

POTENTIALS OF AQUACULTURE PRODUCTION TO FOOD SECURITY IN RWANDA

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ABSTRACT

The traditional way of securing food provision in Rwanda by taking more land under cultivation, is no longer an adequate solution, partly because most of the land available for agriculture is less fertile. If sufficient food is to be produced for a population that is expected to double in the next 10 to 15 years, more options for food production must be made from the land and waters. Despite the new Fisheries and Aquaculture Policy laid out at ensuring food security, poverty reduction and natural resources and environmental protection, the aquaculture sector in Rwanda is still at the infancy stage and the population display poor interest in it. While constraints, strategies and benefits of aquaculture production and development in the country to meet fish production demand have been well documented in previous studies, these perspectives have not adequately detailed its positive link to increased food security and improved dietary nutrition and quantitative data highlighting its contribution to food security is limited, with few or no objective evaluations available. This study will review the role of aquaculture as a substantial solution to food security in Rwanda and highlight the potentials of integration of aquaculture into agricultural farmers' production systems leading to increased nutritional diversity. In this study, five types of method will be used for assessing the extent of hunger and malnutrition: Qualitative methods to assess the perceptions of hunger and behavioral responses while also measuring the stability of supply, the FAO method to estimate dietary intake and its relation to energy needs thus providing an indication of the availability of food supply, the individual dietary survey and the household income and expenditure survey (HIES) methods to measure access to food supplies, anthropometry to determine the physical effects of malnutrition on growth thus indicating the extent of the biological utilization of food as part of integrated approach for income generation and employment opportunity and finally the role of aquaculture to support income-security and nutritional diversity will be assessed by looking at its impact on a variety of different aspects of food security using several core indicators.

Key words: aquaculture production, food security, Rwanda, nutritional diversity, hunger, malnutrition

Introduction

High population growth associated with increasing pressure on natural resources is asserted a major factor for food-insecurity in sub-Saharan region. Various experts on the study of food security points out that feeding a growing global population put pressure on natural resources. A recent study by the Food and Agriculture Organization (FAO) highlights a large disproportion between the rate of population increase and the rate of food production in Rwanda (FAO, 2008). The FAO study capitalized the inadequacy in food provision on high population density, enormous decrease in land fertility across the country and a shift to cash crop production to earn foreign exchanges. Many studies argue that aquaculture contributes significantly to food security and livelihoods in many parts of the world, particularly in developing countries, either as a stand-alone activity or in association with other income generating activities, such as crop agriculture and livestock rearing (Allison, 2011; Zuberi and Thomas, 2012; Lehane, 2013). Fish provides a good source of protein and essential micronutrients needed for normal growth, development and an active and healthy life (Williams and Poh-Sze, 2003). In addition to the nutritional advantages of increased fish production, aquaculture provides opportunities for employment and income generation essential for household and national food security (FAO, 2008, Lehane, 2013). Millions of people around the globe are employed in aquaculture industry and depend on aquaculture for their livelihoods (FAO, 2003a, Lehane, 2013). In countries endowed with valuable natural fisheries or conditions favoring aquaculture development, fish can also provide important contributions to the National economy through trade, tax revenues and license fees (Allison, 2011). With respect to Rwanda National economy, there is a great interest in the possibility of producing more food through fish farming as this will contribute to alleviating poverty and malnutrition. By giving the small-scale farmer the opportunity to increase his cash income and diversify his products, aquaculture practices will make better use of some types of land that cannot be used for farming and it would strengthen and diversify the internal market; it will also create some new employment opportunities (FAO, 2008). It is fairly certain that the average diet in Rwanda provides too little animal protein and such a significant lack of animal protein indicates a substantial potential demand for fish in Rwanda, in spite of the fact that fish is not part of the traditional local diet in the country (FAO, 2008).

