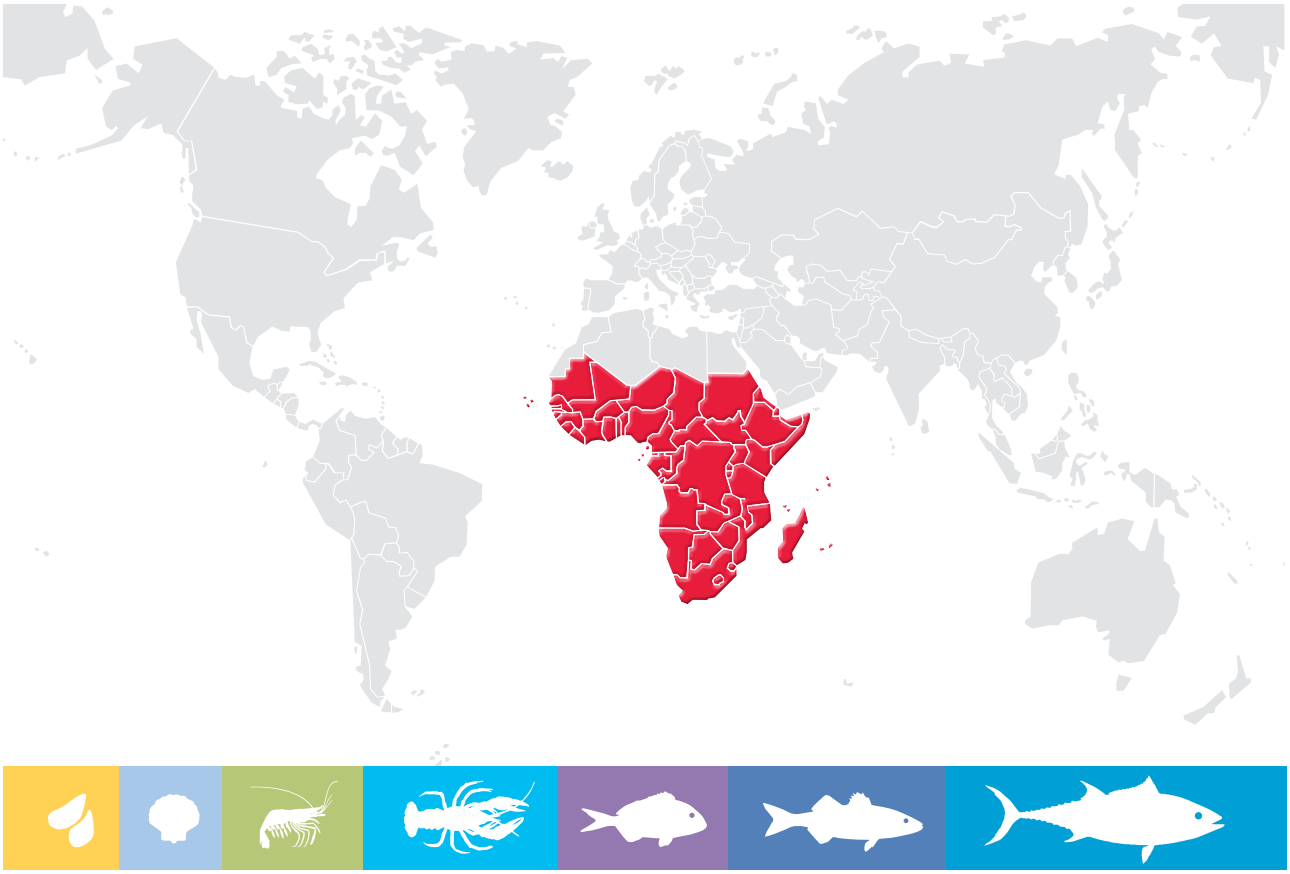
Food and Agriculture Organization of the United Nations

FIAA / C1135/4 (En)

FAO Fisheries and Aquaculture Circular

ISSN 2070-6065

REGIONAL REVIEW ON STATUS AND TRENDS IN AQUACULTURE DEVELOPMENT IN SUB-SAHARAN AFRICA – 2015



FAO Fisheries and Aquaculture Circular No. 1135/2 FIAA/C1135/2 (En)

REGIONAL REVIEW ON STATUS AND TRENDS IN AQUACULTURE DEVELOPMENT IN SUB-SAHARAN AFRICA – 2015

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2017

ISBN 978-92-5-109656-7

PREPARATION OF THIS DOCUMENT

The author greatly appreciates the valuable inputs of L. Awity, R. Berzak and M. Amechi (the Republic of Ghana), G. Manor, B. Onapito and R. Osinde (the Republic of Uganda), P. Ngalande (the Republic of Zambia), B. Nyandat and I. Wanee (the Republic of Kenya), J. Kouam and Kemgang (the Republic of Cameroon), G. Mba-Asseko (the Gabonese Republic), A.M. Agenuma and P. Anyanwu (the Federal Republic of Nigeria). Special thanks to N. Gueye (FAO RAF) and A. Menezes (FAO SFE) as well as M. Beveridge, L. Dabbadie, F. Marttin and T. Pongthanapanich of the FAO for their contributions.

Finalization of the document, including technical editing, review and linguistic quality, was carried out by Brian Harvey, FAO Senior consultant. Xiaowei Zhou, FIAS, developed the main FAO statistical datasets with different levels of details used for the analysis in the document, and provided clarification to specific questions that arose in the course of its writing. The document was edited and formatted in line with FAO house style by Danielle Rizcallah who also assisted in the preparation of the final layout.

FAO. 2017.
Regional review on status and trends in aquaculture development in sub-Saharan Africa – 2015, by Benedict P. Satia. FAO Fisheries and Aquaculture Circular No. 1135/4. Rome, Italy.

ABSTRACT

The present regional review and synthesis for sub-Saharan Africa (SSA) provides an overview of major issues and trends in the aquaculture sector between 2004 and 2014 with emphasis on outstanding issues over the last five years. The regional review reflects development in 41countries in SSA for which production was reported to FAO in 2014. The production volume and value data have been derived from the latest FAO global aquaculture dataset 1950–2014 (FishStat), compiled by Xiaowei Zhou.

The population of SSA in mid-2014 was 920 million. The annual growth rate was 2.5 percent. The population is projected to be between 1.5 and 2 billion by 2050. Unemployment rates were 6.9 percent for males and 8.8 percent for females in 2014. The informal economy absorbs nearly 70 percent of workers, mostly women and youth. In 2014, the average income per capita ranged from US$604 for the Central African Republic to US$32 266 for the Republic of Equatorial Guinea. The real GDP growth in the last five years was 5 percent with great disparities between countries and subregions. High inflation and currency depreciation affected growth in many countries. Progress in achieving the Millennium Development Goals (MDGs) is positive overall, with widely varying progress among goals and countries, and within countries. More than 40 percent of the population still lives in extreme poverty.

Freshwater (inland), brackish water and marine (coastal) environments are used for aquaculture production, but most of the activities are concentrated inland. The operations, particularly inland, are either subsistence, small-scale market-driven or large industrial scale. Between 2004 and 2014 there was a seven-fold increase in production with an average percent growth rate (APR) of 21 percent. The first sales value (farm gate price with no value addition) of the 2014 production was US$1.6 billion. Most (98 percent) of the production was from inland aquaculture, predominantly of indigenous and ubiquitous species of tilapia and the African catfishes. Seven countries (the Federal Republic of Nigeria, the Republic of Uganda, the Republic of Ghana, the Republic of Kenya, the Republic of Zambia, the Republic of Madagascar and the Republic of South Africa) accounted for 93 percent of the total production. Mariculture production decreased by 17 percent in the last five years owing to the decimation of the shrimp industry in the Republic of Mozambique by white spot syndrome virus.

Dedicated commercial hatcheries are functional in some countries and emerging in others. Important developments include development of appropriate technologies to produce all-male tilapia fingerlings, making possible the production of a crop comprised primarily of high-value large fish and spawning of Clarias in large numbers using injections of fresh pituitary followed by hand-stripping. Genetic improvement including advances in pedigree-based breeding programmes for both tilapia and catfish are in various stages of development by the public and private sectors in the Republic of Ghana, the Republic of Uganda, the Republic of Kenya and the Federal Republic of Nigeria. There are aquafeed shortages but the situation is improving. Significant quantities of aquafeed are imported but expansion of local feed mill capacity is under way in a number of countries. Access to loans is limited due to complex bureaucracy and rules, high interest rates of 20–25 percent a year and short pay-back period of 5 years. Investment facilities include national development and commercial banks and non-formal sources. Farmers who obtain loans from non-formal sources are obliged to insure the farm; this is tied to the loan and is centrally done. There is a need to develop high quality, cost effective aquafeeds designed specifically for species and life stages being grown, undertake profitability or viability studies of different aquaculture production systems and subsequently develop business plans.

Fish prices vary between and within countries based on consumers' preference, location, and imported vs domestic product and product forms. In 2013, prices for tilapia ranged from US$2.5 per kg (fresh whole round and gutted) in the Federal Republic of Nigeria to US$15 in the Republic of Angola. The price of fish is constantly on the increase because of high demand. Many countries are importing aquaculture products, particularly tilapia, from China, India and Thailand to meet demand. The impact of imported fish on aquaculture products is minimal. There is increased uptake of bilateral and intra-regional trade in aquaculture products but issues of quality standards persist. Value chain for aquaculture products is not well developed.

Certification and quality standards for export markets, such as the hazard analysis and critical control point (HACCP) system, have been met by some countries. The per capita fish consumption in 2014 was 8.9 kg compared to the World average of 19.7 kg. Consumption in SSA is projected to increase by 2.2 percent in 2025 owing to a combination of rising incomes and urbanization interlinked with the expansion of aquaculture and improved distribution channels. About 34 percent of those employed in the aquaculture sector in SSA are women. Women are owners of farms and actively involved in the value chain operations of post-harvest and marketing of product. Women, particularly in seaweed farms, face health issues and need better working condition and sustainability.

Over 40 SSA countries have adopted national environmental framework laws and some countries have incorporated specific regulations to promote environmental management of aquaculture. Several governments have made concerted efforts to improve aquaculture governance and management of the sector but this effort is not evenly spread. Many countries have yet to elaborate policies, framework strategies and plans. The rate of implementation of elaborated instruments is low. Regulations on the use of alien species, monitoring of aquaculture activities, improvement in the implementation of environmental impact assessment (EIA), the prevention and mitigation of escapes and aquaculture zoning as a well as the application of ecosystem approach to aquaculture (EAA) deserve more attention in the region. Some countries undertook activities implementing FAO's Blue Growth Initiative in an aquaculture context. The activities included Spatial Planning (the Republic of Angola), Ecosystem Services and Biodiversity (the Republic of Kenya) and Aquaculture Enterprise Development (the Republic of Zambia).

The main drivers for the progressive regional expansion and remarkable growth of SSA aquaculture in the last five years include the increasing importance being placed by SSA countries on the sub-sector for improving food security, job creation, economic growth and resource use. Assistance has come from FAO and other development partners (international and bilateral) and donor organizations and investors, including the African Union – InterAfrican Bureau for Animal Resources (AU-IBAR), the World Bank, African Development Bank (AfDB), European Union (EU), United States Agency for International Development (USAID), Department for International Development of the United Kingdom (DFID), Swedish International Development Cooperation (SIDA) and WorldFish Center (WFC). In addition, there is increased willingness by the private sector to effectively engage in aquaculture activities in several countries.

Weather and climate change-related shocks, insecurity, rapid growths of the working-age population, increasing urbanization, access to land and water resources, competition for these resources by multiple users and their degradation as well as lack of excellent basic infrastructural capacity in many countries have weighty implications for the promotion of aquaculture development in SSA. This notwithstanding, the possibilities for increased growth are good and indications are that the APR of 21 percent witnessed during the past decade can be maintained. Aquaculture production in SSA in 2025 is projected to be 1 million tonnes, an increase of 84 percent.

