

Improving Fish Production and Nutrition in South Sudan: A Pathway to Food Security and Sustainable Development

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Abstract: This study explored the status and potential of South Sudan's rich fisheries resources to enhance food security and sustainable development through improved fish production and nutrition. Despite the abundant aquatic resources in South Sudan, the fisheries sector remains underdeveloped and characterized by artisanal practices, limited infrastructure and policy gaps that restrict productivity as well as accessibility. Fish plays a critical role in household nutrition by providing high-quality protein, essential micronutrients and omega-3 fatty acids that all have the potential to alleviate malnutrition and food insecurity. But challenges such as political and fishing conflicts, climate variability, poor market access and cultural barriers hinder the growth of the fisheries sector in South Sudan. This desk review research, therefore, synthesized secondary data to assess the current status, challenges and opportunities in the fisheries sector in South Sudan. As a result, the importance of multifaceted interventions including aquaculture development, modernization of fishing practices, infrastructure investment, policy reform, and nutrition education were highlighted and emphasized. Upgrading production and postharvest related activities is considered a pathway towards improving nutrition, economic empowerment and resilience for vulnerable communities in South Sudan. Furthermore, the study appealed for integrated approaches and further research investigations to realize the full potential of the fisheries sector in contributing to national food security and sustainable development.

Keyword: Fish Production and Nutrition, Capture Fisheries, Aquaculture, Conflicts, Food Security, Sustainable Development, Developing Countries, South Sudan.

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I. INTRODUCTION

Fish production in South Sudan holds immense potential due to the country's vast and rich aquatic ecosystems – including rivers, lakes, swamps, streams and flooded grasslands (Shamsuzzaman et al., 2020; Darwall et al., 2005; Delgado et al., 2003; Bailey, 1989). These water bodies support a wide range of fisheries activities, starting from small-scale artisanal fishing practices to potential commercial fisheries, which play a vital role in enhancing nutrition and food security (Alosias and Draga, 2022; Arthur et al., 2022; Kjelleevold et al., 2022; March and Failler, 2022; Hishamunda and Ridler, 2006).

Despite such richness, the fisheries sector in South Sudan remains wholly underdeveloped and poorly managed,

commonly mirrored in trends observed in other developing countries (Khan, 2006; Platteau, 1989). Majority of fishing activities usually rely on traditional methods and rudimentary tools or equipment that limit productivity and the ability to meet the nutritional needs of the population, particularly in most rural areas where poverty and malnutrition are widespread (Hungevo et al., 2025; Ochiewo, 2004; Platteau, 1989). Failure to harness these abundant fisheries resources effectively had left many individuals and communities vulnerable to food insecurity and protein deficiency; which underscore the urgent need for national prioritization of investment in fisheries development (Vianna et al., 2020; Bennett et al., 2018). Compounding this issue is the reliance on unreliable production estimates and lack of studies investigating a clear pathway to improve fish production and nutrition in South Sudan (Vianna et al., 2020; FAO, 2016; De

Graaf and Garibaldi, 2015). Using secondary data through desk review, this study aimed at assessing the status and common hindrances affecting fish production, consumption

and opportunities for development of the fisheries sector towards food security and sustainable development in the Republic of South Sudan.