The focus of this review article is on food security as a primary concern toward an active and healthy life, with an emphasis on aquaculture and to encourage its integration into Rwandan citizens' agricultural production systems while also addressing the need for increasing nutritional diversity and eradicating hunger and malnutrition. Numerous policies and programs aiming at increasing agricultural production have been recently adopted by the Government of Rwanda in rapid succession. Land tenure policy, agricultural development policy, promotion of soil fertilization, increased livestock breeding, developments of marshlands irrigation, land consolidation policy, privatization of state-owned enterprises in both coffee and tea industry have all been part of government's attempts to increase food production (Promar, 2012). Aquaculture, a sector which is not part of Rwandan tradition, seems to be a relatively new agricultural practice compared to crop and livestock husbandry, thus it gains little focus. This paper aims at increasing the visibility of aquaculture in Rwanda national food security agenda and ensuring that the issue of this sub-sector of agriculture is explicitly considered in the on-going processes of fisheries and aquaculture reform.

Nutritional Values of Fish

Despite continued efforts to provide a more stable food supply including provision of an adequate nutritional quality for life functions for the poorer and disadvantaged population, a great proportion of the population in the developing world still suffers from chronic malnutrition. Ensuring an adequate production and supply of cereals and staple food commodities has dominated the debate on food security in the developing countries during past decades (Ahmed and Lorica, 2002). Agricultural policies in the developing countries, while continuing to focus on ways of increasing supply from traditional crop farming, have overlooked the role of diversified production, employment and income generation on farms in achieving food security (Ahmed et al., 1999; Williams, 1996). Hence, the cereals and crop commodity supply perspective of food security has now changed to include products such as fish and livestock (Ahmed et al., 1999; Delgado et al., 1999). At present, aquaculture is regarded worldwide as one of the fastest growing food producing sub-sectors, demonstrated by a continuous increase in total production throughout the last decade or more, particularly in a number of developing countries. Widespread adoption of aquaculture on traditional agricultural farms in a number of countries, such as Bangladesh, China, India, Indonesia, Thailand and Vietnam, has shown some early signs of aquaculture's ability to improve productivity, contribute to the diversification of farm operations, and create additional employment and income in developing country. (Ahmed and Lorica, 2002). Fish is used in many developing countries as a primary source of protein. Recent estimate by FAO (2014a) suggests that, in 2010, fish accounted for 17 percent of the global population's intake of animal protein and 6.5 percent of all protein consumed. FAO, 2014a valued fish as a major source of livelihoods and income, particularly in developing countries. It is estimated that more than 158 million people in the world depend directly on fish-related activities (fishing, fish farming, processing and trading). More than 90 percent of them are small-scale operators living in developing countries. In a broad sense fish, from fisheries and aquaculture, plays a crucial role in food security in terms of food (availability), livelihoods and income, particularly for some vulnerable and marginalized populations and provides essential micronutrients. It is particularly nutritious, rich in numerous micronutrients that are often missing in diets, particularly those of the poor. The presence of essential nutrients (such as iodine, vitamin B12 and D), omega-3 fatty acids, protein of high quality and fish's very rich content in calcium, iron, zinc and vitamin A, is well documented in the literature (FAO, 2014a)

Rwanda profile

Rwanda is a landlocked country located within the Great Lakes region of the central eastern part of Africa covering a surface area of approximately 26,338 square kilometres land surface. In 2014, Rwanda had an estimated population of 12,410,000 with an annual growth rate of about 3.8% and an estimated population density of 395 per square kilo meter (Promar, 2012) making it the most densely populated country in Africa (MINIRENA, 2011; Veverica et al, 1999). More than 80% of Rwanda's inhabitants live in the villages and they depend on agriculture for their livelihoods and a large part of the country surface area is used for agriculture (FAO, 2010). Due to the lack of cultivatable land as regards high population density, farming activities have been taking place on steep slopes, exacerbating land degradation, and causing massive soil erosion and deforestation, thus fertile land is becoming scarce ending up in enormous decrease in agricultural yields (MINIRENA, 2011; FAO, 2012). Given its dependence on subsistence agriculture as the primary means of livelihood for the majority of the population, Rwanda faces the challenges of providing all the inhabitants with enough food all times leading to prevalence

of nutritional deficiencies (Engle, 1993; Berg and Bort, 2010). The 1994 genocide severely exacerbated Rwanda's food insecurity, creating both short-term emergencies and longer-term effects resulting largely from destruction of the rural infrastructure and loss of agricultural inputs.

