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The role of small-scale fisheries in Nigeria's food system

LAGOS STATE UNIVERSITY

FOR TRUTH AND SERVICE

INTERNATIONAL YEAR OF ARTISANAL FISHERIES AND AQUACULTURE 2022

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Citation

This publication should be cited as: Byrd KA, Fakoya K, Akintola S, Westlund L, Isa S, Cohen PJ. (2022) The role of small-scale fisheries in Nigeria's food system. WorldFish, Penang, Malaysia.

About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving aquatic food systems, including fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world.

The WorldFish headquarters is in Penang, Malaysia, with regional offices across Africa, Asia and the Pacific. The organization is a member of CGIAR, the world's largest research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security and improving natural resources.

Acknowledgments

This research was supported by the CGIAR Research Program on Fish Agri-food Systems and make a contribution to the Resilient Aquatic Foods Initiative which are led by WorldFish and supported by contributors to the CGIAR Trust Fund. Support to the study was also provided by Lagos State University (LASU), the International Collective in Support of Fish Workers (ICSF), and the Food and Agriculture Organization of the United Nations (FAO), as well as through the Illuminating Hidden Harvest Project (IHH) led by FAO, Duke University and WorldFish, with additional financial support from the NORAD, Sida, and Oak Foundation.

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Table of Contents

Key Findings

This discussion paper draws together recent data on fish and aquatic foods, and nutrition in Nigeria, to examine how small-scale fisheries fit within and contribute to Nigeria's food system. Much of the analysis and exploration we present here are of very recent data from global, national, and local initiatives. This discussion paper has a particular focus on Sustainable Development Goals 2, and other goals and targets related to human nutrition, food security, and sustainable food production and supplies.

- Fish supply in Nigeria is estimated at around 24 g/person/day, which is substantially higher than other animal source foods such as other meats (21 g/person/day), eggs (8.2 g/person/day), and milk (3.5 g/person/day). Wild fish caught by small-scale fishers provide the bulk of Nigeria's fish supply, however there is very little information available on species-level catch.

- Nigeria's inland fisheries provide approximately 40% of the fisheries catch (all of which is harvested via small-scale fisheries). As such both freshwater and marine ecosystems are critical contributors to food security, in particularly through direct provision of a nutrient rich food to local diets. The contribution and potential of small-scale fisheries is generally underexamined in food production policy, with freshwater fisheries regularly completely overlooked.

- One of the major environmental changes underway in Nigeria is large scale deforestation which in turn, affects the integrity of aquatic ecosystems and water quality that support small-scale fisheries. On a lesser scale, small-scale fisheries themselves contribute to localized deforestation through using wood in the creation of 'brush parks' in inland fisheries; in turn this local deforestation leads to less protection of the freshwater fish habitats that supply fish to the nearby communities.

- On average, Southern Nigeria states produce more fish than the Northern Nigeria states and consumption mirrors production: children consume fish more frequently in the Southern states (35% of children consuming fish in the prior 24 hours), and less frequently in the North (13% of children).

- In two relatively high fish-producing states - Zamfara and Borno - children consume very little fish, and as such targeted programs to increase fish consumption in children would likely improve childhood nutrition and health.

- Fish commonly consumed in the Nigerian diet provide important, bioavailable nutrients. There is an opportunity to reduce hidden hunger (micronutrient deficiencies) by increasing the sizes of fish servings consumed amongst vulnerable populations.

- Women gain income and food from their employment in the small-scale fisheries sector, yet they are more often exposed to the hazards of the small-scale fisheries supply chains. For example, smoke inhalation from fish smoking falls disproportionately on women.

- Up to 30% of the volume of fish and other aquatic foods harvested by small-scale fisheries may be lost through damage, waste, and discards. Loss and waste of fish is highest in the seasonal

fishing peaks. The bulk of this loss is experienced by fisherfolk who do not have the capacity available to them to process the large quantities of fish. Addressing waste and loss provides an under invested opportunity to increase fish supplies and fish quality to meet nutritional needs. This would also improve economic returns to fishers and those working in fish supply chains.

Introduction

Poor dietary intakes are problematic the world over, contributing to morbidity from both low intakes of vitamins and minerals (Victora et al., 2021) and high intakes of sodium and fats (Afshin et al., 2019). Morbidity stemming from diets inadequate in micronutrients is overrepresented in low- and middle-income countries), however many low- and middle-income countries are also increasingly suffering from overconsumption of ultra-processed foods that are high in solid fats, sugar, and salt (Bromage et al., 2021).

The dietary situation in Nigeria is no exception. The most recent Demographic and Health survey (National Population Commission (NPC) [Nigeria] & ICF, 2019) found that 77% percent of Nigerian children do not consume a diverse diet (i.e., they consume less than five food groups of a total of eight), meaning many children are likely consuming insufficient vitamins and minerals. Nearly half (47%) Nigeria's children 12-35 months old are stunted, a condition often caused by malnutrition which is associated with constrained cognitive development and poor health outcomes later in life (Victora et al., 2008). Additionally, more than half (51%) the women in Nigeria who are of reproductive age suffer from anemia, a condition often caused by an inadequate intake of iron, which can lead to fatigue and poor pregnancy outcomes (The Global Nutrition Report, 2020).

Fish and other aquatic foods harvested from the wild have recently gained increasing recognition for their potential to address micronutrient deficiencies (Hicks et al. 2019). They are also relatively affordable, nutrient dense, and commonly have a low environmental footprint (Costello et al., 2019; Funge-Smith, 2018). In most low- and middle-income countries, small-scale capture fisheries are the main provider of fish and aquatic foods (FAO, 2020), and provide untapped opportunities to make progress on the Sustainable Development Goals.

The purpose of this discussion paper is to draw together the most recent data on fish and aquatic foods, and nutrition in Nigeria, and look at the relationships between the small-scale fisheries sector across the food system. Many of the latest data we present include Nigeria's contribution to 'Illuminating Hidden Harvests', a global research initiative co-led by Food and Agriculture Organization, Duke University and WorldFish that seeks to build understanding of the contribution small-scale fisheries make to sustainable development (FAO et al., 2022). This paper uses the updated catch estimates, obtained from unpublished data at the Federal Department of Fisheries and fisheries experts in Nigeria, to examine the relative importance of the small-scale fisheries sector to a healthy and sustainable food system. In this discussion paper we highlight both new data, synthesize previously published data, and point out some key data deficiencies; in doing so we intend this paper to be both a useful resource to guide decision making associated with Nigeria's food systems, but also a starting point for further efforts to address knowledge gaps.

