

A Review of Aquaculture Production in Tanzania; Recent Status, Challenges and Opportunities, and Its Impact in Poverty Alleviation

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Article History

Received: July 20, 2020

Revised: August 22, 2020

Accepted: August 25, 2020

Published: August 29, 2020

Abstract

Tanzania endowed with abundant water resources with a huge potential to develop marine and freshwater aquaculture. Efficient utilization of these resources are required as the demand of fish is increasing with increase in the population of an average of 2.47% per year. Due to that, a gap between fish supply and demand is widening which in turn causes low fish protein supply leading to malnutrition. To bridge this gap, several strategies have been implemented by the government including fish importation to supplement fish shortage in country. However, this strategy seems to be unable to satisfy the fish demand of the large population due to high importation costs. Therefore, a review was conducted to explore recent aquaculture production in Tanzania, challenges and opportunities, different strategies implemented, as well as impacts in poverty alleviation. Several government reports and online-published papers were explored. Therefore, this review indicates a remarkable increased in fish production due to fish species diversification, government support and private sector investment. Hence, provide more opportunities to the people to be employed and earn money, as well as availability of protein from fish to improve their nutrition status. In addition, this review suggest some areas to be emphasized including; development of technology and investment in seeds and feeds production, investigation of alternative protein sources for fish, policies harmonization, and financing mechanism development.

Keywords: Tanzania; Aquaculture production; Malnutrition; Income generation; Food security; Poverty.

1. Introduction

The population in Africa expected to be over 2 billion by 2050, and food production projected to increase by 300%, to provide minimal adequate diets [1]. Therefore, fish farming sector will play a significant role as a means of livelihoods to millions of people in Africa. In many African countries including Tanzania, the demand of fish is increasing with increase in population of an average of 2.47% per year [2]. Several reports indicated that, the gap between fish supply and demand is widening which in turn causes low fish protein supply leading to malnutrition [3, 4]. The imported fish from other countries used to supplement fish shortage in the country [5]. However, this strategy is unable to satisfy the fish demand of the large population due to high importation costs. Therefore, the development of fish farming sector can significantly contribute to the economy by increasing household income, food security and employment opportunities [6].

In addition, Tanzania endowed with abundant water resources with a huge potential to develop marine and freshwater aquaculture. The country, possess about 49% of the Lake Victoria, which is the largest lake in Africa, as well as the Indian Ocean coast from Northern East to the Southern East. Further, the country have 21,300 grow-out earthen ponds and nine operating raceway systems [7, 8]. These facilities can contribute to poverty reduction and enhance food security in the country. However, the majority of people who lives in the rural areas where there are plenty of resources are poor. Indeed, aquaculture development is very crucial for the country's economy and as a strategy for poverty reduction. Therefore, the aim of this review was to explore recent aquaculture production in Tanzania, challenges and opportunities, different strategies implemented, as well as impacts in poverty alleviation.