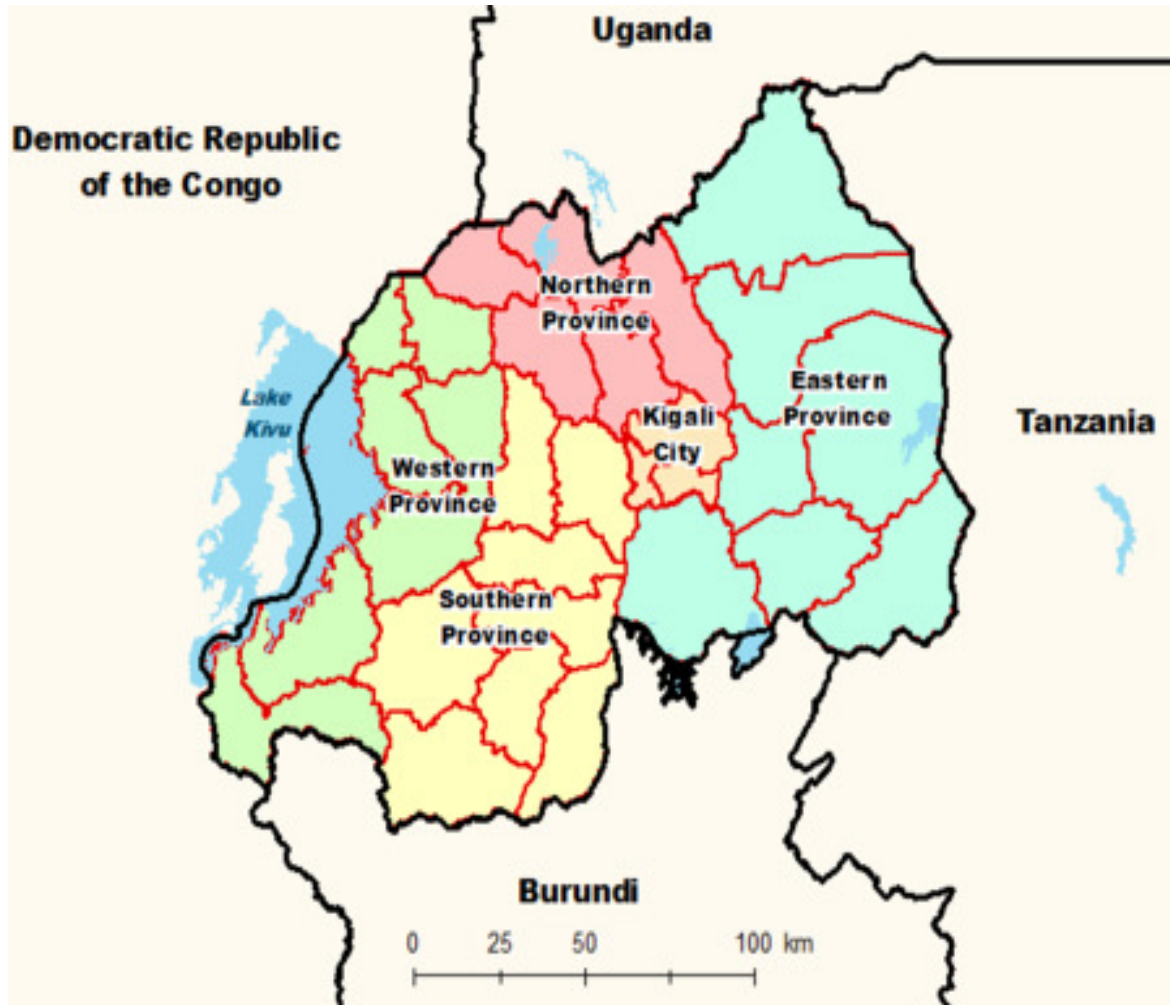


Fig 1: Map of Rwanda showing the boarder countries

Food security

The United Nations define food security as “People having at all times, physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” (Pérez-Escamilla and Segall-Corrêa, 2008). Both food security and health are strongly linked with available household income. Another factor that influences food security is the availability of a variety of nutritious foods at the local, regional, and national level. The availability of foods at the national level depends on local production for local consumption, as well as on the ability to import a variety of healthy and nutritious foods. (Pérez-Escamilla and Segall-Corrêa, 2008). In Rwanda, Approximately 90% of Rwandans live in rural areas. The vast majority are engaged in subsistence agriculture conducted on small family plots. Most are living below the poverty-line. In Rwanda, issues of poverty, food security,

