Fish in food systems in Nigeria: A review

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Authors

Bradley B[1], Byrd KA[1], Atkins M[1], Isa SI[3], Akintola SL[2], Fakoya KA[2], Henrietta Ene-Obong[4], Thilsted SH[1]

Authors' Affiliations

[1] WorldFish, Penang, Malaysia
[2] National Biotechnology Development Agency, Nigeria
[3] Department of Fisheries, Lagos State University, Nigeria
[4] Department of Biochemistry, University of Calabar, Nigeria

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Contact

WorldFish Communications and Marketing Department, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia.
Email: worldfishcenter@cgiar.org

Photo credits

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List of abbreviations

FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FDF	Federal Department of Fisheries
GAIN	Global Alliance for Improved Nutrition
IFAD	International Fund for Agricultural Development
LGA	local governmental area
NAS	National Aquaculture Strategy
NGO	nongovernmental organization
SDG	United Nations Sustainable Development Goal(s)
SUN	Scaling Up Nutrition
UN	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Definitions and terms

1000 days: The period from conception to 23 months of life. It is an extremely vulnerable and critical window for a child's growth and cognitive development.

By-catch: Fish and seafood caught or harvested other than the species that was intended to be caught.

By-product: Materials unintentionally produced in the process of making something else.

Complementary feeding: Defined by the WHO as the process of introducing age-appropriate and safe foods and liquids other than breastmilk, or a breastmilk substitute, when breastmilk is no longer enough for an infant's nutritional needs. The transition occurs during a critical period of growth, no earlier than 6 months of age up to 24 months. Complementary foods are intended to *complement*, and not replace, breastmilk.

Finfish: Fish species with fins, as opposed to shellfish.

Fish: The term is used in the broadest sense to include all aquatic animals, such as fish (both fed and non-fed), crustaceans (e.g. shrimp, prawns, crabs), molluscs (e.g. oysters, mussels, snails) and other aquatic invertebrates.

Food and nutrition security: Food and nutrition security exists when all people at all times have physical, social and economic access to food, which is consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life, as defined by the Committee on World Food Security (2012).

Food system: Encompasses all the stages of keeping humans fed: growing, harvesting, packing, processing, transforming, marketing, consuming and disposing of food, as defined by the Committee on World Food Security (2016).

Malnutrition: According to the WHO, malnutrition refers to deficiencies, excesses or imbalances in energy and/or nutrient intake, encompassing undernutrition, overweight, obesity and diet-related noncommunicable diseases. These are collectively known as the multiple burdens of malnutrition.

Micronutrients: Needed only in minuscule amounts, they enable the body to produce enzymes, hormones and other substances essential for proper growth and development.

Prevalence: The total number of individuals in a population with a condition or illness at a specific point in time, often a percentage of a population.

Rickets: A vitamin D deficiency disease that can affect the proper skeletal growth of young children when inadequate calcium assimilation causes soft and/or deformed bones.

Stunting: Impaired growth and development that children experience from poor nutrition, repeated infection and inadequate psychosocial stimulation. It is defined by height-for-age more than two standard deviations below the WHO Child Growth Standards median.

Supplementation: Addition of micronutrients using a tablet, capsule, syrup or powder to an individual's regular diet.

Supply chain: Sequence of processors and value chain actors involved in the production and distribution of a product into the market place.

Total fish length: The length of the whole body of a fish, from the most anterior point of the body to the most posterior point, in a straight line, not over the curve of the body.

Value addition: Activities and processes involved in enhancing the flavor, texture, aroma, preservation and/or appearance of a raw material.

Wasting: Indicated in most cases by a recent and severe process of weight loss, which is often associated with acute starvation and/or severe disease. It is defined by weight-for-height more than two standard deviations below the WHO Child Growth Standards median.

Executive summary

This review was undertaken in 2018–19, prior to the COVID-19 pandemic. Thus, the resources reviewed do not reflect the changes that happened in Nigeria as a result of the pandemic. However, in our research gaps and conclusion, we have taken into account the current COVID-19 situation in Nigeria.

In Nigeria, like many coastal developing countries, fish is an important source of food for the population, which is currently estimated at 186 million people (World Bank 2016). A recent study estimated that Nigeria ranks third globally for the number of people dependent on coastal fisheries for food and nutrition security, and the demand for fish is growing, alongside growth in population and incomes. However, household fish consumption in Nigeria—measured at 13.3 kg/capita/year—is low compared with the world's average of 20.3 kg/capita/year (FAO 2018). This national average likely masks a much lower average among resource-limited and vulnerable population groups as well as a notable supply-demand gap.

Increased fish production and consumption may contribute to alleviating food and nutrition insecurity. The majority of households in Nigeria (58%) suffer from chronic or transitory food insecurity (Ogundari 2017). In 2016, 14.3 million people in Nigeria were classified as undernourished (FAOSTAT 2017). An average of 67% of children aged 6–23 months living with their mothers did not eat foods rich in iron, and 52% did not eat vitamin A-rich foods in a 24-hour diet recall (NPC and ICF 2014). As a result, fish—which is rich in micronutrients such as zinc, iron, iodine, calcium, vitamin B12 and vitamin A, as well as essential fatty acids and protein—could play an instrumental role in attaining food and nutrition security.

Consumer behavior and demographic drivers

Income, market value, region and seasonality determine availability and access to fish. Complex sociocultural and behavioral factors influence fish consumption. Food taboos, and community and household perceptions of different species of fish also affect decisions around fish consumption.

In Nigeria, households in the southern region eat more fish than those in the northern region. Similarly, household fish consumption is higher in urban than rural areas, and people of higher socioeconomic status consume fish more often than those of lower status. As incomes grow in Nigeria, demand for fish is predicted to increase. Missing from the nationally representative data on fish consumption is information on the species consumed. A variety of species are eaten in Nigeria, including crayfish, sardines (freshwater and saltwater), bonga and mackerel, as well as cultured fish species, such as tilapia, carp and catfish.

Food taboos influence fish consumption in Nigeria, especially the dietary behaviors of pregnant women in some groups. For example, pregnant women are advised not to eat the head of dried salted cod (stock fish) because it is believed that if they do, their children will look like stock fish. These practices, though important to society and culture, can lead to misconceptions and undervaluation of the nutritional quality of foods.

Taste, texture and convenience-based preferences are also significant factors to consider when analyzing consumer behavior. For instance, people of high socioeconomic status are more likely to purchase fresh fish. Individuals who value convenience favor dried fish, as it needs little time for preparation (IPSOS 2016).

Food supply chains: Fish production systems

Nigeria's vast inland water bodies and coastline measure over 800 km and support nearly 1.5 million people engaged in fish-based livelihoods (FAO 2007; WorldFish 2017b). Nigeria produces around 1 million t of fish per year: over 750,000 t from capture fisheries and roughly 310,000 t from aquaculture (WorldFish 2017b). However, the role of aquaculture in Nigeria is growing, as the sector is becoming increasingly economically and politically incentivized. As of 2012, over 13,000 people were employed in aquaculture, though only 2% were women (FAO 2017b).

Aquaculture, which is mostly monoculture of large species like catfish and tilapia, is seen as a pathway through which Nigeria can close its existing fish supply-demand gap. Culturing more fish species would widen the nutrient diversity to feed the growing population. Aquaculture in general, however, can help meet the demand for fish domestically; over 600,000 t of fish—primarily marine fish—are imported per year to meet the demand of Nigeria's growing population (FAO 2007; Igoni-Egweke 2018).

Food supply chains: Fish processing, preservation and value addition

In Nigeria, fish is commonly processed, mostly by women, using traditional postharvest techniques to preserve, improve flavor and add value to the fish. Common processing techniques include salting, sun-drying, smoking and frying. These methods vary among the individuals involved, depending on infrastructure, fish species, knowledge and wealth. Other value addition products have been documented, such as fish cakes and fish cake burgers made from shrimp by-catch, and developed by fishers as an entrepreneurial endeavor (DFID and FAO 2002). There is no indication that the products were made with the intention of providing nutritional benefits or whether they were locally accepted.

Political, program and private sector actions

The government of Nigeria is interested in promoting nutrition-sensitive agriculture and aquaculture, but programs remain resource-constrained. However, nongovernmental organizations (NGO) are supporting the Ministry of Health, via the Scaling Up Nutrition (SUN) Business Network, to assist small and medium enterprises to become more nutrition-sensitive. This is part of Nigeria's efforts to address the multiple burdens of malnutrition through the private sector, of which fisheries and aquaculture could play a large part. From the public sector perspective, fish for optimum nutrition could be communicated more clearly to the population, as Nigeria's food-based dietary guidelines mention fish only briefly.

Identified research gaps

From this review, the following areas of research were identified to strengthen the food systems in Nigeria to deliver fish for optimum nutrition. These research gaps were identified prior to the COVID-19 pandemic, however, they are still relevant, and perhaps more so, given the reliance on fish for food and nutrition security in Nigeria.

- status of fish consumption at the species level, disaggregated by state, sex, age and household income
- affordability of fish throughout the value chain
- modifications in the nutrient profile of fish during various processing and preparation methods
- nutrient analysis of small pelagic inland fish species and species with high potential for aquaculture
- common practices for using fish in complementary feeding and in intrahousehold consumption of fish
- use of fish by-products for value-added products in women's enterprises
- alternatives for fishmeal and fish oil in aquaculture feeds to redirect more fish for human consumption
- effects of climate change on communities dependent on fish, as well as on fish species diversity, supply and consumption.