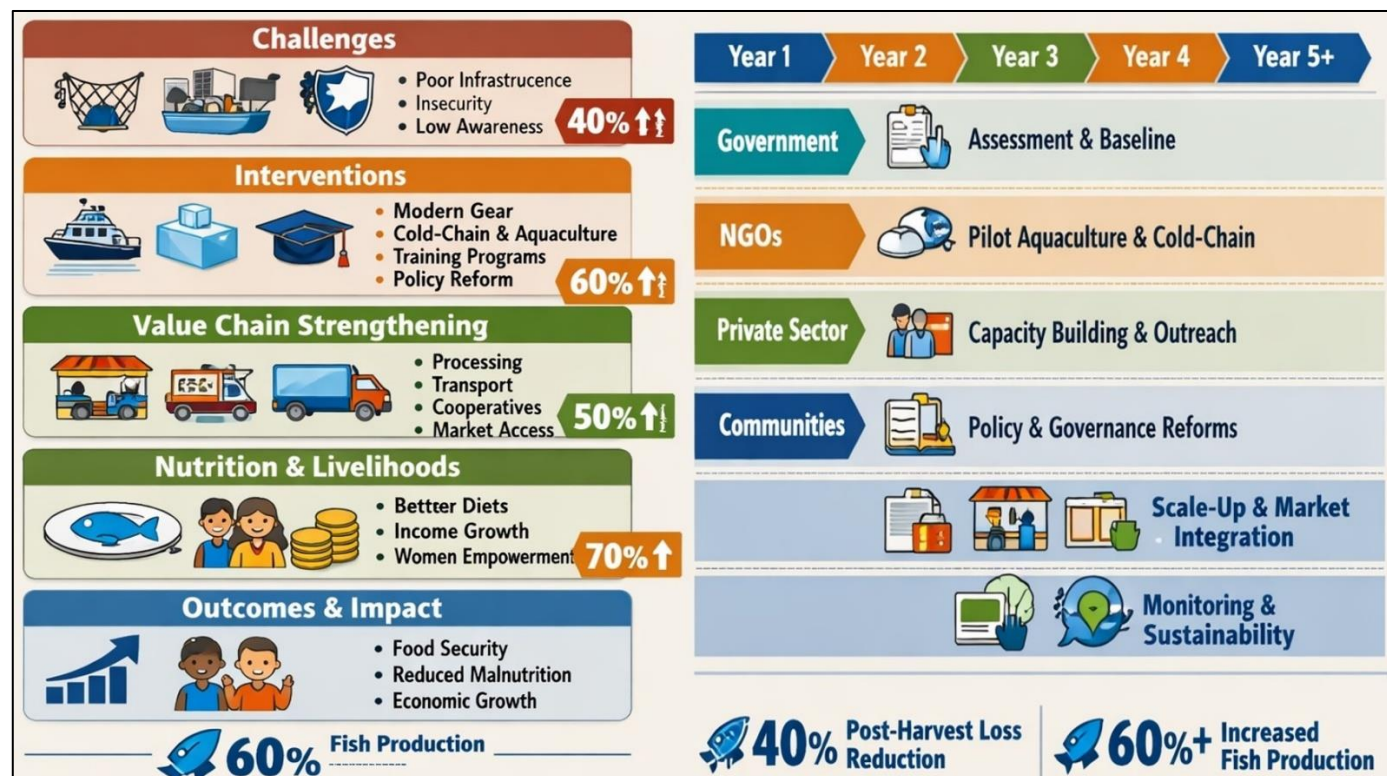


Fig 1 Infographic Multifaceted Pathway Towards Improving Fish Production and Nutrition using at Least Five-Year Timeline with Milestones for Assessment, Piloting Aquaculture Development and Expansion, Capacity Building, Outreach Education, Policy Reform, Scaling-up and Sustainability.

II. RESEARCH METHODOLOGY

➤ Research Approach

This research or study employed and relied on qualitative research approach using desk review to obtain credible secondary data of the existing literature and policy materials on the topic. Through such qualitative inquiry to assess and synthesize a pathway between the current state and potential for development of the fisheries sector (as shown in Fig 1), the study reviewed and developed the case for improving fish production and nutrition in South Sudan. Emphasis was placed on meaning and themes rather than quantitative statistical testing (Creswell, 2013; Bowen, 2009).

➤ Research Data Collection

The study relied entirely on secondary data obtained from a variety of reputable sources, including published peer-reviewed articles, reports, policy documents and blogs or website-contents of organizations such as the Food and Agriculture Organization (FAO) of the United Nations, and the World Bank Group (etc.). In addition, other sources such as the African Development Bank and government documents were also consulted or read. Information obtained from these sources were supplemented by other relevant academic literature to provide an overview of the fisheries sector and nutritional context of fish and fish products (AfDB, 2023; Alosias, 2023; FAO, 2016) in developing the

pathway to food security and sustainable development in South Sudan.

During the initial stage of this study, selected principles of inclusion and exclusion with a focus on titles (and often abstracts) were applied. Generally, the principles of inclusion relied on sources directly related to fish, fish production and nutrition, and developing countries to build the case for South Sudan. Materials specific to the fisheries sector or related contexts from other sectors were used without restriction to study area, methodology or publication details (e.g. type of publication, author, year or time period, and source). Conversely, the principle of exclusion used in this study focused on eliminating sources lacking academic credibility, which include unverified online articles, contents of commercial media reports and newspapers with no associated policy or scientific merits. As a result, a total of 87 articles (including reports, blogs or websites contents) were identified and used in this study. All in-text citations were arranged in a descending order; starting with the most recent source(s), chronologically.

➤ Research Ethical Considerations

Although human participants were not involved in this study, ethical standards governing academic research were strictly observed. As such, all the secondary sources of data were properly acknowledged through in-text citation and

listed as references. This way, intellectual property rights of authors and institutions is believed to be upheld.