and rural development are intimately intertwined. The food insecurity is high. Mostly poor, rural households, living in small crowded homes, depend on low income agriculture and casual labor. Household level poverty is an underlying cause of both food insecurity and malnutrition. Poor households simply cannot afford to access enough nutritious food to live a healthy active life or to invest in their livelihood. They are more vulnerable to high food prices - especially during the lean season when their own stocks have run dry. And they have no monetary backup to protect them from the consequences of shocks such as drought, flooding, illness, crop disease etc. The food insecure are more likely to rely on a small number of livelihood activities; others have no kitchen garden and their household food stocks are not sufficient to last through the lean season until the next harvest.

Who are the food insecure people?

In Rwanda, food insecure households are typically rural households with few adult household members, and who mainly depend on agricultural daily labour, their own agricultural production or external support for their livelihoods. Food insecure households engaged in agriculture, they typically have less livestock; farm small amounts of agricultural land, grow fewer crops, have lower food stocks and consume more of their own production at home. Households headed by women are more often food insecure than those headed by men. Vulnerable household tend to be headed by women and the elderly or by divorces, widows and those who never married. The less land households have the more likely they are to be food insecure, and the more they need to cope with lack of food. Household having only one activity are worse off than those who practice a combination of activities. Households surviving with precarious activity like gifts and daily wages are more food insecure so also the less the head of household has formal education, the more the households is food insecure.

Food security measurement

Five types of methods are used for assessing the extent of hunger and malnutrition, each having different applications and comparative advantages. All the methods complement each other and the method of choice depends on the question being answered and the economic and logistical resources available to collect valid data. Three of these methods known as FAO, household income and expenditure surveys (HIES), and individual's dietary intake estimate dietary intake and try to relate this to energy needs. The fourth, called Anthropometry, measures physical effects on growth and thinness and the fifth, experience-based food insecurity measurement scales, assesses perceptions of hunger and behavioral response (Pérez-Escamilla and Segall-Corrêa (2008).

- *The Food and Agriculture Organization (FAO) method* for estimating calories available per capita at the national level. This method use Food Balance Sheets and energy intake variance data derived from household income and expenditure surveys. Despite several limitations such as lack of dietary quality specification, this method is inexpensive and allows all countries to generate data needed and estimate their daily per capita caloric availability. It also allows data on food security trends across time to be examined and compared at national regional and global level.
- *Household income and expenditure surveys*, a method based on interviewing respondents in their households regarding the information on the amount of money they spend on food and

other necessities on weekly or monthly basis. It procures data on: the quantity of food bought (or expenditures) and costs associated with different foods consumed within and outside the house; foods received by any household member as either a gift or as payment for work, goods or services; and foods grown for consumption by household members. There are several advantages associated with this method: i) it allows for the identification of households at risk of food insecurity, thus in addition to mapping from the local to the national level, the determinants and consequence of food insecurity can be examined; ii) it collects dietary quality data that can be taken into account to understand the dimension of the food insecurity construct; iii) it can be used to evaluate national food and nutrition, and anti-poverty programs.

- *The individual's dietary intake* can be measured through (i) 24-hour memory recall; (ii) food frequency questionnaires; (iii) food records kept by individuals or by an observer. Dietary intake assessment has some unique, as well as common, advantages: i) it measures food consumption directly and not only food availability; ii) it addresses both dietary quality (macro and micronutrients) and caloric intakes at the individual level; iii) it allows for mapping from the local to the national level, and the determinants and consequences of food insecurity at the individual level can be examined; this is important for understanding, for example, intra-household food consumption patterns and how it is influenced by gender; iv) different dietary intake methods can be used to understand recent (e.g., 24-hour recall) versus longer term dietary intake patterns (e.g. food frequency questionnaires).
- *Anthropometry* is defined as the measurement of size, weight, body proportions and ultimately the composition of the human body. Anthropometric indicators measure the impact of both food insecurity and health status on the nutritional status of individuals. The anthropometric indicators most commonly used in national surveys are based on weight and height (or length) of infants, young children, youth and adults. The cost of doing the measurements is relatively low making it a very popular method in national surveys worldwide. It is highly standardized and bears evidence-based cut-off points.
- *Experience-based food insecurity measurement scales* is a fundamental measurement of household food insecurity using scales based on the perception or experience reported by the affected individuals. It brings in the following food insecurity dimensions: psychoemotional, ii) dietary quality and iii) dietary quantity. It focuses on lack of access to nutritional foods or enough amounts of foods because of lack of money. Questions are usually answered by a respondent who is in charge or well informed about food acquisition and food intake patterns in the household. The questions are ordered following the assumption that chronic food insecurity results in a process managed at the household level that involves predictable coping mechanisms or adaptations specific to the degree of severity of the food insecurity challenge. As a typical instance, a food secure household may first experience a negative event, such as the loss of employment of the head of the household, that triggers a state of anxiety and worry in the household reflecting a feeling of uncertainty about how to keep food on the table in the near future. If the situation does not get corrected the household will start using strategies to “extend” the food so that it lasts longer, e.g. adding water to milk, consuming artificial sweetened drinks instead of 100% fruit juices, consuming more pasta or rice instead of legumes or other vegetables. At this stage, households are likely to sacrifice their dietary