To understand the values of small-scale fisheries beyond catch levels or employment, we organize the information in this paper into the **food supply chains**, **food environments**, **consumer behavior**, and **diets** (Figure 1). A food system reflects the interconnected dimensions of food supply, nutrition outcomes, and social and environmental sustainability. As defined by the High-Level Panel of Experts on Food Security and Nutrition, a food system "*gathers all the elements and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes*" (HLPE, 2017, p. 23), and the small-scale fisheries sector relates to each of these components differently.

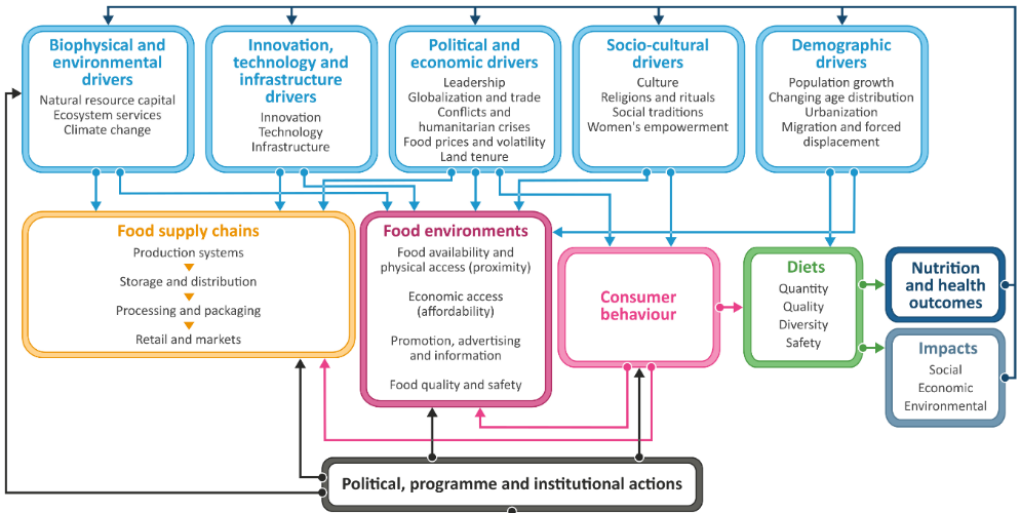

Figure 1. The food system as defined by the HLPE (2017). The figure is adapted, and reproduced with permission (Simmance et al., 2021)

Food supply chains (production and distribution systems)

Nigeria's fish supply come from four main sources; small-scale fisheries, large scale fisheries, aquaculture, and imported products. Combined, these four sources supply an estimated 1,859,000 metric ton of fish and other aquatic foods (Figure 2A). Most fish harvested in Nigeria are captured by small-scale fisheries; in 2017 approximately 941,000 metric tons of fish and other aquatic products were harvested by small-scale fisheries, compared with 13,000 metric tons from large scale fisheries (Figure 2B).

However, species level catch is severely lacking in Nigeria; the Food and Agriculture Organization (FAO) and the Federal Department of Fisheries provide records on fish production, but production is reported at the Family or Genus level; very rarely are the production records reported at the single species level. This hinders analyses of both nutrient contribution and economic access to specific fish species. An analysis of nutrient composition and cost of fish globally found that while 97% of fish catch was reported at the Family or Genus level, *Ethmalosa fimbriata* or the Bonga Shad, a fish found in brackish/marine waters in Nigeria was reported at the species level, and was found to be the lowest cost nutritious species (Robinson et al., 2022). While this is encouraging and highlights the importance of Bonga Shad to affordable healthy diets, many of the other categories in the analysis were of mixed species, and thus there may be fish that are even more accessible to poor families. Concerningly, the Bonga Shad is a

type of small pelagic species, a type of fish commonly caught for fish meal and fish oil production, thus diverting nutrients out of the diets of people who need them the most (Péron et al., 2010).

Aquaculture is a growing sector in Nigeria, but mainly focuses on two fish species: catfish and tilapia (Subasinghe et al, 2021); future research could be done on more nutrition-sensitive aquaculture methods, such as the polyculture systems introduced in South Asia (Castine et al., 2017). Fish production from the aquaculture sector is much smaller in Nigeria; 305,000 metric tons of fish were produced from aquaculture in 2019, with catfish as the main species (90%) produced (Subasinghe et al., 2021). In addition to fish and other aquatic food harvested from national waters, imports represent around a third of fish supply. An average of 600,000 ton of (predominantly marine) fish are imported into Nigeria each year (Bradley et al., 2020), representing an important contributor to fisheries supplies (32%; Figure 2) and Nigerian's diets. Nigeria's fish imports (mainly from Thailand, Netherlands, and Germany) has the potential to provide the equivalent of 100% of the nutrient requirement for calcium, iron, zinc, and vitamin A for 6.5 million people (approximately 3% of Nigerias population) for a year (Nash et al., 2022). Fish from large-scale foreign fishing fleets, mainly from fishing in the high seas has the potential to provide the same nutrients for approximately 14,500 people per year (Nash et al., 2022).

These four sources equate to supplies of approximately 25.5 grams per person per day, though others have calculated Nigeria's fish supply to be 31 grams per person per day (Subasinghe et al., 2021). Within Nigeria, these rates fish supply are higher than other animal source foods such as meats (21 g/person/day), eggs (8.2 g/person/day), and milk (3.5 g/person/day) (Global Alliance for Improved Nutrition (GAIN) & Johns Hopkins University, 2020), indicating that fish is one of the most abundant animal source foods available to diets in Nigeria.