For complementary views on aquaculture in the Region, please see the Report from the COFI Sub-Committee on Aquaculture, Brasilia, Brazil, 3–9 October 2015, available at the following link: www.fao.org/cofi/43341-04a74a5d167de0034251e8eaf83de443e.pdf

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ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
AIDS	Acquired immune deficiency syndrome
ANAF	Aquaculture Network for Africa
APDRA	Association Pisciculture et Développement Rural en Afrique
APR	Average percentage rate
AUC	African Union Commission
BGI	blue growth initiative
BMP	better management practices
CAMFA	Conference of African Ministers of Fisheries and Aquaculture
CBD	Convention on Biological Diversity
CCA	climate change adaptation
CCRF	Code of Conduct for Responsible Fisheries
CIFAA	Committee for Inland Fisheries and Aquaculture of Africa
COFI	FAO Committee on Fisheries
DRM	disaster risk management
EAA	Ecosystem Approach to Aquaculture
EAC	East African Community
ECA	United Nations Economic Commission for Africa
EIA	environmental impact assessment
EUS	epizootic ulcerative syndrome
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FCR	Feed conversion ratio
GAPCM	Shrimp Farming and Fishing Industry Association of Madagascar
HIV	human immunodeficiency virus
IAA	integrated agriculture-aquaculture
ICT	information communication technology
IIA	integrated irrigation-aquaculture
ILO	International Labour Organization
INRA	Institut National de la Recherche Agronomique
LVFO	Lake Victoria Fisheries Organization
MDGs	Millennium Development Goals
NACA	Network of Aquaculture Centres in Asia-Pacific
NALO	National Aquaculture Legislation Overview
NASO	National Aquaculture Sector Overview
NEPAD	New Partnership for Africa's Development
NFFP	NEPAD FAO Fisheries Programme
NGOs	non-governmental organizations
FP&RS	fisheries policy and reform strategy for African fisheries and aquaculture
SCARDA	Strengthening Capacity for Agricultural Research for Development
SARNISSA	Sustainable Aquaculture Research Networks in sub-Saharan Africa
SDG	sustainable development goal
SMEs	small and medium-size enterprises
SPADA	Special Programme for Aquaculture Development in Africa
SSA	Sub-Saharan African countries
UN	United Nations

UN-DESA	United Nations Department of Economic and Social Affairs
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
WSSV	white spot syndrome virus

1. SOCIAL AND ECONOMIC BACKGROUND OF THE REGION

1.1 Status and trends

1.1.1 Scope

This Circular covers the status and trends in aquaculture development in sub-Saharan Africa (SSA) between 2004 and 2014 with emphasis on outstanding issues over the last five years.

1.1.2 Regional demographic dynamics

The population of SSA in mid-2014 was 920 million (Central Africa 142 million, Eastern Africa 378 million, Southern Africa 61 million and Western Africa 339 million) representing 13 percent of the world's population of 7.238 billion (PRB, 2014). The annual growth rate in the region was 2.5 percent. According to UN-DESA (2015), the population is projected to be between 1.5 and 2 billion by 2050. Owing to declining infant mortality and fertility rates the region's share of global population is projected to grow to 25 percent in 2050 because, while infant mortality and fertility rates are also declining in other regions, their aging populations are increasing while it is the youth population in SSA that is increasing. The region therefore could play a central role in shaping the size and distribution of the world's population over the coming decades. By 2050, the youngest subgroup (ages 0–14) is projected to double to about 685 million; the working age population (ages 15–64) will triple to 1.25 billion and the number of elderly (older than 65) quadruple to 100 million, reflecting improvements in life expectancy. The magnitude of these demographic developments will have major implications both for SSA and for the global economy, as labour could flow from SSA to other regions and capital flow from other regions to SSA.

The region is plagued by unemployment and underemployment, mutually reinforcing and exacerbating widespread informal activities in countries. Unemployment rates were 6.9 percent for males and 8.8 percent for females in 2014 (ILO, 2015), marking marginal declines of 0.2 and 0.1 percentage points from 2009. Economic growth has not kept pace with employment growth, largely because it has been driven by capital-intensive sectors (mining and oil) and by exports of primary commodities with little added value. The informal economy absorbs nearly 70 percent of workers, mostly women and youth, who are vulnerable because of limited social protection, poor working conditions and low incomes. AfDB (2013) intimates that, over the next decade, at best only one in four youths will find a wage job, and only a small fraction of those jobs will be formal ones in modern enterprises.

Urban areas account for more than 55 percent of SSA GDP (AfDB, 2012). SSA's urbanization is not linked to industrialization, leading to "consumption cities" populated mainly by workers in non-tradable services. The region's urban population is projected to more than double between 2015 and 2040, reaching 1.02 billion, surpassing the rural population and increasing demand for urban services, infrastructure and employment, whose provision is already severely constrained (ECA and UNEP, 2015).

1.1.3 Economic and social conditions

The economy of SSA countries consists of agriculture, trade, industry and human resources (services). In 2014, the average income per capita for the region ranged from US$604 for the Central African Republic to US$32 266 for the Republic of Equatorial Guinea. Seven countries (the Republic of Equatorial Guinea, the Republic of Seychelles, the Gabonese Republic, the Republic of Mauritius, the Republic of Botswana, the Republic of South Africa and the Republic of Namibia) had GDP per capita of US$10 000 to US$32 000. The Republic of Angola, Republic of Cabo Verde, the Kingdom of Swaziland, the Federal Republic of Nigeria, the Republic of the Congo, the Republic of Zambia and the Republic of Ghana had GDP per capita between US$8 000 and US$4 000; while the rest of the countries' GDP per capita was less than US$4 000 (IMF, 2015). Economic growth in SSA

continued to lose momentum between 2010 and 2014, buffeted by global, regional and internal headwinds. While many countries embarked on a gradual process of economic diversification, with investment increasingly directed towards the manufacturing sector, the region remains highly commodity-dependent (UNECA, 2016). Given the low level of global commodity prices, export income in many countries dropped sharply.

Overall growth slipped in both Central and Western Africa due to security concerns (the Nigerian-based Boko Haram and civil unrest in Central African Republic), decreased oil production in the oil-producing countries and the consequences of the Ebola outbreak in the most-affected countries, the Republic of Guinea, the Republic of Liberia and the Republic of Sierra Leone. Growth was marginal in Southern Africa, while Eastern Africa maintained the highest growth rate at 7.0 percent in 2014, contributing to the growing service sector, infrastructure development and robust private consumption and exports (the Federal Democratic Republic of Ethiopia, the Republic of Kenya and the United Republic of Tanzania) and the dominant mining sector of the Democratic Republic of the Congo.

Most SSA currencies depreciated in 2014 driven partly by low oil prices, a strong US dollar and tightening of US monetary policy. Fiscal deficit widened and inflation increased in all the regions in 2014. Inflation ranged from 5.3 percent in Eastern Africa to 2.5 percent in Central Africa, reflecting political instability, weather-related shocks and consequent increases in food prices, and depreciation of domestic currency and rise in domestic food prices. Total exports of goods and services fell by 3.2 percent in 2013 and by 5.2 percent in 2014, while total imports grew by 3.0 percent and by 1.7 percent over the two years. The region's imports are dominated by consumer goods and its exports by primary commodities (UNECA, 2016).

1.1.4 Trends in social development

Progress in achieving the Millennium Development Goals (MDGs) is positive overall but varies widely among goals and countries, and within countries. More than 40 percent of the population in SSA still lives in extreme poverty. The poverty rate in SSA has fallen by only 28 percent since 1990, with 57 percent to 41 percent of the population living on less than US$1.25 a day between 1990 and 2015 (ECA, 2015). The proportion of hungry people fell from 33 percent in 1990–1992 to 23 percent in 2014–2016. However, the number of undernourished people (not having enough to eat, particularly calories) has increased by 44 million since 1990, reflecting the region's high population growth rate. In education and health, SSA is close to achieving universal primary enrolment. Under-five mortality fell from 146 deaths per 1,000 live births in 1990 to 65 in 2012, an improvement of 55.5 percent against the MDG 4 target of a two-thirds reduction by 2015. Efforts to combat HIV/AIDS, malaria and tuberculosis have yielded some reductions in incidence, prevalence and mortality.

Progress toward environmental goals has been lackluster. Only a quarter of the population has gained access to an improved water source and the proportion of people with access to improved sanitation rose from 24 percent in 1990 to 30 percent in 2012. But the disaggregated figure of both indicators is skewed towards urban areas. This inadequate attention to rural areas, when combined with population growth, degrades land and reduces agricultural productivity, thus lowering incomes and food security.

1.2 Outstanding issues

Regional risks include weather-related shocks. Drought in Eastern Africa and some parts of Southern Africa, as well as in the Sahelian belt in Western and Central Africa could hurt agriculture and aquaculture. Drought may affect hydropower generation capacity, threatening the greening of Africa's industrialization and the blue growth initiative (BGI) as economic agents switch to thermal power. Security in some countries remains an issue and is hurting tourism receipts. The Nigerian terrorist group Boko Haram in Western and Central Africa and political unrest in several countries continue to disrupt domestic economic activity including aquaculture development and foreign investment. Currency depreciation should in theory see increased exports and decreased imports, but for most SSA countries that association seems either weak or non-existent indicating SSA's lack of

competitiveness, production diversification (since there are no local substitutes for expensive imports in terms of production inputs and final goods) and value added. The rapid growths of the working-age population, increasing urbanization and the dominance of informal employment have weighty implications for SSA structural transformation and the promotion of aquaculture development.

2. GENERAL CHARACTERISTICS OF THE SECTOR

2.1 Status and trends

2.1.1 Farming environments

All three aquatic environments – freshwater (inland), brackish water and marine (coastal) – are used for aquaculture production, but most of the activities are concentrated inland. Coastal aquaculture dates to less than 30 years ago and is limited to a few countries, for example the Republic of Madagascar, the Republic of Mozambique, the Republic of South Africa and the United Republic of Tanzania. In these environments, particularly freshwater, the operations are either subsistence, small-scale market driven or large industrial scale.

2.1.2 Main production systems

There are three major production systems in use – earthen ponds, cages and concrete or earthen lined tanks. Of these, probably the most profitable is the production of fish (mainly tilapia and catfish) in cages placed in large public waters. The major advantage of cage farming is reduced capital investment per unit of fish production relative to ponds and tanks. Barring license fees, the "land" (water, in this case) is free, and cages are generally cheaper to build than ponds with their associated drains, valves, wells etc. The less-costly non-fed aquaculture is largely undeveloped in SSA, but may offer potential, through species diversification, to improve national food and nutrition security in the region. Recycling and land-based pump systems are also in use, for example in the Federal Republic of Nigeria and the Republic of South Africa, but the unreliability of electricity in many countries (UNECA, 2016) makes their sustainability questionable unless farms have individual sources of power (which increases operation costs).

2.1.3 Secondary production systems

In some countries (e.g. the Republic of Guinea, the Republic of Côte d'Ivoire, the Republic of Cameroon) dam ponds (dams closing a valley to create a large pond) are also considered as highly cost-effective and profitable. There are integrated agriculture-aquaculture systems in which vegetable garden, poultry and pigs are components to aquaculture (the Republic of Benin, the Democratic Republic of the Congo, the Republic of Malawi, the Federal Republic of Nigeria and the Republic of Uganda). Another variation is aquaculture associated with rice fields in the highlands of the Republic of Madagascar and the Republic of Guinea as well as in drought prone areas, particularly in western Africa (Burkina Faso, the Republic of Mali and the Federal Republic of Nigeria).

2.1.4 Minor production systems

The "tie-tie" system, whereby fronds of seaweeds are tied to ropes (±20 m) that are stretched between pegs and placed in shallow intertidal lagoons, is used for seaweed culture in the United Republic of Tanzania and the Republic of Mozambique. Prawn culture in the Republic of South Africa, the Republic of Seychelles, the Republic of Mozambique and the Republic of Madagascar includes highly sophisticated hatcheries and standard pond farming techniques for growout, at extensive to intensive stocking densities. Abalone farming in the Republic of South Africa and the Republic of Namibia is premised on land-based pumped systems using highly technical hatchery technology and concrete or plastic tanks. For mussel and oyster farming, spat is collected from the wild and growout occurs on a Spanish raft and/or New Zealand long line systems in Saldanha Bay, the Republic of South Africa.

