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Is Aquaculture a Success? Evidence from Africa

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Globally, human population growth worldwide is something that cannot be controlled, and so there is a need to sustain the needs of a growing population. In Africa, for instance, population projections are made yearly, not even once stagnation is seen. Feeding and nutrition issues, hunger eradication have become a problem with the continuing growth of the population, which in turn is putting a lot of pressure on available resources like capturing fisheries from the lakes, oceans, and rivers, leaving them void. Aquaculture has then proven useful in supplementing the dwindling catch fisheries stocks, which have become incapable of supporting the growing population. Since its introduction in Africa, however, changes have been seen as it has contributed to food security and malnutrition and improved livelihoods by creating jobs and generating income. Currently, diversified products come from aquaculture practices both in inland and freshwaters, ponds, and intensification of aquaculture farming methods, which all put together boost the production to a higher level. Genetics has also been employed to ensure seeds produced for aquaculture are worth being cultured for production. A lot of fisher folks are benefiting both directly and indirectly making a living. Although the contribution of aquaculture is small, sometimes termed insignificant, its growth is steady and it has a promising future as far as its goals (increased protein food production and improved livelihoods of fisher communities) are concerned.

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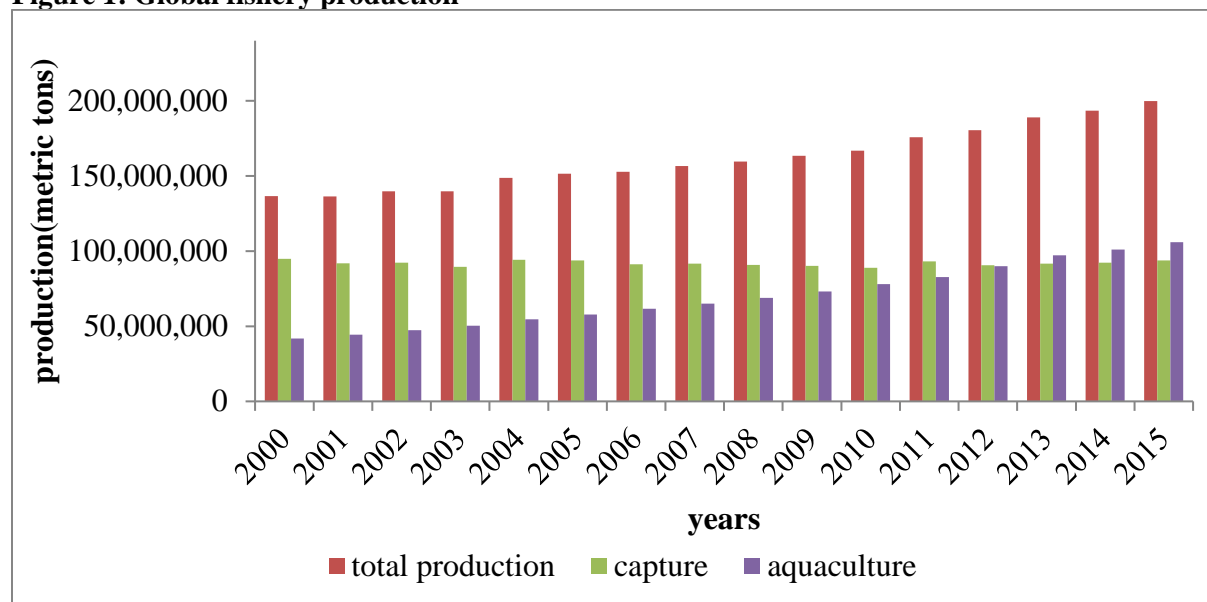
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INTRODUCTION

The goal of every continent and the entire world is to feed a population that is expanding every day while guaranteeing that concerns about food security have been addressed. Around the world, there are 200 million people who depend on fisheries and aquaculture, with at least 43.5 million of them being directly employed (FAO, 2016). However, capture fisheries from both lakes and oceans have been dwindling globally, which has highlighted the significance of bolstering aquaculture as a backup strategy (Daw et al., 2009). Global aquaculture production increased to 114.5 million tonnes as of 2018, and it is anticipated to reach 204 million tonnes by 2030 (FAO, 2020). This

should reduce food security, employment, and standard of living by increasing the supply of food (FAO, 2020; Garlock et al., 2020). Diversification in fish and aquatic plants has occurred in aquaculture from ponds to lakes to oceans (Tacon & Halwart, 2007; Tacon et al., 2020). As of 2018, Asia contributed more than 35% of all aquaculture goods, whereas developing countries could only produce about 6% yearly, according to FAO (2020; Garlock et al., 2020; Tacon et al., 2020). Due to the decline in capture fisheries, the consumption of aquaculture products has since expanded globally, with emerging countries seeing the largest increases (5200 tons in 1961 to 18800 tons in 2013) (Orina et al., 2021).