Introduction

According to the FAO, production from global fisheries and aquaculture subsectors in 2016 reached an all-time high of 171 million metric tons, 88% of which was used for direct human consumption. This high level of fish production resulted in a record-high global average fish consumption of 20.3 kg/capita/year (FAO 2018). Nevertheless, the sector faces several challenges. Demand for fish in Africa, Asia and the Pacific is growing. To meet these demands, many countries will have to at least double fish production by 2030 (WorldFish 2017a). Yet some wild fishstocks are overexploited, and some capture fisheries are experiencing declining trends (Olopade et al. 2017). However, aquaculture, which is commonly seen as a production mechanism that will keep pace with increased demands, is confronted with its own set of hindrances with regards to sustainability, high costs of production, and lack of technical capacity.

Nigeria relies heavily on fisheries for both the economy and for food and nutrition security (Selig et al. 2018). Fish consumption is estimated at 13.3 kg/capita/year. Although this is higher than the regional average for Africa (9.9 kg/capita/year), it is still substantially lower than the global average of 20.3 kg/capita/year (FAO 2018; WorldFish 2017b). Recent studies suggest that as many as 58% of households in Nigeria suffer from chronic or transitory food and nutrition insecurity (Ogundari 2017) and in 2016, 14.3 million people were considered undernourished (FAOSTAT 2017). If harnessed effectively in a sustainable food system, fish can play a key role in improving food and nutrition security.

In this review, conducted in 2018–19, the food system is understood as an interconnected and interdependent system. It includes the various stages of the food supply chains: production, processing, marketing and consumption. The report takes informative guidance from the conceptual framework of food systems for diet and nutrition (Appendix C) developed by the High Level Panel of Experts on Food Security and Nutrition (HLPE 2017).Although this report attempts to include the various economic, ecological, sociocultural, technological, institutional and political factors that interact to shape a food system, it emphasizes consumer behavior and dietary outcomes.

The objective of this review is to better understand the role of fish throughout the food system in Nigeria, identify opportunities to implement nutrition-sensitive research, policy and interventions, and initiate programmatic partnerships for maximizing the fisheries sector's contribution to nutrition.

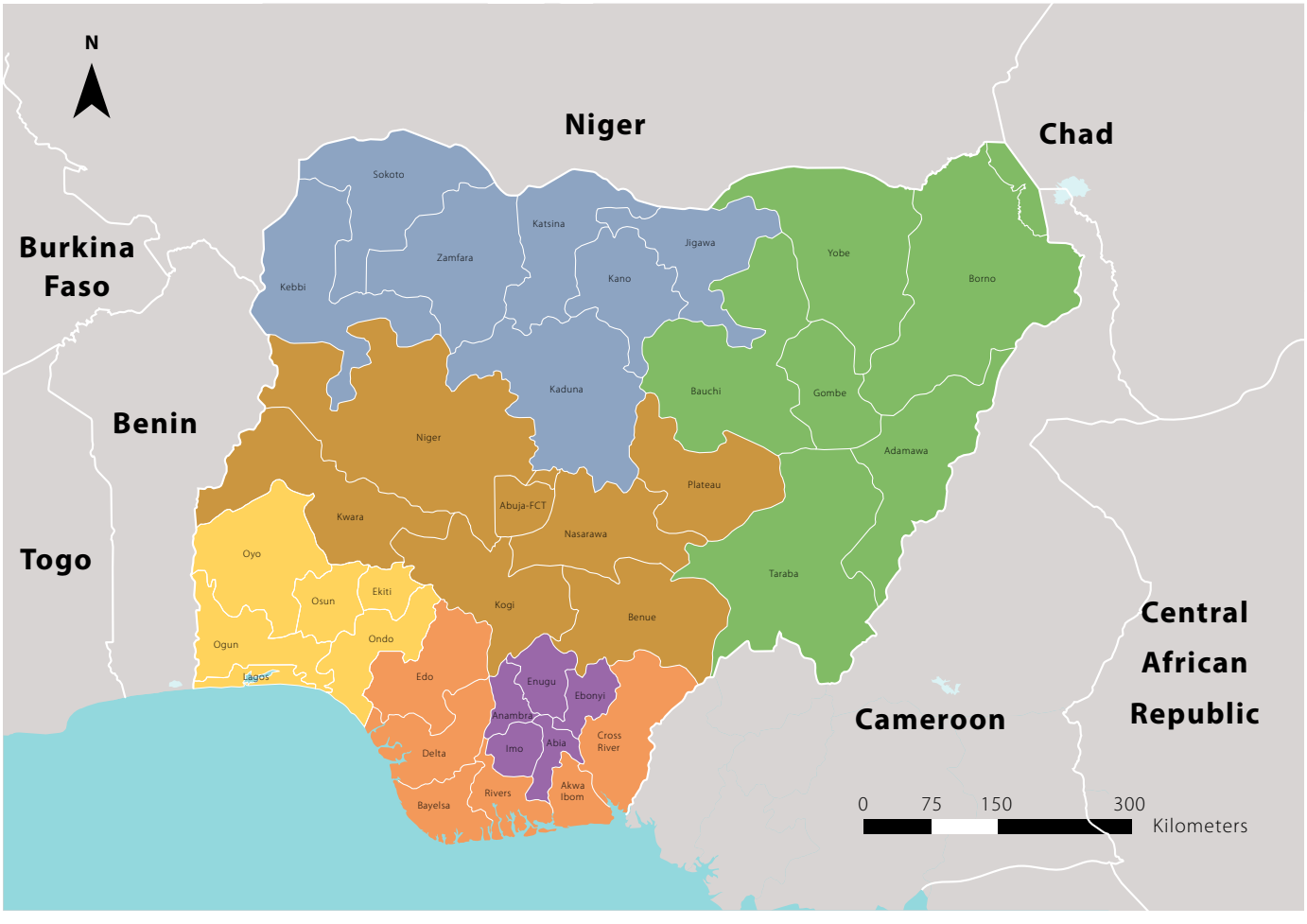
Nigeria: A contextual overview

With 186 million people, Nigeria is the most populous country in Africa (CIA 2018; WorldFish 2017b), and it continues to grow steadily each year. From 2010 to 2016, Nigeria's population grew an average of 17% annually (World Bank 2016).

There are over 250 ethnic groups in Nigeria: the largest are the Hausa, Yoruba and Igbo. The official language is English, but there are an estimated 500 languages spoken in the country. The majority of people follow Islam, but a large percentage of the population is Christian (NPC and ICF 2014b).

Nigeria is divided into 36 states, each with its own state government, and the Federal Capital Territory, which houses the country's capital city of Abuja (CIA 2018; World Bank 2016). The country is split into six geopolitical zones (Figure 1): the semi-arid North East and North West zones and the higher rainfall and cooler North Central, South West, South South and South East zones, which are clustered around the equator (CIA 2018).

The northern zones produce cereals, oil seeds, vegetables, livestock and some tubers, such as potatoes and yam. Yet much of these food crops make their way to the population-dense southern zones (NBS and CADP 2010). The semi-arid northern zones are known for their agricultural productivity, but they also contain the highest percentage of people living in absolute poverty. The absolute poverty rate in Nigeria, defined as living on or less than NGN 55,235.20 per capita/year, remained close to 62%, without improvement from 2004 to 2010 (Table 1) (NBS 2009).



Source: Nigeria Demographic Health Survey 2013.

Figure 1. Nigeria's six geopolitical zones and 36 states.

Agricultural production is foundational to the Nigerian economy and provides the main source of livelihood for most Nigerians (CIA 2018). National statistics suggest about 80% of rural and 20% of urban households are engaged in some form of agriculture (NBS and CADP 2010). Agricultural products in Nigeria include food crops such as rice, maize, millet, sorghum, cassava, potatoes and yams, and cash crops such as cocoa, cotton and palm oil (CIA 2018). Cereals and starchy roots make up 66% of the daily energy (kilocalories per capita per day) consumed, but the country relies on imports to supplement domestic production (FAOSTAT 2013a).

Nigeria's food deficits are reflected in the food and nutrition insecurity of its people. The steady prevalence of undernourishment, amid the continually growing population over the past decade affected 8.8 million people in 2007 and 14.3 million in 2016 (FAOSTAT 2017). The prevalence of food insecurity is higher in low-income, urban households and in rural areas (Matemilola and Elegbede 2017). As of 2017, stunting impacted 43.6% and wasting 10.8% of Nigerian children under 5 years of age (NBS and UNICEF 2017), but the average masks a prevalence of stunting that varies up to four-fold between states (Kinyoki et al. 2020). According to the Global Hunger Index, which takes into account undernourishment, child wasting, stunting and child mortality, Nigeria suffers a "serious" level of hunger (GHI 2018). Food and nutrition insecurity is particularly acute in the North East and North Central zones where pastoral conflicts and violent attacks—instigated by the Islamic State-aligned Boko Haram—have disrupted livelihoods and economic activities, including food production and essential food system functions in the area (FEWS NET 2018).

Over the past few years, fluctuating international oil prices and recession have shifted the government's attention away from investments in the petroleum industry toward more inclusive agricultural growth and sustainable development in line with the UN Sustainable Development Goals (SDGs) (FAO 2007).