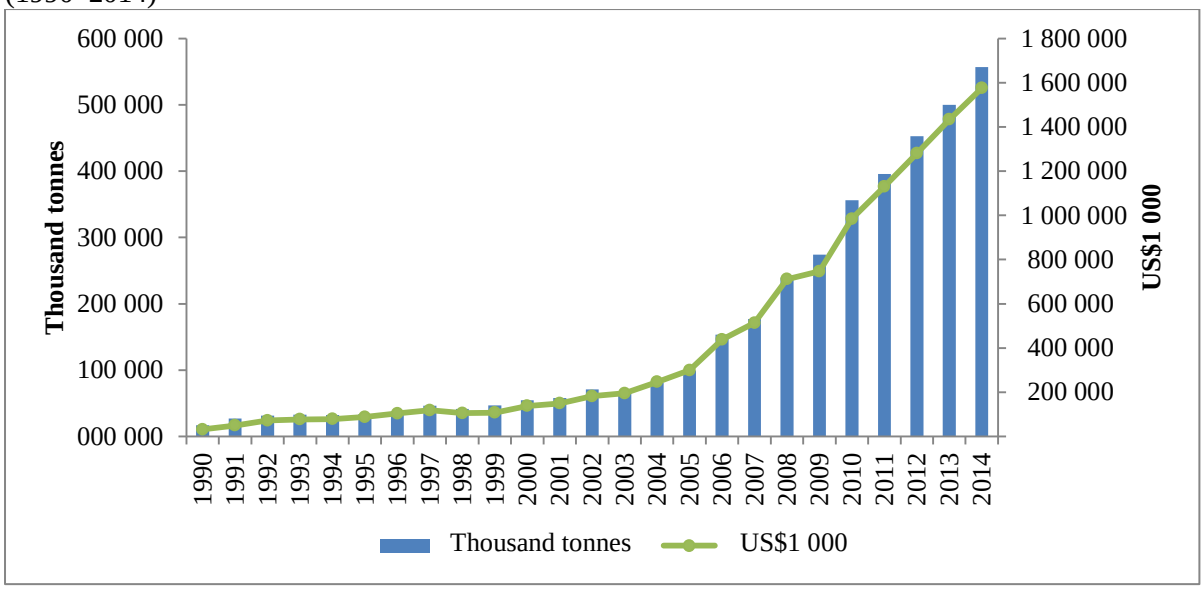
2.1.5 Non-food aquaculture technologies

The culture of crocodile and ornamental fish continues to expand. Ornamental fish is produced in the Republic of Burundi, the Republic of Cameroon, the Republic of Kenya, the Republic of Malawi, the Republic of South Africa, the Republic of Uganda and the Republic of Zambia for domestic and export markets (FAO/Globefish, 2015). Crocodile farming is practised in the Republic of Kenya, the Republic of Madagascar, the Republic of Zambia, the Republic of Mozambique, the Republic of South Africa, the United Republic of Tanzania and the Republic of Uganda, while live baitfish is produced in the Republic of Kenya and the Republic of Uganda for sport fishing. Pearl farming is undertaken in the Republic of Seychelles using nuclei imported from Japan and Australia (Hecht, 2013).

2.1.6 Regional aquaculture production, species and values

Production in 2014 was 556 950 tonnes, up from 80 900 tonnes in 2004 and representing a seven-fold increase and an annual percentage rate (APR) of 21 percent between 2004 and 2014. The first-sale value of the 2014 production was US$1.6 billion, up from US$247 million in 2004 (Figure 1).

Figure 1. Aquaculture production and value in sub-Saharan Africa excluding aquatic plants (1990–2014)



Source: FAO, 2016a.

In 2014, SSA share of global aquaculture production was 0.75 percent (FAO, 2016a). The Federal Republic of Nigeria is consistently the largest producer. It accounted for 56 percent of production by quantity compared to 60 percent in 2008, indicating growth by other countries. Other major producers were the Republic of Uganda and the Republic of Ghana; these three countries together contributed 83 percent of the total production in 2014. The seven major producers remained the same compared to last reporting but with changes in ranking as the Republic of Ghana, the Republic of Kenya and the Republic of Zambia made impressive gains during the last five years (Table 1). The top seven countries accounted for 93 percent of the total production by quantity in 2014. Their individual share in quantity and value of SSA aquaculture production in 2014 is depicted in Figure 2.

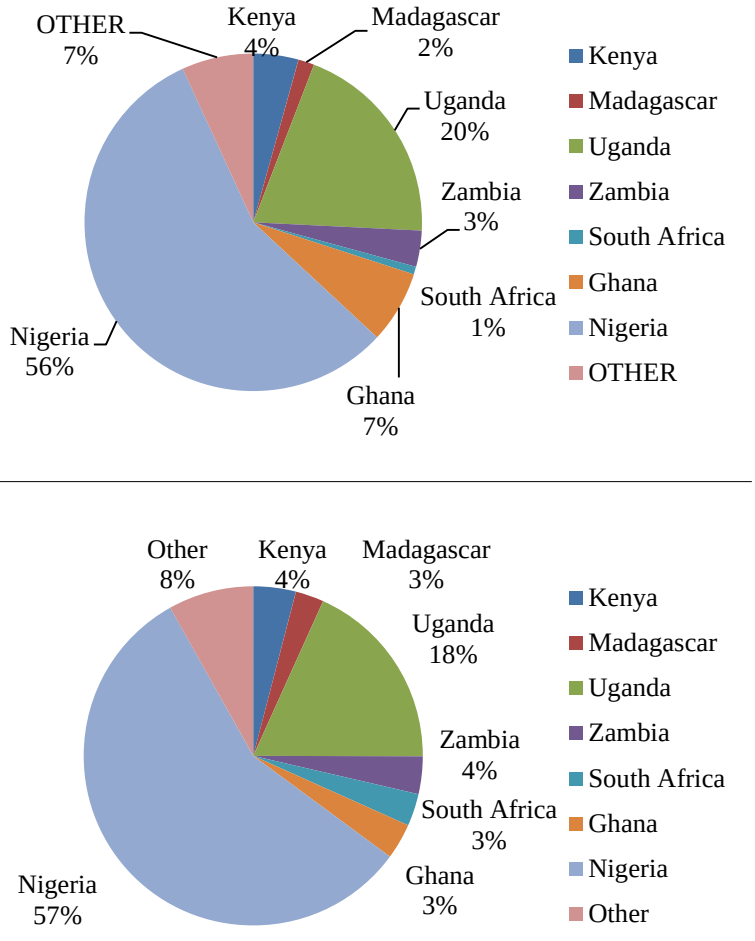
Reasons for the remarkable growth by major aquaculture producers include adoption of good governance, emphasis on capacity-building to create critical mass, promotion of public and private sector partnerships, emphasis on research and outreach and provision of credit. In addition, the promotion of private sector-led market-driven aquaculture is manifested in investments in the development and use of new production systems, sound management, establishment of efficient commercial hatcheries, construction of aquafeed mills and use of aquafeeds. These investments demonstrate great confidence in the young industry.

Table 1. Top seven aquaculture producers in sub-Saharan Africa from 2008 to 2014 by quantity (in tonnes)

Country	2008	2009	2010	2011	2012	2013	2014
Nigeria	143 207	152 796	200 535	221 128	253 898	278 706	313 231
Uganda	52 250	76 654	95 000	85 713	95 906	98 063	111 023
Ghana	5 594	7 154	10 200	19 092	27 450	32 513	38 545
Kenya	4 452	4 895	12 154	22 135	21 488	23 501	24 098
Zambia	5 640	8 505	10 290	10 530	12 988	20 271	19 281
Madagascar	10 836	6 116	6 886	8 845	8 585	8 974	8 470
South Africa	3 587	3 433	3 133	3 572	3 999	4 010	4 160
Other	14 001	14 426	17 917	24 898	28 380	33 683	38 142
Total	239 567	273 979	356 115	395 913	452 697	499 721	556 950

Source: FAO, 2016a.

Figure 2. Major aquaculture producers by quantity and value in sub-Saharan Africa (2014)



Source: FAO, 2016a.

2.1.7 Production by subregion

Production by subregion (Table 2) shows that Central and Southern African countries consistently contribute least to overall regional production. The dominant producer in each subregion remained the same: Western – the Federal Republic of Nigeria (87 percent); Eastern – the Republic of Uganda (60 percent); Southern – the Republic of South Africa (70 percent); and Central – the Democratic Republic of the Congo (66 percent). Compared to 2008, there is a five to 15 percent decline for the major producers in each subregion, indicating potential growth by countries within subregions (e.g. the Republic of Ghana and the Republic of Kenya for Western and Eastern African regions respectively).

Table 2. Aquaculture production (excluding plants) by geographical subregion, 2010–2014

Subregion	2010	2011	2012	2013	2014
Central (tonnes)	4 196	4 207	4 323	4 342	4 352
(US$1 000)	11 537	11 716	13 064	13 242	14 068
Eastern (tonnes)	131 997	140 230	155 772	170 832	185 821
(US$1 000	291 021	356 760	405 329	465 725	522 411
Southern	4 187	4 406	4 939	5 220	5 921
(tonnes)(US$1 000)	61 500	58 716	68 633	60 956	61 433
Western (tonnes)	215 735	247 069	287 664	319 327	360 857
(US$1 000)	619 755	703 349	792 782	893 317	977 685
Total (tonnes)	356 115	395 913	452 697	499 721	556 950
(US$1000)	983 813	11 303 541	1 279 808	1 433 242	1 575 597

Source: FAO, 2016a.

2.1.8 Production by environment

Production by aquatic environment (Table 3) shows the prominence of inland aquaculture. In 2014, coastal aquaculture production was 9 919 tonnes, accounting for only 2 percent of production quantity with a first sales value of US$86 million.

Table 3. Aquaculture production in quantity (in tonnes) and in value (in US$1 000) by environment, 2010–2014

Environment	2008	2010	2011	2012	2013	2014
Inland (tonnes)	227 602	347 988	386 607	443 675	490 114	547 031
(US$1 000)	622 805	900 786	1 034 545	1 186 855	1 341 351	1 488 906
Marine/coastal (tonnes)	11 965	8 127	9 306	9 022	9 607	9 919
(US$1 000)	88 278	83 027	95 996	92 954	91 891	86 691
Total (tonnes)	239 567	356 115	395 913	452 697	499 721	556 950
(US$1 000)	711 082	983 813	1 130 541	1 279 808	1 433 242	1 57 5 597

Source: FAO, 2016a.

Compared to production in 2008 (11 965 tonnes, or 5 percent of total production) coastal aquaculture production contracted by 17 percent. This can be attributed in part to the outbreak of white spot syndrome virus (WSSV), which decimated the shrimp industry in the Republic of Mozambique in 2011 (Omar, 2013). The main marine/coastal aquaculture producers in 2014 were the Republic of Madagascar (4 697 tonnes), the Republic of South Africa (2 405 tonnes), the Republic of Namibia (695 tonnes), the Republic of Mauritius (686 tonnes) and the United Republic of Tanzania (601 tonnes).

2.1.9 Production by species

NASO data show that 45 species are used in SSA farms. Catfishes, tilapias and cyprinids are the main inland species groups and account for 86 percent of total production, while five marine/coastal species were the major contributors to coastal production in 2014 (Table 4).

Table 4. Production (in tonnes) for three inland major aquaculture species and five major coastal species in SSA

Inland aquaculture species			Marine/coastal aquaculture species		
Cultured species	**2008**	**2014**	**Cultured species**	**2008**	**2014**
North African catfish	111 561	223 520	Giant tiger prawn	9 093	5 102
Torpedo shaped catfishes nei	11 690	35 879	Perlemoen abalone	1 041	1 165
Nile Tilapia	33 567	132 287	Red drum	282	709
Cyprinids nei	15 692	27 906	Pacific cupped oyster	447	990
Tilapias nei	10 723	43 564	Mediterranean mussel	742	860
Nile perch	8 585	15 728			

Source: FAO, 2016a.
Symbol: nei = Not elsewhere included

The most important producers of seaweeds (> 1 000 tonnes in 2014) are the Republic of Madagascar (8 363 tonnes), the United Republic of Tanzania (139 723 tonnes, of which 133 020 were from Zanzibar), and the Republic of South Africa (2 000 tonnes).

2.1.10 Main drivers for regional expansion and growth

The main drivers for the regional expansion and remarkable growth during the last five years include the increasing importance being placed by SSA countries on the sub-sector for improving food security and resource use, and new expectations linked directly to current major macro-economic challenges – improving national fish supply while making significant impact on job creation and economic growth. Assistance has come from FAO and other development partners (international and bilateral) as well as donor organizations and investors including the African Union-InterAfrican Bureau for Animal Resources (AU-IBAR), the World Bank, African Development Bank (AfDB), European Union (EU), United States Agency for International Development (USAID), Swedish International Development Cooperation (SIDA), WorldFish, etc. Momentum has been generated by the 2005 AU/NEPAD Fish for All Summit in Abuja, the Federal Republic of Nigeria, implementation of the FAO Special Programme for Aquaculture Development of Africa (SPADA) and the NEPAD-FAO Fish Programme (NFFP), the Conference of African Ministers of Fisheries and Aquaculture (CAMFA) in Banjul, the Islamic Republic of the Gambia in 2010 and Addis Ababa in 2014, and adoption of the Policy Framework and Reform Strategy for African Fisheries and Aquaculture (PFRS). The private sector has exhibited willingness to engage in aquaculture in several countries.

2.2 Outstanding issues and success stories

Interventions and impact pathways leading from aquaculture production to policy goals such as local food production, local income generation or export earnings are different, and this has important implications for national policies aimed at encouraging the growth of aquaculture. Currently, the private-sector is leading in income generation, job creation and export earning goals while less emphasis would seem to be placed by government on issues such as household food security, nutrition and increased resilience for the poor.