Figure 1: Global fishery production

Source: FAO, 2022

In Africa, for instance, a population increase to about 2.4 billion by 2050 has been predicted, whereas there is a big challenge as far as the two Sustainable Development Goals of food security and poverty are concerned (AFD, 2011; Chan et al., 2019; Troell et al., 2014). Capture fishing from rivers, lakes, and coastal systems has also been the major source of fish in Africa, although due to many factors like climate change, pollution, and overfishing, the sector has seen a decline. Aquaculture has also chipped in to contribute to the production of food on the continent, but despite the collaboration, the supply is not meeting the demands of the consumers (Chan et al., 2019; Tran et al., 2019). The gap between suppliers and consumers is predicted to broaden due to the projected increase in population, increased demand for fish protein, changes in diets due to urbanization, changes in consumer preferences and climate effects (Thurstan & Roberts, 2014; Tran et al., 2019). For instance, parts of Africa in the northern and southern halves have been predicted to experience high water stress, whereas eastern, central, and western Africa are predicted to receive heavy rains and flooding (IPCC, 2007). These changes will therefore create more stress on the aquatic ecosystems with implications on fish supply hence leading to a reduction of fish catches in the Exclusive Economic Zones (EEZs) in Africa (Lam et al., 2012).

Production in aquaculture has been doubling each decade over the past 50 years, with a global production of 30.1 million tonnes of aquatic plants and 38,000 MT of other products (Bush & Oosterveer, 2019; FAO, 2018). As of 2014, for example, the production of aquaculture outweighed that of capture fisheries in terms of providing fish for human use (FAO, 2016; Golden et al., 2016; OECD, 2015). The OECD-FAO Agriculture Outlook projects a growth of 30.1% in aquaculture production between 2018 and 2027, and this will greatly exceed the production of captured fisheries in 2020 (OECD, 2018). In Africa, NEPAD (New Partnership for Africa's Development) approximated the total production at 10.4 million tonnes (AUC-NAPAD, 2014), with 6 million tonnes from capture fisheries, 2.8 tonnes from inland water fisheries and roughly 1.6 million tonnes from aquaculture.

DEVELOPMENT OF AQUACULTURE IN AFRICA

Since its introduction with the purpose of meeting colonial recreational fishing needs in the 20th century, the sector has been showing slow development (ICLARM and GTZ, 1991; Lazard et al., 1991). For instance, tilapia was introduced in Kenya in the 1920s but not until the 1940s when it was introduced widely in Africa with different

objectives, among them the issue of food security, social objectives, and the creation of employment (Coche et al., 1994; Brummett et al., 2008). FAO was able to accelerate aquaculture development from the 1970s to the 1990s through collaboration

with various bodies, whether governmental or non-governmental, national, or international (Coche et al., 1994). The breakdown of the adoption process can therefore be a:

Table 1: Evolution of Aquaculture

Phase	Period	Activity
i	1950-1970	<ul style="list-style-type: none"> ✓ Introduction of aquaculture ✓ Inadequate knowledge understanding and technical skills of aquaculture ✓ Construction of fish ponds by the government
ii	1970-1995	<ul style="list-style-type: none"> ✓ Expansion of aquaculture ✓ Significant donor support ✓ Active R & D ✓ Government involvement in seed supply and extension services ✓ Commercialization of aquaculture in some countries; Nigeria, Madagascar, Cote d'Ivoire, Zambia, and South Africa
iii	1995 to date	<ul style="list-style-type: none"> ✓ Reduced donor support ✓ Emergence of commercial aquaculture ✓ Re-orientation of public support toward facilitation

Adapted from (Hecht et al., 2006).

The adoption process has been slow. In spite of this, large-scale investments in meaningful products have been experienced in Egypt, Nigeria, Uganda, and Ghana (Cai & Quagrainie, 2017; FAO, 2018). Between 1995 and 2018, an increase from 110,200 tons to 2,196,000 tons with a Compound Annual Growth Rate of 15.55% was a boost due to the introduction and strengthening of private sectors managed by medium-scale enterprises (FAO 2016; Halwart, 2020; SMEs; Satia 2011). A high

percentage of production (99%) in Africa comes from inland fisheries, mainly the culture of tilapia and African catfish, whereas only 1% is from mariculture (FAO, 2016; 2018; 2020). Egypt, Nigeria, Uganda, Ghana, Tunisia, Kenya, Zambia, Madagascar, Malawi, and South Africa are the top producers of aquaculture in Africa, with their success linked to the promotion of private sectors (Satia, 2011; 2017).