quality to sustain their caloric needs, and in some instances this approach may even lead to excessive caloric consumption. If the food insecurity process continues moving forward, household members will start eventually reducing the amount of foods needed to sustain their caloric needs, leading to hunger first in adults and then children.

Aquaculture profile in Rwanda

Aquaculture is a non-traditional practice introduced to Rwanda at the end of the 1940s nurtured by the Belgian colonial administration. Two main fingerling production centres were constructed in the southern Part of Rwanda: one at l'Ecole des Assistants Agricoles, Butare, in 1952 and the the other at Kigembe Station in 1954 and Direct support was provided to fish farmers in form of extension services and training, seed, and other inputs (MINAGRI, 2011). During the years 1960–65 development of fish culture in Rwanda came to a standstill and many existing ponds were abandoned. The main reason for this was the disappearance of the support for rural fish farming formerly provided by the colonial administration. From 1967 to 1973, the government undertook to revitalize fish farming (MINAGRI, 2011). However, despite the efforts by the government through the Ministry of Agriculture and Animal Resources (MINAGRI), non-government organizations (NGOs) and donors to promote aquaculture as a sustainable technology that is easily integrated into farming systems, and has the potential to improve food security and incomes for rural populations, aquaculture has been adopted by Rwandans to a very limited extent. The category of aquaculture that exists until now is subsistence fish farming characterized by low input and low output, primarily based on livestock pond fertilization (MINAGRI, 2011).

FISHERIES IN NATIONAL ECONOMY DEVELOPMENT OF RWANDA

Surface water bodies in Rwanda occupy a total of 135,000 Ha which is 8% of the country's surface area which includes 101 lakes totaling 1,495 km², 861 rivers totalling 6,464km. The main lakes for fishing are Kivu, Cyohoha and Mugesera. There are several minor lakes and many rivers, floodplains and swamps all of which are ideal fish breeding and nursery grounds. Fisheries resources are among the most significant natural endowments in Rwanda as they represent a major source of protein in the diet of most Rwandan and also for revenue generation.