Nigerians are highly reliant on marine fisheries for food and nutrition security (Selig et al., 2018), but inland water bodies and ecosystems also provide large quantities of fish locally. The latest estimates indicate that catch from inland waterbodies comprise 42% of the total catch from Nigeria's small-scale fisheries (Figure 2C). As such inland waters and fish are particularly important sources of economic and nutritional contributions directly into local communities. For example, the inland waters of Akwa Ibom State, Anambra River, Brass and Nun River, Ekole River, Calabar River, Apodu Reservoir and Osinmo Reservoir are all important inland fishing locations in Southern Nigeria from where the highly nutritious fish, such as freshwater clupeids *Pellonula leonensis* (Guinean sprat) and *Sierrathrissa leonensis* (West African pygmy herring) are caught. Additionally, most freshwater fisheries are fished year-round (Akintola & Fakoya, 2017), providing nutrition security across seasons. These species are not only highly nutritious, they are highly productive because they are fast-growing and have high turnover rates with this life history characteristics they can be harvested sustainably at relatively high rates (Kolding et al., 2019).

Thus, the inland waters of Nigeria supply nutritious fish to families who live in the surrounding areas (Lo et al., 2019), but these inland fisheries are affected by high rates of deforestation (Mfon et al., 2014), given that the forest plays an important role in protecting these freshwater habitats. Furthermore, attempts to improve fisheries productivity have inadvertently contributed deforestation through the creation of "brush parks." Brush parks are built as a habitat for fish and by aggregating fish can help to increase fisheries yields (either through increased production or increased catchability), but to keep the brush parks functioning requires a large amount of wood (up to 40 tonnes of wood each year); the harvesting of which contributes to local deforestation (Gutierrez et al., 2022). Thus, the establishment of brush parks must be done thoughtfully to preserve the forests that preserve fish habitats through tactics such as leveraging indigenous knowledge around building sustainable brush parks.

These diverse production systems of Nigeria – spanning different fisheries methods, ecosystems, geographies, and subsectors require diligent conservation and protection as they contribute to a diversity of species important to food and nutrition security. This includes Africa's largest Mangrove forest, and the second largest river delta in the world (Chuku et al., 2020) that are both found in Nigeria. From Nigeria's marine and inland capture fisheries at least 59 families/mixed species groups are accounted for in national production statistics (FAOSTAT), which is worth highlighting given that biodiversity contributes to both a healthier diet and planet (Lachat et al., 2018).

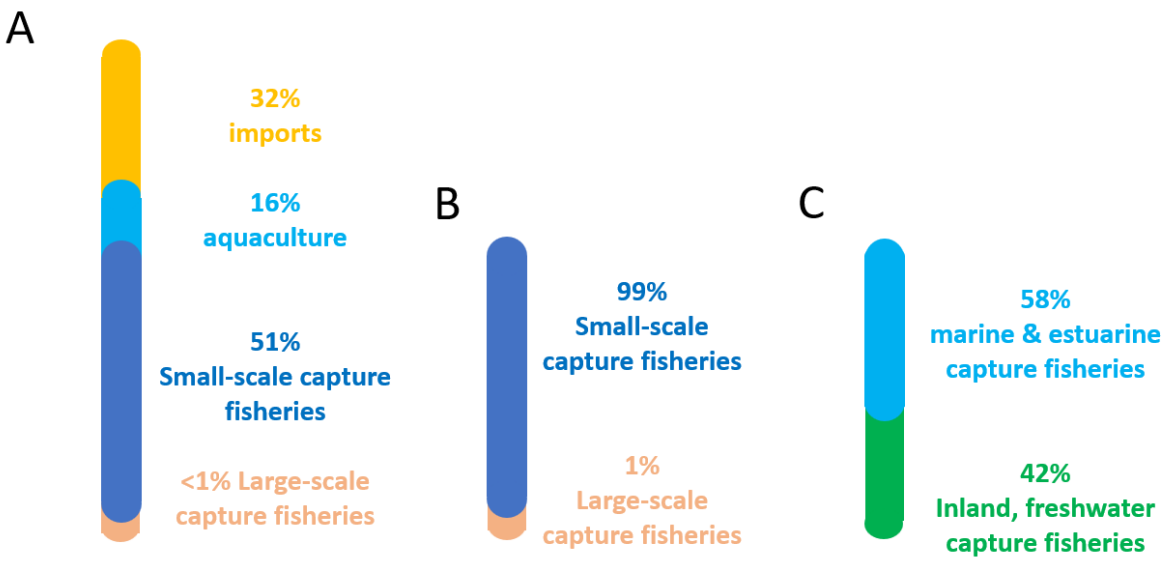

Figure 2 (A) **Total supply of fish and aquatic food production in Nigeria.** Nearly 2 million metric tons are supplied from import, aquaculture, large scale fisheries and predominantly small-scale capture fisheries. (B) **The percentage of landings derived from small-scale fisheries and large-scale fisheries in Nigeria.** Fish volumes were obtained from FAOSTAT using the form FISHSTAT_FI-NS1 and the proportion of landings that were caught by LSF were removed based on expert elicitation from Federal Department of Fisheries and Aquaculture in Nigeria (C) **Small-scale fisheries landing by ecosystem.** Fish landing estimates were available for 2013-2015 by state from unpublished data from the Federal Department of Fisheries and Aquaculture and extrapolated for 2016-2017 (y2) using the prior year (y1) in the equation [growth = (y2-y1)/y1]. The catch per year was averaged and reported the catches by inland or marine ecosystems. The catch from each state was classified as 'marine and estuarine' or 'inland freshwater.'

Women's engagement with small-scale fisheries in Nigeria

Gender-disaggregated employment data are not available at the national level, however, anecdotal evidence and *in situ* observations of small-scale fisheries indicate that most people working in the pre-harvest and post-harvest activities are women. Despite this important role women play, women's labor in fisheries and food systems is undervalued and often invisible in Nigeria as much of the duties relating to fishing are considered household duties (i.e., net-mending) (Akintola & Fakoya, 2017). Furthermore, women often fill the lower-paying jobs, and are more frequently exposed to hazardous and unsafe work environments; this includes in the preparation of smoked fish products where working conditions and air quality are poor (Akintola & Fakoya, 2017).