Population	186 million (World Bank 2016)
Population growth rate	6.6% (NPC and ICF 2014b)
Female: Male ratio	49:50 (NPC and ICF 2014b)
Rural %	63.4 (NBS and UNICEF 2017)
Urban %	36.6 (NBS and UNICEF 2017)
Average household size	5.4 (NBS and UNICEF 2017)
Avg. % literate females (age 15–49 years)	52.1 (NPC and ICF 2014b)
Avg. % literate males (age 15–49 years)	75.5 (NPC and ICF 2014b)
Poverty (absolute poverty) rate %*	62.6 (NBS 2009)
Total fertility rate	5.5 (NPC and ICF 2014b)
Adolescent fertility rate**	122 (NPC and ICF 2014b)
Life expectancy at birth	53.4 years (World Bank 2016)

**Absolute poverty threshold was NGN 55,235.20 (USD 151.74) or less per capita per year.*
***Adolescent fertility rate is defined as births per 1000 women aged 15–19 years.*

Table 1. National statistics.

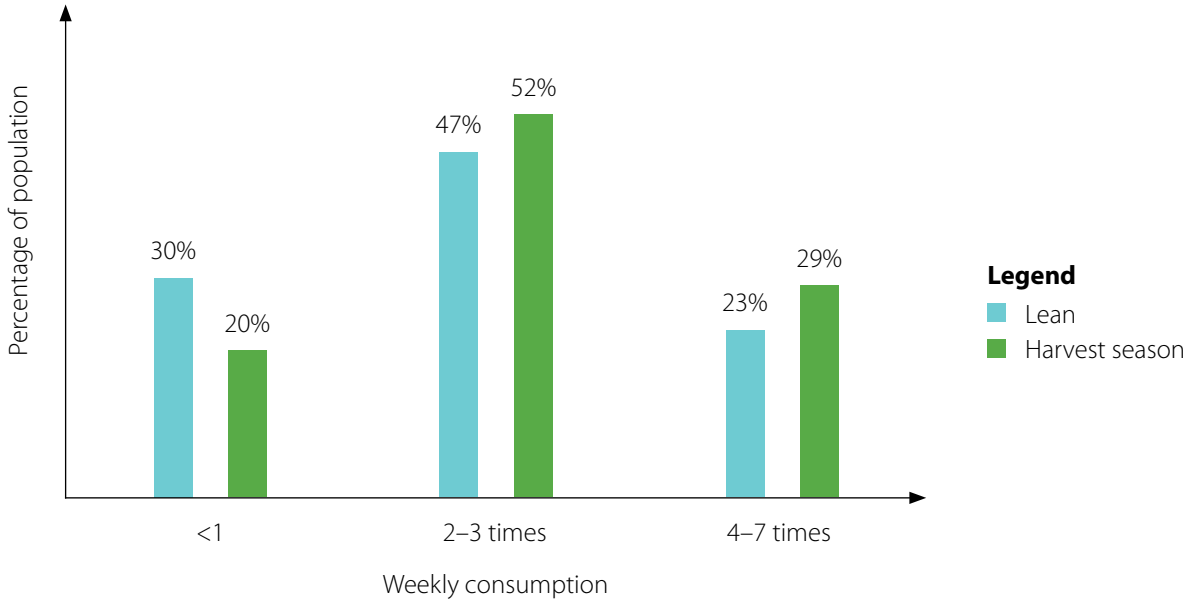
The role of fish in food and nutrition security

As recently as 2018, Nigeria was ranked third globally for the most people dependent on coastal ecosystems for nutrition (Selig et al. 2018). Coastal countries in West Africa have a high prevalence of both overnutrition and micronutrient deficiencies, despite the fact that children's dietary nutrient requirements could be met with less than 20% of current fish catches (Hicks et al. 2019). Some of the factors that influence food and nutrition security are household income, region and seasonality, all of which impact fish availability and accessibility. Fish consumption is also impacted by community and household perceptions of different fish species and taboos that limit fish consumption at both the household and individual level.

Fish consumption patterns in Nigeria

Fish consumption is relatively common in Nigeria, though little published literature exists that is disaggregated from meat and seafood. Between 1980 and 2013, the ratio of fish and/or seafood to overall animal protein consumption increased from 36% to 42% (Allen et al. 2017). Over that period annual fish consumption in Nigeria increased from 984,000 t to 2.317 million metric tons. However, the population grew from 73 million in 1980 to 172 million in 2013, so the stark population increase over this time meant that the intake of fish remained at 13 kg/capita/year in both years (Allen et al. 2017).

A nationally administered survey reported that 47% of the population ate fish and/or seafood two to three times per week, as shown in Figure 2a (IPSOS 2017). Socioeconomic status heavily influences fish consumption patterns and consumption preferences. Wealthier individuals are more likely to eat fish at least twice weekly; one study found that 74% of high-income Nigerians ate fish/seafood at least two times a week, while only 64% of middle-income Nigerians and 40% of low-income Nigerians ate fish at the same rate (IPSOS 2017). Among those who ate fish at least twice per week, women ate fish slightly more frequently than men (IPSOS 2017). A study on intrahousehold consumption patterns conducted in Niger and Lagos states found that male household members consume the body of the fish, and children eat the head (Gomna and Rana 2007). As a result of this cultural practice, male heads of the household consumed 59% more fish in grams per bodyweight than women and children (Gomna and Rana 2007).



Source: IPSOS 2017.

Figure 2a. Fish and seafood consumption in the 30 days prior to being surveyed in the lean and harvest seasons.

Fish consumption among young children is low and appears to be declining. Only 33% of mothers in Nigeria reported giving fish or shellfish to a child under 36 months in 2008, and in 2013 this number had dropped to 16% (NPC and ICF 2014b).

A combination of factors drives fish consumption among consumers in Nigeria. These include socioeconomic status, food traditions, food and nutrition security status, convenience, and taste preferences. Although fish is known to be high in protein and promote immune health, low-income individuals do not view fish as a "filling" food, so it is seen as a luxury item and an indication of wealth. The low-income consumers who are seeking to maintain food and nutrition security, yet who place a high value on education and family needs, preferred adding stock fish or dried salted cod into their diet. Although the cost of fish is relatively low for Nigerians who value convenience, they still prefer dried fish because it requires little to no preparation (IPSOS 2016).

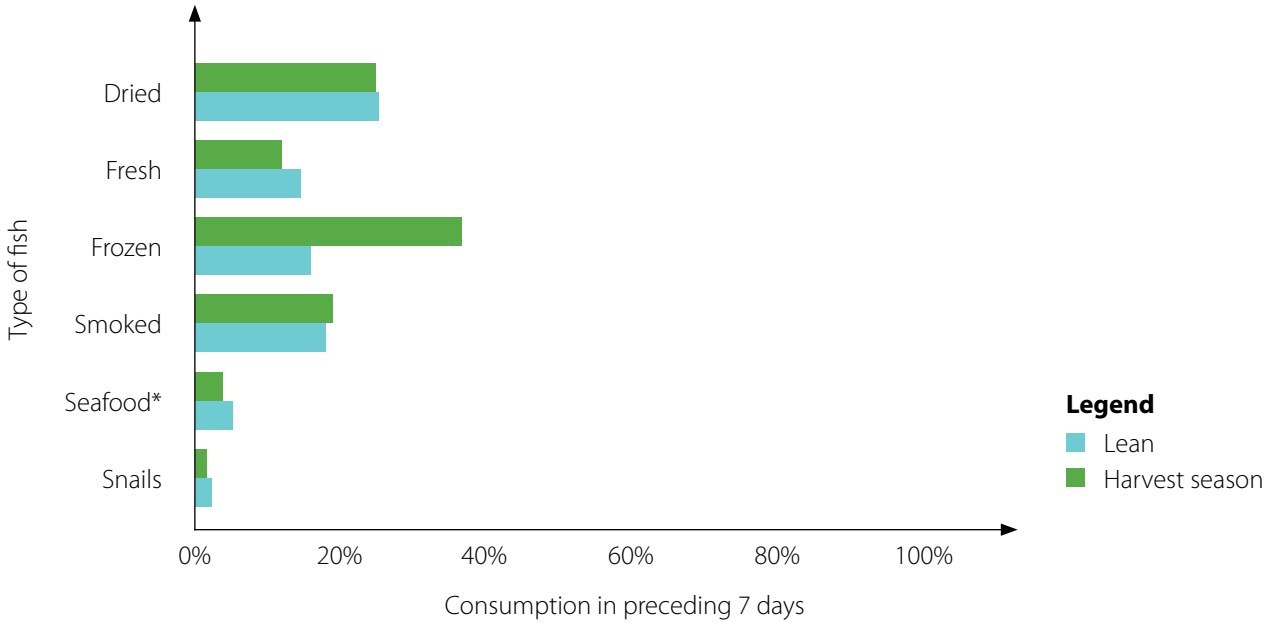
Individuals with higher income recognized the importance of fish to the immune system, but felt some fish was expensive and took too long to prepare. Consumers with the highest total expenditure on fish products were associated with those who enjoy food and value social status. Status-driven individuals favored both dried and fresh fish, while consumers who prioritize taste often opted for fresh fish (IPSOS 2016).