Table 2: Comparison of aquaculture produce between 2008 and 2018

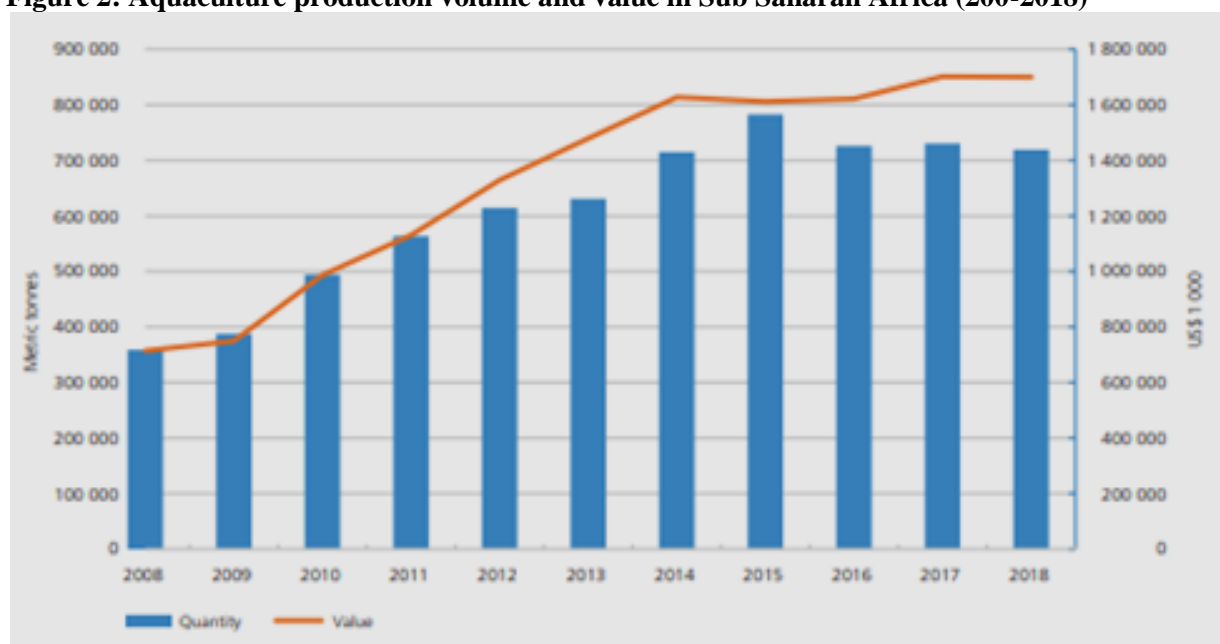
Area	Tonnes	
	2008	2018
World	70,203,425	114,508,041
Africa	1,061,593	2,308,673
Sub-Saharan Africa	358,948	719,013
Western Africa	152,106	384,876
Eastern Africa	196,657	305,094
Southern Africa	6,117	10,956
Northern Africa	0	10,000
Middle Africa	4,067	8,087

Source: (FAO, 2020).

Table 3: Top 10 aquaculture producers in Africa as at 2018

No	Country	Production (metric tons)	Regional share (%)	Global share (%)
1	Egypt	1,561,457	71.10	1.90
2	Nigeria	291,233	13.26	0.35
3	Uganda	103,737	4.72	0.13
4	Ghana	76,630	3.49	0.09
5	Zambia	24,300	1.11	0.03
6	Tunisia	21,756	0.99	0.03
7	Kenya	151,124	0.69	0.02
8	Malawi	9,014	0.41	0.01
9	Madagascar	7,421	0.34	0.01
10	South Africa	6,181	0.28	0.01

Source: (FAO, 2003-2020).

Figure 2: Aquaculture production volume and value in Sub Saharan Africa (200-2018)