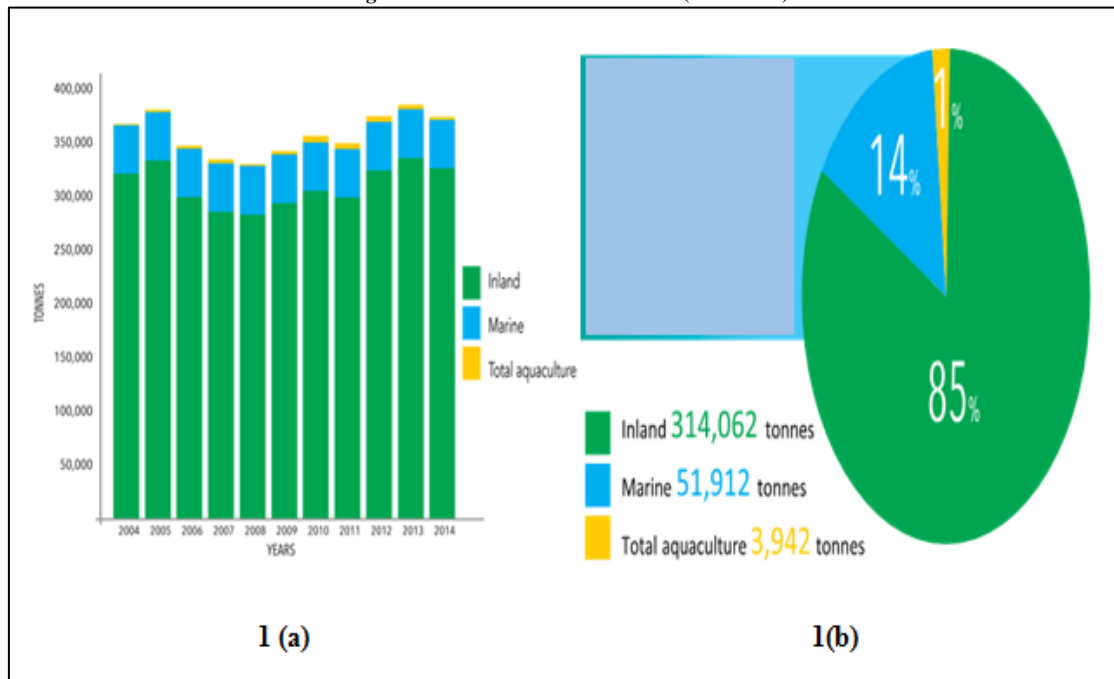
2. Fish Production in Tanzania

The fisheries sector in Tanzania divided into the following subsectors: marine and inland capture fisheries, aquaculture, and fish processing. Over the last decade, Tanzania's fisheries production has been in the range of 325,000 to 380,000 tonnes per annum, in which 85% is from inland fisheries, marine fisheries (14%) and aquaculture (1%) as shown in Figure 1a and b [6].

Recent reports show that, total fisheries production in 2017 was 376,002 Tonnes and its contribution to the GDP was 1.4% [9]. In 2018, aquaculture sector contributed about 11,800 Tonnes, valued US\$ 41 million [10].

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Figure-1. Fish Production in Tanzania (2004-2014)



Source: Fisheries Statistics 2014 and Department of Fisheries Development [6].

3. Fish Consumption in Tanzania

Fish consumption in Tanzania reported to increase every year. In 2009 to 2011, the average kg of fish and seafood/capita/year was 6.1. In 2013, the average fish and seafood consumption was 7.0 kg/capita/year [11]. In addition, in 2014, fish consumption was 7-8 kg/year and contributed to 30% of the total animal protein intake [6]. This level of per capita consumption is low, compared to the global per capita consumption of about 20 kg. Therefore, with a population growing at 2.7% annually, increased fish supplies are important to maintain protein requirement in the diet.

4. Aquaculture Sector in Tanzania

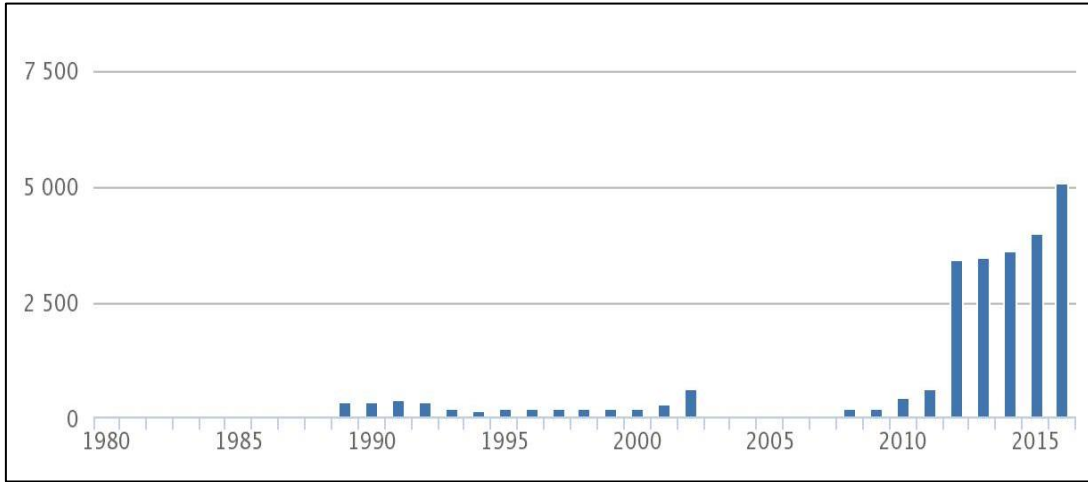
Aquaculture activities in Tanzania started in the early 1950s with an experimental tilapia culture in earthen ponds. Then, followed by domestication of other species such as trout, and catfish (in fresh water), and a small marine aquaculture (mariculture) which produced milkfish and prawns. Also, there was a small seaweed farming (red algae) mostly practiced by women [6]. FAO [12], estimated 14,100 ponds of an average size of 150 m² were existed in the country, with the total production of 1,523 tonnes.