Consistent purchasing patterns suggest that the more affordable, domestically processed fish (dried and smoked) are the primary source of fish consumption despite seasonal and income fluctuations (Liverpool-Tasi et al. 2018). During the harvest months, which are generally around February for many crops, Nigerians primarily bought imported frozen fish (38%), followed by dried (25%) then smoked (18%) fish, as shown in Figure 2b (NBS, 2015). Households continued to purchase dried and smoked fish at nearly the same rates during the lean season (August to October), but frozen fish consumption drastically declined to 17%. Fresh fish consumption remained below 20% for both harvest and lean seasons (NBS 2015).

> *Therefore, fish is a staple for Nigerians throughout the year, especially traditionally smoked and dried fish—though more emphasis needs to be placed on feeding this staple to young children.*

Geographic variation in fish consumption

Although variability in fish consumption is often attributed to sociocultural factors and income level, notable distinctions between the northern and southern regions of Nigeria also play a role. Fish consumption overall is much lower in the north, where 42% of people eat fish or seafood at least twice weekly, compared with 72% of



**Seafood consists of lobsters, crabs and prawns in this survey.*
Source: NBS 2015.

Figure 2b. Distribution of population fish consumption across different forms of unspecified fish in Nigeria.

people in the south (IPSOS 2017). The ingredients of local recipes collected in a nutrition survey among the different regions of the country further support this distinction. Popular dishes in the northern region—such as *okro*, groundnut, and benni seed—mainly contain unspecified dried fish in limited quantities. In contrast, recipes in the southern region contain a wider variety of fish ingredients, including dried fish, stock fish (cod) and crayfish. Quantities of fish included in southern recipes range depending on affordability of the fish type. Crayfish is considered an affordable animal source food in the south, where it is widely consumed. However, it is not consumed as frequently in local dishes in the north (Ene-Obong et al. 2013).

From 2010 to 2015, according to data from the Living Standard Measurements Survey – Integrated Surveys on Agriculture (LSMS-ISA), the percentage of Nigerian households in the south consuming fish increased 20%. The percentage of household food budget allocated to fish also steadily increased (Liverpool-Tasi et al. 2018). In the north, meanwhile, the percentage of households consuming fish remained steady during that period, even as the household budget allocated to fish decreased in 2015 (Liverpool-Tasi et al. 2018). These trends suggest that there is strong demand for fish throughout the country, despite the speculation of household budget constraints in the northern region.

The climate in the north, where Nigeria skims the edge of the Sahel region, is considerably drier than in the south. Northern states have fewer water resources and less scope for aquaculture than the southern region, which can exploit the Niger Delta. Communities of the southern region also benefit from more forest coverage, which is positively correlated with consuming fresh fish presumably because of the synergistic relationship of forest-freshwater ecosystems (Lo et al. 2019).

Moreover, rural communities are predominant in the north and have a lack of roads and market infrastructure, which makes transportation and temperature control of fish costly in these regions (Adedeji and Okocha 2011). Despite lower overall consumption of fish in the north, a survey of men in the northern state of Katsina found that there is a large unmet demand for fish products (Dauda and Yakubu 2013). When compared to southern Nigeria, the lower fish consumption, fewer varieties of fish in recipes and a lack of resources indicate fish is likely less affordable and less available in the north.

Cultural perceptions of fish

Beliefs around food in Nigeria vary by gender, age, religion and region. It is important to understand how they affect the diets of women and children, as food taboos often involve pregnant women and children and may cause them to decrease their fish consumption (Ikeyi 2017). When food taboos involve animal-source foods, it raises the risk of nutritional deficiencies and developmental setbacks (Onuorah and Ayo 2003). In one study of 149 mothers in southeast Nigeria, 37% avoided certain foods because of traditional beliefs around consumption, despite maternal education, status and occupation (Ekwochi et al. 2016). In a cross-sectional survey of 244 women of childbearing age in Lagos State, 44% of pregnant women avoided eggs, fish and meat because of taboos—even while expressing receptiveness and knowledge of good nutrition practices (Fasola et al. 2018). In the southern state of Ogun, a survey of 50 pregnant women found that all of them ate fish at least 2–3 times per week and 76% ate it every day (Ademuyiwa et al. 2013).

Taboos also exist around children's food choices. For example, children who cease breastfeeding because the mother expecting another child must refrain from eating eggs, fish and meat. Adherence to these taboos increases the risk of malnutrition in children under 5 years old (Onuorah and Ayo 2003).

Cultural-driven factors, such as perceived medicinal properties, influence consumption. For example, a study of recipes used for traditional healing in the Yoruba people found that 9% of the recipes contained finfish (Sowunmi 2007). Most of the recipes with fish were used to treat infertility, and the most common species was catfish (*Clarias* spp.). In many parts of northern Nigeria, eating African lungfish (*Protopterus annectens*) is considered taboo (Reed 1967) for males because of the perceived effect on male reproduction. Up until the late 1990s, this taboo was strongly held among fishing communities and marketers. A recent study conducted along the Benue River in Adamawa State reveals that both sexes now

eat lungfish, provided the vein-like tissue running from the head down to the caudal region is removed. This tissue is perceived to be responsible for the harmful effect on the male reproductive organ. Another study done on fishers operating along rivers and seasonal pools in Kalong, a part of Shendam local government area (LGA) of the LGA of Plateau State, revealed that some males now eat the entire fish, without removing the tissue. This perception has diminished the value of this tasty, high fillet yielding and drought tolerant fish for a long time (Reed 1967).

Fish species consumed

Missing from the nationally representative data available on fish consumption in Nigeria are the types of fish that are eaten. (Emmanuel et al. 2014; Gomna and Rana2007).

> *Tilapia, catfish and common carp (Cyprinus carpio) are commonly cultured in Nigeria; however, there were 39 different fish species consumed in Lagos and Niger states alone from capture fisheries, indicating a rich biodiversity of species available in some environments.*

Small indigenous fish are often found to be more nutritionally dense than large fish, as they are often consumed whole, or mostly whole, but they are commonly under-valued as they do not have as high of a market value (Thilsted et al. 2016). One small fish eaten in Nigeria is the freshwater sardine of the clupeid family, a small fish species found in freshwaters and popular in northern regions (Akintola and Fakoya 2017). The clupeid species, *Pellonula leonensis* and *Sierrathrissa leonensis*, also known as pygmy herring, are harvested from the Lake Kainji reservoir in northwest Nigeria (Kolding et al. 2019). *Pellonulla* spp. is also fished in Anambra River and the Niger Delta. There are no official harvest records for these species in commercial and subsistence fisheries. As a result, their roles in markets and consumption have gone unreported (Kolding et al. 2019).

Clupeids are harvested in large quantities between November and May (Akintola and Fakoya 2017). Unfortunately, large harvests of clupeids lead to market saturation and low prices, as well as a high rate of waste and loss. Additionally, the availability and affordability of clupeids have dwindled in the past decade as a result of overharvesting and habitat destruction (Akintola and Fakoya 2017). Because of its high protein content and easily digestible energy, the use of clupeids in the aquafeed industry in Nigeria has increased in the past two decades, replacing imported fish feed (Ibiyo et al. 2018). Informal observation shows that this has further reduced its availability for human consumption. Vendors selling fried fish in popular hawker stalls have resorted to replacing clupeids with small tilapia species.

Crayfish (a mix of species) are another small indigenous fish that are rich in important nutrients (Akintola and Fakoya 2017; Ijarotimi and Ogunsemore 2006). Also called "spiny lobsters" they are sourced from southern Nigeria and popularly included in homemade and restaurant meals because of their flavor. Sundried crayfish are most often sold by women in local markets. Even though crayfish are expensive and only a small quantity is added to a dish, they are exceptionally rich in micronutrients and protein (Ene-Obong et al. 2013).

Nutrient content of fish species consumed in Nigeria

While many commonly consumed fish in Nigeria have been analyzed for their macronutrient content, an analysis of micronutrient content in locally prominent fish types is missing (Table 2a). Disaggregating this information is important because nutrient composition varies greatly between families of fish, and a wide range of species is consumed across Nigeria. Additionally, information is lacking on the nutrient content of key species after common postharvest processing and preservation methods, such as smoking or sun-drying.

We identified 37 fish species consumed in Nigeria and listed them in Table 2a; 38% have no documented micronutrient analysis. The *bonga* (*Ethmalosa fimbriata*), a principal fish caught from capture fisheries, is present in the FAO foods database, but the contents or micronutrients are not reported (Akintola and Fakoya 2017). Similarly, freshwater sardines, locally called clupeids (*Pelonula* spp., *Sierrathrissa leonenses*), are commonly caught in northern Nigeria but are completely missing from nutrient composition databases (Kolding et al. 2019).