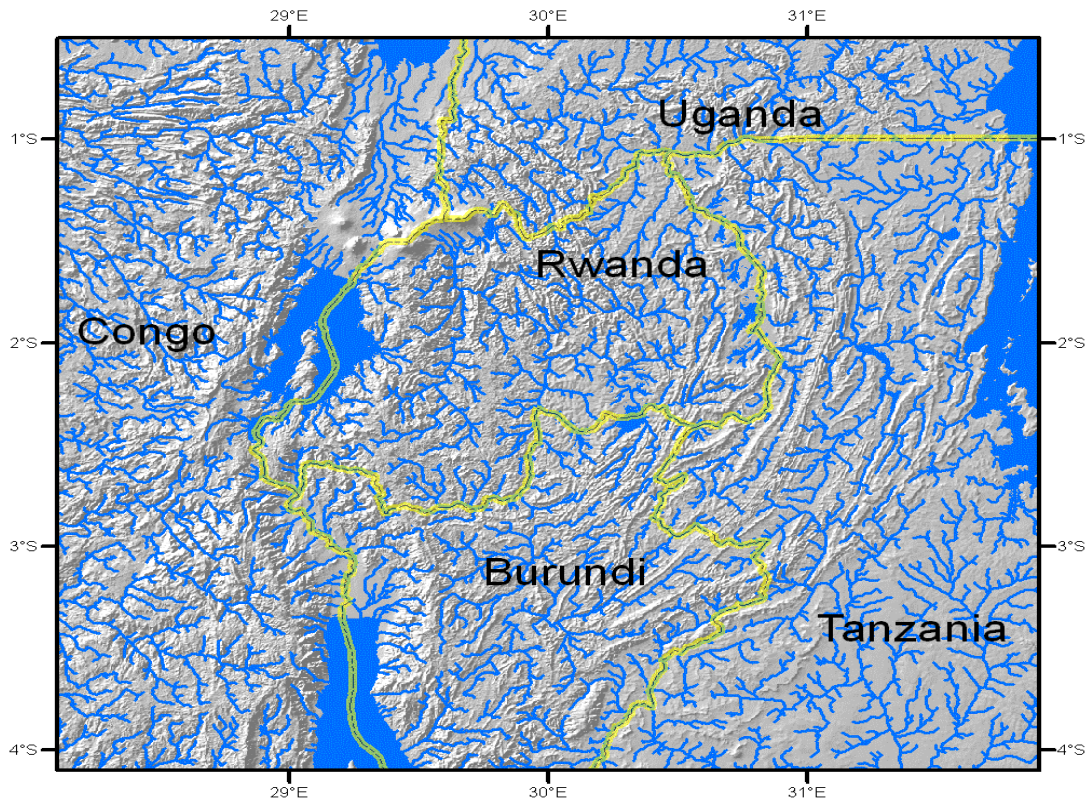


Fig 2: Rwanda hydrological network

Source: <http://rocky.ess.washington.edu/areas/Rwanda/>

Fishing activity is largely confined to the lakes of Kivu, Cyohoha and Mugesera and undertaken through co-operatives or associations of fishers. Fish production figures are still low and the country imports fish mainly from Tanzania and Uganda to meet the domestic demand. The country in general is protein deficient and this significant lack of animal protein indicates a substantial potential demand for fish in Rwanda, in spite of the fact that fish is not part of the traditional local diet in the country. Part of the potential (future) demand for fish could be satisfied by the expansion and intensification of the capture fisheries. The Government is taking active steps in these directions. The fishery sub sector has not yet contributed much to Rwanda's GDP. This is due to inadequate replenishing of fish in the lakes and a resultant low output. Fishing is however, conducted by various cooperatives and associations. The main lakes for fishing are Kivu, Cyohoha and Mugesera and initiatives are being implemented to develop the fishery industry by encouraging and supporting fish farming through rehabilitating the old fish ponds and developing new ones. 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. Local market for fish products is guaranteed as fish has remained on high demand. Currently one kilogram of fish costs about US \$3 while the fish fetched better prices in the export market. The prices of fish in the local market have been on the increase for the last twenty years and the trend is likely to continue for some years.

Reasons for investing in Aquaculture in Rwanda

Market opportunities

Rwanda's imports since 2007 up to date is 60,000MT of fish. Rwanda produced 19,475 MT (2012). By 2020, Rwandan projection is 155,000MT of Fish Nationally, there is a big demand and as it is the plan to become a hub of business for the whole region and even the whole Africa, fish production increased from 9,117MT to 19,475MT since 2007 to 2012. A local market of almost 12.5 million people is demanding (not yet satisfied). Rwanda's Fish market demand consists of almost 70% of Tilapia, 25% of Sambaza and 5% of others like Cat fish. Rwanda is located centrally bordering three countries in East Africa which has an existing Customs Union and forming a Common Market in 2010 for 125 million people. The country is quickly becoming an active redistribution platform to other neighbouring countries, due to zero Corruption and highly encouraging business environment.