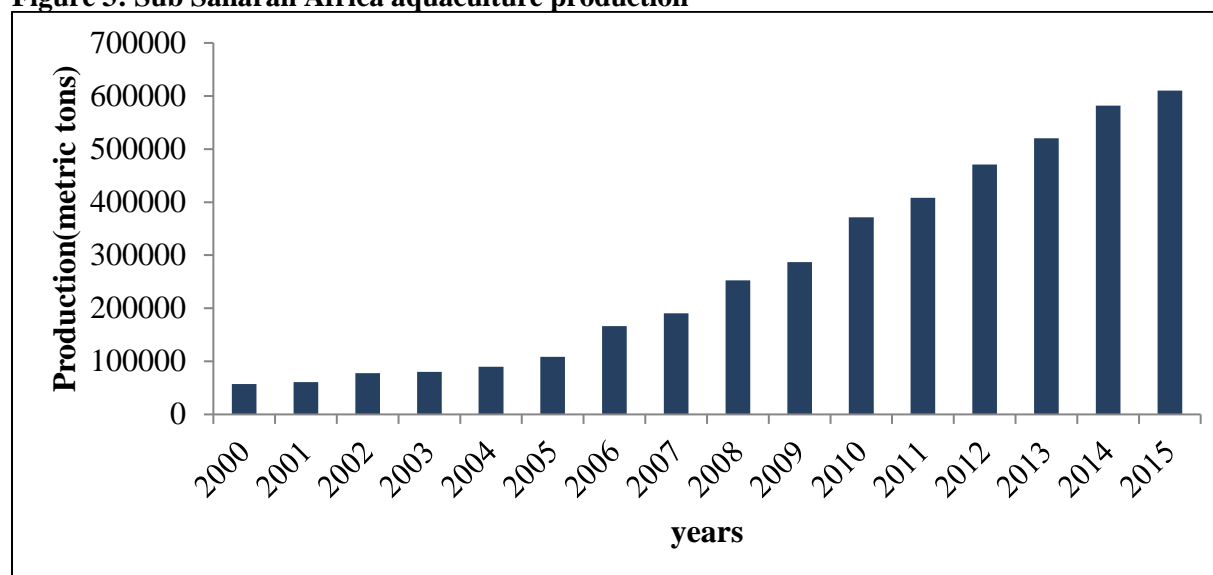
Source: (FAO, 2020)

Success of Aquaculture Africa

Success here is mainly the achievement of goals that were set before aquaculture was incorporated into Africa. Some of the communal goals of aquaculture after its introduction were the sustainable production of food and improvements in nutrition in rural areas, the generation of employment, which in turn will ensure additional income, the reduction of crop failure risks, primarily between the 40s and 50s, and sport fishing (Coche et al., 1994; Brummett et al., 2008). Food and nutrition security cases were emerging as a result of this alone, with 28% of the

population undernourished (FAO, 2006). Fish was therefore seen as an alternative for combating food security and under nutrition.

The consumption of fish by this time was 50 million tons, mainly wild catch and at least 10% from aquaculture (FAO, 2006), and this was projected to go up four-fold to 232 million tons by 2030. Because of the growing population, wild stocks have been depleted, and aquaculture has emerged as a solution to meet current and projected demand (FAO, 2006).

Figure 3: Sub Saharan Africa aquaculture production

Source: World Bank, (FAO, 2022)

Food Security and Malnutrition in Africa

FAO (2000) explained food security as the safe access to sufficient food whenever one needs it. Also, it is a way of satisfying dietary needs by physically and economically accessing enough secure and nutritious food, according to Gareth (2001). Fish has been an extremely significant source of food in many African countries, especially developing countries, with a contribution of around 50% of the entire animal protein in many African diets with the ability to feed more than 3 billion people in developing countries (FAO, 2018).

Fish has a wide range of nutritional values which are best for human beings and include essential amino acids, minerals, especially iron, zinc, vitamins, micronutrients, and fatty acids, mainly poly-unsaturated fatty acids, that are irreplaceable by other food types (Béné et al., 2015; Golden et al., 2016; Beveridge et al., 2013), hence referred to as "nature's super food" (FAO, 2017). For instance, the likes of dagaa from Lake Victoria and Kapenta from South Africa offer micronutrients (Grainger, 2016). Increased income and knowledge of the importance of eating fish as far as health is concerned, together with intensifying urbanization, changes in lifestyle and globalization, have led to increased fish consumption. This may be a clear indication that aquaculture should produce more to accommodate these changes (Anderson et al., 2017; Thurstan & Robberts, 2014).

According to AUC-NAPAD (2014), more than 30% of the African continent's population consumes fish as the main animal protein source. Despite the fact that there is a good amount of produce from aquaculture, the post-harvest losses are a big challenge in Africa, hence reducing the strength of the fight against food insecurity (Affognon et al., 2015).

Africa has the lowest per capita level of fish consumption despite its high dependence on fish for protein (FAO, 2017). Nonetheless, capture fisheries in Africa are still being depended on for domestic fish supply, with Morocco, Nigeria, and South Africa being the top fishing producers (FAO, 2018). According to NEPAD (2016), the stocks in capture fisheries of most countries in Africa are overexploited. Therefore, in spite of the dominance of capture fisheries, aquaculture is still promising as a reliable source of fish for food (FAO, 2018).