Box 1. Success Story: The phenomenal growth of aquaculture in Ghana (2009–2014)

The growth of aquaculture in the Republic of Ghana has been remarkable. Production was 950 tonnes in 2004 and rose to 38 343 tonnes in 2014 with an APR of 45 percent. There was a five-fold increase in production between 2009 (7 154 tonnes) and 2014. This is attributed to the emergence and intensification of private sector-led small and medium-size enterprises (SME) and the expansion of large commercial cage culture aqua-farms, as well as the provision of an enabling environment (strategies, plan and policy instrument, fiscal policies, tax exemption on the importation of aquafeeds and aquaculture equipment, emphasis on capacity building on different aspects of aquaculture, etc.). Contributors to this development include availability of improved genetic resources such as the Akosombo strain distributed to government hatcheries and producers and widely used in the country, development of appropriate technology for producing all-male tilapia fingerlings, and production of a crop comprised principally of high-value large fish. There are other signs of a growing industry infrastructure, including a dynamic private sector that makes significant investments (with some public-sector and third party support) in many areas of aquaculture (e.g. feed mills, processing and marketing, seed production and food fish production) and offers training both alone and in collaboration with government. According to FAO Fish production model (FAO, 2016b) the Republic of Ghana is projected to produce 75 000 tonnes in 2025, an increase of 97 percent over 2014.

Source: With contributions by Lionel Awity and Department of Fisheries, Ghana.

2.3 The way forward

Production of tilapia can be increased through known management techniques: availability and use of quality aquafeeds, reducing the production cycle, using faster-growing variety of Nile tilapia, producing and marketing smaller fish, using larger fish for stocking; etc. In areas of cooler water

temperatures, such as central the Republic of Kenya or the Republic of Madagascar highlands, the common carp, if marketable, may be a better culture candidate because of its lower temperature tolerance; this will help diversify production. The production potential of catfish is so great that consumer education/promotion/sales efforts to increase local demand or for exports are warranted.

3. RESOURCES, SERVICES AND TECHNOLOGIES

3.1 Status and trends

3.1.1 Land and water

Access to land and water resources, competition for these resources by multiple users and their degradation remain important issues for aquaculture development in SSA. In many countries, insecurity in land ownership or lease and potential conflicts with other users (crop and animal farmers, developers, etc.) limit investment in the sector. Because investment in SSA has become increasingly contingent on ease of access to land and arguably water (German, Schoneveld and Mwangi, 2011), strengthening of customary rights and investment promotion are threatening to become conflicting policy objectives and could potentially compromise the expansion of SME commercial aquaculture.

Freshwater resource distribution in SSA is characterized by complex patterns and striking contrasts, with an abundance of rainfall in some areas and drought in others. In the last 20 years, available fresh water resources have become greatly reduced due to severe and prolonged droughts (UNECA, 2016). Water pollution from industrial effluent, urban runoff, sewerage and agro-chemicals is increasing and continues to degrade freshwater quality. Many parts of SSA are thus facing freshwater shortage at a time when there is a trend towards intensification and diversification in SSA aquaculture, including increased importance and expansion of cage culture in several countries.

3.1.2 Seed

As with the development of any new animal industry, availability of seed is the first factor limiting commercial production. The availability of seed remains a serious problem in many SSA countries. Dedicated commercial hatcheries are functional in some, e.g. the Federal Republic of Nigeria, the Republic of Ghana, the Republic of Uganda, the Republic of Kenya, the Republic of South Africa, the Republic of Zambia, the Republic of Madagascar, etc. and emerging in others like the Republic of Benin, the Republic of Cameroon, the Gabonese Republic (Mba-Asseko, personal communication, July 2016). In terms of seed, the most significant developments in the last ten years include:

- development of appropriate technologies to produce all-male tilapia fingerlings, making production of a crop comprised primarily of high-value large fish possible; and
- spawning of *Clarias* in large numbers using injections of fresh pituitary followed by hand-stripping.

These techniques are now widely known and practiced in several countries. Seed production is presently the most profitable segment of aquaculture in SSA (Aulanier *et al.*, 2011).

In the major aquaculture producing countries, some hatcheries are already seeing increased competition and some operators are able to produce their seed more cheaply, offer consistent quality, offer a money-back guarantee for a limited time after delivery, and/or provide other services to their customers, such as advice, training and sales of feed and equipment. However, different kinds of commercial seed production ventures can emerge and happily coexist by addressing different markets. In the Republic of Madagascar, for example, the emergence of “Écloseries Paysannes” (EP), or peasant hatcheries, was controversial at first, as small egg producers were seen as unfair competitors to the large “Pisciculteurs Producteurs d’Alevins” (PPA or Fingerling Producers). Moreover, there was concern that they would not have the capacity to maintain good genetic quality. The genetic

assessment project by APDRA and INRA, however, showed that there was no inbreeding. The PPAs also eventually accepted that they were not adversely impacted, as most were not interested in selling a few hundred fry at a time, as was being requested by most rice farmers, so there was no serious competition. Both now peacefully coexist[1].

3.1.3 Genetic resources

Advances in pedigree-based breeding programmes for both tilapia and catfish are in various stages of development by the public and private sectors. In the Republic of Ghana, the Akosombo strain of tilapia, which was developed from fish sourced from Lake Volta, has been selected for increased growth for nine generations and provides a 30 percent improvement in growth relative to the control population. The Akosombo strain has been distributed to government hatcheries and is widely utilized in the Republic of Ghana. In the Republic of Uganda, the Source of the Nile (SON) Fish Farm has eight strains of Nile tilapia, produced using fish sourced from three Ugandan lakes (Victoria, Albert and Kyoga) and bred at the Fisheries Centre in Kajjansi. The farm is currently breeding the seventh generation of fish from these eight original strains. Genetic improvement programmes are also being conducted for tilapia and *Clarias* at Sagana, the Republic of Kenya. An improved line of *Clarias gariepinus* developed by Dutch researchers has been introduced and is widely cultured in the Republic of Cameroon, the Republic of Kenya and the Federal Republic of Nigeria. Hybridization of *Heterobranchus bidosalis/longifilis* with *Clarias gariepinus* is ongoing in the Federal Republic of Nigeria. The offspring of this crossing is meatier and hardier than either of the parents, but is less fecund and more cannibalistic. The growth disparity within the cohort is high and the ecological impact to the environment has yet to be assessed (Agenuma, 2013).

3.1.4 Feed resources

Significant quantities of aquafeed are imported but there is an expansion of local feed mill capacity underway in a number of countries (the Republic of Ghana, the Republic of Kenya, the Federal Republic of Nigeria, the Republic of Uganda, the Republic of Zambia, etc.). However, there are frequent aquafeed shortages. Commercial private sector feed mills in the Republic of Kenya and the Republic of Uganda produce floating (extruded) pellets. One of the feed mills (Sigma Feeds Ltd, Nairobi, the Republic of Kenya) is a joint project between the Government and the private sector. Some of the local feeds produced in the Federal Republic of Nigeria are reported to have low digestibility and poor feed conversion ratio (FCR) with the majority of them sinking to the bottom (Agenuma, 2013). There are aquafeed distribution networks (all bagged feed) in the major aquaculture producing countries.

High competition and demand for feed should stimulate continued development of local mills, making aquafeed more affordable and widely available. Both imported and locally produced aquafeed are expensive and of unknown quality. There is also a variety of local feed manufacture solutions, especially in the less productive aquaculture countries, ranging from farmer-formulated meal-type diet to a quasi-pellet produced with a grinder and subsequent drying to form water-soluble, hard sinking pellets. The price of aquafeeds varies between countries and within countries due to source of import and for locally produced feeds the costs of feed ingredients and seasons. Feed costs are always increasing. Countries lack appropriate aquafeed policy, regulatory frameworks, and feed standards.

3.1.5 Animal health support services

Almost all countries depend on services provided by government veterinary or public health departments. A number of disease problems and the occasional severe epizootic – such as the ulcerative syndrome (EUS) and white spot syndrome virus (WSSV) which decimated the shrimp industry of the Republic of Mozambique in 2011 (Omar, 2013) – have exposed the vulnerability of aquaculture systems to pathogens and to the factors that make them virulent and cause their spread.

[1] Lionel Dabbadie, pers. comm., November 2016.

These and other incidents have highlighted the need to lay emphasis on improved capacity for disease diagnosis, aquatic animal health certification and quarantine, disease surveillance and reporting on-farm level management, contingency planning, zoning and import risk analysis (AUC-NEPAD, 2014). Some countries, for example the Republic of Zambia, are in different stages of development of their national aquatic animal health strategies and action plans (Marttin, personal communication, July 2016).

3.1.6 Financial products and services

Credit and insurance worthiness are closely linked and commercial credit and insurance providers continue to be risk-averse regarding aquaculture. A range of investment facilities is available from national development and commercial banks and non-formal sources. Most small-scale operators do not insure their farms. Large operators tend to insure their farms. Farmers who obtain loans from formal sources to undertake aquaculture, irrespective of the size of operation, must insure the farm, a requirement tied to the loan and done centrally in the Federal Republic of Nigeria and the Republic of South Africa. Access to loans is limited. The underlying problem is that SME operators (and potential entrants) do not generally keep records and lack the business acumen to articulate fully their projects to private sector investors. Private sector financiers in turn lack the expertise and expertise to appraise aquaculture projects Complex bureaucracy and rules make access to credit through public sector schemes difficult. Interest rates of 20–25 percent a year with a payback period of 5–10 years in several countries (the Republic of Ghana, the Federal Republic of Nigeria, the Republic of South Africa, the Republic of Uganda, etc.) are further constraints. The situation is, however, improving. A large cage producer in the Republic of Ghana is moving toward computerized records, including bar codes on tanks to allow scanning of stocking, harvest and feed records.

Access to credit has improved in many of the major aquaculture producing countries as operators have demonstrated that, with a pivotal shift to a business-oriented model, aquaculture is a viable proposition. In the Federal Republic of Nigeria, the Agricultural Credit Guarantee Scheme, a central bank guarantee, loans up to 75 percent and requires that the farm, irrespective of size, is insured. A similar provision also applies for loans obtained through government in the Republic of South Africa and the Republic of Uganda. However, in many countries producers still depend on non-formal sources or resort to non-market strategies for crop loss mitigation. For small poor farmers this reduces their capacity to invest in farm assets and adopt better management practices (BMPs). Ongoing solutions in some countries include training in aquaculture for lenders in the banking sector, capacity-building, including proper documentation and business planning, to help SMEs profitably to undertake their business, and easy access to credit facilities, including options for establishing SME investment funds at national or regional levels (AUC-NEPAD, 2014).

3.1.7 Infrastructure

SSA countries, including some of the major aquaculture producing countries, lack basic infrastructural capacity such as roads/transport, electricity and farming machineries and equipment to support the growth of the aquaculture sector. According to UNECA (2016) Southern Africa is expected to make increased investments in electricity, technology and in large infrastructure projects. Growth in Central Africa will be driven by investments in energy, infrastructure and strong service performance; while growth in West Africa will be boosted by an improving economic performance with emphasis on diversifying investments. These actions coupled with increased efforts in several countries (including the Republic of Ghana, the Federal Republic of Nigeria, the Republic of Uganda, the Republic of South Africa, the Republic of Madagascar) to develop capacity of public sector veterinary services to serve the aquaculture sector in terms of health management and export certification would contribute to enhance the competitiveness of the sector.

3.1.8 Knowledge and technological capacity

Aquaculture is a technology-driven industry, and modern technological tools are used to improve seed production, aquafeeds, genetic resources and other aspects of the industry. A good example is abalone culture technology, which is "homegrown" to the Republic of South Africa, internationally competitive, and globally provides the Republic of South Africa with a comparative production advantage. Sub Saharan Africa is home to several academic institutions with aquaculture research capacity but these tend to be geographically isolated with minimal networking and sharing of resources. Through concerted efforts and networking these institutions (See Box 2) could contribute to alleviate some of the problems facing the aquaculture sector.

Box 2. Promotion of networking between institutions to develop regional research and teaching capacity in aquaculture

- Under the auspices of the NEPAD-RFN programme (NEPAD-Regional Fish Node), Bunda College of Agriculture, University of Malawi, has developed a regional aquaculture Ph.D training programme for students from Eastern, Central and Southern Africa to build and strengthen a network of researchers involved in refining and implementing projects to enhance fisheries and aquaculture production and biodiversity.
- The Forum for Agricultural Research in Africa (FARA), the technical arm of the African Union Commission (AUC) on matters concerning agriculture science, technical and innovation, through its programme Strengthening Capacity for Agricultural Research for Development (SCARDA), aims to strengthen human and institutional capacity of African National Agricultural Research Stations.
- The African Union Interafrican Bureau for Animal Resources' (AU-IBAR) Aquaculture Working Group is potentially a mechanism for coordinating aquaculture research.
- The Association of African Universities has identified the need to upgrade the curricula of African universities to ensure they deliver skills and professionals required by the labour market. This can be promoted as a collaborative area of work with the Southern Regional University Association.
- The Sustainable Aquaculture Research Networks for sub-Saharan Africa (SARNISSA) project has effectively linked researchers, farmers and the private sector and has proved highly effective in promoting networking within the farming community and as an information and educational tool.
- The Aquaculture Network for Africa (ANAF), modeled after its Asian counterpart NACA, was conceived to facilitate the exchange of aquaculture information in SSA and develop an informal, flexible and efficient network of regional experts for aquaculture development.