➤ *Research Data Analysis*

The study employed thematic and content analysis to interpret the reviewed secondary data from journals and reports or website-contents. In the analysis and presentation of the findings, the case for improving fish production and nutrition in South Sudan has been reviewed and developed in the context of relevant themes and narrative with interpretations that focused on current status, hindrances, contributions and development opportunities as a pathway to food security and sustainable development. The application of the thematic analysis (Braun and Clarke, 2006) on improving fish production and nutrition facilitated the organization of the secondary data into articulated or coherent narrative to develop a pathway to food security and sustainable development in South Sudan. Co-Pilot and Quillbot artificial intelligence platforms were used for reviewing the initial draft texts, figure(s) and table(s) in this study.

III. RESEARCH FINDINGS

➤ *Status of Fish Production and Development Hindrances*

Even though fish production in many developing countries is characterized by abundant freshwater or inland water resources, the sector remains underutilized and underdeveloped (Hungevo et al., 2025; Ibrahim et al., 2020; Yongo-Bure, 1989) up to present time. Similar to other developing countries endowed with rich inland water resources, production and sustainable management of fish and fisheries resources remain an important component of the food system and economic development in the Republic of South Sudan.

In South Sudan, rivers and wetlands such as the Nile and the Sudd wetlands are the main sources of fish and

fisheries resources that support both artisanal and commercial fisheries (Bailey, 1989; Darwall et al., 2005). Most fish production comes from capture fisheries which relies predominantly on the use of rudimentary fishing tools such as gillnets, hooks and spears (Table 1) among others (Welcomme et al., 2010; Platteau, 1989) that, however, continue to limit productivity and sustainability, and also indirectly negatively affected by water levels in river and expansion of floodplains in terms of their harvest efficiencies. During rainy season, similar to other countries (Welcomme, 2018; Hague and Dey, 2017; Moses, 1987), floodplains usually expand and bring fortune by increasing fish availability and catches for local communities. Fluctuating water levels as well as increasing temperatures due to climate change are additional crucial issues that require adequate attention and appropriate adaptable approaches because of their effect on fish and fisheries production and management (Tefera and Ali, 2019; Portner and Peck, 2010; Ficke et al., 2007).

Communities living along rivers and floodplains depend heavily on fishing practices for both food and income generation. The availability of fish also helps in supporting local markets and small trading networks across cities and states, with women playing active roles in processing and selling of fish and fish products. Other processed fish products in the forms of dried, salted and fermented fish products are usually transported to distant markets and sold for direct consumption and income. And because fish processing and preservation methods are still practiced at traditional level in South Sudan (similar to other developing countries [Elsheikh, 2021; Mohamed, 2015; Hall, 2011]), smoking, sun-drying, salting and fermentation remain the dominant techniques or methods applied by local communities to convert fish and fish products in to other forms still acceptable for consumption or other usage as well as extending their shelf life for future consumption.

Table 1 Summary of Selected Aspects and Contexts of the Fisheries Status in South Sudan

ASPECT	CONTEXT	REFERENCE
Fishing methods	Predominantly artisanal: gillnets, hooks, spears, canoes	He et al. (2021)
Aquatic habitats	White Nile, Sudd wetlands, numerous rivers, lakes, streams and flooded grasslands	Mulatu et al., 2022; Bailey and Litterick, 1993; Hickley and Bailey, 1987
Aquaculture development and expansion	Very limited and at infancy stage; commonly traditional earthen ponds with low productivity; and the need to combat fish deficit via aquaculture expansion; research and investment	FAO, 2026a-b; Haque and Mahmud, 2025; Hossain et al., 2023; Mohammed, 2023; Alosias, 2018; Tran et al., 2017; Pucher et al., 2015
Post-harvest losses	Approximately > 30% due to spoilage, poor storage as well as traditional processing and preservation methods; modernization is crucial	Alosias, 2020; Maulu et al., 2020
Marketing and infrastructure	Market structures, organization and information are informal; investment in infrastructure development (road, cold storage etc.); and strengthening cooperatives or associations	FAO, 2026b; Alosias, 2023; Islam and Chuenpagdee, 2022; Ameyaw et al., 2020; Deng, 2020; Alosias, 2019; Obiero et al., 2019; Lentisco and Lee, 2015; Bene and Friend, 2011