In sub-Saharan Africa, aquaculture production systems in the past were mostly from extensive systems and semi-intensive systems, which are mostly in ponds and lagoons with little or no management at all, which was producing less than the demand. But at present, aquaculture has evolved to use more intensive systems that are in tanks, cages with the installation of re-circulating systems and aquaponic systems (FAO, 2020). Lined and unlined earthen ponds, which are mostly semi-intensive, have also been employed, which was not the case when aquaculture was introduced. Tilapia, catfish, trout, and other marine finfish have been

widely cultured in Nigeria with semi-intensive aquaculture in earthen ponds being common. The yields are maximized with over 30,000 tonnes of freshwater and brackish water species produced in intensive and semi-intensive systems (FAO, 2020; Kaleem & Sabi, 2020).

Cage farming, both on a small scale and a large scale, has received a lot of attention and is now being practiced in many bodies of water in different countries. For instance, there are tilapia cage farms in Ghana, Malawi, Nigeria, Uganda, Zambia, Zimbabwe, and Kenya along the shores of Lake Victoria, and equally in Rwanda on Lake Kivu. The DRC is also ramping up tilapia cage farming in Lake Kivu (FAO, 2020). 90% of the total produced tilapia comes from cages and the production is projected to be on a rising scale (Ragasa et al., 2018).

On the other hand, re-circulating aquaculture systems (RAS) have been widely accepted by farmers with hatcheries and grown in intensive and commercial aquaculture to increase production. It is used in Kenya, Namibia, Nigeria, and South Africa for tilapia and catfish. However, the system is expensive because it requires electricity and high management, but the production is still high (FAO, 2020).

For instance, in 2017, a public-private partnership in East Africa, FoodTechAfrica, established a grow out fish farm in Kenya with the aim of producing more fish with up to 125 kg of fish per cubic meter with a low food conversion ratio and high survival rate due to complete control of water quality (FoodTechAfrica, 2019). Tanks (plastic, concrete, fibre glass), both circular or rectangular, have also been employed in Sub-Saharan Africa for hatcheries

and grow-out production. Some have advanced to covering their homes with a green house, which is a technology that was not there before. Tilapias are the most common tank-grown fish, with trout being in raceway tank systems in countries like Kenya, Zimbabwe, and South Africa (FAO, 2020)

Countries such as Ghana, Malawi, Rwanda, Tanzania, and Zambia, for example, have seen significant increases in production. Uganda and Kenya have decreased their production as Nigeria, South Africa, and Zimbabwe show stagnation (FAO, 2020). According to FAO (2017), Sub-Saharan Africa is expected to grow more in aquaculture in the coming years because of different factors like public understanding of aquaculture and acceptance by the public; good governance in some countries; concentration on commercial aquaculture; capacity building; partnerships (both public and private); and the emergence of different research in aquaculture sectors. The use of new systems of production, best seed qualities, and feed qualities have also contributed to the growth of aquaculture (FAO, 2020).

Also, there has been diversification of aquaculture species to increase production and quickly counteract the food security issues. For instance, in the past five to ten years, Tanganyika Tilapia (*Oreochromis tanganyicae*) in Zambia, macroalgae species *Meristotheca senegalense* in Senegal, milkfish (*Chanos chanos*) in Kenya, Tanzania, and Zimbabwe, among others. However, their production is still low, but their acceptance is an indication that they will pick up (FAO, 2020).

Table 4: Diversification of Aquaculture species in different countries in Africa

New species	Producing country	Production at 2018 (tons)
Tanganyika tilapia (<i>Oreochromis tanganyicae</i>)	Zambia	1,690
SenMacro-algae (<i>Meristotheca senegalense</i>)	Senegal	300
Shrimp (<i>Penaeus monodon</i>)	Nigeria	90
Milkfish (<i>Chanos chanos</i>)	Zanzibar, Kenya	7
Sandfish (<i>Holothuria scabra</i>)	Zanzibar, Madagascar	63
Japanese meagre (<i>Argyrosomus japonicus</i>)	Mauritius	63

Source: (FAO, 2020)

Production of fish that have fast growth, are disease resistant, can tolerate any environment is a good idea to help small scale get a good return as well as

help combat food security by providing healthy and nutritious food and all this has been achieved through genetics. This was since the introduction of the Genetically Improved Tilapia in Philippines in

1988 to 1997 (Bentsen et al., 2012; Dey & Gupta, 2000) but it got access to Africa in 2007 after thorough consultations by World Fish Centre who later approved the policy but with a lot of caution (World Fish Center, 2007). Otherwise, a lot of selective breeding has been employed in Africa. Genetically improved strains have been used for enhancing fish breeding and for strain improvement although it is still low because it is receiving less funding in Africa with all this focusing on alleviating food production.