Adapted from: FAO. 2015. *Working document Research and Education for Aquaculture Development, Sub-Committee on Aquaculture, Eighth Session, Brasilia, Brazil, October 2015.*

Key areas for future research and appropriate technologies include:

- development of high quality, cost-effective aquafeeds designed specifically for species and life stages being grown;
- development of hatcheries;
- high quality seed and guarantee/certification system;
- profitability or viability of different aquaculture production systems and subsequent development of business plans;
- value-chain improvement, marketing and research to inform policy;
- impact pathways; and
- public sector veterinary services to develop capacity to serve the aquaculture sector, in terms of health management and export certification.

3.2 Outstanding issues

Major outstanding issues include how to make best use of on-going pedigree-based breeding programmes. Aquafeed availability and quality is a major constraint to the growth of aquaculture production in SSA. Producers express doubts about the quality of both imported and locally produced

aquafeeds. Improvements to the quality and preparation of such feeds should boost productivity and cut costs. Feed formulation issues, in particular the provision of species-specific feeds that meet the nutritional requirements of different life stages, remain important for both commercial and farm-made feed. In addition, appropriate aquafeed policy, regulatory frameworks, and feed standards are lacking in SSA countries.

3.3 The way forward

Public sector agencies should increase their investment in aquaculture research and education. FAO could consider helping SSA countries initiate a regional network and programme on Science and Technology Innovation in Aquaculture integrated within the work programme of AU-IBAR. Pedigree-based breeding programmes such as "The Volta Basin Tilapia Project" are very expensive and require long-term commitment in order to produce significant results. Due to the high costs of initiating and continuing these breeding programmes, it would be beneficial for public entities responsible for such projects to consider sharing resources or at least sharing germplasm and information with other SSA countries and private companies. Appropriate aquafeed policy, regulatory frameworks and feed standards need to be developed and institutional capacity strengthened in agencies responsible for aquaculture management, monitoring and compliance.

4. AQUACULTURE AND ENVIRONMENTAL INTEGRITY

4.1 Status and trends

4.1.1 Scarcity of land and water resources

Land and water resources are scarce in SSA. Recurrent droughts adversely affect water availability in several parts of SSA, particularly in the Sahelian western-central belt, Southern Africa and parts of Eastern Africa (UNECA, 2016). These droughts justify the importance placed on the development and expansion of cage culture, viewed as efficient in terms of water use in common property (public lakes, reservoirs and coastal areas) where boundaries and access rights are less defined.

Land-based aquaculture needs a supply of water, so floodplains and wetlands are often chosen for aquaculture sites. Deforestation of coastal wetlands, especially mangrove forest systems, for coastal aquaculture in the Republic of Kenya, the Republic of Madagascar, the Republic of Mozambique, the United Republic of Tanzania, the Republic of Côte d'Ivoire and other countries means a loss of the services provided by these fragile ecosystems. Faced with limitations in land and water resources and in order to improve the economic efficiency of operations, technologies such as Geographical Information Systems (GIS) and remote sensing are being used to identify suitable aquaculture sites (Ross *et al.*, 2013). In the framework of the FAO project "Spatial Planning of Aquaculture in the Republic of Angola" it is planned, for the first time in SSA, to use unmanned aerial vehicles (drones) to facilitate reconnaissance fieldwork for aquaculture site selection (FAO/Blue Growth Initiative blog, 2016).

4.1.2 Impacts from nutrient loading

Negative environmental impacts from aquaculture occur in many ways. One of the most visible is the discharge of nutrients/wastes to streets from homestead aquaculture facilities in the Federal Republic of Nigeria (Agenuma, 2013). There are also isolated cases of nutrient discharge from large farms into the environment and the accumulation of both solid wastes with high carbon load and soluble wastes with their dissolved nutrients in effluent water, with compounding effects of eutrophication of surrounding ecosystems. Chemical residues discharged from aquaculture operations result from the use of pest and disease-controlling agents, compounds that reduce biofouling, and hormones for inducing breeding or sex reversal. All impact their surrounding environment. Their effects and significance have not yet been documented; limited quantities of chemicals are used in aquaculture

operations in SSA. In the Republic of Seychelles, all fish cage farmers will be required to fallow their sites every second year for not less than 12 months or until the seabed has recovered (Hecht, 2013).

Farmers have learned that environmental responsibility makes good business sense and that pollution reduces economic returns. Producer associations supported by technical and policy experts in academia and government have developed and continue to adopt BMPs to improve the environmental performance of aquaculture. Examples include Manual for Commercial Pond Production of the African Catfish in the Republic of Uganda (Isyagi *et al.*, 2009a), the Code of Conduct/practice for Shrimp Culture in the Republic of Madagascar and on-going efforts in the Republic of Ghana, the Federal Republic of Nigeria and by Bunda College in the Republic of Malawi.

4.1.3 Biodiversity and alien species

Reported cases of introductions of alien species in the past 10 years relate to *Pangasius* sp. in the Federal Republic of Nigeria and the Republic of Kenya; impact on the environment is yet to be determined (Agenuma, 2013). National environmental framework law in SSA countries is often specific in mentioning species introductions as subject to prohibition or to strict control and only approved under exceptional circumstances. At the regional level there is the Nairobi Declaration on Conservation of Aquatic Biodiversity and Use of Genetically Improved and Alien Species for Aquaculture in Africa. The African Union in 2003 added political weight to this position by requesting that member states strictly control the intentional and, in as far as possible, accidental introduction, in any area, of species not native to that area. The Code of Conduct for Responsible Fisheries (CCRF) is the reference guide for the management of aquaculture in SSA and over 40 SSA countries have ratified the Convention on Biological Diversity (CBD). Both the CCRF and CBD seek to establish a precautionary approach to the use of alien species. It is not known if the low number of reported introductions reflects adherence to these instruments or that such introductions are not reported.

4.1.4 Conflicts and vandalism

Land tenure practice varies considerably across SSA. It is not only an issue of ownership, but also frequently of traditional communal or community access to land for various essential uses. Aquaculture can disturb the local equilibrium of land access and use. The multiple-use aspects of land and water resources often result in localized conflicts, for example between fishers and cage fish culture operators in Lake Kariba, vandalism in cage farms in the Republic of Uganda and in oyster farms in the Republic of Seychelles (Gatward, 2009; Hecht, 2013). In 2013 the Republic of Seychelles developed an aquaculture awareness/education plan that will be transferred to society through, among others, youth groups and non-governmental organizations (NGOs) to reduce potential conflicts in the sector (Hecht, 2013).

4.1.5 Contribution to environmental sustainability

Integrated aquaculture systems, the integrated irrigated aquaculture (IIA) model and culture-based fisheries in reservoirs are being promoted in drought-prone countries (Burkina Faso, the Republic of Guinea, the Republic of Madagascar, the Republic of Malawi, the Republic of Mali, the Republic of the Niger, the Federal Republic of Nigeria and the Republic of Senegal) to maximize water use efficiency. They have the potential to increase productivity of scarce freshwater resources, reduce pressure on natural resources and conserve aquatic biodiversity. Environmental sustainability is being enhanced by promoting the adoption of the principles of EAA (FAO, 2010) in the region.

4.1.6 Public perception

Not all aquaculture enterprises are well planned, and intensification is undertaken in some cases without due regard to environmental, health and social concerns. However, even when efforts are made to conform to standards, the lack of communication and understanding tend to reinforce the so

called “perception gap” between current, more sustainable and environmentally friendly aquaculture practices and how the general public perceive the sector. In recent years there has been greater awareness of environmental issues in general among the public, and governments are taking steps to mitigate potential adverse effects by providing effective environmental stewardship. Over 40 SSA countries have adopted national environmental framework laws (Nugent, 2009), and national aquaculture legislation overviews (NALOs) show that some countries have incorporated specific regulations to promote environmental management of aquaculture. These instruments are aimed at helping aquaculture investors interpret the environmental framework laws. One such regulation, the application of environmental impact assessment (EIA) requirements, is considered by the industry in the Republic of South Africa to be a bottleneck to the growth of the sector (Shipton *et al.*, 2009).

4.2 Outstanding issues and success stories

Several countries (the Republic of Angola, the Republic of Benin, the Republic of Cameroon, the Republic of Côte d’Ivoire, the Republic of Ghana, the Republic of Kenya, the Republic of Namibia, the Republic of Senegal, the Republic of South Africa and others) are developing comprehensive coastal and river basin plans in implementing their national environmental framework law. There are a number of regional initiatives on shared water resources such as the Niger Basin Climate Resilience Investment plan by nine countries of west and central Africa, Lake Victoria Basin Strategic Action Plan by the five lacustrine countries, and the Zambezi River Basin Water Course by the eight countries that share the Zambezi watercourse. It is important that the aquaculture industry be represented in the process to ensure that their concerns are heard and opportunities for future growth are not lost. Mangrove ecosystems are known to sequester carbon better than their terrestrial counterparts but these areas are being lost even to aquaculture due to rapid coastal development and mismanagement. Countries need to be assisted by the international donor community to assess the ecosystem services provided by these mangrove forests and develop incentives for better use of these ecosystems.

4.3 The way forward

Countries need to undertake a comprehensive and coordinated spatial plan to secure more and appropriate allocation of space in waters and land for sustainable growth of aquaculture. Emphasis should be placed on capacity-building to develop and implement BMPs and COPs. As appropriate, countries should scale up of mangrove reforestation programmes and mainstream BGI in national programmes as is happening in the Republic of Kenya’s mariculture industry. New tools should be developed to help the stakeholders understand the cumulative implications of various individual and collective strategies. An analysis of regional performance on the implementation of the Code of Conduct for Responsible Fisheries presented at the Eighth Session of the Sub-Committee on Aquaculture (COFI:AQ/VIII/3015/3) indicated that regulations regulating the use of alien species, monitoring of aquaculture activities, improvement in the implementation of EIA, regulations relating to fish stocking, carrying capacity, the prevention and mitigation of escapes and aquaculture zoning as a well as the application of EAA are issues that deserve more attention in SSA.

5. MARKETS AND TRADE

5.1 Status and trends

5.1.1 Marketing and distribution systems

Marketing and processing of the fish in SSA is undertaken mainly by women. Some quantity of table fish is sold at farmgate as fresh fish; the bulk is sold to major distributors who sell to retailers unprocessed. Other quantities are processed (chilled or frozen, smoked, dried, depurated or filleted) and sold to wholesalers or retailers. There are unofficial collection points from which commodities are disposed of locally, transported or exported to other countries. Private ice plants, cold storage

facilities and trucks loaded with thousands of kilos of iced aquaculture products are common features in the major producing countries (Agenuma, 2013; Isyagi *et al.*, 2009b).

Daily harvests/sales of 25 tonnes and annual single-farm production of 4000 tonnes of tilapia/catfish are achieved at some farms in the Republic of Ghana, the Republic of Kenya, the Federal Republic of Nigeria or the Republic of Uganda; examples include Tropo Farms (on Lake Volta, the Republic of Ghana) and Source of the Nile Fish Farm, Ltd, Jinja, the Republic of Uganda. Marketing and distribution strategies are clearly important and have already received private investment, with plans for more. In some countries (the Republic of Benin, the Republic of Cameroon, the Republic of Côte d'Ivoire, the Republic of Ghana, the Republic of Kenya, the Federal Republic of Nigeria, the Republic of Uganda, the Republic of South Africa, the Republic of Zambia) there is increasing use of information and communication technology (ICT) including mobile phones for marketing to reduce the information asymmetry between traders and producers to the benefit of the latter. There has been an overall increase in the use of new communication tools by professionals and many stakeholders' groups to access information to improve the output of their operations.

A case study of tilapia markets by Mapfumo (2015) in nine SSA countries (the Republic of Angola, the Democratic Republic of the Congo, the Republic of Ghana, the Republic of Kenya, the Republic of Malawi, the Federal Republic of Nigeria, the Republic of Zambia, the Republic of Uganda and the Republic of South Africa) in 2013–2014 indicated that distribution systems and infrastructure exist in the majority of the countries. Fish prices varied between and within countries based on consumers' preference, location, imported vs domestic product and product forms. In 2013, prices ranged from US$2.5 per kg (fresh whole round and gutted) in the Federal Republic of Nigeria to US$15 in the Republic of Angola. Indicative regional retail average prices per kg were fresh whole round (US$2.75), frozen whole gutted (US$3.00), fillets with skin on/off (US$9–12) and dried product (US$5.00). The price of fish is constantly on the increase because of demand due to the shortfall for tilapia in nine countries which ranges between 10 000 tonnes for most countries to 30 000 tonnes for the Democratic Republic of the Congo. Locally produced fish (fresh or chilled) is more expensive than imported aquaculture products. Consumers' preference is for fresh products.