Women also play important roles in the harvest of other aquatic foods, i.e., other than finfish. Finfish frequently dominate data and discussions about food supplies, yet other aquatic foods are also critical sources of nutrition, health, and incomes (Golden et al., 2021; Tilley et al., 2020). The vast Niger Delta, home to nutrient-rich species such as oysters, periwinkles, clams, and cockles are primarily harvested or gleaned by women (Nlerum & Bagshaw, 2015). These aquatic foods are often particularly rich in omega-3 fatty acids and vitamin B-12 (Golden et al., 2021). However, water pollution from crude oil and gas companies is a commonly reported threat to the periwinkle harvest (Moruf, 2020; Nlerum & Bagshaw, 2015), and are thus a threat to this important economic activity. More research is urgently needed to address the threats to this aspect of the SSF sector. An important priority is to determine the number of women in Nigeria engaged in the shellfish industry, and to more adequately quantify shellfish production (Chuku et al., 2020).

Waste and loss

All forms of fish production in Nigeria (SSF, large-scale fisheries, and aquaculture) suffer from waste and loss at different points of the supply chain. Reducing losses and waste is one way to increase supplies, as well as retaining or increasing their potential to contribute to nutrition gains. Waste and loss of fish and other aquatic foods is typically very difficult to quantify, but studies suggest it varies by species. Some estimates show that around 8% of catfish, tilapia, and Nile perch are lost during production or landing sites of capture fisheries (Kruijssen et al., 2020). During fish processing, an additional 4-10% of the fish may be lost, and over 5% of tilapia and Nile perch might be wasted at the market.

However, the biggest losses in Nigeria are likely to be during the harvest of freshwater fisheries. Small-scale fishers harvesting freshwater clupeids face serious challenges in processing and preserving a large harvest because the quantities are overwhelming relative to processing capacity; up to 30% of this harvest may be lost given the seasonality of this catch. (Akintola & Fakoya, 2017). The bulk of this loss is experienced by fisherfolk who do not have the capacity available to them to process the large quantities of fish that are landed during these seasonal peaks.

Smoking of fish is an important means of preservation, but traditional smoking practices may play a role in deforestation in some areas of Nigeria, as traditional smoking uses large amounts of wood (Akintola & Fakoya, 2017). And while smoked fish are a concentrated source of nutrients, the smoking process may lead to the development of carcinogens in the fish, such as polycyclic aromatic hydrocarbons (PAHs) (Hasselberg et al., 2020). Fish smoking innovations, and other fish preservation technologies and techniques have been developed and tested across Africa but require investment into scaling in Nigeria to have substantive environmental, efficiency and human health gains (Osineye et al., 2020).

Like trends in other agri-food systems, most waste and loss occur at the early stages of the food systems, with relatively less waste and loss caused by actions of the consumer (Alexander et al., 2017). Indeed, in Nigeria there is very little waste of fish by consumers; most parts of the fish are consumed, and only very small amounts of fish are left behind on plates. Household surveys indicated that 41% of the time that Nigerians eat fish, they eat the whole fish, and in 93% of the occasions that Nigerians eat fish they consume the head of the fish (Byrd et al, 2021).

Food environments

The food environment is the spectrum of external and personal factors that mediate food acquisition and consumption (Turner et al., 2018). Food environments include factors that affect food availability, physical and economic access, and food quality and safety, and can include factors that impact upon waste and losses of food quantity and nutritional quality**.**

Physical and economic access

Most families in Nigeria are able to access fish (i.e., it is with physical and economic reach) when they want to (Byrd et al., 2021). However, accessibility of fish is slightly lower in Northern households, with 72% of respondents form the North claiming they can access fish 'most of the time', as compared to 87% of the Southern households (Byrd et al., 2021).

As incomes increase, Nigerians maintain their purchases of dried and smoked fish, but tend to increase their purchases of fresh fish (Liverpool-Tasie et al., 2021). These fish can be sourced from large scale fisheries, aquaculture, or imports, with the majority provided by the small-scale fisheries sector. The demand for dried and smoked fish remains consistent across seasons; demand is about the same in the lean season (which is generally considered August to October when most crops have recently been planted) and in the harvest season in February (Bradley et al., 2020), indicating that dried and smoked fish consumption is not affected by seasonality.

At a national or regional level, as consumer choices and preferences for fish and other foods change, there can be increased or decreased demand for fish products which in turn can affect prices and sector investments. Overall, demand for fish in Nigeria has been increasing – in 2010 59% of Nigerians households consumed fish and by 2015 this had increased to 72% of households (Liverpool-Tasie et al., 2021). But these changes are not nationwide: in the Northern state, consumption remained steady with 50% of households consuming fish, while the South increased from 71% to 90% between 2010 to 2015 (Liverpool-Tasie et al., 2021).

Fish quality and safety

The fish markets are well respected in Nigeria as consumers overwhelmingly trust fish quality; 90% of consumers surveyed agreed with the statement "most of the time, the fish available in the market is not spoiled or diseased" (Byrd et al, 2021). In an interview of Nigerian consumers, fish often appeared on a list of 'safe foods' (Nordhagen et al., 2022). However, the safety of fish is of concern, especially given that access to cold chains is limited (Subasinghe et al., 2021), and the potential for carcinogens to be present in smoked fish (Hasselberg et al., 2020).

Consumer behavior

Nutrition and associated health outcomes are influenced by choices made by consumers, and these choices involve which foods to purchase, prepare, cook, and eat (Obiero et al. 2019). For fish and other aquatic foods, these choices can include the type (e.g., species), form (e.g., dried, fresh, frozen, whole, part), and how much (i.e., volume or number). These choices can be influenced by social factors (e.g., cultural beliefs, taste preference), economic factors (e.g., household income, budget allocated to food), geographic or seasonal factors (e.g., distance to fishing grounds or markets, seasonal availability), and by fish attributes (e.g., appearance, taste, price, quality). Consumer behaviors also affect how the

product is eaten, prepared, and with which other foods is it consumed. All these choices ultimately affect the potential fish or other aquatic foods contribute to the diet and nutrition.