In Sub Saharan Africa, the farmed fish in aquaculture have low yields when compared to other regions like Asia who have in cooperated the improved strains. Also, Genetically Improved Abbassa Nile Tilapia (GIANT) strain made Egypt the leading producer in Africa and the third globally but at the same time it reduced environmental impacts (Henriksson et al., 2017).

The Genetically Improved Farmed Tilapia strain is modified to have strong resistance to diseases, fast growth, and low Food Conversion Ratio (FCR) and its highly possible in Sub-Saharan Africa (Barria et al., 2021). GIFT in Ghana is seen to have increased to 18,200 tons in 2011 from 1600 tons in 2007 (FAO, 2013).

However, much the reports from other regions report the success of the GIFT, it is facing strong resistance in most of the African countries with fear of introducing exotic species in their countries. With this, Ghana, Kenya, Malawi, Zambia decided to make their own modified species by doing different local breeding programs (Ragasa et al., 2022). In Southern Africa, *salmonids* were genetically improved between the late 1970s and 1980s to increase the yields in aquaculture (Gjedrem, 1975; 1985; Kincaid et al., 1977; Kincaid, 1983).

Source of Employment and Income Generation

Worldwide, the number of people and their dependents on fishing and aquaculture is estimated at about 200 million and is mostly in developing countries (FAO, 2005). This has seen 43.5 million being directly employed in fisheries and aquaculture, with at least 90% being small-scale fishers, as others are engaged in different activities associated with the sector, to mention but a few: supply of fish; supporting activities e.g., boat making and repairs; net making; engine manufacturers (Daw et al., 2009). A lot of farmers

have ventured into aquaculture with the hope of earning an income out of it, as some are doing it as a full-time job.

Globally, fish is a highly traded commodity, according to the United Nations Conference on Trade and Development (UNCTAD, 2020). Annually, a total estimate of US\$24 billion comes from fishing products, accounting for 1.6% of the Gross Domestic Product (GDP) (AUC-NEPAD, 2014). On the other hand, commercial aquaculture development has received a lot of emphasis in a number of countries, offering both direct and indirect employment in the value chain and its support activities. Most of the farms for tilapia and catfish offer full-time jobs of up to 70%. In Africa, 12.3 million people work in the fisheries and aquaculture sectors, 50% (6.1 million) as fishers, 42% (5.3 million) as processors, and 8% (0.9 million) as fish farmers (De Graaf & Garibaldi, 2014).

According to FAO (2020), the number of fish farmers in Sub-Saharan Africa (primary sector) is estimated at 300,863 in 2018, with Madagascar leading with 43,800, Kenya with 43016, and Ghana with 32,268 being the top leading countries. In Zambia in 2014, over 8000 people were employed by the sector, working in two large-scale commercial sectors: feed processing and seed production. According to Genschick et al. (2017), with the diversification of aquaculture, the number of jobs in Zambian aquaculture will exceed 22,000 by 2022. The seaweed sector employs nearly 24,000 farmers in Tanzania and Zanzibar, with 90% of them being women (Largo et al., 2020). In 2012, 13627 people were employed by the aquaculture sector, with 2% female representation (FAO, 2017e).

FAO (2014a) reported that 150 jobs are created for every 100 tonnes of fish that are produced. In 2019, Lake Harvest Aquaculture Group in East Africa was the largest employer who produced more than 10,000 tonnes of aquaculture produce, with almost 800 direct and indirect jobs in Zimbabwe, with secondary operations in Uganda and Zambia.

In Zambia, Yalelo Fish Farm in 2019 produced 12000 tonnes with an employment of 800 workers on the farm and other operations, among them distribution of the products to different export points across the country. Also, its partnership with Aller Aqua has seen the employment of 270

employees (FoodBusinessAfrica, 2020). In Madagascar, the Unima shrimp aquaculture group, producing over 5,500 tonnes of shrimp annually, employs over 1,500 people (FAO, 2014a). Ghana has Tropo Farms that employ nearly 800 direct and 700 indirect workers.

Furthermore, the big farms that are practicing aquaculture on a large scale for commercial purposes have taken the initiative of training youths and graduates from the institutions for internships and industrial attachments, thereby providing them with hands-on experience as well as deepening their knowledge in the aquaculture sector. This therefore conforms to regional aspirations for youth employment in aquaculture (FAO, 2020).

