0 | 25 | 100 |
| 4.3 fisheries with concessionaries | 4 | 30 | 650 |
| 4.4 Fisheries graduates per year (No) | 6 | 60 | 900 |

*Total Production 227,500 mt – 112,000 mt (local consumption) times the value of $3/kg of fish.

# Annexes

**Annex 1:** *Cost Table for Implementation of Fisheries and Fish Farming Master Plan in Rwanda 2011 – 2020*

| **Thematic Area 1: Developing of Knowledge-based Aquaculture and Fisheries Systems** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | **Objective** | **Outputs** | **targets** | **Outcomes** | **Activities** | **Inputs** | **Quantity** | **Unit cost (USD)** | **Amount (USD)** |
| **1** | *Developing knowledge-based private sector led aquaculture industry* | Creating awareness, promotion and support cage fish culture production | 140,000 tons annually by 2020 valued at USD 420 million annually | Environmentally Responsible Increased Fish Productivity and Production | Statutory and policy setting of cage culture production sites on identified water bodies guided by GIS technical studies | Technical Consultancies | 2 | 200,000 | 400,000 |
| | | | | | Media Awareness Campaign | Annual Media Campaigns | 2 | 200,000 | 400,000 |
| | | | | | Hands-On Farmer Training and Exposure | Technical Service Provision for 5 Years | 5 | 100,000 | 500,000 |
| | | | | | Training of Technical Service Providers | 100 Technical Service Providers | 100 | 500 | 50,000 |
| | | | | | Support to Model Lead Farmers | 6 Zonal Farmers | 6 | 100,000 | 600,000 |
| | | Introduction, Promotion and Support to Fish Production Using Tanks/Raceways Based Aquaculture | 9,000 tons annually by 2020 | Effective and Efficient Use of Water Resources for Increasing Fish Productivity and Production | Acquisition of Technical Assistance (TA) on tanks and raceways to provide advisory services to pioneer investors in the system | Technical Consultancies for 3 Years | 1 | 200,000 | 200,000 |
| | | | | | Setting up a tank based production unit in each province of the country | construction of 4 tank parks | 4 | 500,000 | 2,000,000 |
| | | | | | Setting a pilot raceways project around the shallow lakes of Bugesera or | Construction of 2 raceways producing 2,500 tons of | 2 | 500,000 | 1,000,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gisaka | fish each | | | |
| | | | | | Awareness raising and engagement with relevant stakeholders | Annual Media Campaigns | 10 | 50,000 | 500,000 |
| | | Promotion, Establishment and Development of Aquaculture Parks | 8,500 tons annually by 2020 | Equitable Rural Aquaculture Development | Marking out river catchments or lake areas where the park can be established and development of Management Plans for each park | Technical Consultancies | 10 | 50,000 | 500,000 |
| | | | | | Public Awareness Campaign & Sensitization Of Target Farmer Groups | Annual Media Campaigns | 2 | 500,000 | 1,000,000 |
| | | | | | Physical planning of identified sites for organized production | Engineering designs and supervision of aquaculture parks | 17 | 50,000 | 850,000 |
| | | | | | Developing infrastructure (ponds, roads, canals, farm enclosures, holding facilities, cold chain, value addition) and extending utilities | Establishment of 17 Aquaculture Parks | 17 | 1,000,000 | 17,000,000 |
| | | | | | Establishing of a fisheries and aquaculture mechanized unit with machinery and equipment to maintain the parks | Assorted heavy machinery unit for each park | 2 | 200,000 | 400,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Establishment and development of seed supply industry/enterprise for commercial aquaculture | 50 Locally based hatcheries specialized in at least any of 4 commercial target farmed species | Ready availability and supply of quality fish seed for all the major farmed species in the country | Design hatchery systems and Demonstrate profitability of fish seed business | Technical Assistance for 3 years | 3 | 100,000 | 300,000 |
| | | | | | Complete the rehabilitation of Kigembe and equip the centre for seed production based on PPP arrangement | Rehabilitation works including engineering designs and supervision | 1 | 500,000 | 500,000 |
| | | | | | Acquire the land at Rwesero and support the establishment of a commercial fish hatchery at this site | Land Acquisition, engineering design, construction and supervision | 1 | 1,500,000 | 1,500,000 |
| | | | | | Extend power to Rwesero | 20 Kms of power line | 20 | 5,000 | 100,000 |
| | | | | | Establish an African Catfish Hatchery at Cyabayaga Following a PPP Approach | Design and construction works | 1 | 200,000 | 200,000 |
| | | | | | Establish two commercial hatcheries following PPP approach in the Nasho Valley | Design and Construction Works | 2 | 200,000 | 400,000 |
| | | | | | Attract investment for establishment of a hatchery for cold water fishes in the Birunga area | Build, operate and transfer through PPP | 1 | 400,000 | 400,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 500,000 tons of formulated industrially produced quality feed | Self sufficiency in aquaculture feeds to support the commercialization of aquaculture production | Support establishment of industrial level feed mill | Build, Operate and Transfer of feed mill under PPP arrangement | 2 | 5,000,000 | 10,000,000 |
| | | | | | Build and develop capacity for on-farm made feeds | Technical assistance and supply of small/medium feed mills | 30 | 20,000 | 600,000 |
| | | | | | Training on fish handling and feeding regimes | Technical Assistance in fish handling and feeding | 3 | 100,000 | 300,000 |
| | | | 20 suppliers/ distributors of general aquaculture inputs including farm implements, chemicals, materials | Ready availability and supply of farm implements and supplies for aquaculture production | Identify and support enterprises in supply and distribution of aquaculture implements and supplies | Considered under support to private sector | - | - | - |
| **3** | Recovery and Development of Fisheries Production Potential in all Appropriate Natural Water Bodies and Reservoirs | Revitalization, development and utilization of existing natural potential for fisheries production | Capture fisheries production raised from 9,500 tons to 120,000 tons | Sustainable and efficient utilization of natural fisheries production potential | Review, update, development and implementation of appropriate fisheries management measures | Technical Assistance | 3 | 100,000 | 300,000 |