Common name	Scientific name	Macronutrients analyzed	Micronutrients analyzed	Source of information*
Finfish				
African carp	*Labeo* spp.	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012)
African knife fish, *aba aba*	*Gymnarchus niloticus* and other species	Yes	Yes	(Adeyeyeand Adamu2005)
African river pike	*Hepsetus odoe*	Yes	Yes	UFiSh1.0 (FAO 2016)
African tigerfish	*Hydrocynus vittatus*	Yes	Yes	(Andrew et al. 2017)
African catfish	*Clarias gariepinus*	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012) and UFiSh1.0 (FAO 2016)
Atlantic bumper	*Chloroscombrus chrysurus*	None	None	N/A
Barracuda	*Sphyraena afra*	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012)
Bonga	*Ethmalosa fimbriata*	Incomplete	No	BioFoodComp4.0 (FAO 2017a)
Bony tongue fish, African bony tongue fish, African arowana	*Heterotis niloticus*	Yes	Yes	(Fawole et al. 2007)
Catfish	Many families and species	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012) and UFiSh1.0 (FAO 2016)
Cod	*Gadus morhua*	Yes	Yes	UFiSh1.0 (FAO 2016)
Common carp	*Cyprinus carpio*	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012) and UFiSh1.0 (FAO 2016)
Common sole	*Solea solea, Cynoglossus browni*	Yes	Yes	UFiSh1.0 (FAO 2016)
Croakers	*Pseudotolithus elongatus*	Yes	Yes	BioFoodComp4.0 (FAO 2017a)
Grouper	*Epinephelus* spp.	Yes	No	West African Food Composition Table (Stadlmayr et al. 2012) and BioFoodComp4.0 (FAO 2017a)

Common name	Scientific name	Macronutrients analyzed	Micronutrients analyzed	Source of information*
Hake	*Merluccius* spp.	Yes	No	BioFoodComp4.0 (FAO 2017a)
Longfin crevalle jack	*Caranx fischeri*	No	No	N/A
Mackerel	Multiple species	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012) and UFiSh1.0 (FAO 2016)
Moonfish	*Citharinus citharus*	Yes	No	BioFoodComp4.0 (FAO 2017a)
Mormyrids: Elephant snout fish	*Gnathonemus* spp.	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012)
Nile perch	*Lates niloticus*	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012)
Tilapia	*Oreochromis niloticus* and many other species	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012) and UFiSh1.0 (FAO 2016)
Sardines (saltwater)	*Sardinella* spp.	Yes	Yes	West African Food Composition Table (Stadlmayr et al. 2012)
Sardines (freshwater)	*Pellonula* spp. *Sierrathrissa leonenses*	No	No	N/A
Shad	*Ilisha africana*	No	No	N/A
Silver minnow, silversides	*Micralestes* spp.	Yes	No	(Leung et al. 1968)
Skipjack tuna	*Katsuwonus pelamis*	Yes	No	BioFoodComp4.0 (FAO 2017a)
Snakehead	*Channa obscura*	Yes	Yes	BioFoodComp4.0 (FAO 2017a)
Snapper	*Lutjanus* spp.	Yes	No	BioFoodComp4.0 (FAO 2017a)
Other aquatic foods				
Bivalves	Mix of species	No	No	N/A
Crabs	*Callinectes amnicola* and other species	Yes	Yes	UFiSh1.0 (FAO 2016)
Crayfish	Mix of species	Yes	Yes	UFiSh1.0 (FAO 2016)

Common name	Scientific name	Macronutrients analyzed	Micronutrients analyzed	Source of information*
Mudskipper	*Periophthalmus koelreuteri*	Yes	No	BioFoodComp4.0 (FAO 2017a)
Mangrove oyster	*Crassotrea gasar*	Yes	Yes	UFiSh1.0 (FAO 2016)
Periwinkles	*Tympanotonos fuscatus*	No	No	N/A
Prawns	*Macrobrachium* spp.	Yes	Yes	UFiSh1.0 (FAO 2016)
Shrimp	*Penaeus* spp.	Yes	Yes	UFiSh1.0 (FAO 2016)

*Note: * These three databases are commonly used to assess dietary adequacy in African countries.*

Table 2a. Nutrient content of fish and other aquatic animals consumed in Nigeria.

	Macronutrients			Micronutrients					
Capture – small fish	**Energy kJ**	**Protein g**	**Fat g**	**Iron mg**	**Zinc mg**	**Calcium mg**	**Iodine µg**	**Vitamin A µg RAE**	**Vitamin B12 µg**
Clupeid (freshwater sardine)	-	-	-	-	-	-	-	-	-
Sardine (marine)	436	19.4	2.9	1.8	1.57	71	-	19	11
Silver minnow	423	57.0	19.9	-	-	1000	-	-	-
Capture – large fish									
Bonga	-	60.9	7.6	-	-	-	-	-	-
Croaker (marine)	381	18.1	2.4	1.7	2.1	1900	41	-	2
Nile perch	413	19.9	2.0	0.7	1.1	89	-	6.0	1.9
Capture – shellfish									
Crayfish	308	15.5	1.1	2.6	1.88	59	92	16	2.1
Shrimp	389	19.3	1.1	1.4	1.43	59	49	11	2.1
Aquaculture									
Catfish	431	17.8	3.5	0.5	1.07	23	2	9	3.5
Tilapia	391	18.3	2.1	0.8	0.44	15	5	1	1.3

Note: RAE (retinol activity equivalents) is a measure that accounts for the bioactivity of different forms of vitamin A.*

Table 2b. Macro- and micronutrients per 100 g of the raw, edible portion of major fish species in Nigeria.

Despite gaps in information, some fish in Nigeria show promise toward addressing micronutrient deficiencies. A limited analysis of unconventional animal-source foods in the country showed that smoked *Pellonula* is high in crude protein and calcium compared to crayfish, shrimp and mudskippers (Ojewola and Udom 2005). *Bonga*, which is eaten fresh (mostly in southern Nigeria), retains a high ratio of protein and minerals (calcium, magnesium, potassium, phosphorus) to weight when oven dried (Ojimelukwe et al. 2017). These are examples of fish species with some records of nutrients and local acceptance. A thorough analysis to include micronutrients such as iron, zinc, vitamin A and B vitamins, especially vitamin B12 in both raw and processed forms, would confirm their potential for future interventions to combat micronutrient deficiencies.

Fish processing and preservation

Postharvest processing and preservation of fish are often necessary to prevent economic losses (Igoni-Egweke 2018). Processing and preservation techniques to extend the shelf life of fish include refrigeration, freezing, canning, smoking, salting and sun-drying (Adeyeye et al. 2015). In Nigeria, smoking is the most practiced preservation method; practically every species of finfish available in the country can be smoked (Adeyeye et al. 2015). Over 30% of the fish harvested from small-scale fisheries are preserved by smoke drying, as small-scale fishers, especially in rural areas, often lack cold storage facilities (King 2003). Smoking fish can also enhance the taste and thus the economic value of the products (Akinpelu et al. 2013).

Processing methods and scale of operation depend largely on the type, quality and quantity of fish handled and the processing materials available. For example, in northern Nigeria, sun-drying is favored because of the dry weather conditions, low humidity and shortage of firewood. Fish are laid to dry on either tarpaulin sheets, raised nets or floor platforms. According to Adeogun and Adebisi-Adelani (2016), it is common for clupeids to be sundried because fire-based processing often destroys them, given their small size. With the additional step of crushing dried fish into a powder, mothers can add fish powder to infant *ogi* or *pap* as a way of boosting the nutrient content of complementary foods (Ijarotimi and Ogunsemore 2006). Adding dried fish to porridge is relatively common in some parts of Nigeria, though more research is needed on this practice at the national level (Ene-Obong et al. 2013).

For larger fish with more moisture and fat content, traditional smoking still takes place. In southwestern Nigeria, smoking is often used to preserve fish because firewood and charcoal are locally and readily available (Kolawole et al. 2010). Fish are smoked in mud kilns and metal drums, while small fish are smoked in grasses (Adeogun and Adebisi-Adelani 2016). Smoking techniques vary based on region-specific market demands and customer preferences (Adeogun and Adebisi-Adelani 2016). However, the safety and environmental impact of smoking fish requires further investigation.

A retailer selling live catfish kept in large tubs to customers in an open market (left). Processor at the retail point of catfish and tilapia carrying out processing (right).

Fermentation is another processing technique employed in some parts of Nigeria. Bony-tongue fish (*Heterotis niloticus*) is a popular species to eat, but in some parts of Nigeria, it is regarded as a low-value fish because of its mild taste. However, it is highly regarded in Niger State, where it is used by the Nupe people in a local delicacy. The Nupe ferment this fish overnight with sprinkles of potash. This method of fermentation is said to improve the taste and aroma, and given that it is fermented, may have positive effects on gut health.

Silver minnows (*Micralestes* spp.) is a group of seasonal small fish in many states of northern Nigeria. They are abundant during the onset of the harvest season between the months of September and December, during which they are harvested and deep-fried to prolong their shelf life. The oil from this fish is said to be popular among inhabitants near the Kaduna River and different settlements along the Niger River. Kawara oil is extracted during the process of deep-frying, and the fish lose a significant portion of their oil from the heat, which is retained in the cooking oil. In most cases, only the first batch of fish is fried using vegetable oil. Subsequent batches are fried in the oil produced from previous batches. The resulting product is accumulated fish oil extraction that is hawked in the streets or sold in the market. This is also the case with another popular fish species, the silver catfish (*Bagrus bayad*). This fish is not seasonal or as abundant as silver minnows, but it is high in fat, and its oil is extracted in a similar manner.