According to a survey done by FAO and their 2020 report, the number of males who are employed in aquaculture is greater than that of females in the Sub-Saharan Area (FAO, 2020). Women are mostly involved in post-harvest activities like trading, supplying fish gear, processing fish, and credit provision (Cox, 2013). In a study at Msaka (Lake Malawi) and Kachulu (Lake Chilwa), the number of

women who were local brokers was high (67%); processors, 51% at Msaka beach and 81% at Kachulu beach; and fish exporters, 100% at Msaka and 83% at Kachulu beach (Manyungwa-Pasani et al., 2017).

A study in Congo revealed that 80–90% of fish traders are women (Harper et al., 2013). Thus, this is an indication that aquaculture is empowering women as well improving their livelihoods in different countries (Harper et al., 2013), hence boosting fishing households' incomes. Therefore, it is because of this income that the lives of the fishers are improved and they have the ability to access food and nutrition security and also to purchase a variety of diets, hence eradicating malnutrition (Kupaza et al., 2015).

In Kenya, at Anyanga beach, fisherfolk were engaged in different activities that all earned them a living. Here, there was a representation of four categories of fisher folks; fishermen with 54.8%, fish traders with 26.2%, cage farm workers with 16.7%, net weaving and repairs with 2.4% (Anjejo, 2017).

Table 5: Number of fishers employed in aquaculture by region and country in Africa in 2018.

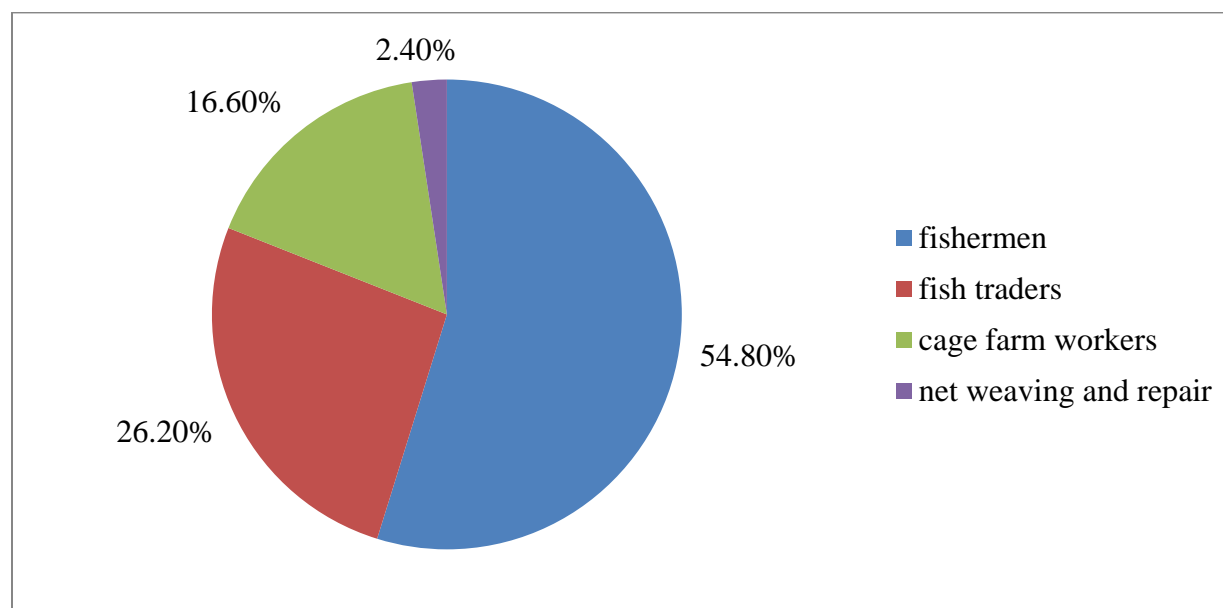
Geographical region	Gender	2018
Eastern Africa	Male	121,370
	Female	26,179
	Unspecified	33,774
Middle Africa	Male	5,486
	Female	27,421
	Unspecified	10,472
Southern Africa	Male	1,011
	Female	451
	Unspecified	3,257
Western Africa	Male	65,390
	Female	4,974
	Unspecified	1,078
Total	M Male	193,257
	Female	59,025
	Unspecified	48,581

Source: FAO, (2020)

Table 6: Employment by sub sector in Sub Saharan Africa

Sub sector	Number of employees (thousands)	Share sub sector (%)
Inland fisheries	4,958	40.4
Marine artisanal fisheries	4,041	32.9
Marine industrial fisheries	2,350	19.2
Aquaculture	920	7.5

Source: de Graaf and Garibaldi, (2014).

Figure 4: Fisher folk categories at Anyanga beach Lake Victoria, Kenya

Source: Anjejo, (2017).