Rwanda's advantages

Favourable weather, natural water resources, and efficient manpower. About 8% of the entire country is covered by water: Lakes occupy about 128,000 Ha, Rivers occupy about 7,260 Ha and Water in wetlands and Valleys occupy about 77,000 Ha. Therefore, this makes Rwanda a good investment destination for fish and Aquaculture. Rwanda has over 25 Lakes and most of them are located in Eastern province and Lake Kivu is the largest with 2700 square Kilometres in Size and presents the best condition for fish farming in cages for its water temperature is 25⁰C all year round with dissolved Oxygen in the 10 m layer of 8ppm. It has an average productivity of 1 Tons / cage with a maximum of 1.5 Tons /cage

Investment highlights

It is well known that Fishing industry and Animal Feed Production sector are still at the infancy stage but growing fast in the country. The following are the companies engaged in fishing industry: Rwanda fish industry, Lakeside fish farm, Sopicaki Ltd and other cooperatives. Presently fish farming is being carried out on only 218 Ha and 718 cages operating in over 186 cooperatives with a membership of up to 6269 people of which females were 3718 and males were 2551. Concentrated fish feeds are on high demand. A Feed factory of a high producing capacity is needed. Development of Aquaculture parks is another opportunity for this industry to attain more growth. Finally, Cage culture System on Lakes Kivu, Muhazi, Burela and Ruhondo is another huge opportunity.

Present challenges in fish farming in Rwanda

The farmers are faced with the following challenges; the aquaculture of fish in ponds and cages are quite expensive, increasing price of feeds as one of the major challenges that fish farmers face, getting quality feeds for the fish that is reared in both the cages and in ponds, neighboring farms using herbicides on weeds, which are then washed into the ponds when it rains. Fish is also eaten by birds, snakes and other predators and this reduces the fish numbers and minimizes the farmer's income, finally, the cooperatives' management is still fragile and not commercially oriented.

Constraints of Aquaculture Development in Rwanda

Although cool temperatures, acid soils, and silted and polluted water pose challenges to fish culture in Rwanda the major Constraints to the development of aquaculture sector in Rwanda are associated to social and economic aspects as pointed out by Veverica (1999) and MINAGRI (2011). Such as lack of fish eating tradition that did not consider fish as a high value commodity which brings about poor interest of population interested in fish farming, high population density associated with lack of farmland. The average farm size is less than 1hactare per family which results in a paucity of available inputs, deprivation of private ownership and construction right in the marshlands. Farmer's home are therefore at a distance from their fish ponds and the absence of land tenure discourages farmers in investing in land improvements. Insufficient cash flow in the rural areas is another major factor which hindered both purchase of inputs and sales of fish. Poor linkage of aquaculture and other agriculture production systems, lack of private sector investments in the sub-sector and poor instructional and regulatory framework for aquaculture management.

Conclusion and Recommendations

Although aquaculture technology adoption to date has been very poor in the country, increasing numbers of food insecure rural poor, persistent land degradation, and pollution and overuse of traditional fishery resources suggests that aquaculture should be revived as a potential development pathway to steady food security. A serious constraint to an increased per caput consumption of fish is the low purchasing power of the rural population. Therefore planning for fish culture development with the aim of countering the deficit of animal proteins in the rural diet will have to envisage small, family-based units, which provide fish for home consumption only on a limited scale. Estimates and comparisons of costs and earnings in Rwanda suggest that fish is likely to be more profitable to the farmer than most other agricultural products. In this regard, for a rural family using the main locally available resources; the only major input apart from family labor and agricultural wastes would be the fingerlings needed for initial stocking of the pond. Eliminating hunger and malnutrition can save millions of lives every year. It is generally recognized that aquaculture could make a substantial contribution to achieving this goal, especially in sub-Saharan Africa because it is socially acceptable, economically viable and environmentally friendly; aquaculture could also play an essential role in reducing poverty.

The methodology for assessing the contribution of aquaculture, to food security and poverty reduction are poorly documented. Due to the complexity and extent of food insecurity, it may be difficult to devise a single method for assessing aquaculture's contribution to alleviating poverty and hunger. There are a number of biological and socio-economic indicators that give a good indication of whether a technology is beneficial to global, national and local food security. Assessing and quantifying even small benefits is essential for improving food security as it allows the advantages of one type of food production to be compared with the advantages of others. Further work should combine the indicators outlined in this study to form a single methodology to assess the contribution level of both small-scale and commercial aquaculture to alleviating hunger and poverty in different parts of sub-Saharan Africa. The outcome would determine the extent to which the promotion of this sub-sector should be encouraged in the many food insecure regions of the world where its sustainable development is possible.

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