In the past few decades, the sector continued to face many challenges and still has a very limited development with the exception from industrial shrimp farm projects, which implemented in a small-scale basis [6]. This was due to few fish species cultured with mainly Tilapia as a dominant species. For instance, Ministry of Agriculture Livestock and Fishery MALF [6] reported that, the aquaculture sector had a total production of 4,000 tonnes per year, where three quarters of the production was tilapia. In addition, some reports show that, there was experimental rainbow trout farm (25m x 25m in size) in Arusha region [13]. Further, most fish farmers reported to use animal manure as the main source of fertilizer in ponds, and they were using local available feed materials and domestic leftovers including maize bran, wheat bran, vegetables and wild grass to feed their fish [6].

In recent, the sector has gained popularity in the country due to the reformation and establishment of the Aquaculture Development Division (DOA) in 2009, where all aquaculture activities fall under mandate of this division in the Ministry of Livestock and Fisheries Development. This was evidently in 2017, where fish production increased up to 11,802 Tonnes compared to 3,407 Tonnes in 2012 [9]. In addition, there were high demand of some fish species such as African catfish (*Clarias gariepinus*), which was used as food, control of over-population in tilapia ponds and as bait for the Nile perch fishery in Lake Victoria [14].

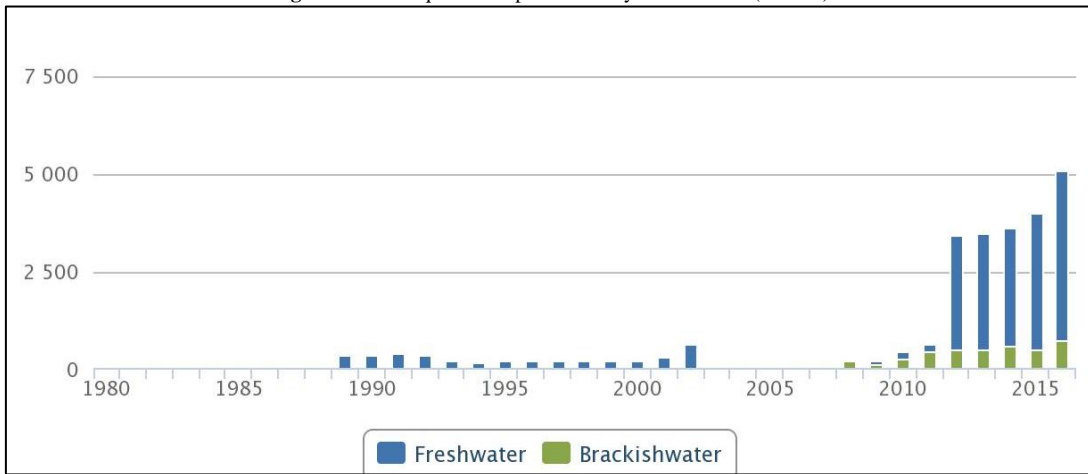
Further, some advancement have reported in some areas around the Lake Victoria where there are some larger vertically integrated production units with cage farming, and some larger ponds for shrimp production in coastal areas (MALF, 2016). Due to this, in 2015-2016 the aquaculture production reported to increase from 3,992 tonnes to 5,047 tonnes (Figure 2 and 3) [15]. In addition, due to this advancement, there are 15 hatcheries for tilapia in operation (5 of owned and operated by the government) with production reaching slightly over 5,000,000 fingerlings, against a demand estimated by the Department of Fisheries Development to be over 30,000,000 fingerlings countrywide [6]. Therefore, to ensure aquaculture continue to grow, Government has strongly supported investment in aquaculture training, with degree programs at Sokoine University of Agriculture and University of Dar es Salaam, and skills training at Mbegani Fisheries Development Centre and FETA.

