Sustainable aquaculture development in sub-Saharan Africa

Aquaculture must grow above the current rate of 11% per year to meet projected demand and reduce dependence on seafood imports. Government support and private investment are urgently needed for sustainable growth.

Catherine Ragasa, Harrison Charo-Karisa, Eugene Rurangwa, Nhung Tran and Kelvin Mashisia Shikuku

Since the year 2000, aquaculture production in sub-Saharan Africa (SSA) has grown by 11% annually on average — almost twice as fast compared with the rest of the world, with a few countries growing at 12–23% per year (Fig. 1)¹. Private sector investments led to aquaculture expansion across SSA's inland water, from 9 cages in 2006 to more than 20,000 in 2019. Today, lakes Victoria (Kenya, Tanzania, Uganda), Kariba (Zambia, Zimbabwe), Kivu (Rwanda, Democratic Republic of the Congo), Muhazi (Rwanda) and Volta (Ghana) host 91% of the total inland cage aquaculture².

Beginning in 2015, fish diseases triggered by poor water and farm management practices, the high cost of local production, and competition from cheap fish imports — then with the addition of the COVID-19 pandemic — have all led to production levels stagnating. Despite financial and

technical support and a decade of fast growth, SSA continues to account for less than 1% of global aquaculture production¹. To meet the large supply demand of fish, SSA's fish imports were 1.5 times higher in 2015–2019 than its aquaculture production³. The projected increase in demand for aquatic foods in SSA and the need to reduce dependence on imports requires that aquaculture produces an additional 5.0 million tonnes by 2030 and 10.6 million tonnes by 2050³. This growth must not only be accompanied by reduced production costs and competitive aquatic foods, but must also be environmentally sustainable.

Strategies for sustainable aquaculture growth

Sustainable aquaculture production requires strategies that encourage increased productivity and open up the markets for fish. This is especially needed considering

the effects of climate change, environmental risks, biosecurity and fish health concerns, and the need to apply new technologies that require skilled workforce. Several strategies to sustain the aquaculture growth are discussed below.

Productive and efficient systems. Highly productive cage systems have expanded and will remain an important driver of sustainable aquaculture growth — provided that promotion and enforcement of biosecurity and environmental standards and zoning improve. In Ghana, Lake Volta cage aquaculture represents nearly 90% of total national tilapia production and is expected to remain within environmentally sustainable limits even if expanded three times over current levels⁴. SSA has many underutilized reservoirs and water bodies for cage farming. However, many current cage installations are poorly regulated,

Fig. 1 | Annual growth rate in production volumes for aquaculture, tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*). Growth rates are shown for global, African continent and SSA subcontinent production, and for major-producing countries in the continent for 2000–2019. Note that tilapia and catfish are the two dominant species in SSA and account for 70% of its aquaculture production volume. For Tanzania, production of seaweed, its major species, is in decline, whereas the production of minor species such as tilapia and catfish is rapidly growing. Number of countries included in Africa, 51; number of countries included in SSA, 45. Raw data sourced from FAO FishStatJ¹.

placed near shore waters that are either eutrophic or vulnerable, and adhere only partially to good practices². Ignoring good practices during establishment and management of cage aquaculture is not only detrimental to the environment but also could disrupt and further discourage investments. Governments have a crucial role to play in regulating the expansion of cage aquaculture.

Sustainable intensification of pond farming can also aid aquaculture growth. However, careful zoning and selection of sites suitable for aquaculture and improvements in resource-use efficiency, energy-efficient pond aeration, in-pond raceway systems, recirculating aquaculture systems (RASs)⁵ and aquaponics⁶ can enable small-scale and medium-scale farmers to intensify and increase pond productivity. RASs and aquaponics can be deployed in many locations, including those close to cities and areas with temperatures unsuitable for aquaculture. With much of the future population growth of SSA predicted to occur in cities, producing fresh fish (and vegetables in the case of aquaponics) closer to cities can improve urban nutrition security.

Genetically improved fish strains. National capacity for aquaculture research and development, including fish breeding and strain improvement, is weak and poorly funded. Farmed fish strains in SSA yield sub-optimally compared with strains elsewhere, so access to improve fish seed would benefit production. For example, the introduction of genetically improved farmed tilapia (GIFT) in Southeast Asia led to improved productivity, ranging from 18% to 58% in China and Bangladesh⁷, with each generation yielding 7–10% gains in productivity. Similarly, the genetically improved Abbassa Nile tilapia (GIANT) strain fuelled the aquaculture revolution that saw Egypt become Africa's leading tilapia producer — and the third highest globally — while reducing environmental impacts⁸. Disease resistance and feed efficiency traits are being incorporated into fish breeding⁹, with huge potential for SSA.

Nevertheless, genetically improved strains face resistance in many SSA countries, fuelled by concerns that exotic strains will hinder conservation of native strains. Instead, Ghana, Kenya, Malawi and Zambia have started local breeding programmes. Although Nigeria is planning to introduce GIFT, the continent is yet to fully benefit from genetically improved technology. For SSA to benefit from the introduction of genetically improved strains, it must gather adequate benchmarking data to understand the performance of existing

strains in diverse systems and management, expand strain performance trials, conduct risk and economic assessments of alternative strains, and enhance the capacity and readiness of national systems and the private sector to manage the improved strains.