5.1.2 Exports and imports

Many SSA countries are importing aquaculture products, particularly tilapia from China, India and Thailand to meet demands. In 2010, the Republic of Ghana imposed a ban on tilapia imports and the Federal Republic of Nigeria increased import tariffs to protect their growing industries (Mapfumo, 2015). In many countries the impact of imported fish on aquaculture products is minimal and not significant. The imported fish are perceived to be of low quality, cost less than locally produced fish and their market and marketing, particularly in the major aquaculture producing countries, are distinctly different. Within countries the best niche for imported (frozen) products is distant markets.

A significant part of the production in the Republic of Uganda is trucked to neighboring the Democratic Republic of the Congo, the Republic of South Sudan and the Republic of Rwanda (Isyagi *et al.*, 2009b; Robert Osinde, personal communication, August 2016). Products from the Federal Republic of Nigeria are exported to some African countries from major collection points, for example from Badagry and Idiroko (Lagos and Ogun States respectively) to the Republic of Ghana, from Nsidung (Cross River State) to the Republic of Cameroon, and from Onitsha (Anambra State) to the Republic of the Niger, the Republic of Tunisia, Libya, the Arab Republic of Egypt and others (Agenuma, 2013). Products of Lake Harvest Aquaculture (the Republic of Zimbabwe) are sold primarily to the Republic of Zimbabwe, the Republic of Zambia and other regional African markets with little exports of fresh fillets to the United Kingdom of Great Britain and Northern Ireland. Despite increased bilateral and intra-regional trade in aquaculture products, issues of quality standards persist.

Quantities of cold smoked catfish (*Clarias gariepinus*) are exported from the Republic of Uganda to the European Union and smoked dried catfish are exported from the Federal Republic of Nigeria to

the United States of America, showing the potential of African inland aquaculture products for export. Most mariculture products (prawns, abalone and seaweeds) are exported. The seaweed market in Zanzibar and the United Republic of Tanzania is dominated by a few international buyers who export to their mother companies in the United States of America, the French Republic, the Kingdom of Denmark and the Kingdom of Spain for processing (Msuya, 2009). The Republic of Namibia exports oysters and seaweed to Europe. The ornamental fish trade represents an important means of subsistence and income for rural people. In 2011 the Republic of Burundi, the Republic of Cameroon, the Republic of Malawi, the Republic of Zambia and the Republic of South Africa all received more than US$200 000 from the export of ornamental fish (FAO/Globe Fish, 2015).

5.1.3 Promotion of value chain

The farm-gate price is crucial to the economic viability and sustainability of farms, big and small, even more so with the rising cost of inputs and the additional cost of complying with an increasing number of requirements for market access. The value chain for aquaculture products is not well developed, in part because of poor infrastructure and insufficient policies and programmes directly related to value chain development; these include information awareness raising and coordination of value chain activities, developing skills and increasing innovation, increased access to finance and promoting inclusive standards. Therefore, some major producers are adopting strategies to increase their profit margins (keeping the fish alive until it reaches consumers, use of cold storage, drying or smoking, depurating, filleting, etc.). Some governments, for example in the Republic of Kenya, the Republic of Uganda and the Federal Republic of Nigeria, are making significant investments in infrastructure development such as the building of cold storage facilities. In some countries (the Republic of Kenya, the Federal Republic of Nigeria and the Republic of Uganda) market/distribution channels traditionally used by capture fisheries are employed in the value chain for aquaculture products.

5.1.4 Certification, food safety and animal health

Certification is not a regulatory condition for marketing aquaculture products in SSA countries. However, a number of export-oriented aquaculture countries recognize the marketing advantages certification can provide and are adopting appropriate mechanisms to remain viable in the market. Product labelling is applied in the Republic of Madagascar, the Republic of Mozambique, the Republic of South Africa and the Republic of Uganda. There is an enlightenment campaign in some countries on the requirements for exporting aquaculture products to the EU and American markets. In the Republic of Ghana and the Federal Republic of Nigeria, several officers in government agencies and private sector representatives have been trained locally and abroad for this purpose (Agenuma, 2013). The major exporting countries are aware that biosecurity and aquatic animal health management are essential for the sustainability of their industry and are investing in policy formulation and capacity building to address the issue. There is interest in risk analysis but implementation is hampered by lack of capacity to mainstream its use and ensure that it is used effectively. In order to ensure the harmonious reactivation of its mariculture sector, the Republic of Seychelles has preemptively developed comprehensive fish health management guidelines (Hecht, 2013) and the Republic of Zambia is developing aquatic animal health strategies and action plans. In 2013, the Republic of South Africa n retailers have committed to procure all their seafood from sustainable fisheries and responsible farming operations and to work with local and international seafood sustainability and awareness programmes to ensure that seafood is responsibly sourced and traceable (Mapfumo, 2015).

5.1.5 Potential for increased demand for aquaculture products

The demand for fish in SSA countries is barely tapped at present. Four factors will increase the demand for aquaculture products: (i) increasing population; (ii) decreasing or stagnating supply from wild fishery; (iii) the rising awareness of the health benefits from consuming fish; and (iv) the fact that fish remains the preferred and affordable animal protein for the majority of the population.

However, for this to happen, major efforts will be necessary to increase production and expand markets.

Tilapia is the favourite fish in many countries and the potential for increased production is promising. The production potential of catfish is very great and consumer education/promotion/sales efforts to increase the demand are warranted. Currently, a target market size for both tilapia and catfish is 400–500 g. To obtain this size on many tilapia farms requires about nine months from egg to harvest. Decreasing the market size to 100–300 g, for example, may allow a farmer to double production by reducing the production period. Even if sold at a slightly lower price, which may not be necessary with aggressive marketing, a farmer would likely show a greater profit due to greater volume and quicker turnover.

Common carp could be introduced in Central Kenya and other countries where the temperatures are lower, and non-fed aquaculture should be promoted where warranted. The key results for the period 2016–2025 for the FAO fish model (FAO, 2016b) indicate that aquaculture production in 2025 in SSA region would be 1.002 million tonnes, an increase of 84.6 percent. The Federal Republic of Nigeria is projected to produce 579 000 tonnes, an increase of 89 percent from 313 000 tonnes in 2014; and the Republic of Ghana 75 000 tonnes, an increase of 97 percent from 38 000 tonnes in 2014.

5.2 Outstanding issues and success stories

Major outstanding issues include: expansion of domestic and intra-regional markets; the availability of better and up-to-date information on fish retail prices and consumer requirements and demand at the domestic, regional and international levels; the reduction of trade barriers to improve access to key inputs; and improvements in implementing international standards and developing more value-added products to open the door to new markets.

Box 3. Success Story: SON Fish Farm Ltd, Jinja, Uganda

(A model of economic viability of large scale aquaculture business in Eastern Africa)

SON fish farm Ltd was established in 2005. It is a subsidiary of Lake Harvest Zimbabwe (mother company, African Century LTD. United Kingdom). SON is the first major cage operation in Lake Victoria. The farm consists of a pond-based hatchery unit and cages for grow-out. SON Fish Farm has eight strains of Nile tilapia, which were originally bred using fish sourced from three Ugandan lakes (Victoria, Albert and Kyoga) and were bred at the Fisheries Centre in Kajjansi. The farm is currently breeding the seventh generation of fish from these eight original strains. SON currently imports all the aqua feed for fry, fingerlings and grower biomass, due to lack of good quality feed locally. SON Fish Farm consumes 150 tonnes of feed monthly. The farm produces about 100 tonnes of whole tilapia per month which are sold whole round fresh, 15 percent locally but the bulk of the production (85 percent) on ice to Kenya and Rwanda. SON contributes toward the social and economic improvements for the local community through employment (110 staff), improvements in food and nutrition security and income generation for local fish traders, mainly women. SON also contributes to knowledge transfer both internally with employed staff and externally through training of out-growers and other tilapia farmers.

Source: Contributions from Robert Osinde, General Manager Source of the Nile Fish Farm Ltd, Jinja, Uganda.

5.3 The way forward

For aquaculture to be both a major contributor to food security and a driver of economic development through markets and trade there should be a focus on improved collection, documentation and dissemination of market information, and investment in public infrastructure, including road networks, energy supplies, public feed and cold stores and fish marketing facilities at local markets. Where possible, there should be reduction in regional and international trade barriers and the

harmonization of import/export regulations through strengthening competent authorities' capacity and facilities to fully implement food Sanitary and Phytosanitary (SPS) regulations and risk analysis.

Box 4. Success Story: Tropo Farms, Mpakadan, Ghana

(Western Africa's Premier Tilapia Farm)

Tropo Farms is located in Mpakadan, Eastern region of the Republic of Ghana, 5 km upstream of the Akosombo dam on a deep-water site in the Ajena Gorge. The Farm originated with a start-up pond aquaculture facility in Asutsuare, near Lake Volta in 1999 where it still maintains a dedicated 13 hectare hatchery which has a fry production capacity of 3.0 million sex reversed tilapia fry per week. The vertically integrated cage system was started at its present site in 2005 and employs approximately 700 staff. Tropo Farm fabricates its own square cages and also utilizes imported high density polyethylene (HDPE) cages. Initially the farm produced its own aquafeed but now obtains most of its feed from Raanan Fish Feed, West Africa LTD near Accra. No chemicals, antibiotics or additives are used in grow-out. High mortalities are sometimes experienced due to various diseases after transport to the lake during the first week. Theft and sabotage are often major challenges. Production was > 6 000 tonnes in 2014 with a target of 10 000 tonnes in 2016. Tropo Farms markets their fish as "Volta Catch" using cold chain facilities. The harvest is sold gutted and fresh in ice in several towns including Accra, Kasoa, Takoradi and Kumasi. The company's customers also supply hotels and restaurants. Although a large proportion of the product is greater than 500 g, consumer preferences seem to be for fish between 250–350g. Tropo Farm trains its own staff. This aquaculture SME is the largest tilapia farm in terms of production in West Africa and the second in SSA after Lake Harvest in Zimbabwe.

Source: Contributions from Mr Mark Amechi, Chief Executive Officer of Tropo Farms Mpakadan, Ghana.

6. CONTRIBUTION OF AQUACULTURE TO FOOD SECURITY, SOCIAL AND ECONOMIC DEVELOPMENT

6.1 Status and trends

6.1.1 Fish supplies, food and nutrition security

The per capita fish consumption in SSA in 2014 was 8.9 kg (World average 19.7 kg) and is projected to increase by 2.2 percent to 9.1 kg in 2025 (FAO, 2016b). The driving force behind this increase will be a combination of rising incomes and urbanization interlinked with the expansion of aquaculture production and improved distribution channels. However, there are wide variations between countries and even within countries. Consumption in the Republic of South Africa in 2014 was 7.7 kg and is expected to decline to 7.4 kg in 2025, while consumption in the Federal Republic of Nigeria is expected to increase to 12.5 kg in 2025 from 11.8 kg in 2014. The per capita fish supply in some SSA countries (the Republic of Mauritius 19.8 kg, the Republic of Senegal 26.8 kg and the Republic of Sierra Leone 17.3 kg) is among the highest in the world (FAO, 2016b). Studies in the Republic of Malawi (Kawarazuka, 2010) showed that the frequency of fresh fish and dried fish consumption is higher in households with fish ponds, energy intake is 10.9 percent (285 Kcal/capita/day) higher in households engaging farming with aquaculture than that of farming with waged earner, prevalence of malnutrition was lower in fish pond owned households, and increased purchasing power through fish ponds might influence oil and fats intake thereby mitigating malnutrition.

In many countries, the average price of fish is lower than that of meat and poultry. The low price can make cultured fish highly accessible even to the poorest segment of the population. Furthermore, nutritional value is particularly important in SSA where approximately 28 percent of all deaths are attributed to malnutrition (Benson, 2008). Hence, aquaculture commodities available even in small amounts are very important, in view of their relatively high content of some essential nutrients such as iron, iodine, zinc, calcium, vitamin A and vitamin B, especially in the diets of infants, young children and pregnant women. These essential nutrients are not found in staples such as rice, cassava, wheat and maize that make up the bulk of food consumed by the people, or are found only in small quantities. These nutrients together with essential fatty acids found in fish are necessary for functional human development (Satia, 1989; HLPE, 2014; Béné *et al*., 2016). Studies by FAO and WorldFish

initiatives[2] have shown that these minerals are found in significant amounts in parts of fish that have hitherto been discarded. In several countries (the Federal Republic of Nigeria, the Republic of Côte d'Ivoire, the Republic of Uganda, the Republic of Kenya, the United Republic of Tanzania) these hitherto discarded parts are ground into powder and used as condiments in several local dishes. In the Republic of Uganda the fish powder is used in some FAO school feeding programme.