| | | | | | Establishment and support to 15 fisheries concessionaires held by private entrepreneurs and/or organized fishers groups | 15 concessionaires | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Establish and conduct regular fisheries standing biomass and volume of fish produced | Catch Assessment, frame survey and stock assessment | 10 | 200,000 | 2,000,000 |
| | | | 70% of fish produced is processed and marketed as quality products | Reduced post harvest losses and increased quality and value of fish | Provide incentives and support to investors to set up appropriate fish processing and marketing establishments | Considered under support to private sector | | | |
| | | | | | Establish and operate a fish quality and safety assurance control unit/program | Support to fish inspection and quality assurance unit | 10 | 200,000 | 2,000,000 |
| | | | | | Support export enhancement programs and international trade missions for aquaculture products. | Export trade missions and exhibitions | 10 | 100,000 | 1,000,000 |
| | | | | | Improve and expand market information for producers, processors and consumers related to characteristics and handling of aquaculture/fish products | Information packaging and dissemination | 10 | 50,000 | 500,000 |
| | | | | | Provide training and marketing education for producers, processors, and consumers related to handling of aquaculture products | Stakeholder Tailored Short Practical Training | 10 | 50,000 | 500,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Support the improvement of fish marketing infrastructure | live fish markets and cold chain systems | 4 | 100,000 | 400,000 |
| | | | Establishment and support to a USD 50 million ornamental fisheries industry | | Support the establishment of ornamental fish holdings, multiplication centres, displays and trade with attendant quality control and biosecurity management system | Ornamental fish production, demonstratio n and promotion centres | 4 | 100,000 | 400,000 |
| | | | Exploitation and efficient utilization of natural and existing ornamental fisheries in Rwanda | | Set up and operate a national aquaria with local and regional fish species and other aquatic life forms | National aquaria exhibiting aquatic diversity for local and tourism | 1 | 2,500,000 | 2,500,000 |
| | | | Establish and Develop a USD 150 million sport fishing industry | Exploitation of the fisheries production potential in selected natural and artificial water bodies for recreational fishing | Work with tourism industry to establish, promote and support the emergency and development of recreational (sport) fishing | Considered under support to private sector | | | |
| | | | | | Establish regulatory and managerial regimes to support recreational fishing | Support to Sport fishing promotion unit | 10 | 100,000 | 1,000,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Develop the production and recreational potential of key selected water bodies through stocking and restocking with appropriate recreational fish species | Original Stocking and Annual Restocking | 10 | 100,000 | 1,000,000 |
| | | Environmental Health | | | Annual aquatic environment monitoring | Support to monitoring activities | 10 | 20000 | 200,000 |
| **Thematic Area 2: Creating institutional capacity to management and develop aquaculture and fisheries resources** | | | | | | | | | |
| 1 | *Developing institutional capacity* | Management and Regulation of production and development activities for aquaculture and fisheries | Design of management services | Sustainable and efficient utilization of fisheries resources | Description and design of requisite management and fish production technological infrastructure | Consultancies | 1 | 300,000 | 300,000 |
| | | | Operational fisheries and aquaculture management agency | Appropriate legal and policy environment for fisheries and aquaculture development | Review, update and development of policies, guidelines and measures for aquaculture development | Consultancy | 1 | 100000 | 100,000 |
| | | | Operational fisheries and aquaculture management agency | Appropriately managed fisheries and aquaculture sector that is operated sustainably and efficiently | | Support to management of fish environment | 10 | 50,000 | 500,000 |
| | | Research, technological development, innovations and advisory services | | | Establish a national fisheries and aquaculture research program under the National Agriculture Research Systems | Establish RAFRI | 1 | 2,000,000 | 2,000,000 |
| | | | | | | Annual support to RAFRI | 10 | 500,000 | 5,000,000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Training services | | | Conduct an HR survey and trainings needs assessment | Consultancy | 1 | 100,000 | 100,000 |
| | | | | | Hands-on skills enhancement on commercial fish farms in the region | Short training | 50 | 10,000 | 500,000 |
| | | | | | Support aquaculture-related public education programs | Publication and media | 20 | 10,000 | 200,000 |
| **Thematic Area 3: Enabling environment for private sector** | | | | | | | | | |
| | | Private sector engaged, incentives and organized to take up aquaculture and fisheries enterprises | Establishing business information system for investment in aquaculture and fisheries enterprises | | Production of information packages | Development of information, packaging and disseminatio n (ICT, databases etc) | 100 | 5000 | 500,000 |
| | | | Demonstration of viability and profitability of aquaculture and fisheries production systems | | | Covered under Theme one | | | 0 |
| | | | Detailed resource mapping and zoning of production areas as well as defining user access rights | | Mapping, and zoning, definition of access and user systems | Consultancy | 1 | 300000 | 300,000 |
| | | | Private sector shared grants Fund | | Setting up the fund and its administration | Consultancy and wages for fund staff | 1 | 10000000 | 10,000,000 |
| | **Total** | | | | | | | | **71,000,000** |