Fish health management. In Ghana, infectious spleen and kidney necrosis virus caused huge production losses in 2019¹⁰. Tilapia lake virus, which can kill 10–90% of infected fish and is present in Asia and South America¹¹, was recently detected in both farmed and wild Nile tilapia in Tanzania and Uganda¹², and was reported to be responsible in part for fish mortality in Lake Victoria in 2018. Several SSA countries halted the importation of fingerlings from the affected countries — further curtailing production and supply. Only a few specialists and reference laboratories specialize in fish diseases and fish health management. Although vaccination programmes under public–private partnerships and breeding for disease resistance have shown promise, lasting solutions require continuous disease monitoring and surveillance within and across borders, rapid diagnosis, and strengthened biosecurity in hatcheries and breeding centres.

More affordable quality feeds. Several large-scale feed companies, such as Aller Aqua, Skretting, Unga Feeds, Durante and Raanan Feeds, operate in Cameroon, Kenya, Malawi, Nigeria, Ghana, Uganda and Zambia, but feed remains prohibitively expensive for small-scale farmers. Local feed producers face high costs when importing raw materials and processing equipment. Research on alternative, locally available and cheaper ingredients for aquafeeds has been expanding and will have tremendous benefits for aquaculture in SSA¹³. Recent innovations such as green water pond and nutritious pond concepts — which utilize local underused ingredients such as banana and cassava peels, rice and maize bran, different types of insect and worm, and food discarded along the food supply chain as a carbon source — can increase pond productivity, generate environmental benefits through efficient use of feed waste and contribute to a circular economy¹⁴.

Human capacity development and extension services. Limited availability of skilled labour is an ongoing challenge for aquaculture firms. A lack of state-of-the-art knowledge and agribusiness skills, including poor recordkeeping, sanitation, stocking, feeding and water management practices, stifles productivity and profits of small-scale

fish-farm enterprises. Therefore, SSA governments must invest in capacity strengthening for aquaculture-extension workers and fish-farmer associations to facilitate training and expand good aquaculture practices. Farmer training conducted in Egypt and Ghana improved technology adoption and productivity among small-scale farmers¹⁵, and technology transfer programmes such as the Technologies for African Agricultural Transformation Aquaculture Compact — now available in over ten countries — show promising results¹⁶. Beyond government extension efforts, practical aquaculture training curricula in universities and technical colleges would produce professionals with hands-on experience. Information and communication technologies such as radio, video and smartphone apps can reach farmers in a cost-effective manner, aiding information dissemination and provision of regular support, and can be used for data collection to monitor and improve productivity.

Policy and public investment support

In many African countries, aquaculture is high on the political agenda for the promotion of food and nutrition security, and job creation. Although policies and strategies for aquaculture development are in place on paper, government funding has been low and implementation weak. For example, in 2012, Ghana launched the Ghana National Aquaculture Development Plan (GNADP) to increase aquaculture production from 10,200 tonnes to 100,000 tonnes by the end of 2016. However, GNADP did not achieve its target because it lacked sustained funding to enable policy, institutional and regulatory reforms⁴. Similarly, the proposed US\$141 million funding for the Ghana's Aquaculture for Food and Jobs initiative for 2018–2021 is yet to be fulfilled¹⁷. Despite high-level aquaculture targets, Nigeria relies on fish imports, which have not decreased for the past 20 years, and aquaculture production has plateaued. Production amounted to 307,000 tonnes in 2016 — well below the annual demand of more than 3.6 million tonnes of fish¹⁸.

To further stimulate and protect private-sector investment and ensure sustainability of the sector, countries in SSA need to enable policy and high-level support, enforce regulations, invest in infrastructure, and support institutional innovations. Enabling policies can consist of easing and facilitating business processes, cutting taxes to promote businesses and reducing import duties on inputs, such as equipment needed for local production of

fish feeds. In Ghana, for example, around 80% of imported feed costs go towards tariffs, taxes and transportation; import duties are 5%, but combined with other taxes and fees, they represent a 20–30% difference in the price of aquafeed from when it arrives at the port to when it gets transported to the buyer¹. Depreciation of the local currency has increased the price of imported feed and ingredients, resulting in farmers facing higher fish feed costs — making locally produced tilapia much more expensive than imported tilapia⁴. Potential policy pathways to improve access to, and affordability of, inputs and productive assets for feed and fish production are either poorly understood by policy- and decision-makers or are understudied and should be a future direction for research.