6.1.2 Source of employment, income and wealth creation

Aquaculture is a new source of year-round, better-paying jobs in a number of countries. On tilapia/catfish farms, over 70 percent of the jobs are full-time. Shellfish farming is characterized by some level of seasonality and, as a result, many of the jobs tend to be part-time. De Graaf and Garibaldi (2014) sampled 19 countries in SSA and reported that in 2012 the sector employed 82 017 persons, However, some major producing countries, for example the Federal Republic of Nigeria, the Republic of South Africa and the Republic of Zambia, were not sampled, thus the statistics probably grossly underestimate the employment potential of the sector. Total employment in the Federal Republic of Nigeria in 2012 was 253 898 (Agenuma, 2013); total regional employment in 2012 was thus at least 355 915. The emphasis on commercial aquaculture in several countries has created jobs for farm technicians and skilled labour as well as temporary employment, especially for youths and women. In addition, new industries and financial services in support of aquaculture are also providing employment opportunities in a number of countries.

The total value of aquaculture products in 2014 was estimated at US$1 575 597 compared to US$246 691 in 2008 (FAO, 2016a). The importance of aquaculture to regional and local economies varies considerably. The impact is greatest in Western and Eastern Africa and in particular in the Federal Republic of Nigeria/the Republic of Ghana and the Republic of Kenya/the Republic of Uganda area, which are the centres of the tilapia/catfish industry. In addition to generating wealth, large(r) commercial farms are hubs for the dissemination of knowledge and catalysts or pathways for non-commercial farmers to become advanced farmers or small entrepreneurs; aquaculture thus offers a way out of poverty for the household. A small scale confectionary industry based on catfish by-products is emerging in the Federal Republic of Nigeria in which fat in the gut of the fish is transformed to a variety of products (body cream, cooking oil and soap); components of the gut such as the intestine, liver and other visceral organs are recycled and incorporated into catfish/chicken feed. Catfish flakes and crackers are also being produced, and catfish are canned (Agenuma, 2013). In the Republic of Malawi, income of households with fish pond is 1.5 times higher than that of households without fish pond, there was a 50 percent increase in farm incomes with farmers who integrated the culture of fish and vegetables and income from fish pond is suggested to protect against being underweight as the purchasing power of farmers increased through fish ponds might influence oil and fats intake (Kawarazuka, 2010).

6.1.3 Women in aquaculture

About 34 percent of those employed in the aquaculture sector in SSA are women (De Graaf and Garibaldi, 2014). There are two times more females than males in the sector in the Islamic Republic of the Gambia and the Republic of Mozambique, while in the Republic of Kenya gender is evenly split. Women are owners of farms (16 percent) and actively involved in the value chain operations of post-harvest and marketing of product. Many of the women are heads of households and fish trading provides a major source – for some, the only source – of income.

Seaweed farms in the United Republic of Tanzania, the Republic of Mozambique and the Republic of Madagascar are family-owned businesses; more than 80 percent are owned and/or managed by women. Seaweed culture in Zanzibar, the United Republic of Tanzania is commonly presented as a successful story. However, the result of a study by Frocklin *et al.* (2012) provide a nuanced picture of the activity identifying serious health problems among farmers. Seaweed farmers considered their

[2] www.fao.org/blue-growth-blog/guess-whats-for-dinner-healthy-nutritious-fish-byproduct-powder/en/

health significantly poorer than non-seaweed farmers with fatigue, musculoskeletal pain, hunger, respiratory problems, eye related problems, injuries from hazardous animal and sharp shells in the water and allergies. Income was further reported below the extreme poverty line. In some countries a large proportion of the adult labour force lives with HIV/AIDS. Small-scale ponds offer a valuable addition to local farming systems without substantially adding to the labour burden – an option that has been taken up by HIV/AIDS-affected households including those headed by widows and orphans in the Republic of Malawi. These families are reported to show improved nutritional status through fish consumption and use income from fish sales to obtain further health services, including HIV/AIDS care (Nagoli *et al.*, 2009; Kawarazuka, 2010).

6.1.4 Organizations of producers and service providers

Fish farmers' associations exist in several countries with branches at the provincial or regional level (Satia, 2011). Aquaculture associations have recently been formed in the Republic of Benin, the Republic of Côte d'Ivoire and the Republic of Cameroon. These organizations are ensuring farmers' voices are heard in defining research agendas and in national and continent-wide policy making, in improving dialogue and exchange among producers and enabling them to better share their successes and failures (AUC-NEPAD, 2014). In addition, they encourage farmers to pool resources to access technical services and training and do collective marketing, acting as aquaculture equipment supply centers and selling a variety of feeds, chemicals and equipment; Isyagi *et al.*, 2009b; Agenuma, 2013). The industry associations in a number of countries have voluntarily developed BMPs to improve farm-level efficiency, with the objective being to produce more with less in the face of limited resources.

Developments in some countries, including the Republic of Ghana, the Republic of Kenya, the Federal Republic of Nigeria, the Republic of South Africa and the Republic of Uganda, have demonstrated that extension does not have to be a government monopoly. There are many examples of private sector involvement in the training of the next generation of aquaculturists. College students serve internships on private farms, larger and more productive farms/hatcheries provide (paid) training programmes to their customers in an effort to increase participants' skill level. Farmer field schools have developed and are supported by NGOs, as in the Republic of Uganda (Isyagi *et al.*, 2009b). In the Republic of Madagascar, the Smartfish project has funded comic books on rice-fish farming as well as secondary school teacher's training for rural kids to transfer knowledge of technologies to their families. A franchise of six commercial "aqua-shops" was established in 2010 under a DFID programme in rural areas in western Kenya, through which private individuals or farmers' associations sell aquaculture supplies, equipment, feed, chemicals, pharmaceuticals and fertilizer; the franchise also provides information for beginners or established fish farmers. Farmer-farmer interactions between operators from several African countries and those in the Federal Republic of Nigeria, particularly in the framework of ACP FISH II Programme, have strengthened the capacity of those smallholder farmers for competitive and sustainable aquaculture and showed them the advantages of and mechanisms for organizing farmer clusters.

6.2 Outstanding issues

At the regional level, there is limited attention to the social role of aquaculture and chronic insufficient support for small farmers. Furthermore, there is general agreement that development in water management should take several forms and benefit many people by better integrating irrigation with other uses, but there is a general neglect of aquaculture as part of the solution and its potential for improved nutrition has generally received negligible attention. Seaweed farming affects thousands of households in SSA. The results of the study in Zanzibar, the United Republic of Tanzania should encourage change towards better working condition and sustainability. There is need to include health issues in the seaweed research/development discourse, which might include comprehensive medical studies, management considerations and a thorough revision of the activity as a tool for development.

6.3 The way forward

Countries should, as appropriate, include fish in nutritional programmes and interventions aimed at tackling micronutrient deficiencies, especially among children and women, while respecting cultural specificities, promoting local procurement, and taking into account costs and benefits. Increased efforts are needed to improve supporting and enhancing mechanisms, such as including aquaculture in watershed and coastal zone management plans, ensuring positive impacts of aquaculture in local communities and livelihoods by adapting EAA and fully addressing the gender dimension of aquaculture for each intervention in order to overcome the unintended gender blindness of many approaches.

7. EXTERNAL PRESSURES ON THE SECTOR

7.1 Status and trends

7.1.1 Climate change

The impact of climate change on aquaculture in SSA is not yet fully known. Allison *et al.* (2009), Cochrane *et al.* (2009) and others have indicated some of the potential impacts of climate change on aquaculture in the region. Allison *et al.* (2009) reported that among the 33 countries most vulnerable to climate-induced changes in the fisheries sector, two thirds were African countries that are relying more and more on their aquaculture sector (includes the Republic of Ghana, the Federal Republic of Nigeria, the Republic of Uganda and the Republic of Zambia). Climate-related drivers of change that are in some cases already affecting aquaculture production systems can generally be grouped as: changes in air and water temperatures, ocean acidification, sea level rise, changes in frequency or intensity of extreme events, and water stress.

7.1.1.1 Temperature changes

Increasing temperature would have both positive and negative impacts for aquaculture. The type and scale of aquaculture system is significant in terms of temperature impacts, with shallow ponds with limited water exchange probably being most at risk. Water depth plays an important role with shallow ponds being much more prone to exceeding critical temperature throughout their water column during the hottest part of the day or during periods of unusually warm weather. Climate warming may stimulate the growth of harmful algae blooms that release toxins into the water and kill fish and shellfish. Cage-based finfish aquaculture and shellfish aquaculture populations in open water are susceptible to this increased toxicity, resulting in economic loss. Unexpected hot spells are likely to pose the greatest risks. In September 2013 a generalized mass mortality of 2–4 week old fry of catfish in the Federal Republic of Nigeria was attributed not only to poor nutrition but also to increased temperature that triggered stress and low resistance to disease agents (Agenuma, 2013). On the positive side, warming waters will increase availability of new sites, especially in regions where cold temperatures restrict growth of the popular species.

7.1.1.2 Sea level rise

Sea level rise will cause loss of land and erosion that in turn increase the risk of inundation for aquaculture. Coastal systems such as mangroves and salt marshes may also be lost as they struggle to adapt to the speed of sea level increase and/or are unable to retreat inland because there is developed land behind them. Salinization of ground water may also occur in some low-lying areas, reducing the availability of freshwater for aquaculture and other uses. The potential effects of these changes include increased costs in terms of defense against flooding and the loss of services provided by the coastal systems; these services include defense against extreme weather as well as provision of spawning and nursery grounds for species that may be important in terms of fisheries recruitment or supplying aquaculture seed.

The effects of sea level rise are evident in the coastal Ghanaian town of Keta, a major aquaculture production area where, according to long-term residents of this historically vibrant trading town, about two-thirds of the original coastal town has been lost to the sea over the years. In neighbouring Côte d'Ivoire, the eastern "tourist" coastline which also had vibrant coastal aquaculture enterprises is being eroded and an integrated coastal area management is being applied to save Kribi in the Republic of Cameroon.

7.1.1.3 Ocean acidification

Increasing concentrations of atmospheric carbon dioxide are having a direct influence on ocean pH. The ecological consequences and the indirect impacts on aquaculture may be significant, with potential changes in primary productivity of calcifying plankton (Gangstoe, Joss and Gehlen, 2011). The economic impact of ocean acidification on shellfish aquaculture in SSA could be significant, bearing in mind that the sector has been contracting over the last five years (FAO, 2016a).

7.1.1.4 Water availability changes/stress

Reduced annual rainfall in combination with higher temperatures and evaporation rates pose potential threats to aquaculture, especially when considered in relation to competing uses of water. In areas of marginal water availability, culture in small ponds by poorer farmers is perhaps at greatest risk; there is potential for reduced harvests, shorter growing seasons and increased limitation in choice of species and harvest size.

7.1.1.5 Effects of extreme weather

The Republic of Madagascar and the Republic of Mozambique have significant aquaculture sectors with the majority of production taking place in coastal systems. The two countries are also prone to tropical storms and cyclones. Heavy rainfall during intense storms can present a significant risk through localized flooding (flash floods) and lowering of salinity. According to the World Meteorological Organization (WMO, 2010), during a cyclone event in the Republic of Madagascar in 2010, heavy rain caused the diversion of a river upstream from a shrimp farm. The farm's pumping station had to be moved to a new location at considerable expense. Flooding combined with sea level rise can potentially damage coastal defenses including natural barriers such as mangroves.

7.1.2 Adaptation to, and mitigation of, climate change

According to Allison *et al.* (2009), the vulnerability of aquaculture (and inland fishing) communities to climate change is a function of exposure, sensitivity and adaptive capacity. The mitigating possibilities range from abandoning aquaculture altogether to developing insurance and early warning systems (as in the Republic of Mozambique and the Republic of Zambia) and changing operations. The promotion of EAA, which among other things will enable the conservation of biodiversity as well as the adoption of appropriate policy and legal framework, is another strategy to mitigate climate change. Other possibilities include the promotion of good governance in aquaculture and the construction of reservoirs for irrigation and hydroelectric generation (with the possibility of using reservoirs for cage culture). Policy and legal frameworks should take into account the needs of resource-poor and marginalized groups, including women, as well as the promotion of international cooperation especially in the management of shared water bodies (FAO, 2016b).

7.2. Impacts of economic crisis, civil unrest and drought on aquaculture

According to UNECA (2016), the following have affected agricultural development and implicitly aquaculture development: severe drought wrought by El Niño in parts of Southern Africa, the Federal Democratic Republic of Ethiopia and parts of Somalia as well as the Sahelian belt in west and central Africa, civil arrests and terrorism in parts of west and central Africa attributed to Boko-Haram, and inflationary pressures from widespread currency depreciation These factors tend to increase the costs

of inputs, particularly aquafeeds and farm machinery, resulting in increased production cost that makes fish more expensive for most people. In addition, rural insecurity in some countries (the Republic of Madagascar and Central African Republic) negatively affected aquaculture development including the abandonment of operations.