Decline in fish production has commonly been observed in dry season due to lack of modern production and post-harvest technologies (Welcomme et al., 2010; Getu, 2015). Furthermore, concerns over fish supply fluctuations

leading to irregular access to fish and fish products and the overall growth of the fisheries sector have been slowed down due to various hindrances such as limited infrastructure and targeted investment. Concerns over the possibility for

overfishing because of the supply of small-size fish (e.g. tilapia and others) in the local markets could become a reality if investigated. Due to remoteness of some fishing grounds or fish production areas, poor infrastructure is one of the major hindrances or challenges affecting transportation and market accessibility (Islam and Chuenpagdee, 2022; Deng, 2020; Lentisco and Lee, 2015; Bene and Friend, 2011). Transporting fresh fish to urban markets is difficult – leading to some fish spoilage before reaching the targeted consumers – also due to limited cold storage facilities (besides poorly organized market systems; with reliance on niche market system) which are considered inevitable contributing factors to postharvest losses.

The impact of inadequate proper infrastructures, such as poor transport and lack of cold storage, is one of the driving factors causing high cost post-harvest losses at an estimate between 40% and 50% (Islam and Chuenpagdee, 2022; Getu et al., 2015) or even probably more percentages if re-assessed. Such percentages of post-harvest losses constrained fish availability and market access. Market access and

supply/value chain inefficiencies (Table 2) continue to hinder the profitability of fish production (Islam and Chuenpagdee, 2022; Deng, 2020; Lentisco and Lee, 2015; Bene and Friend, 2011) similarly in South Sudan. These hindrances are still happening (as previously mentioned) because most fishing areas are located in remote locations that remain constrained by poor transport networks, creating difficulties for producer groups to access existing and emerging markets; besides the absence or limited appropriate cold storage and processing facilities that intensify the magnitude of postharvest losses, and concerns over unorganized marketing systems that prevent producer groups from obtaining fair prices.

Although women play a critical role in fish processing, marketing and household nutrition, they still face limited access to credit, supporting tools or equipment and decision making opportunities (Ameyaw et al., 2020; Lentisco and Lee, 2015). Additionally, notable absence of or outdated fisheries policies and weak governance are making effective fisheries resources management and accountability difficult (Alosias, 2023; Jentoft, 2000; Karpoff, 1987).

Table 2 Summary of Common Hindrances Affecting Fish Production and Nutrition

HINDRANCE	EFFECT	REFERENCE
Conflict and instability	Displacement, destruction of fishing equipment, reduced investment	Devlin et al., 2022; Glaser et al., 2019; Hendrix and Glaser, 2011
Climate variability	Floods and droughts disrupt ecosystems and breeding cycles; flooding often boosting fish production variably and unpredictably (e.g. plenty of catfishes and other types of fish species), and attracts fish business opportunities	World Bank, 2024; Tefera and Ali, 2019; Hague and Dey, 2017; Portner and Peck, 2010; Ficke et al., 2007
Policy gaps	Reliance on outdated 1954 fisheries law; weak regulation; lawfulness and sincerity in fisheries management; contribution of fisheries to improve food and nutrition security; aquaculture in supply and demand; classification of vulnerable small-scale fisheries; role of women in fisheries	FAO, 2026b; Alosias, 2023; Islam and Chuenpagdee, 2022; March and Failer, 2022; Ameyaw et al., 2020; Bennett et al., 2018; Tran et al., 2017; FAO, 2016; Hishamunda and Ridler, 2006; Jentoft, 2000
Infrastructure deficits	Lack of good roads, cold storage and marketing facilities drive high spoilage rates and limit access to premium markets among others	FAO, 2026b; Alosias, 2023; Islam and Chuenpagdee, 2022; Getu et al., 2015
Gender barriers	Women central roles in processing and marketing are limited by poor or lack of access to credit, supporting tools/equipment, targeted allocation of space and other opportunities	Alosias, 2019; Cardoso et al., 2013

Several other hindrances or barriers also impede fisheries development in South Sudan as similarly observed in other developing countries. The reliance on rudimentary fishing tools in the forms of gillnets, hooks and spears (etc.) delineates the artisanal nature of the sector having limited productivity and scalability (Welcomme et al., 2010; Platteau, 1989). Furthermore, dependence on natural food cycles (commonly in rural settings) to boost fish catches also highlights the vulnerability of the fishers or fishing communities to environmental variability and climate change in South Sudan and other developing countries (Tefera and Ali, 2019; Hague and Dey, 2017).