High transportation costs and unstable electricity in SSA are serious constraints to attracting and sustaining private sector investment and aquaculture value chains. Live fish are highly susceptible to mortality and fish products can undergo spoilage during transport, production and distribution. Thus, investment is needed to fund road building and maintenance, transportation systems and electricity to support cold chains. The highly productive RAS depends on a continuous supply of electricity and the use of solar energy is becoming more attractive, even to less-intensive RAS farmers. Similarly, solar-powered cold chains initiated in Nigeria have reduced food losses and increased horticultural incomes¹⁹. The new Africa Blue Economy Strategy highlights infrastructure investments in energy and transportation that — if implemented — will benefit the aquaculture sector. Current initiatives to reduce infrastructure and logistical costs in some SSA countries include the development of aquaculture parks (such as the African Development Bank project in Zambia), clusters or hubs of aquaculture farms, and satellite fish

farming that can be integrated with packages of services to reduce input and services delivery costs, reduce production risks and improve access to services, markets coordination and efficiency.

The recent impacts of fish disease and government-forced cage closures have made aquaculture riskier, slowing down private-sector investments in this area. In the short and medium term, government, development financial institutions, impact investors and innovative financing such as blue bonds are needed to jump-start new waves of growth. Expansion of cage and pond aquaculture will require proper zoning and establishment in suitable and capable areas, and good practices to be enforced to avoid detrimental impacts on the environment and unnecessary disruptions in aquaculture investments and operations. Reliable production data are rarely available; UN Food and Agriculture Organization data and industry estimates do not always agree. Rigorous impact evaluations are scarce in aquaculture. Improving the quality of data collection, monitoring systems and assessment for aquatic foods systems from the economic, social and environmental dimensions and taking advantage of low-cost digital technologies, innovative crowdsourcing and public-private partnerships will allow for data-driven and evidence-based policy reform and decision-making by stakeholders.

The sector has tremendous potential to contribute to jobs, youth employment and food security in the subcontinent, and the realization of this potential is within reach with stronger government leadership and collaboration among actors. Governments are in the position to enable and regulate these actors across the aquaculture supply chain to utilize environmentally sustainable practices, bring down production costs, support data and monitoring systems, and encourage private investments. Through this vital linkage between the aquaculture

sector and wider food systems, governments can strive to address the larger challenges of attaining economic prosperity and food security in SSA.

Catherine Ragasa ¹,
Harrison Charo-Karisa², Eugene Rurangwa³,
Nhuong Tran⁴ and Kelvin Mashisia Shikuku ⁵

¹International Food Policy Research Institute, Washington DC, USA. ²World Bank Group, Washington DC, USA. ³Wageningen Marine Research, Wageningen University and Research, IJmuiden, The Netherlands. ⁴WorldFish, Penang, Malaysia. ⁵International Livestock Research Institute, Nairobi, Kenya.

e-mail: c.ragasa@cgiar.org

Published online: 18 February 2022
<https://doi.org/10.1038/s43016-022-00467-1>

References

1. *FishStatJ Datasets* (2000–2019) (FAO, accessed 20 June 2021).
2. Musunguzi, L. et al. *J. Great Lakes Res.* **45**, 1340–1347 (2019).
3. Chan, C. Y. et al. *Glob. Food Secur.* **20**, 17–25 (2019).
4. Ragasa, C. et al. *A Blue Revolution in Sub-Saharan Africa? Evidence from Ghana's Tilapia Value Chain* (IFPRI, 2018).
5. Clough, S. et al. *Integr. Environ. Assess. Manag.* **16**, 934–941 (2020).
6. Obirikorang, K. et al. *Front. Sustain. Food Syst.* <https://doi.org/10.3389/fsufs.2021.705549> (2021).
7. Tran, N. et al. *Aquaculture* **536**, 736846 (2021).
8. Henriksson, P. et al. *Aquaculture* **468**, 53–59 (2017).
9. Barria, A. et al. *Heredity* **127**, 334–343 (2021).
10. Ramirez-Paredes, J. P. et al. *Transbound. Emerg. Dis.* **68**, 1550–1563 (2021).
11. Jansen, M. D., Dong, H. T. & Mohan, C. V. *Rev. Aquac.* **1**, 725–739 (2018).
12. Mugimba, K. K. et al. *J. Fish. Dis.* **41**, 1181–1189 (2018).
13. Ssepuuya, G. et al. *J. Insect. Food Feed* **3**, 289–302 (2017).
14. Verdegem, M. et al. *Sustainable and Accessible Fish Feeds for Small-Scale Fish Farmers* FISH-2021-06 (CGIAR FISH, 2021).
15. Dickson, M. et al. *Aquaculture* **465**, 172–178 (2016).
16. Adoption of Fingerling Production Technologies transforms livelihoods in Kenya. *Relief Web* <https://go.nature.com/3rFCj3Y> (2021).
17. Ragasa, C. et al. *Aquaculture* **547**, 737476 (2022).
18. *WorldFish Nigeria Strategy 2018–2022* (WorldFish, 2018).
19. Takeshima, H. et al. *Solar-Powered Cold-Storages and Sustainable Food System Transformation: Evidence from Horticulture Markets Interventions in Northeast Nigeria* (IFPRI, 2021).

Competing interests

The authors declare no competing interests.