Figure-2. Total aquaculture production in Tanzania (Tonnes)



Source: Department of Fisheries Development [6].

Figure-3. Total aquaculture production by environment (Tonnes)

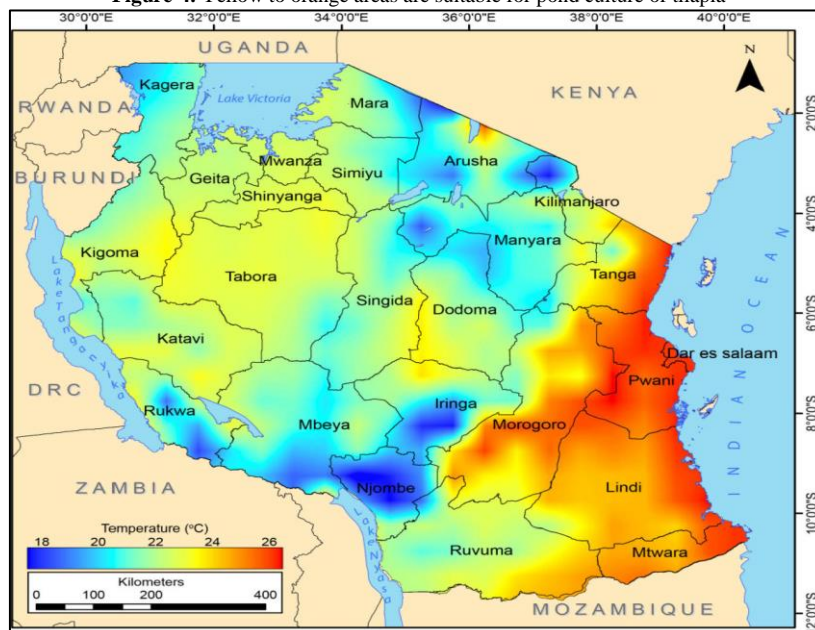


Source: Department of Fisheries Development [6].

5. Aquaculture Production Systems and Areas

A potential for increased aquaculture production in Tanzania exists and is yet to be fully realized [16]. The area considered suitable for aquaculture development estimated to be 58,000 and 64,300 square kilometers of fresh and marine waters respectively, which is equivalent to 30% of the land area in Tanzania [17]. The suitability for pond culture of tilapia species in the areas have been indicated with yellow to orange and its spatial temperature variations (Figure 4).

Figure-4. Yellow to orange areas are suitable for pond culture of tilapia



Source: Department of Fisheries Development [6]

6. Major Aquaculture Fish Species in Tanzania

6.1. Nile Tilapia (*Oreochromis Niloticus*)

Tilapia farming in Tanzania started in the early 1950s with an experimental culture in earthen ponds. The most common culture species were Tilapiine cichlids (genus *Oreochromis*) which reported to be abundantly in lakes and slow flowing rivers across the country [18]. During that time, there were 23 *Oreochromis* species, where 21 of these are still considered valid *Oreochromis* species [19] and are distributed all over the country. Also, it was estimated that, 14,100 ponds of an average size of 150 m² were existed and the total production was of the order of 1,523 Tonnes from 212 hectares of ponds [12]. Animal manure were used for ponds fertilization, with the supplement feeds made from a combination of maize and rice brans.