While climate variability impacts aquatic ecosystems and fish breeding cycles, civil and political conflicts (including fishing conflicts) disrupt fishing activities and marketing of fish and fish products (Glaser et al., 2019; Tefera and Ali, 2019). Studies have shown that previous or ongoing

political/civil (Glaser et al., 2019; Hendrix and Glaser, 2011) and specific fishing/fisheries-related (Devlin et al., 2022; DeSombre, 2019) conflicts (e.g. fishing conflict or fish war) have caused disruptions in fishing activities and market operations – adding uncertainties into efforts aimed at improving fish production and nutrition. Prolonged conflicts and political instability do not only disrupted fishing activities but also damaged critical fishing assets which undermine progress or growth of the actors involved in the fish supply/value chains (Glaser et al., 2019; Hendrix and Glaser, 2011). When conflicts erupted, fishers usually avoid risking their lives by postponing fishing practices for weeks or months. Years of conflicts, economic instability and displacement of settlers are additional significant hindrances of fish production, nutrition and local economic development. Political or civil conflicts commonly trigger: (1) disruption of fishing activities, destroying fishing equipment and delaying or denying access to major fishing grounds; (2) loss of

livelihoods opportunity for those struggling to access inputs such as boats and nets etc.; (3) and reduction of fish outputs and profitability that leave many rural families trapped in poverty – with dire need for dialogue for lasting peace and stability as key steps in reviving and sustaining the management of fish and fisheries resources.

South Sudan's dependency on imported foods, coupled with limited local food production, is worsening nutritional deficiencies with records above 50 percent (7.8 million) of the people facing high level of acute food insecurity, especially among children and women (etc.) (IPC, 2026; AfDB, 2023). In spite of all these existing issues, South Sudan's fisheries sector holds significant potential for growth from its aquatic environment or water bodies. With proper

investment in capture fisheries and aquaculture, capacity building and improved infrastructure (etc.), South Sudan can boost its fish production that can play a major role in economic development and food security.

➤ *Contribution of Fish to Nutrition and Food Security*

Fish is globally recognized as a rich source of high-quality protein, essential fatty acids (notably omega-3), and vital micronutrients including calcium, iron, zinc and vitamins A and D (Saidu, 2025; Alosias and Draga, 2022; Kjelleve et al., 2022). These nutrients, as shown in Table 3, are crucial for growth, brain development and public health, particularly in vulnerable populations prone to malnutrition (Robinson et al., 2022; Bennett et al., 2018).

Table 3 Summary of Common Nutritional Contributions of Fish to Nutrition and Food Security

NUTRIENT	CONTRIBUTION	REFERENCE
Macronutrients	Protein provides essential amino acids supporting muscle repair, build immune defenses, regulate metabolism; bioactive peptides supporting cardiovascular health (reduce inflammation, manage blood pressure); prevent age-related muscle loss etc.	Haque and Mahmud, 2025; Noreen et al., 2025; Alosias and Draga, 2022; Mendivil, 2021; Mishra, 2020; Tacon et al., 2020; Bennett et al., 2018
	Lipids provide omega-3 fatty acids that support brain development and cardiovascular health.	
Micronutrients	Rich in calcium, iron, zinc, vitamin A, magnesium, iodine etc.	
Other health impact	Reduces stunting, anemia, and micronutrient deficiencies in vulnerable groups etc.	

Because malnutrition and food insecurity are pervasive in South Sudan (IPC, 2026), fish and fish products play a pivotal role in improving dietary quality and overall public health (Saidu, 2025; Shams et al., 2024; Bennett et al., 2018). As an important contributor to combat malnutrition (Saidu, 2025; Bennett et al., 2018) in South Sudan and other developing countries, studies have shown that fish consumption contributes to reducing cardiovascular illnesses, stunting, anemia and micronutrient deficiencies among other benefits (Saidu, 2025; Shams et al., 2024; Alosias and Draga, 2022; Bennett et al., 2018). Average per capita fish consumption was estimated between 5kg and 17 kg per year in South Sudan (World Bank, 2024; Alosias and Draga, 2022).

Fish consumption also contributes to dietary diversification, with a potential to increase resilience against food insecurity during agricultural failures or economic shocks (McClanahan et al., 2015; Obiero et al., 2019). However, cultural perceptions (since fish is seen as low status food contributing to its underutilization due to lack of nutrition education or awareness) and seasonal availability can influence consumption patterns, indicating a need for targeted nutrition education and awareness campaigns (Alosias and Draga, 2022; Wallnoefer et al., 2021) besides improvement in production and sustainable development of fish and fisheries resources. The affordability of fish relative to other animal proteins makes it a critical dietary component for consumption by low-income households, particularly those living in rural or remote areas (Robinson et al., 2022; Onumah et al., 2020).