The Nigerian fish processing sector is dominated by traditional processing methods, mostly done by women, with few large-scale commercial processing operations—unlike the tuna canning industry in nearby Ghana (O'Neill 2013). Women's involvement in traditional fish processing is high when compared to the number of women directly employed in aquaculture; for example, in 2012, just 2% of employees in aquaculture were women (FAO 2017b; Igoni-Egweke 2018). One example of commercial fish processing in Nigeria is sun-drying clupeids from Lake Kainji. After drying, the fish are pulverized into fishmeal then packaged and used in commercial aquaculture nationwide (Ibiyo et al. 2018). The Nigerian Institute for Oceanography and Marine Research (NIOMR) has proposed catfish canning, for domestic and foreign markets, as an employment generation scheme, but it is still in the pilot phase (Igoni-Egweke 2018). Processing fish into fish oil and fish crackers has been identified as potentially lucrative endeavors for women involved in fish processing and also willing to promote these products (WorldFish and BOP 2018).

Fresh tilapia for sale in an open market.

Fish packaging, storage, distribution and marketing

Major fish markets are located in urban centers and major consumption areas, such as Lagos, Enugu, Abuja and Onitsha (Igoni-Egweke 2018). Fish availability is often reflected in the price in regional markets. Miller and Atanda (2011) report that the price of fish in southwestern Nigeria is lower than the rest of the country because of the concentration of fish farms in this region. The price per kg of catfish can be 25%–50% higher outside the region (Miller and Atanda 2011).

> *Many fish are sold live at the farm-gate and transported to markets by traders. In Rivers State, farmed catfish are sold live from the farm to traders, known locally as "market mammies," who transport them to the market in water-filled basins covered with jute.*
>
> ***- Igoni-Egweke 2018***

However, selling on the farm is reportedly not as profitable as in the open market. Fish farmers report that their options are limited because of unreliable access to necessary postharvest preservation facilities (Amos 2000). In southwestern Nigeria, female retailers elongated the potential selling period for live fish by feeding them with water hyacinth and oil palm fruit (Kolawole et al. 2010). Similarly, small-scale fishers generally sell their fish to processors or wholesalers who live at landing sites, as the majority do not have access to ice or cold storage facilities (King 2003). Fresh fish are commonly transported to processing sites in plastic or aluminum bowls, baskets or sacks (King 2003).

Wholesalers can also buy processed fish and take it to packing houses for distribution to markets up to 600 km away. The Maiduguri fish market in Borno State is an example of a packing house (King 2003). Processed fish are sorted according to quality and packed in recycled materials, such as paper cartons, previously used for cigarettes and biscuits, jute or polypropylene sacks used for rice or sugar, or woven cane baskets (King 2003). More recently, Nigerian entrepreneurs have begun to export value-added smoked catfish products (Miller and Atanda 2011). Despite domestic demand, the government supports the export of Nigerian products in a bid to diversify the economy and generate foreign revenue.

Photo: Brianna Bradley/WorldFish

Catfish processing in a smoking kiln.

Across most of Nigeria, particularly the southwestern region, women primarily process and market both fresh and processed fish (Babalola et al. 2015). Fish marketing has become an important occupation and lucrative livelihood among rural women (Babalola et al. 2015). A small number of women do fish, though most obtain fish through various purchasing arrangements.

Some women obtain fish directly from fishers, while others do so through commission agents, directly from wholesalers or retail markets (Akintola and Fakoya 2017). A woman's bargaining power determines access to fish (Matsue 2014), which is influenced by numerous factors, including, but not limited to, wealth, social status and social networks (Akintola and Fakoya 2017).

Photo credit: Richard Bradley/WorldFish

Dried crayfish being sold in a market in Ibadan, Oyo State.

Postharvest losses

It is worth noting that substantial postharvest losses occur in the fish value chain—largely in storage and distribution, but also during processing. In Nigeria, postharvest losses have been estimated at over 30% of the total catch (Akintola and Fakoya 2017). These losses are both economical and nutritional—as the essential micronutrients, fatty acids and protein in the waste are all lost, as well as money.

During the high season for clupeids (November to May), there are substantial postharvest losses as the large catches overwhelm artisanal fishers (Akintola and Fakoya 2017). Losses occur because of inadequate storage facilities and poor overall infrastructure. Fishing communities are generally highly scattered in remote, relatively inaccessible settlements with an erratic power supply and little access to basic infrastructure (Akintola and Fakoya 2017). In an attempt to extend the shelf life of fish products, smoke-drying preserves over 30% of the fish landed in Nigeria (King 2003). However, further losses occur during transportation and distribution to markets. Packaged fish are often transported for over 600 km, from processing villages to major consumption areas, and are subjected to poor packing conditions, overloading of trucks and poor transportation (Akinpelu et al. 2013).

By-catch derived losses are also high and represent a threat to the sustainability of Nigeria's fisheries. Much of these losses are derived from the industrial sector (Nwafili Sylvanus and Gao 2007). Trawlers are reported to catch 30 kg of crabs as by-catch in Lagos every hour (Nwafili Sylvanus and Gao 2007). With the aquaculture sector, feed millers use a proportion of discards and miscellaneous fish from the crayfish industry. However, information on by-catch in Nigeria is scarce (FAO 2007).

Photo: ©Tabitha Bradley/WorldFish

Fish processor in a market with the parts of the fish she just removed for a customer.

Value-added fish products

Value-added fish products in the context of this report are fish-products made from commercial enterprises that go beyond common processing and preservation techniques. Literature is scarce on activities in processing and marketing fish products from factories or small enterprises in Nigeria. However, there is potential for successfully manufacturing nutrient-rich fish products in Nigeria, based on similar implementation in Uganda and reported consumption of fish-based products in local Nigerian meals in the past.

A few records described fish-based products that fishers developed as supplementary income: crackers made of fish and cassava, packaged smoked-dried sardines and fish fingers, fish cakes and fish cake burgers (DFID and FAO 2002). Fish and prawn crackers are popular snacks among children, mainly in urban areas (WorldFish and BOP 2018). These records do not indicate which fish species were used in the products and to what extent the products are locally desired.

A 2006 study in Ondo State reports that mothers prefer to use complementary foods with local ingredients such as crayfish rather than commercial products (Ijarotimi and Ogunsemore 2006). Women have been reported to incorporate crayfish into *ogi*, which is a common traditional complementary food that is made of either fermented corn or sorghum. A study that determined the nutritional content of milk-*ogi*, soy-*ogi*, cooked beans, and crayfish-*ogi*, found that crayfish-*ogi* required the least amount of fish powder added to meet the recommended daily allowances for energy, protein and fat (Ijarotimi and Ogunsemore 2006; Institute of Medicine 2005).

Adequate consumption of fish-based products can also prevent nutrient-deficient illnesses such as rickets, a skeletal condition caused by lack of vitamin D or calcium in children. In Plateau State, 88 children ranging from 6 months to 10 years old were given either limestone or dried catfish powder for 24 weeks to treat rickets (Thacher 2015). A 2-month supply of dried whole catfish, with bones, was purchased from local markets for NGN 700 (Thacher et al. 2015). All the children who completed the study were healed of rickets with the same effectiveness as calcium tablets, showing that locally sourced ingredients can be used to promote child health in low-income communities. This finding is enough to prompt further investigation into other culturally accepted fish products to meet nutritional needs in children.

© Credit: Brian Bradley/WorldFish

Bunmie, a Nigerian national and entrepreneurial woman, showcasing the fish-based food and snack products she sells including crayfish spice, blended fish powder, and dried fish.

Fish production systems in Nigeria

Fish production has increased in every sector since 2000 (Table 3). However, domestic fish production still does not meet the demand for fish. To close this deficit, Nigeria imports primarily saltwater fish. Since 2001, Nigeria has imported over 600,000 t of fish annually; in 2018, the figure was closer to 750,000 t (FAO 2007; Igoni-Egweke 2018). As the population and incomes increase, the supply-demand gap is projected to further widen more than proportionately (Liverpool-Tasi et al.2018).

Small-scale fisheries

Small-scale capture fisheries, including both coastal and inland fisheries, are the primary source of fish in Nigeria (Igoni-Egweke and 2018). In 2014, 57% were caught from coastal and brackish waters and 43% from inland waterbodies (NBS 2017). The State of World Fisheries and Aquaculture report showed an increase of 11.8% in production from inland capture fisheries from 2015 to 2016 (FAO 2018).

Sector	2000	2005	2010	2015
Aquaculture	25,720	56,355	200,535	316,727
Artisanal (coastal, brackish and inland)	418,069	490,594	616,981	694,867
Commercial trawlers	23,308	32,595	31,510	15,464
Total	**467,098**	**579,544**	**849,026**	**1,027,058**

Source: Akintola and Fakoya 2017; NBS 2017.

Table 3. Fish production (t) in Nigeria in 2000, 2005, 2010 and 2015.