In recent years, Nile tilapia become the most preferred species to farmers, which boosted the total production up to 3,118 Tonnes in 2014 (Figure 5). This was due to some development in feed industries on pelleted feeds production [5], and genetic improvement techniques [20].

6.2. Shrimp Farming

Since 1990s, there were 3,000 ha suitable for shrimp farming along Tanzania's coastline with a production potential of over 11,000 metric Tonnes annually [6]. The seeds were collected from the wild and maintained in tanks for spawning, then, the production of post-larvae for grow out is carried out in hatcheries.

In 2014, the shrimp production from Jimbo farm at Mafia Island was 350,000 MT per annum and 396 Tonnes of prawns (Figure 5) [6]. However, given the gap in production and the readily available markets for prawns, investment opportunities exist in prawn farming in Tanzania will help to meet the market demands.

6.3. Seaweed Farming

In few decades ago, seaweed farming were developed in coastal areas of Tanzania, whereby, two farming methods were adopted; bottom culture and the tie-tie methods. The bottom method was practiced by tied up small branches of seaweeds on a long rope at the interval of 30cm and placed at the bottom during low tide [21]. The tie-tie method involved tying fronds of seaweed to strings stretched between wooden pegs and harvested after two weeks [22]. There were two species namely *Eucheuma spinosum* and *Eucheuma cottonii*, which farmed along the coast of Indian Ocean.

In addition, reports show that, over 3,000 coastal people were involved in seaweed farming and produced over 6,000 metric Tonnes dry seaweed weight in 2009. Only 30% of the area were utilized and 1% of the workforce were engaged [23]. In 2009, the contribution of seaweed to Zanzibar's GDP (Tanzania Island) was 7.6% [15]. However, still there was low production, which could be due to lack of processing plants for value addition to produce variety seaweed products such as soap, sweets as well as extracting carrageenan and agar-agar.

In recent, seaweed farming reported to contribute to the income of the most farmers especially women along the Indian Ocean coasts. In 2018, Tanzania was ranked the 8th top seaweed producer in the world with the production of 119,000 Tonnes compared to 223 Tonnes/year in 2014 (Figure 5) [6, 15]. This remarkable increased in production achieved due to establishment of some projects and full commitment of the government to support farmers.

6.4. Milkfish (*Channos Channos*)

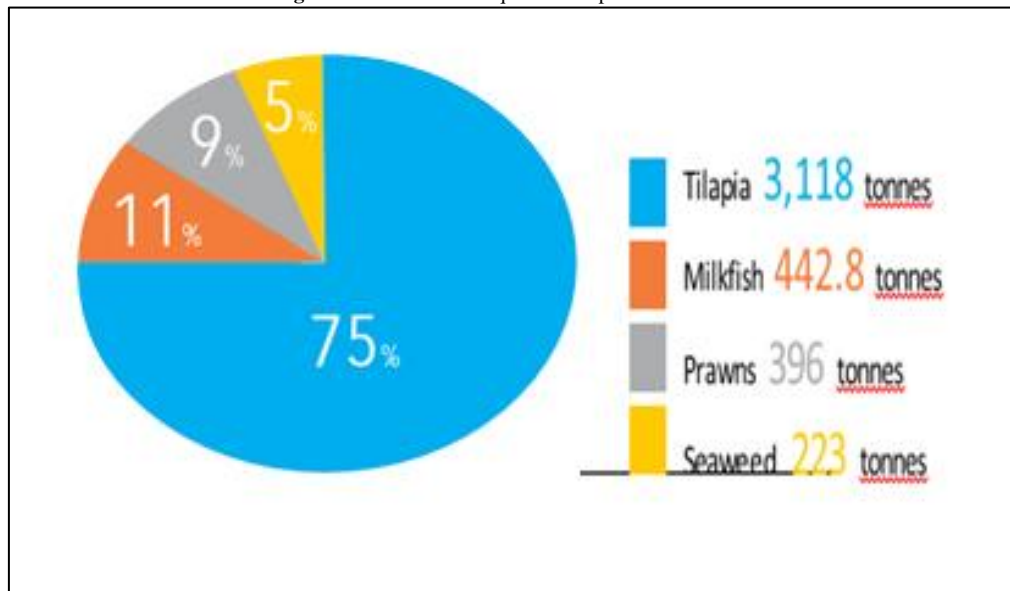
A fish farming group in Zanzibar since 1996 owned the oldest milkfish pond in Tanzania [24]. The group had six milkfish harvests on record amounting to total revenue of US\$ 0.97/fish with average weight of 0.33kg to 0.50kg [24]. The farming activities spread to the mainland where there were more than two dozen operations along the coastal districts of Mtwara, Lindi, Kilwa, Rufiji, Mkuranga, Bagamoyo and Tanga. In 2000, it estimated that, there were approximately 100 milkfish ponds of one-hectare size throughout the country [25].