In addition to live catfish purchased as the market, and frozen (i.e., imported) fish, dried and smoked fish are important parts of diets in Nigeria - and are key ingredients in dishes that are important to cultural heritage and food traditions. In a nationally-representative survey of Nigerian households, about 25% of households reported cooking dried fish in the previous seven days; 20% of households reported cooking smoked fish (Bradley et al., 2020). However, in Nigeria fish serving sizes are generally small, and fish is frequently used as a condiment or seasoning rather than a main components of the meal (Ene-Obong et al., 2013). For example, in certain parts of Nigeria, the most popular way to cook catfish is to make it into pepper soup (Webber & Labaste, 2009).

Regardless of the type of fish, the distribution of fish among household members is not uniform. In Lagos and Niger states, women consumed a portion of fish that was half the size of the man's portion (Gomna & Rana, 2007), which means this distribution is not equal, nor equitable. Women's nutrient per calorie needs are higher during certain physiological phases (e.g., pregnancy and lactation) than men's nutrient needs (Adu-Afarwuah et al., 2017). Therefore, this inequitable distribution of nutrient rich foods (including, but not limited to fish) can further exacerbate micronutrient deficiencies amongst people already vulnerable to malnutrition (Schneider et al., 2021). This inequitable household distribution of food is likely a reflection of overall gender dynamics in the household. In a consumer household survey of 700 women across nine states in rural and urban Nigeria, found nearly half (47%) of women reported that they are not involved in making decisions about non-food purchases (Byrd et al, 2021).

The geography of production also clearly affects consumption, as there is a clear relationship between higher production and higher consumption in Southern Nigeria, and lower consumption in Northern Nigeria where production is lower (**Figure 5**). In a consumer survey across 700 households it was found that the most consumed fish types by 295 children under the age of two were catfish, mackerel, tilapia, and crayfish (Byrd et al., 2021). However, in a nationally representative survey, children 6-24 months living in the Northern region were less likely to have consumed fish than those children living in the Southern region (13% versus 35%, respectively). Correspondingly, children in the North disproportionality suffer from the burdens of undernutrition (Kinyoki et al., 2020).

Trends are variable between within North and South regions, and the link between consumption and production is less clear at the level of the state and for children's diets (**Figure 6**). Children in Zamfara and Borno states eat relatively fish infrequently, yet the moderate production levels in those states suggest more fish could be made available for local consumption. Katsina is another state that stands out with relatively low consumption, despite having relatively high fish production. Conversely, a relatively high proportion of children living in states such as Enugu and Nassarawa consume fish, despite those states producing very little fish.

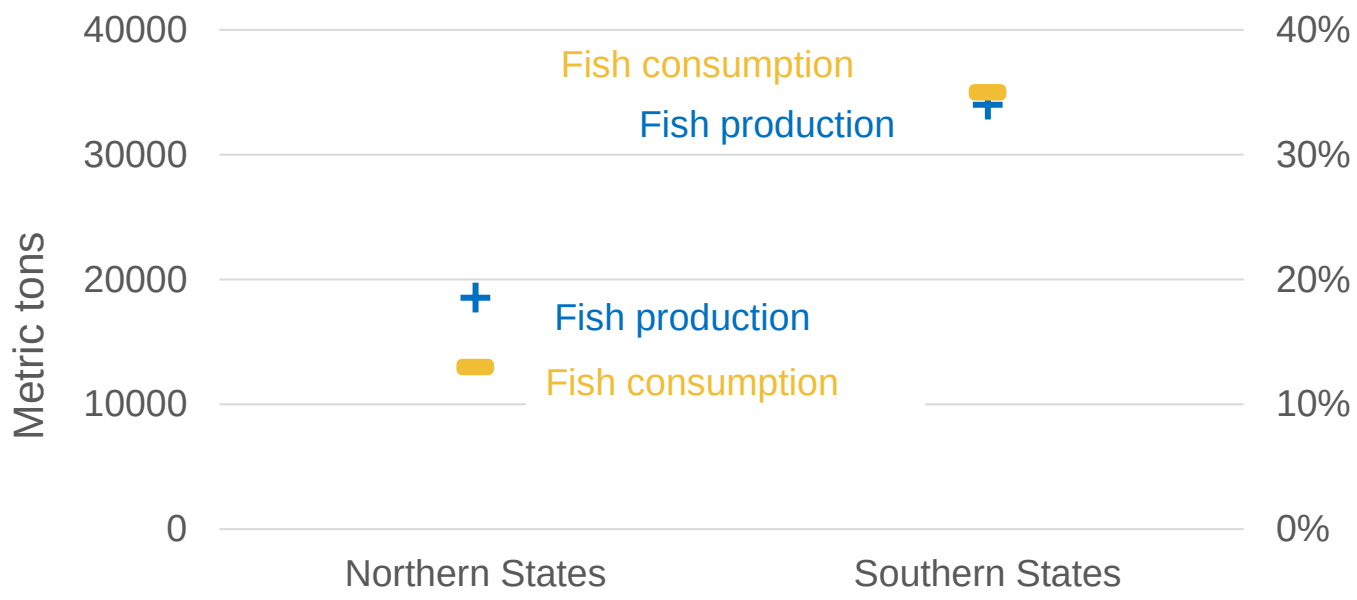

Figure 5. Fish production and consumption in the Northern vs the Southern States of Nigeria. Fish production is based on production from 2017, which was extrapolated from observed production values between 2013 and 2015, as reported by the Federal Department of Fisheries in Nigeria. Fish consumption from all sources of fish is from a nationally representative survey in which caretakers of children aged 6-23 months were asked in the children consumed fish in the previous 24 hours (National Population Commission (NPC) [Nigeria] & ICF, 2019).