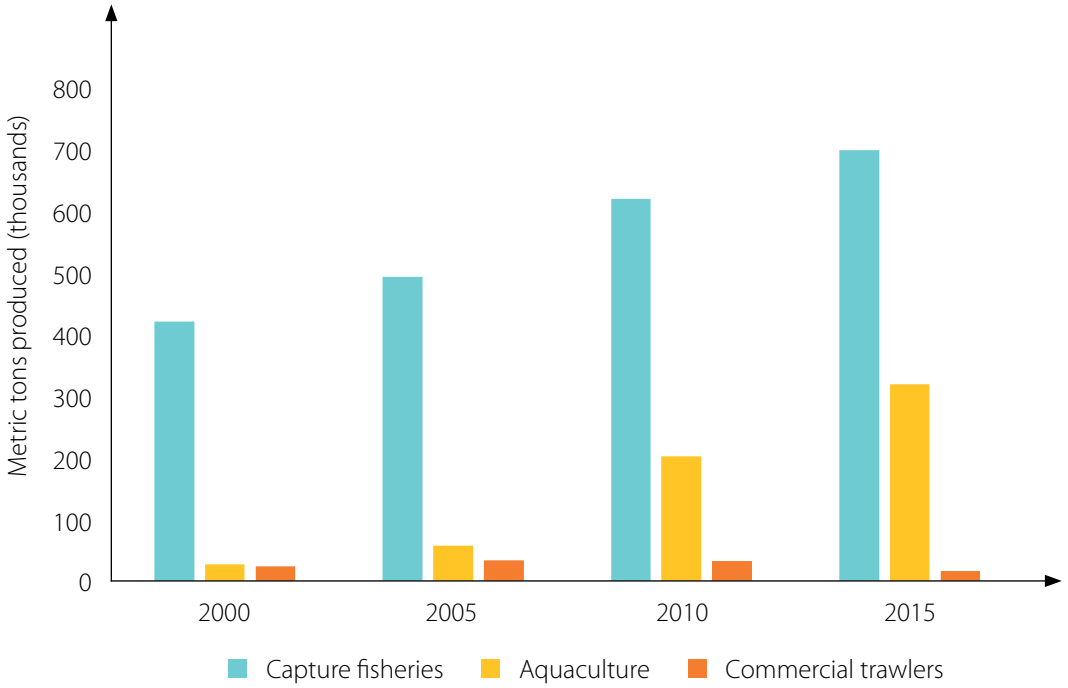


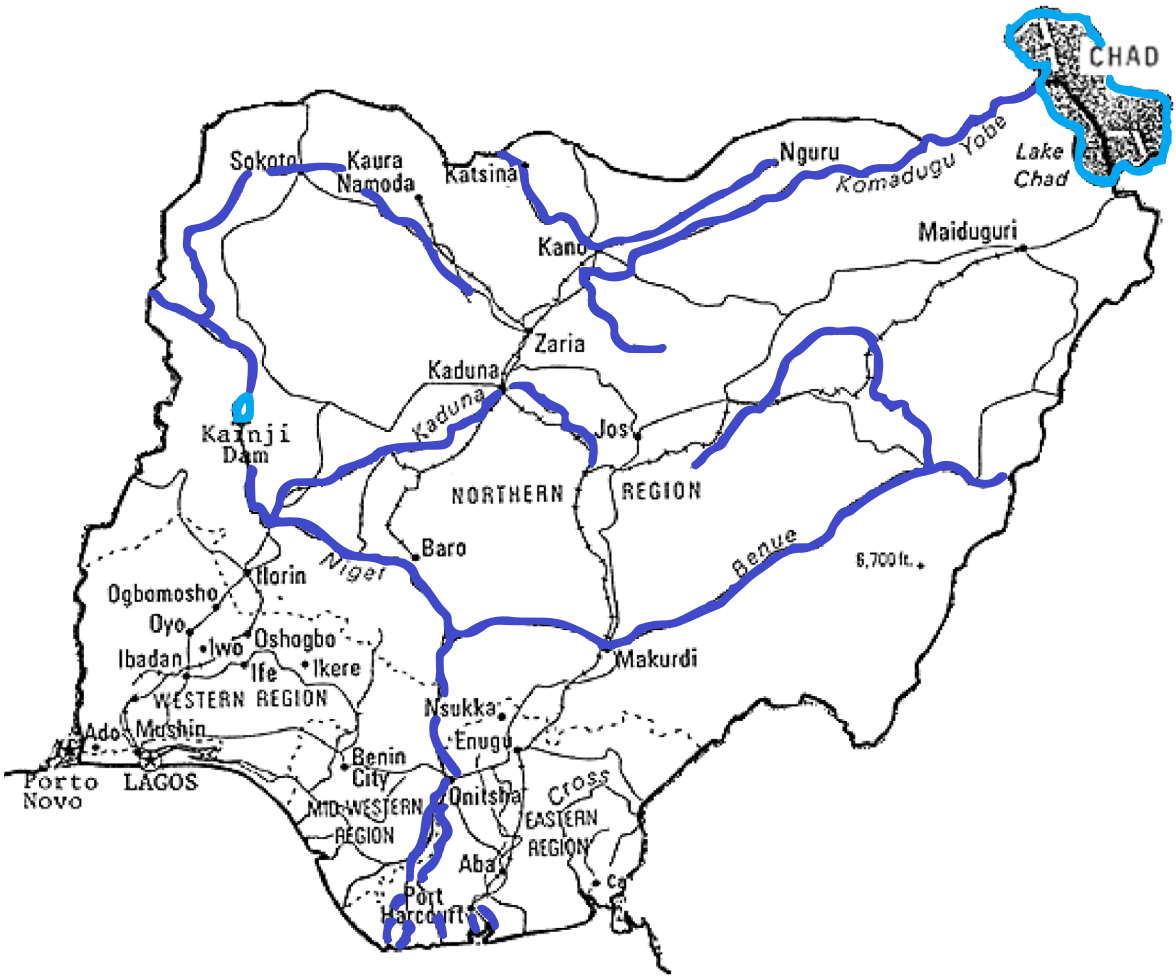
Figure 3. Fish production systems in Nigeria in 2000, 2005, 2010 and 2015.

However, production from small-scale fisheries in Nigeria is certainly underestimated, by as much as 100,000–180,000 t annually according to some sources (Akintola and Fakoya 2017). Moreover, there is limited data available from Lake Chad, the Nguru-Gashua wetlands and the Komadugu-Yobe River basin—three notable water bodies in areas with ongoing political instability (Bene et al. 2003).

Inland capture fisheries contribute substantially to national fish supplies—almost 29% of total fish production in 2014 (NBS 2017). Inland artisanal (small-scale) fishers operate in various forms of water bodies, such as lakes, reservoirs, rivers, tributaries and floodplains (Akintola and Fakoya 2017). Some of these fishing activities are seasonal, as the opportunities to fish appear and disappear with flooding. The following are the notable inland fisheries in Nigeria, as shown in Figure 4 (rivers and lakes highlighted):

- the western shores of **Lake Chad** in the North East, Sahelian region (Bene et al. 2003)
- **Kainji Lake** in Niger and Kebbi states, where over 4000 fishing canoes landed a total of 9248 t of fish in 2004, which, at the time, represented 5.5% of total fish production in Nigeria (Ahmed and Eyo 2009)
- the **Niger and Benue rivers** and their several tributaries, which flow through the central belt of the country
- the **Nguru-Gashua Wetlands** in the northern Yobe State (Bene et al. 2003).

Kainji Reservoir and Lake Chad are the dominant waterbodies in the country. The surface area of Lake Chad has fluctuated in response to climate change in recent decades; it is currently half of the surface area that is pictured in Figure 4. Although the amount of water has reportedly increased, competition for the lake's resources in surrounding areas has heightened (Vivekananda and 2019).



Source: www.fao.org/3/T0360E/T0360E08.htm (1985).

Figure 4. Major inland rivers and bodies of water for fisheries.

Freshwater, marine and brackish fish species commonly caught in inland small-scale fisheries are listed in Table 4. Large fish species prevail, but small fish from the Clupeidae family, such as the small-toothed (*Pellonula leonensis)* and big-toothed pellonula *(Pellonula vorax)* are also present in rivers, streams, lakes, reservoirs and lagoons.

Demersal species harvested from small-scale coastal fisheries include croakers, soles, threadfins, catfish and sharks (FAO 2007). Reportedly, small pelagic fish account for about 50% of the total marine catch and include West African shad (*Ilisha africana*) and sardines (*Sardinella maderensis*) (Nwafili Sylvanus and Gao 2007).

Pollution from the oil industry and the degradation of mangrove forests threaten the productivity of brackish water fisheries in the Niger Delta (FAO 2007). A high number of bony-fish species, in the Niger Delta and the inshore area east of the delta, are considered threatened according

Habitat characteristics	Species	Fisheries	Reference
Freshwater rivers, streams, lakes, reservoirs, lagoons	Nile perch (*Lates* spp.)	Inland	(FAO 2007)
	Tilapia (*Oreochromis* spp., *Hemichromis* spp.)		
	Catfish (*Clarias* spp., *Heterobranchus*, *Synodontis* spp.)		
	Silver catfish (*Chrysichthys* spp., *Bagrus* spp.)		
	Elephant snouts (*Gnathonemus* spp., *Mormyrus* spp.)		
	Trunkfish (*Gymnarchus* spp.)		
	Tongue fish (*Heterotis* spp.)		
	Clupeidae family (*Pellonula* spp., *Sierrathrissa leonenses*)		
Demersal marine waters	Croakers (*Pseudotolithus* spp.)	Coastal	(FAO 2007)
	Soles (*Solea solea*, *Cynoglossus browni*)		
	Threadfins (*Galeoides decadactylus*)		
	Sharks		
Pelagic marine waters	Bonga (*Ethmalosa fimbriate*)	Coastal	(Nwafili Sylvanus and Gao 2007)
	West African shad (*Ilisha africana*)		
	Flat sardine (*Sardinella maderensis*)		
	Catfish (*Arius* spp. and *Chrysicthys* spp.)	Niger Delta	(FAO 2007)
Brackish water creeks, lagoons, estuaries	Tilapia (many species)		
	Shrimp (*Macrobrachium* spp.),		
	Crabs (*Callinectes* spp.)		
	Crayfish (*Nematopalaemon hastatus*)		
	Periwinkles and oysters		

Table 4. Commonly caught fish species in small-scale fisheries.

to the IUCN Red List classifications (Polidoro et al. 2017). For example, the Madeiran sardine (*Sardinella maderensis*), which is an affordable and important source of food and nutrition in the Eastern Central Atlantic, is listed as vulnerable, largely because of overfishing along the coast of Western and Central Africa (Polidoro et al. 2017). As well as being threatened directly and indirectly by fishing activities, aquatic species in the region are threatened by habitat loss and coastal development. This includes urbanization, oil and gas drilling, mining, dams, aquaculture, agriculture, tourism and other ecosystem modifications and associated pollution (Polidoro et al. 2017).