In recent years, milkfish production was 442.8 Tonnes per year in 2014 (Figure 5). This was due to high investors and efforts form Government of Tanzania to prosper aquaculture sector [6].

6.5. Mud Crab Fattening

It involved collection of crablets from the wild for fattening and it is commonly practiced along the coastal areas. In 2009, the fattened species in the country was *Scylla seratta* with an estimated production of 1 Tonne per annum [25]. The crab fattening gained popularity due to its high demand in domestic and export markets. However, crab collection from the wild is not sustainable for a viable industry, therefore, a call for investment in crab post larvae production, culture and fattening for domestic and export market is highly encouraged.

Figure-5. Production of aquaculture species in Tanzania



Source: Department of Fisheries Development [6].

7. Ranking of Tanzania in Aquaculture Production in East Africa

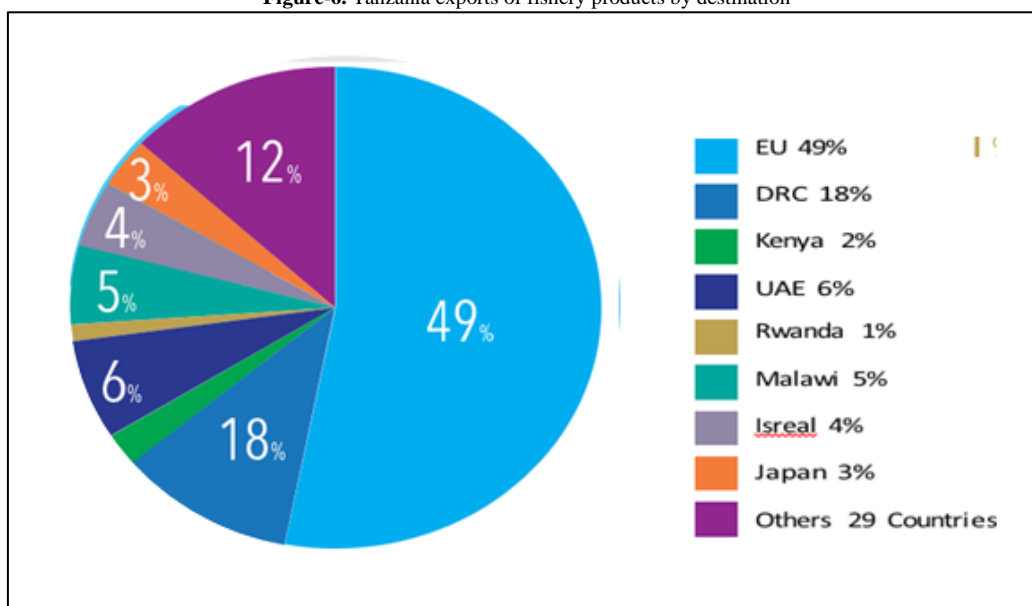
East African aquaculture dominated by production for human consumption. The contribution of aquaculture to total fisheries production varies sharply from country to country [25]. In Tanzania, aquaculture reported to be the fastest growing food-producing sector. The country was ranked as 11st in production among all African countries and 3rd among East African countries [26].