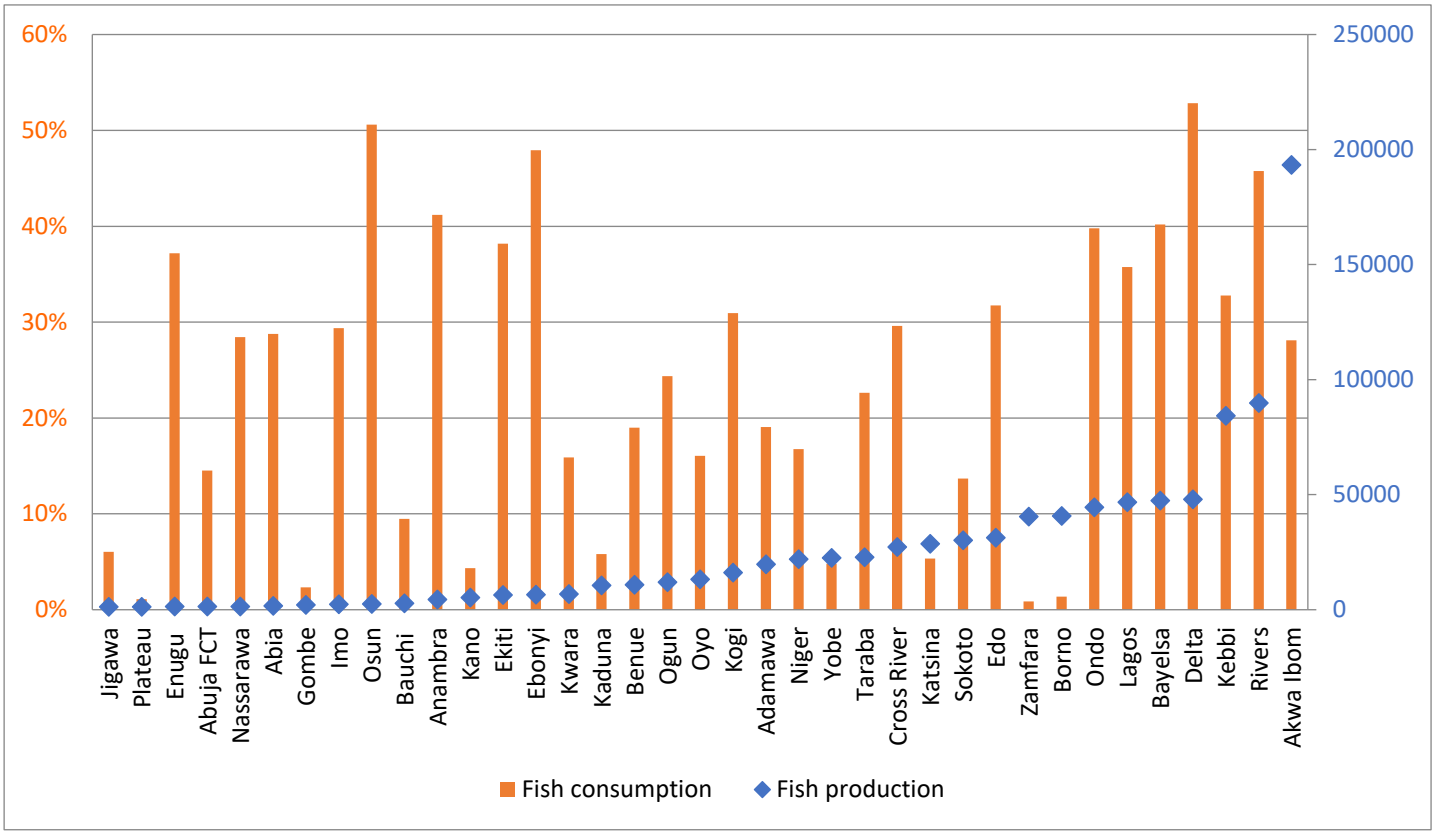

Figure 6. Relationship between fish production and observed rates of fish consumption in children. For each state in Nigeria, the total annual capture fish production (metric tons in 2017) and proportion (%) of children 6-23 months who were reported to have consumed fish in the previous 24 hours rates (National Population Commission (NPC) [Nigeria] & ICF, 2019). Fish production is from the year 2017 and data were obtained from unpublished data from the Federal Department of Fisheries in Nigeria.

Diets

Dietary diversity is an indicator of diet quality and can be used to indicate whether women and children are receiving adequate nutrition (FAO & FHI 360, 2016; World Health Organization, 2008). Ensuring adequate nutrition in children under the age of two is critical to optimal physical growth and cognitive development. Conversely inadequate nutrition during this key developmental period can have life-long impacts on the persons physical health, learning, and societal and economic future (Victora et al., 2008). The consumption of fish and other aquatic foods during these first 1,000 days of life can provide health benefits, particularly when consumed as part of a broader diverse diets. Fish and other aquatic foods are most important to diets when other animal source foods are not available, and there is some evidence that when they are habitually consumed, are associated with several positive health outcomes (**Figure 8**).

Given their high nutrient concentrations, the production of dried shrimp, prawns and crayfish hold substantial potential for improving nutrition for women and children in the first 1,000 days to meet nutritional needs (Akintola & Fakoya, 2017). Fish, especially the nutrient rich crayfish and small-bodied freshwater fish can also be made into products like fish powder, which is appropriate as a

complementary food for young children (Byrd et al, 2021). Fish species vary in terms of micronutrients, fatty acids, and protein they contain (Hicks et al. 2019) and there are some fish species in Nigeria that may be more nutritionally important than others (Bradley et al., 2020). These are likely to include the small bodies species of fish that can be consumed whole – these small fish are not only nutrient-dense relative to other species, but their consumption whole means they are delivering even more micronutrients (e.g., iron, calcium) per gram than if just a fillet is consumed (Thilsted, 2012). In Nigeria, some examples of small fish consumed whole are the freshwater clupeids, often called freshwater sardines. These small fish nutritionally outperform many higher economic value species, such as tilapia and catfish, increasingly produced in Nigeria through aquaculture (Hasselberg et al., 2020; Thilsted et al., 2016).