7.3 Outstanding issues

The important concern is to find ways to mitigate the adverse effects of climate change on the vulnerable groups in the region. The critical issues include: the need to deepen the interaction between fisheries and relevant ministries, in particular environment ministries, at country level, to strengthen regional water management for shared water basins, enhancing the capacity of SSA scientists to develop location-specific strategies for adaptation, and to raise the African Voice on the impact of climate change on fisheries/aquaculture during relevant international discourses.

7.4 The way forward

The increasing interest in spatial planning for aquaculture provides an opportunity for the aquaculture sector to plan future growth in areas that will minimize exposure to externalities that have the potential to affect production, and to adopt resilience measures (deeper ponds, more resilient strains, etc.). Through participatory processes with representatives of stakeholder groups, countries should mainstream climate change adaptation (CCA) and disaster-risk management (DRM) in fisheries/aquaculture policies, initiate development and management programmes, improve data collection on farms, enhance information, knowledge and communication systems, build adaptive capacity at the local level, improve policy coherence and coordination at national and regional levels, identify funding opportunities and aggressively promote the adoption of EAA. Stakeholders should be provided with new tools for them to better weigh different options, as cumulative individual strategies can lead to outcomes that are opposed to expectations.

8. GOVERNANCE AND MANAGEMENT OF THE SECTOR

8.1 Status and trends

8.1.1 Policies, framework strategies and plans

In the last decade, several governments have made concerted efforts to improve aquaculture governance and management of the sector, but this effort is not evenly spread. Many countries have yet to elaborate policies, framework strategies and plans, while the rate of implementation of elaborated instruments is low (FAO, 2015a). Many countries (for example the Republic of Angola) have developed or are developing specific aquaculture strategy documents or plans. Such sector-specific plans help to create awareness of the importance of the aquaculture sector and in some cases have resulted in institutional change. In several cases (the Federal Republic of Nigeria, the Republic of Ghana, the Republic of Uganda, the Republic of Cameroon, the Republic of Malawi and others) the plans list a variety of policy objectives but there is no clear link between various policy goals, the specific types of aquaculture and specific support measures to be developed.

There are long time lapses between policy formulation, policy adoption and the formulation of concerted action plans, so that strategies may no longer apply to rapidly changing circumstances. NEPAD/AU-IBAR, through broad consultation processes, elaborated the “Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa” (PFRS) with the purpose of facilitating coherent policy development for the sustainable management of fisheries and aquaculture resources in the member States of the African Union (AUC-NEPAD, 2014). In terms of aquaculture, the PFRS aims to jumpstart market-led sustainable aquaculture throughout Africa by using a variety of strategies and, where appropriate, to support interventionist development approaches in aquaculture using strong strategic and implementation plans.

8.1.2 Legislation and regulatory frameworks

For all countries in SSA the CCRF is the reference instrument for the management of the sector. Many countries are signatories to (or have ratified) the CBD, the RAMSAR Convention and the framework Convention on Climate Change. According to NALOs, countries continue to rewrite and strengthen their fisheries and aquaculture legislation. Some countries have zoned areas for aquaculture and this has ensured the clustering of producers, facilitated the delivery of services and contributed to better economies of scale. These countries have yet to determine the carrying capacity for watersheds. Several countries have incorporated specific regulations to promote environmental management of aquaculture (Nugent, 2009). In many cases, regulation such as the use of EIAs is limited to large commercial farms; a full EIA is not generally undertaken because farms are generally below the prescribed limits. In the Republic of Seychelles, only farms located outside aquaculture development zones and whose potential production is >250 tonnes are required to undertake an EIA (Hecht, 2013). There are conflicts in legislation because several ministries are often involved in aquaculture-related laws and regulations.

Certification and quality standards for export markets, such as the hazard analysis and critical control point (HACCP) system, have been met by some countries. Product labelling is applied only in a few countries (the Republic of Madagascar, the Republic of Mozambique, the Republic of South Africa and the Republic of Uganda) while the Federal Republic of Nigeria, the Republic of Kenya and the Republic of Ghana are adopting processes to meet both the United States of America and the European Union regulations on food safety and quality control and regulation.

8.1.3 Transboundary governance of resources

Improvements are being made in regional governance of transboundary resources by applying the principles of the EAA in the Volta water body ecosystem, which goes beyond countries' boundaries and requires shared and agreed objectives and standards. The East African Community (the Republic of Burundi, the Republic of Kenya, the Republic of Rwanda, the United Republic of Tanzania and the Republic of Uganda) has elaborated the East African Community Fisheries and Aquaculture Policy (LVFO, 2015).

8.2. Outstanding issues

Specific support mechanisms that facilitate the implementation of the regulatory measures are lacking in many countries. Time lapses between the formulation of essential instruments and their implementation is too long, and in some cases many instruments do not address key issues such as rights of access, standards and right to work as well as sustainability of natural resources.

In the Republic of Madagascar, a public-private partnerships initiative for formulation and implementation of plans and strategies is an example of a success story (Box 5, below).

8.3. The way forward

Countries should update their essential instruments in line with changes in the sector; promote participatory and inclusive mechanisms involving all stakeholder groups in the formulation of essential instruments and build capacity for the implementation of developed instruments.

Box 5. Coordination mechanisms for aquaculture sector development in Madagascar

In Madagascar, an aquaculture strategy plan was formulated in 2005 with specific roles assigned to government, the private sector and the fish producers' associations. The aim of the plan is to create employment, improve profit for the producers and boost gross income within the fish-producing sector. Madagascar has gained itself a place in the international shrimp market and has been able to deliver good quality products. The designation "Shrimps Produced in Madagascar" has for many years been a guarantee of quality. Good collaboration between private sector and government in the shrimp sector has been a major factor behind this success. More than 300 technicians have been trained and employed in government services in functions that support development of the sector. The Institute for Shrimp Production Development provides technical training for technicians and for shrimp producers. The Groupement des Aquaculteurs et de Pêcheurs de Crevettes de Madagascar (GAPCM) was formed at the request of the Fisheries Department and acts as unique and valued spokesman for the sector. As part of the master plan, the government handed over all the existing fishery stations to producer associations. This privatization process has resulted in these stations running effectively and still playing a major role in the development of the aquaculture sector.

Source: Ranaivoson, 2009.

9. AQUACULTURE CONTRIBUTION TO FAO's STRATEGIC OBJECTIVES, SUSTAINABLE DEVELOPMENT GOALS AND BLUE GROWTH INITIATIVE

9.1. Status and trends

9.1.1 Links between SDGs, FAO's Strategic objectives (SOs) and BGI

The 2030 Agenda for Sustainable Development and the new Sustainable Development Goals (SDGs), which succeed the MDGs, have the ambitious aim of ending poverty and hunger by 2030. FAO's Strategic Framework including its five strategic objectives, as approved by the Members of the FAO Conference, guides FAO's policies and programmes in the various food producing sectors, including aquaculture. Elements that form the core of FAO's work – food security and nutrition and sustainable management and use of natural resources – feature across the SDGs. FAO's Blue Growth Initiative (BGI), launched in 2013, is a key programme in its work in SSA based on the full recognition of FAO's Strategic Objectives. Blue Growth Initiative not only emphasizes the EAA; it embraces the promotion of sustainable livelihoods for coastal fishing communities, recognizes and supports aquaculture development and fair access to trade, markets, social protection and decent work conditions along the fish value chain.

The SDGs, FAO's Strategic objectives (SOs) and BGI are interlinked. Both the SDGs and FAO's Strategic Framework are geared towards tackling the root causes of poverty and hunger, building a fairer society and leaving no one behind. In particular, SDG 1 (End poverty in all its forms) and SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture) reflect FAO's vision and mandate and are FAO's Strategic objectives 3 and 1 respectively. Other SDGs covering gender (SDG 5), water (SDG 6), economic growth and employment and decent work (SDG 8), inequality (SDG 10), production and consumption (SDG 12), climate (SDG 13), biodiversity (SDG 15), and peace and justice (SDG 16) are also highly relevant, while the agreed means of implementation and the revitalized global partnership (SDG 17) also provide the basis for realization of the 2030 Agenda in an aquaculture context.

Furthermore, FAO's Strategic Objectives provide the political framework for blue growth. In the framework of the BGI, FAO is assisting and will assist member countries in SSA in (a) confronting the risks of famine, malnutrition and food insecurity (SO1/SDG2); (b) strengthening efforts in support of sustainable aquaculture development, including integrated approach to efficient resources management (SO2/SDG 14); (c) improving governance to facilitate the evolution towards more inclusive growth (SO4/SDG 16); (d) reducing rural poverty and developing coastal and inland

economies (SO3/SDG1); and (e) helping to boost the resilience of livelihoods in the face of disasters, creating decent employment (SO5/SDG 8).

9.1.2 Ongoing activities

In promoting the BGI, FAO is working with governments, industry and communities at all levels to help them mainstream BGI in their aquaculture programmes. In the Republic of Kenya, the University of Nairobi and the United Nations Environment Programme (UNEP), sponsored by FAO through the project "Ecosystem Services and Biodiversity for Food and Nutrition Security", carried out a study to assess the value of mangroves for food security and improved livelihoods among coastal communities in Kilifi County and the Tana Delta. The framework for this initiative is implementation of mariculture in the Republic of Kenya using an ecosystem approach. The study investigated four key topics: local-level knowledge of mangrove uses and benefits, ecosystem service values, joint natural resource management experiences and the need for community-based incentives. The ecosystem services provided by the mangrove forest were assessed and the analysis showed that the average value of a hectare of mangrove forest per year is US$2 050 in Mida Creek, and US$1 050 in Tana Delta. The study further generated information to guide FAO and other BGI partners in the development of an incentive mechanism for ecosystem services (Kabubo-Mariara and Mulwa, 2016). As part of the initiative, a five-day training workshop informed and trained managers, developers, farmers and other relevant stakeholders on the EAA and how to develop EAA management plans for mariculture areas in the Republic of Kenya that incorporate other users of the coastal zones.

FAO is providing technical support to the Republic of Angola for the Project "Spatial Planning of Aquaculture Zones in the Republic of Angola." The project aims to facilitate investment and promote an effectively governed aquaculture development sector that is socially inclusive, equitable and environmentally responsible. The spatial planning project is finding innovative ways to plan aquaculture through the adoption of the EAA. Implementation of the EAA has improved cross-sectoral collaboration to promote and better coordinate activities among different sectors in the Republic of Angola. The first phase of the project started in late 2014 and was completed in March 2016. The next phase will focus on a key constraint in Angolan aquaculture development: lack of aquafeed and application of good practices in aquafeed production, management and feed quality monitoring. In all instances, the guiding principle will be to conduct activities based on an appropriate business plan to ensure sustainability (FAO/Blue Growth Initiative blog, 2016).

In the Republic of Zambia, assistance is being provided in the African Development Bank (AfDB)-funded project Zambia Aquaculture Enterprise Development Project (ZAEDP) which covers fish health, food safety, feed quality and training of commercial banks. The aim is to solve the lack of basic infrastructure, including:

- lack of well-equipped laboratories for effective standardization and quality control, especially on both domestic and imported fish products; and
- lack of infrastructure for fingerling production.

Other problems that have tended to slow the effective development of the aquaculture sector include weak capacity on production and value chain of the fish sector, poor accessibility of fishing areas and a weak knowledge base for the fish farmers (Marttin, personal communication).

9.2 Outstanding issues

The challenge is for FAO and its BGI partners to obtain and provide incentives and adequate resources to adapt and implement the BGI framework at the local, national and regional levels and to secure political commitment and governance reform. Limited availability of information may also constrain policy-making and planning for blue growth.

9.3 The way forward

Achieving blue growth needs capacity, policy and legislation, a good regulatory environment and ownership. In this respect, the work under way in the Republic of Madagascar, the Republic of Senegal and the Republic of Seychelles seeks to anchor BGI concepts in national policy plans and actions. The realization of these tasks will contribute to greater policy coherence in order to ensure synergy between those sectors which have a significant impact and influence on the water bodies (marine and inland) and the respective socio-economic sectors such as fisheries, agriculture, water, transport, energy, waste management and tourism. A more integrated economy would bring greater sustainability and efficiency as well as cost savings and benefits to the local populations (FAO, 2015b).

It is also important that in promoting this initiative greater emphasis should be placed on the integration of different data collection projects, across different sectors and throughout the entire value chain, and on efforts made to enhance partnerships and other networking arrangements.

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ISBN 978-92-5-109656-7 ISSN 2070-6065

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I6873EN/1/02.17