Fish is consumed either in fresh or processed forms (Alosias and Draga, 2022). Processed and preserved fish products (e.g. smoked, sun-dried etc.) are often commonly preferably maintained to await low supply periods or for future usage or to be transported to distant markets (Siddhant et al., 2024; Majumdar, 2015). This way, it serves as an approach to ensure year-round continuous access to fish and fish products. Moreover, fresh fish are caught and consumed immediately or within the same day in rural or remote areas; unlike in urban settlements where consumption of fish typically relied on its availability in the markets. Fresh fish are either boiled, fried or smoked prior to its preparation for consumption.

For low-income households, fish is considered cheaper than other animal sources of protein such as beef or goat etc. (Robinson et al., 2022; Onumah et al., 2020; Tacon and Metian, 2018; Mohan Dey et al., 2005). Because fish serves as one of the most accessible animal protein sources, locally caught and affordable for households that even have limited income, it has a significant contributions towards reducing malnutrition and improving overall dietary quality. The high protein content of fish is easily digestible compared to other animal proteins – as it has been considered essential for building and repairing body tissues and maintaining proper body functions (if reasonable amount is regularly consumed) – which support healthy growth in children and contributes towards improving physical and cognitive development. Being easily digestible compared to other animal proteins (besides its beneficial omega-3 fatty acids that are critically needed for healthy human heart and brain development in infants and young children, and reducing the risk of cardiovascular diseases, but rarely found in other food

materials, with vitamins and minerals critically needed to maintain strong bones, healthy immune systems and proper brain functions), fish is considered ideal for children and pregnant women and elderly persons. This makes it an important food option for poorer or vulnerable communities.

Regardless of the importance of fish as a crucial food option for poorer or vulnerable communities, prices may fluctuate depending on supply, cost of transportation or existing/emerging market demands. When fish and fish products become scarce or limited, prices often rise and, as such, limit consumption among vulnerable households. So besides availability of fish, affordability of fish also influences utilization or consumption behavior (in addition to accessibility and stability as components of food security).

As an important component of diet for many households who relied on fish as one of the accessible and affordable sources of food, the availability of fish also helps in diversifying diets besides cereals and vegetables. This way, fish and fish products carry the potential to contribute towards improving household nutrition diversification(s). Cultural preferences, local tradition and seasonality (etc.) are additional important considerations that also affect fish consumption (Alosias and Draga, 2022; Wallnoefer et al., 2021; Can et al., 2015; Cardoso et al., 2013).

Being an available and reliable source of food, fish generally contributes to food security as many communities rely on nearby water bodies for fishing activities (Bene et al., 2007). This way, as previously highlighted above, households can obtain food without depending entirely on market purchases. The availability and reliability of fish and fisheries resources present the opportunity for fishers to practice both

small-scale and large-scale fishing for subsistence and commercial purposes. Such a flexibility makes fish an important safety net during periods of food shortage. For instance, when production of agricultural crops fails or livestock production declines, fishing can continue to help fill the gap or supplement household food supplies and livelihood. As such, access to fish may support resilience to shocks in vulnerable communities if investigated.

Fish also contributes to food security through income generation (Obiero et al., 2019; Bennett et al., 2018; McClanahan et al., 2015) for households who are engaged in fishing, besides the prevalence of women domination in processing and marketing of fish and fish products for livelihood. The incomes generated are commonly used for purchasing other food items and paying school fees as well as medications among others. With women dominantly playing an important role in fish processing and marketing (Ameyaw et al., 2020; Alosias, 2019; Lentisco and Lee, 2015; De Silva, 2011), their involvement helps in strengthening household economies and improving access to nutritious foods. Marketing and trade of fish and fish products also support the operationalization of local markets and regional food distribution systems, which indirectly contributes to food security.

➤ *Opportunities for Sustainable Management and Development*

Emerging research studies (Table 4) highlighted the potential of aquaculture expansion, modern fishing technologies, community-based resource management and regional trade integration to boost production and nutrition (Chilangazi and Magasi, 2023; Odeku and Rikhotso, 2023; March and Failler, 2022).