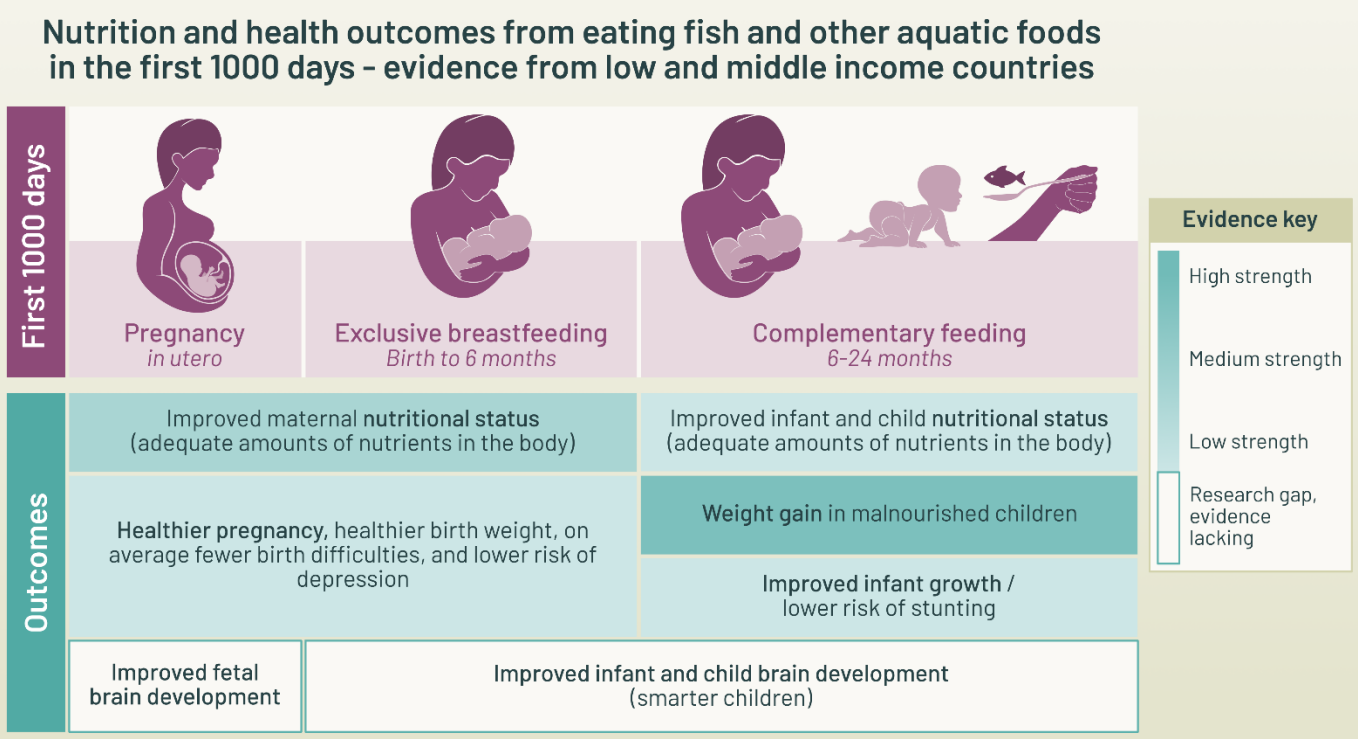

Figure 8. Nutrition and health outcomes from eating fish and other aquatic foods in the first 1000 days of life – which is the "critical window of growth" from the time in utero and up to two years of age. Reproduced with permission from (Byrd et al., 2022)

Data for Nigeria illustrate that if children ate more fish there could be substantial improvements to dietary quality. In a nationally representative survey conducted in 2019, only 22% of children across Nigeria had consumed more than four food groups in the preceding 24 hours (**Figure 9A**). This means that 78% of Nigeria's children under the age of two years old are likely to have low or inadequate dietary diversity, and therefore a high likelihood they experience some form of malnutrition. Only 27% of children under the age of two had consumed foods from the 'meat, poultry and fish' category in the preceding 24 hours, and consumption of other types (i.e., non-flesh) animal sources foods (i.e., milk and eggs) being slightly less prevalent (Figure 9B). Fish was the most common type of 'meat, poultry fish' consumed and was most frequently (49%) the only type of animal flesh food that had been consumed (**Figure 9C**).