**Annex 2:** *Summary of elaboration of the Master Plan*

**The process of developing the Master Plan**

The Government of the Republic of Rwanda through a loan facility from African Development Bank was implementing the PAIGELAC project for rehabilitation and development of the fisheries sector. Among the components is the support for development of a Master Plan for rehabilitation and development of fisheries and aquaculture sectors. To this effect, the PAIGELAC recruited an individual Consultant; Dr. Justus Rutaisire to spearhead the development of the Master Plan for Fisheries and Aquaculture Development. According to the Terms of Reference, the Master Plan development was planned to be done over a period of 70 days. The Master Plan development included a review of the pertaining situation regarding fisheries and aquaculture development and management, and the different policies and measures in place as well as the historical perspective. The plan involved evaluation of past efforts and interventions in fisheries and aquaculture sectors, and presentation of best options for moving the country towards self reliance and sustainable development in terms of fisheries and aquaculture production. Specifics of proposed interventions were presented including cost estimates and any environmental or legal and policy challenges.

**Review of documents relevant to development of fisheries and fish farming in Rwanda**

Following signing of the contract, I embarked on extensive source and review of relevant literature in order to acquaint myself with the historical perspective of aquaculture in Rwanda and the status of Fisheries and Aquaculture. This was complimented with consultation with key persons in Public and Private Sector (Annex 3). The documents reviewed included the following:

- Appraisal report on Inland lakes Integrated Development and Management Support Project (PAIGELAC) by African Development Fund October 2003
- Economic Development & Poverty Reduction Strategy 2008 – 2012
- Etude Sectorielle de la Pêche et al pisciculture au Rwanda, 1991
- Experts of BCEOM report 2008
- IISD 2005. Connecting Poverty and Ecosystem services: Focus on Rwanda
- Law No. 58/2008 of 10/09/2008. Determining the Organisation and Management of Aquaculture and Fisheries in Rwanda

- National Agricultural Policy 20th Ukwakira 2004
- NEPAD, 2005a: Inland fisheries in Africa. Key issues and future investment opportunities for sustainable development. Technical review paper. NEPAD Fish for All Summit 22-25 August 2005. Abuja, Nigeria.
- Rwanda Investment Policy Investment Law
- Rwanda Irrigation Master Plan 2010
- Rwanda Vision 2020
- The Vietnamese Technical Mission Report 2010
- USAID 2008. Rwanda Environmental Threats and Opportunities Assessment 2008.


**Approach to the assignment**

Data collected from literature review and interviews with key stakeholders (Annex 3) was analysed and used to develop a work strategy and suitable methodology that was submitted to the client for approval.

**Information collection from the field**

Upon approval of the work strategy, I and my associates embarked on collection of information from different places in the country. This exercise took us to almost all districts of the country where we held discussions with officials responsible for fisheries production and/or other concerned persons. In addition information was also collected from PAIGELAC field staff, Cooperative Societies, government officials involved in fisheries or fish farming and the Private sector. Details of key persons who provided information and their designations are summarized in Annex 3. The information collected thus far has been analyzed in the context of the Terms of Reference (ToRs) and triangulated with observations and discussed in relation to fish production in the region. It is on this basis that a zero draft of the Master Plan was developed.

Draft zero was presented to a Technical Committee constituted by MINAGRI on 17/02/2011. Comments/recommendations from the Technical Committee were incorporated in the draft while producing draft one which was presented to the Directorate of Planning MINAGRI on

24/05/2011 and thereafter to the Permanent Secretary, MINAGRI on 19/04/2011. The Final Consultancy report was validated by a National Stakeholders' Workshop held at Top Hill Hotel Kigali on 20/05/2011. Comments of the National Stakeholders' workshop were incorporated and the final report is hereby submitted to MINAGRI for adoption and implementation.

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