Table 4 Summary of Common Opportunities and Their Effects on Improving Fish Production and Nutrition

OPPORTUNITY	EFFECT	REFERENCE
Aquaculture development & expansion	Boost local supply, create jobs, reduce reliance on imports; alternative during lean capture period or season; opportunity for mass production for increasing demand	FAO, 2026a; Haque and Mahmud, 2025; Hossain et al., 2023; Mohammed, 2023; Alosias and Draga, 2022
Modern technologies	Use of selective fishing gears, improvement of supply/value chain activities (e.g. processing, cold storage, smoking etc.) and marketing or trade	Siddhnath et al., 2024; Alosias, 2023; Chilangazi and Magasi, 2023; Odeku and Rikhotso, 2023; March and Failler, 2022; Alosias, 2020; Getu, 2015; Welcomme et al., 2010
Community-based management	Ensuring ownership, promoting responsible and sustainable practices, equitable access, and reducing illegal fishing practices	
Regional & international trade networks	Export potential to neighboring countries, premium prices, and foreign exchange earnings	
Nutrition education	Nutrition awareness campaigns, promoting fish in school feeding programs, shift in cultural perceptions; fish for health and livelihood	Alosias and Draga, 2022; Wallnoefer et al., 2021; Mahmudiono et al., 2020; Tacon et al., 2020; Pieniak et al., 2010

Aquaculture expansion presents a promising avenue to supplement capture fisheries and stabilizes fish supply throughout the year (March and Failler, 2022; Hishamunda and Ridler, 2006). Adoption of modern fishing gears and post-harvest technologies can improve production, reduce losses and improve product quality that may enhance profitability (Siddhnath et al., 2024; Welcomme et al., 2010). Strengthening supply/value chains through investment in

infrastructure, market information systems and cooperatives can increase profitability and encourage production (Alosias, 2023; Obiero et al., 2019).

Community-based resource management and strengthened regulatory frameworks are essential to ensure sustainable exploitation, equitable access, and conflict mitigation (Alosias, 2023; Jentoft, 2000). Furthermore,

regional trade integration could open export markets and generate foreign exchange that helps in supporting economic growth (Chilangazi and Magasi, 2023; Odeku and Rikhotso, 2023; Wapmuk and Ali, 2022). So, developing regional trade networks could enable South Sudan to export fish to neighboring countries. Empowering women in fisheries through access to credit and equipment to improve livelihood or local economic development outcomes for the local communities (Ameyaw et al., 2020; De Silva, 2011) and supporting nutrition education aimed at promoting fish in School feeding programs also offer avenues to improve dietary habits, cultural acceptance and well-being (Alosias and Draga, 2022; Wallnoefer et al., 2021). Above all, establishing a robust regulatory framework, enforcement and coordination mechanisms, coupled with community-based management system are needed to promote and ensure sustainable utilization and equitable access to fisheries resources. This may also enhance promotion of responsible practices and accountability in decision-making and activities right from production up to consumption of fish and fish products.

➤ *Policy and Research Implications*

Addressing the multifaceted challenges requires coherent policy reforms that integrate fisheries development with food security and nutrition goals. Thus, there is a critical need for all the relevant stakeholders to develop and/or update tailored legislations, improved governance and investment in infrastructure to unlock the potential of the fisheries sector, besides studies on the viability of aquaculture expansion, impacts of climate change and nutritional outcomes of increased fish consumption among vulnerable groups to guide evidence-based interventions in South Sudan (Shams et al., 2024; Alosias, 2023; Vianna et al., 2020; FAO, 2016).

➤ *Significance of this Research*

Improvement in fish production and nutrition holds profound significance for South Sudan's public health socio-economic development and food security. These include:

- Enhancing food security and nutritional outcomes: South Sudan faces persistent challenges of malnutrition and food insecurity, with a large proportion of the population (> 50%; IPC, 2026) lacking access to diverse and nutrient-rich diets. With fish being a highly nutritious source of food, rich in proteins, vitamins and omega-3 among others, improving fish production raises the likelihood of increasing the availability and accessibility of affordable fish protein that is easily digestible with the potential to combat malnutrition and improve the overall health and well-being of the people of the Republic of South Sudan.
- Enhancing economic empowerment and livelihood support: the fisheries sector has the potential to provide sustainable livelihood opportunities for many South Sudanese, especially those in rural or riverine areas. Improved production of fish helps in boosting household incomes through increased fishing activities and related businesses that also create employment opportunities in fish processing, marketing and distribution etc.
- Bridging existing knowledge: developing such a narrative pathway of the existing knowledge on the challenges,

contribution and development opportunities can provide a foundational reference for future academic inquiries and stimulates more studies on sustainable fisheries and nutrition-sensitive programs in South Sudan.