According to the findings of a study by Anjejo (2017), the introduction of cages in the area gave fisher people at Anyanga Beach new jobs. This was in line with research from Egypt and Uganda (Soliman & Yacout, 2017; Swaibu et al., 2017),

which discovered that diversifying the aquaculture system opened up employment opportunities for the local fishing communities.

Table 7: Major changes witnessed at Anyanga Beach, Lake Victoria with cage introduction

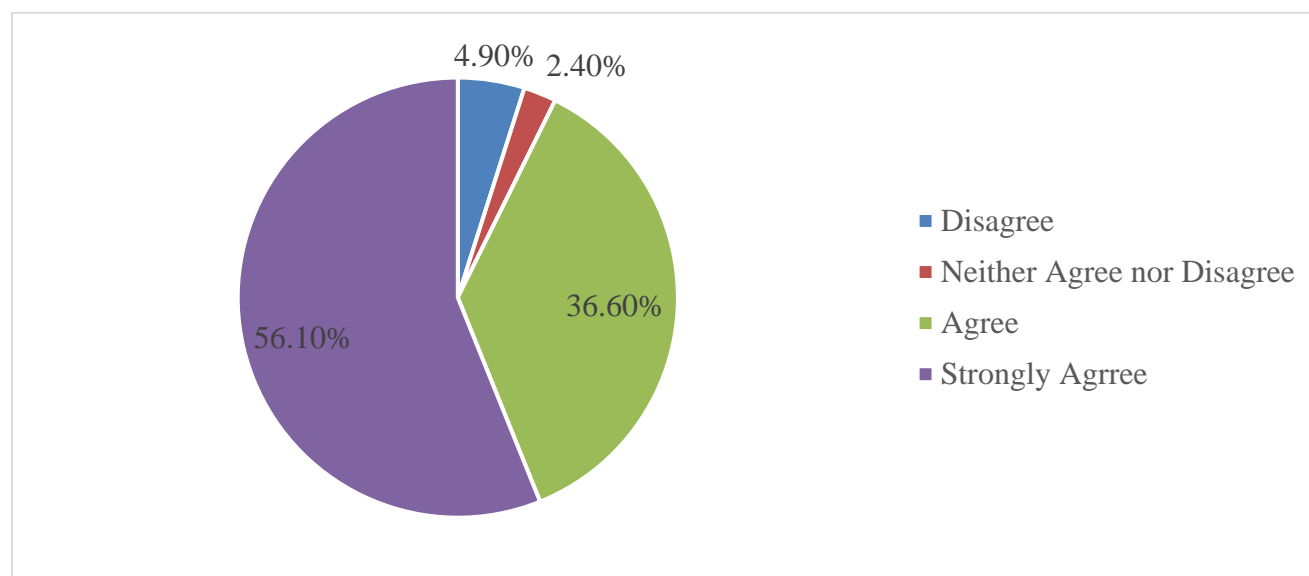
	Frequency	Percentage
New jobs created by cage farming for locals	40	97.6
Fishermen crossing to cage farming	11	26.8
More fish harvest at the beach	10	24.4
Low incidences of crime involving youth	1	2.4
Capture fisheries going down	1	2.4

Source: Anjejo (2017).

The following findings are the result of a study about how cage culture has affected people's well-being that was conducted in Lake Victoria's Anyanga Beach. His findings demonstrated that many cage culture participants firmly agreed that

cage culture had increased their well-being, making aquaculture the preferred method (Anjejo, 2017).

Table 8: Has cage farming improved your wellbeing?



Source: Anjejo, (2017).

CONCLUSION

Based on an evaluation of food safety, employment opportunities, and the ability of the fishing community and those who depend on it to survive, aquaculture in Africa has been successful. Even while it grows slowly, it does so steadily, particularly in Africa. Because they perceive a promising future, nations like Egypt are leading the way in aquaculture. It is therefore necessary to focus more on and diversify aquaculture in order for the industry to remain as promising. It is highly anticipated as it is anticipated to be given the growing population and for it to be able to fill the void left for the supply of fish protein as a result of the decline in catches of the wild stocks, which are faced with a number of issues, among them the effects of climate change and overfishing. The majority of aquaculture activities in Africa have been large or semi-intensive and small-scale, but things have improved as more nations are implementing intensive systems of production. Aquaculture will therefore produce more and achieve the objectives for which it was developed with the help of this trend in Africa. Africa as a whole has to sit down and plan how to expand aquaculture sectors, including the private sectors for shared output. With all the advances in aquaculture, it will be possible to feed a population that is constantly expanding.

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