In recent years, Tanzania’s aquaculture production equates to about 0.2% of fish supplies for human consumption in the country. However, aquaculture contributes to 1.4% and 6.5% in Kenya and Uganda respectively [6]. Therefore, Tanzania has considerable potential for increasing the contribution of aquaculture, given the extensive lake and river water resources, ideal temperatures and availability of raw materials for feed compared to others countries in the region. For instance, Lake Victoria, which is the largest lake, Tanzania owned 49% compared to 6% (Kenya) and 45% (Uganda) [27].

8. International Trade in Fisheries and Aquaculture Products

Tanzania is an importer and exporter of fishery products, although the latter are more significant. Total exports of fishery products have plateaued since 2005 to 2014, valued US\$ 140-188 million [6]. The contribution of fisheries products to GDP in 2009 was 1.3 and 2.2% in 2014. The exports were in 47 countries, including the European Union, which accounts for 45% of the volume and 52% of the total value of all exports [6]. In addition, Tanzania was the main supplier of Nile perch fillets to the EU, exporting 12,400 tonnes (47.5% market share), followed by Uganda with 10,800 Tonnes (41%) and Kenya with 2,900 Tonnes (11%). However, Tanzania export fish products to other countries including DRC, which account for 18% of the value of exports (Figure 6) [6].

Figure-6. Tanzania exports of fishery products by destination



Source: Department of Fisheries Development [6].

9. Impacts of Aquaculture in Poverty Alleviation

To meet a rapidly growing food demand and raising income to the rural people, farmers must increase production and productivity [28]. Among food producing sectors, fish farming play important role in supporting life of many individuals and improves community food and nutritional availability [20, 29]. It argued that, fish are generally cheaper than other animals' meat and contain protein levels of 17- 20% as well as minerals and vitamins [30, 31].

In Tanzania, about 20% of farmers who integrated fish farming technology into the existing farming system produced up to 40-60/kg/acre/year of farmed fish. Moreover, aquaculture integrated into the existing farming system has shown to improve food and income security with little or no external inputs [16].

In 2014, Tanzania fish farming sub-sector employed about 183,800 full time fishermen and 4.0 million people earned their livelihoods from fish farming related activities [8]. Also, the sector contributed to about 2.4 % to the GDP [8]. In addition, about 15,000 to 20,000 people are engaged in seaweed farming sector, and 14,100 in freshwater and 3,000 in the marine sector [6, 32].

10. Challenges Facing Aquaculture Sector in Tanzania

10.1. Low Level of Technology and Competition from other Sectors

Fish farming in Tanzania is characterized by a low level of technology adoption such as small size ponds likened to holes, low input allocation in terms of cash income, time and infrequent harvest [16]. All these factors have made the contribution of fish farming to the local community's wellbeing to be low.

In addition, there are a number of activities, which competes with fish farming. For instance, fish farming competes with livestock and crop production, and off-farm activities to meet animal protein intake and earn cash income [16]. Further, shrimp farming is hampered by conflicts over environmental concerns, in particular the effects of shrimps farming extension on mangrove forests [5].

10.2. Unreliable Seed Supply

Tanzania as other developing countries, is still struggling to promote growth of aquaculture sector due to poor quality seeds. Most fish farmers have to obtain their seeds from wild capture, mainly from rivers. This is due to the constraints that, there are few number of operating hatcheries, low level of technology in larval rearing and live feeds production [33].

Recently, there are only 15 hatcheries for tilapia in operation (5 owned and operated by the government) with production reaching slightly over 5,000,000 fingerlings, compared to the demand which estimated to be over 30,000,000 fingerlings countrywide [6]. Therefore, the apparent lack of good quality fry, and the excess demand over supply results in lower quality and higher levels of mortality, and undermined productivity.