IV. CONCLUSION

The findings of this study revealed that South Sudan possesses significant untapped potential in its rich aquatic ecosystems to improve fish production and nutrition, which are critical for alleviating persistent challenges of malnutrition and food insecurity. Despite abundant water resources, the fisheries sector remains largely artisanal and underdeveloped, and generally constrained by limited infrastructure, outdated policies, conflict and environmental volatility. Fish contributes essential macronutrients and micronutrients that are vital for public health, especially among vulnerable populations.

Limited production from artisanal capture fisheries and the infancy status of aquaculture, poor transportation system and postharvest losses are common hindrances that reduce the amount of fish reaching consumers and the potential of the fisheries sector to contribute towards food security in South Sudan. Addressing these hindrances requires an integrated or multifaceted approach that includes investments in aquaculture development and expansion, modernization of fishing practices in capture fisheries, improving cold storage and postharvest practices and strengthening governance and representations as well as nutrition education. Awareness campaigns through nutrition education and representation may provide opportunities for understanding and shifting cultural perceptions as well as dietary habits across vulnerable communities and the entire population in South Sudan. Incorporating the role of other initiatives such as promotion of fish in school feeding programs, women and youth empowerment, building resilience against climate change and establishing trade networks regionally and globally should not be underestimated. It is believed that scaling up fish production through aquaculture, modernization of capture fisheries, and improved post-harvest practices can enhance availability and affordability, thereby diversifying diets and increasing household livelihood and resiliency. Such a multifaceted pathway, that combines investment, policy and governance reforms, capacity building and outreach education, is central in realizing and elevating the contribution of the fisheries sector as one of the determining and critical pillars to uplift public health and economic growth with the goal of pursuing food security and sustainable development in South Sudan.

The following recommendations were developed to be implemented to help transform the fisheries sector of South Sudan into a dynamic contributor to nutrition, economic growth and sustainable development. These include:

- Investing in aquaculture development and expansion: promote small- and large-scale aquaculture development and expansion initiatives to supplement capture fisheries and stabilize year-round supply of fish and fish products.

- Modernizing fishing practices: introduce selective fishing gears, improved processing technologies, and preservation capabilities to reduce post-harvest losses and enhance the quantity and quality of fish and fish products.
- Strengthening the existing infrastructure and market access opportunities: improve road and transportation networks and establish cold storage facilities to facilitate efficient fish distribution, especially from remote fishing areas that not only targets local consumption to improve public health but also reach urban and regional/international markets.
- Developing and promoting ecosystem approach and reforming regulatory frameworks and governance aptitudes: update fisheries legislation to reflect current realities, strengthen administrative and enforcement configurations, and implement community-based management systems that are environmentally sound or ecosystem-friendly to ensure ownership and sustainable resource use.
- Promotion and empowerment of actors' capacity and education: provide training and resourceful (e.g. financial, equipment/tools etc.) supports for fishing, processing and marketing actors, with special focus on empowering youth and women's roles in the fish supply/value chain. Promoting nutrition education on the nutritional benefits of fish consumption, integrating fish into school feeding programs and public health initiatives to shift cultural perceptions, improve dietary habits and livelihood.
- Supporting climate change adaptation efforts: support, develop and promote strategies to adapt or mitigate the impacts of climate change variability on fisheries, including ecosystem-based management and resilience-building measures.
- Integrating regional trade and harmonization of agreements: facilitate regional and cross-border fish trade to expand market opportunities and generate foreign exchange earnings.

With the multifaceted pathway of this study, the fisheries sector may revamp public health, local economic development and trade opportunities in South Sudan. Hence, effective harnessing of the rich fish and fisheries resources could not only position the fisheries sector as a cornerstone for sustainable development but also as a key strategic segment in combating hunger and malnutrition across rural and urban settlements in South Sudan. Consequently, further research or future studies should explore: (a) the viability of developing and expanding robust aquaculture facilities/practices at small-scale and commercially large-scale levels besides new approaches and modern technologies to improve production, processing, transportation, networking and marketing or trade of fish and fish products in South Sudan; (b) the impacts of climate change on fish production and co-management options of aquatic ecosystems that bolster sustainability and resiliency; and (c) the nutritional outcomes of increased in fish consumption among vulnerable populations to help assess and guide evidence-based decision making towards elevating public health and economic growth with the goal of pursuing food security and sustainable development in the Republic of South Sudan.

➤ Contribution Statement

John Alosias: conceptualization, methodology and analyses, writing and editing the article. Albino Dhuor Garang: writing and editing the article.

➤ Conflict of Interest Statement

The authors declare no conflict of interest.

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