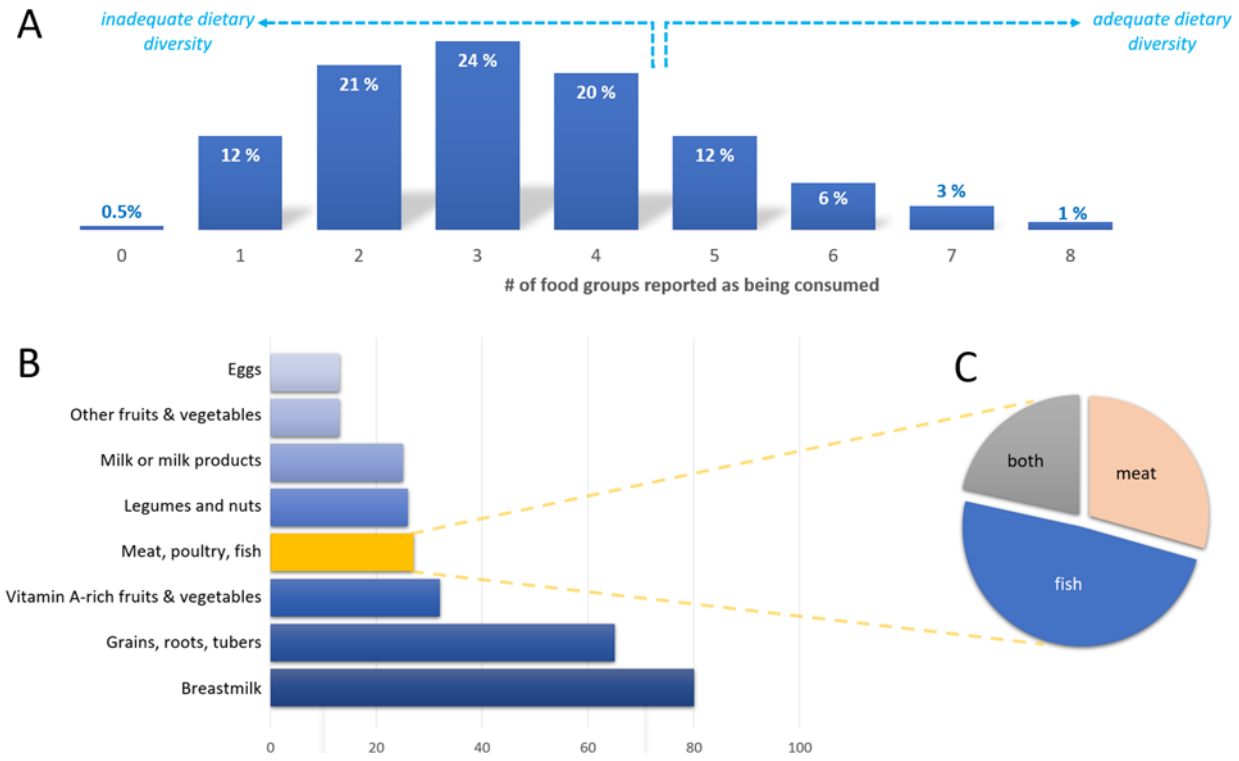

Figure 9 (A) The proportion of children in Nigeria under the age of two years that consume one to the maximum eight foods groups that the World Health Organization (WHO, 2017) consider to be optimal for dietary diversity; (B) The eight different food groups and the proportion of children (under two years of age) consuming each; (C) The composition of the 'meat, poultry, fish' food group illustrating the relative frequency that fish is the main type of flesh food. Data are based on parents recall of consumption in the previous 24 hours by children aged 0-23 months (n = 12,076) (National Population Commission (NPC) [Nigeria] & ICF, 2019).

Women of reproductive age are at risk of being deficient in some of the nutrients that fish contain (Adu-Afarwuah et al., 2017; Thilsted et al., 2016). As such, women can disproportionately benefit in terms of their nutrition and health from consuming fish and other aquatic foods. In a consumer survey of 700 households across nine states in rural and urban Nigeria, 79% of women reported consuming fish in the preceding 24 hours, and the most common were catfish, tilapia, and crayfish. Though this is a high frequency of fish consumption, supply data (Subasinghe et al., 2021) and gender norms (Gomna & Rana, 2007) indicate that the serving sizes of the fish consumed by women is likely small. Furthermore, the amount of crayfish consumed may be small given that crayfish are often used as small ingredients for common recipes (Ene-Obong et al., 2013). Additionally, crayfish consumption was not reported at all amongst women in the North (Byrd et al., 2021).

Regardless, even small servings of fish provide important, bioavailable nutrients. Yet, there may be further potential to reduce hidden hunger (i.e., micronutrient deficiencies) by increasing serving sizes made available to nutritionally vulnerable people. Nigerians over the age of 25 are estimated to consume

an average of 9.2 mg of omega-3 fatty acids daily (i.e., 14% of the global average of 65 mg) and much lower than the amount of 450 mg that is recommended to prevent chronic disease (The Global Nutrition Report, 2020). However, due to the lack of information on fish, other aquatic species and fish based products in dietary databases (in Nigeria, as well as in other parts of the world) there may be some consumption and nutritional contribution that is unaccounted for (Bradley et al., 2020). In particular, it is likely that the consumption of small freshwater fish that are rich in omega-3 fatty acids (Byrd et al, 2021). The data on consumption of fish in Nigeria thus far highlight both the importance of fish to diets, particularly as one of the few animal source foods available, preferred and consumed in many geographies and parts of society. Thus, targeted campaigns to increase fish and aquatic foods consumption among women in Nigeria may be needed to reduce micronutrient deficiencies amongst this vulnerable group.

Conclusion

There are increasingly urgent calls globally for the transformation of food systems towards configurations that are more sustainable, equitable and more effective in meeting human nutritional needs. In these transformations it is critical to examine which food systems elements and sectors hold these characteristics, and how they can be governed to improve sustainability, equity, and nutrition goals.

Relative to other agricultural production sectors, the current and potential values of capture fisheries tend to be overlooked by policy makers. This discussion paper presents an opportunity to better consider and integrate the niche role small-scale capture fisheries, and aquatic foods more broadly, play in Nigeria's food system. The data presented here illustrate small-scale fisheries as an important aspect of the food system in Nigeria, particularly critical as a domestically produced, nutrition-rich foods (approximately 1.8 metric tonnes each year), a sector that provides livelihoods for women and men, and a provider food rich in nutrients (particularly omega-3 fatty acids, iron, zinc, and calcium) that are frequently insufficient in the diets of Nigerian women, children, and infants.

While small-scale fisheries provide important supply, livelihood, and nutrition values in their current form, there are substantial opportunities to increase fish supply, fisheries sustainability, and the quality of foods from small-scale inland fisheries. We argue that the main areas where investment would deliver these benefits is by reducing post-harvest losses through the scale-up of improved fish processing techniques, more equitable distribution of fish toward nutritional needs, and by management efforts to preserve the rich ecosystems that support Nigeria's fish and aquatic foods.

Scaling up improving smoking techniques is of vital importance, given that smoked fish are a high valued food across Nigeria, and a nutrient-rich source of vitamins and minerals to the diet. However, the carcinogenic PAHs found in fish smoked using traditional techniques is of concern, and more research to quantify the exposure to consumers is urgently needed. Improved smoking techniques will also improve the working conditions for the vast number of women smoking fish in Nigeria.

Regardless of processing technique however, fish remains an important component of a healthy diet in Nigeria, and Nigerians frequently consume fish as part of a healthy diet, as a preferred food and in dishes of culturally significance. There are regions where fish consumption could be more targeted

through social and behavior change communication programs, such as in the states of Zamfara, Borno, and Katsina, and nationally among women and young children. Fish consumption in the Northern States is low relative the Southern States, yet production or distribution needs to be increased alongside in some states for social and behavior change communication programs to be effective.

The small-scale fisheries sector is vital to a healthy and equitable food system. Policy and program investments, alongside effective social and behavior change communication programming that promotes fish consumption has the potential to make progress on several Sustainable Development Goals (e.g., zero hunger), and progress on other Sustainable Development Goals (e.g., gender equality, conserving life under water, climate) will greatly benefit the small-scale fisheries sector and preserve it for generations to come. Equal policy attention must be given to the woman gleaning periwinkles, and the woman smoking catfish outside her home, as equal players to the captain of the marine vessel working in the large-scale fishing sector. Through such policy equity, Nigeria can work towards achieving a sustainable and equitable food system that meets the nutrition needs of many.

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