10.3. Inadequate Aquaculture Extension Services and Poor Infrastructures

Despite of the existing potentials of fisheries and aquaculture sector, fish farming in Tanzania is constrained by inadequate aquaculture extension services, aquaculture information and knowledge and poor transport infrastructure [17, 34, 35]. The adoption of improved fish farming practices requires adequate access to information that should be effectively disseminated to the famers and other stakeholders [36].

To overcome these challenges, several traditional approaches have been used by fisheries officers in delivering and disseminating information and knowledge to fish farmers, including public awareness creation and training using Farmer Field School (FFS), demonstration and farmer visit [37, 38]. However, these approaches have been constrained by inadequate extension capacity.

In recent, there are more than 436 fisheries extension officers out of 16,000 who are required in the country to meet information and knowledge needs of fish farmers [39]. Thus, such a constraint decreases the dissemination of information and knowledge to fish farmers [40].

In addition, some of the fishery officers do not have adequate and relevant knowledge on fish farming, because some of them have been trained on livestock or crop production, a situation that makes it difficult for farmer to acquire the right information and consequently lead to poor fish farming productivity [36].

10.4. Insufficient Quality Feeds Supply

A reliable quality feeds supply is another constraint, which have been reported to hinder aquaculture development in most developing countries. In Tanzania, reports show that, there are five fish feed producers and suppliers mainly based in Dar es Salaam [6]. However, the government supports the distribution of affordable fish feed by subsidizing 85% of the commercial selling price to fish farmers.

In addition, there are few commercial operators with vertically integrated facilities, which include small-scale fish feed mills, using locally available raw materials such as fish meal, soya beans, sun flower oil, cassava flour, wheat and maize bran. Also, some feeds are imported directly by larger producers, to ensure better quality and productivity [6].

10.5. Subsistence Activity

Apart from a few notable examples, aquaculture in Tanzania is primarily a small-scale activity, with small ponds, little formal management and low productivity, reflecting its subsistence in nature. Also, small-scale seaweed farms are run by the women assisted by the younger family members long the entire coast from Tanga to Mtwara,

and in Mafia and Zanzibar island [6]. Therefore, government intervene is necessary for the development of aquaculture sector which will enhance income to the communities, hence poverty and malnutrition reduction.

11. Solutions to the Addressed Challenges

- Increasing knowledge to farmers through implementation of different programs as it has been done in Agriculture sector.
- Development of technology and investment in seeds and feeds production.
- Investigation into alternative protein sources for fish such as plant materials and other locally available materials.
- Policy harmonization (Environment Policy) to facilitate private sector investment in aquaculture sector.
- Development of a mechanism for financing some investments in Aquaculture sector.

12. Opportunities for Aquaculture Development in Tanzania

Tanzania has plenty of resources including water resources, environmental conditions and raw materials for fish feed, all of which can underpin a massive expansion of aquaculture. It is well endowed with ideal physical conditions for freshwater and brackish aquaculture. Recently, larger scale investors are beginning to take an interest, and a renewed policy initiative demonstrates the Government's serious intent.

In addition, there are substantial commercial opportunities in the development of hatcheries and feed production systems, as well in grow-out facilities to supply national and regional markets with fresh tilapia on ice. However, barriers such as feed subsidies and a complex regulatory framework need to be sorted out, along with developing a mechanism for financing investments in the sector [6].

13. Conclusion

The following strategies should be taken to promote aquaculture production and poverty alleviation.

- Encourage the allocation and utilization of fish resources in favor of the rural community for human welfare development
- Empowerment of women in the society to access resources for effective poverty eradication.
- Promote private investments in the sector to stimulate fish production, processing and marketing, and other related social economical activities.
- Promoting effective development of the aquaculture industry through production and distribution of quality aqua feeds and seeds
- Promoting aquaculture fish production to complement declining in capture fisheries.

Acknowledgement

The authors acknowledge all the publications used to prepare this review.

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