Small-scale fisheries are an essential source of livelihood to many Nigerian households; however, few women are directly involved in fishing (Akintola and Fakoya 2017). Women fishers are limited to those who fish inshore, or in brackish water, using traps and throw nets (Akintola and Fakoya 2017).

Aquaculture

Small- to medium-scale enterprises dominate aquaculture in Nigeria, with a small but growing number of large-scale intensively managed fish farms (Miller and Atanda 2011). The fish farming industry is clustered in the South South, South West and North Central zones of the country, but the majority of these farms are located in just two states: Oyo and Edo (FAO 2007). In 2014, over 313,000 t of fish were produced in aquaculture in Nigeria (NBS and UNICEF 2017). The sector employs approximately 5,000 people (Miller and Atanda 2011).

In Nigeria, fish are farmed under various production systems:

- natural or constructed burrow pits, which are excavations or depressions in the soil that hold water seasonally (Amos 2000)
- cage and net culture, which are structures suspended in a natural water body and stocked with fish (Amos 2000)
- concrete, plastic and fiberglass tanks, which are easy to clean and manage
- earthen ponds in varying levels of design sophistication, such as those that are dug, treated and impounded with water or others that are concrete or lined with tarpaulin (Williams et al. 2012).

> *Freshwater monoculture is the predominant production practice, but integrated aquaculture systems do exist, highlighting the need for research into polyculture systems that may be more nutrition-sensitive.*

The most common integrated system is fish with poultry, but integrations with pig, sheep, goat, cattle, rice, vegetables and fruit trees are also found (Igoni-Egweke 2018). About two-thirds of fish farmers (64.3%) use systems with consistent flow or movement of water to aid water oxygenation (Emmanuel etal. 2014). However, given the rapid expansion of aquaculture in Nigeria, these figures are likely out of date.

Culture system	**%**
Monoculture	80.4
Polyculture	5.4
Integrated	14.2
Production technique	
Stagnant water	35.7
Flow through system	48.2
Recirculating aquaculture system (RAS)	16.1

Source: Field Surveys 2003–2006 (Emmanuel et al. 2014)

Table 5. Aquaculture production systems in Nigeria.

Catfish species (*Clarias* spp.) are the most dominant cultured fish species, accounting for about 90% (by weight) of the fish produced from aquaculture (Igoni-Egweke 2018). Catfish are favored for their high growth rate, feed conversion efficiency and high market prices (Williams et al. 2012). Other species cultured in Nigeria include tilapia (*Hemichromis* spp. and *Oreochromis* spp.), and African Bonytongue fish (Oluwatobi et al. 2017). Oysters and marine and freshwater shrimp culture are also practiced, but to a much lesser extent (Abdullah 2011).

Nigeria is the largest aquaculture producer in sub-Saharan Africa (FAO 2018), yet the scale of aquaculture production is considered low relative to its potential. In 2014, less than 30% of the nation's total annual fish production was from aquaculture. Nevertheless, the aquaculture sector has been steadily increasing since the 1950s, with the steepest gains made since 2001 (FAO 2007). In Kebbi State alone, the number of aquaculture fish farmers increased 200% from 2008 to 2018, drastically outpacing the number of fishers engaged in small-scale capture fisheries (Gona et al. 2018). National growth in aquaculture is projected to be about 36% from 2016 to 2030 as a result of two decades of concerted investment (FAO 2018).

Increasingly, aquaculture is seen as a mechanism through which Nigeria can close its existing fish supply-demand gap, particularly as the supply from capture fisheries is expected to remain constant or even to decline because of overfishing (Amao et al. 2006). In addition, aquaculture is positioned as a potential source of employment and is encouraged as a profit generating venture for households, entrepreneurs and businesses (Emmanuel et al. 2014). The high cost of aquaculture inputs (feed and fingerlings), lack of credit for fish farmers, poor existing management skills, inadequate supply of good quality seed, and ineffective aquaculture extension services continue to inhibit the growth of the sector (Igoni-Egweke 2018). Additionally, aquaculture requires the use of water, land, and fishmeal - resources for which there is a high degree of competition (Salin and Ataguba. 2018).

A 30% surge of programmatic investments in agriculture were targeted to support youth in aquaculture within the last decade (Miller and Atanda 2011). Encouragingly, a survey conducted among household heads in northern Nigeria found that 91% of men would "love to be trained on fish culture" (Dauda and Yakubu 2013). It is notable that the same survey was not conducted among women.

A group of small-scale fish farmers - mostly men - showing us their catfish farmed in monoculture ponds.

Political, program and institutional actors

Governance of capture fisheries

Nigeria has robust aquatic resources, yet fishers engaged in capture fisheries rely on using low technology gear, small vessels (if any), with low capital investment, fishing close to shore and mainly catching fish for subsistence and local markets (Bene et al. 2003). Laws and regulations for the capture fisheries sector focus on increasing yield to meet the supply-demand deficit through technological and developmental advances in recent decades.

Nigeria has sovereign rights, with regards to using water resources, over its exclusive economic zone—a demarcated area extending 200 nautical miles from the coastline (FAO 2007). Up to 5 nautical miles from the coastline is legally reserved for artisanal fishers, with a ban on trawling activities, as stipulated in the Sea Fisheries Regulations of the Sea Fisheries Decree (1992) (Akintola et al. 2017). However, artisanal fishers are not restricted to this area. Those with motorized vessels frequently fish in deeper waters beyond this reserved zone.

Since 1962, the government of Nigeria, with technical and/or financial assistance from the FAO, the Economic Community of West African States and the International Fund for Agricultural Development (IFAD), has launched several projects with the intention to develop the artisanal fisheries sector (Amos 2000). These include the Canoe Mechanization Scheme, the Artisanal Fisheries Processing and Marketing Project, and the National Accelerated Fish Production Project, implemented by the Federal Department of Fisheries and state level fisheries departments (Amos 2000).

In addition to tax exemption and subsidizing production inputs to increase productivity, the interventions are also meant to upgrade artisanal fishing technology, provide crafts and develop harbors and landing sites (FAO 2007; Williams et al. 2012). Between 1971 and 1978, there was a 45% increase in the number of operational artisanal fishing boats in Nigeria (Nwafili Sylvanus and Gao 2007).

However, the small-scale fisheries sector remains relatively stagnant. If government policy shifts to prioritizing supplying fish as a solution to food and nutrition insecurity, a shift away from fisheries policy that only maximizes profit and yield is necessary (Hicks et al. 2019).

Aquaculture policies

More than 2000 small-scale aquaculture ponds were built during the colonial era, prior to 1960, but these ponds were not maintained post-independence (Miller and Atanda 2011; Ramesh 2013). In the 1980s, a severe drought heightened food and nutrition insecurity in the northeastern states, and an end to booming oil prices encouraged the government of Nigeria toward private investment in aquaculture to diversify the economy (Amos 2000; (Abaje et al. 2013).

The scale of fish farming has substantially increased as a result of a nationwide homestead fishpond and hatchery construction project that the Directorate of Food, Road and Rural Infrastructure initiated in the 1980s (Igoni-Egweke 2018). Still, aquaculture development has been slow and constrained by the high cost of production and fish feed, low quality of fingerlings, lack of capital and high farm-level losses (Adewumi and Olaleye 2011; Miller and Atanda 2011; Adeoye et al. 2012; Omobepade et al. 2015; Igoni-Egweke 2018).

Since the early 2000s, the government has introduced a series of plans that attempt to address these challenges. The National Aquaculture Strategy (NAS), developed in 2008 is one example. The objective of NAS was to sustainably increase domestic fish production and fish exports while reducing imports by 25% in five years (Federal Ministry of Agriculture and Rural Development 2008). The plan was developed to align with the overarching fisheries policy framework, the Nigerian National Fisheries Policy. Interest in developing local markets for fish and fish-based products is highlighted, in addition to building out international export markets with fish and value-added fish-based products.

Until recently, fisheries-related policies have been production-centric, with less emphasis on postharvest activities, such as processing and distribution; however, the NAS emphasizes value addition in fish processing as a way to reduce postharvest losses (Akintola and Fakoya 2017). The NAS also lists other key areas for programmatic and policy focus. These include fish hatchery establishment, fish feed production, skills development and extension activities, financing and insurance of aquaculture operations, quality control and certification, and the promotion of shrimp culture and cage-based mariculture (Federal Ministry of Agriculture and Rural Development 2008). Private sector involvement has driven recent interests in shrimp culture. Developments in this sector will focus on the marine tiger shrimp species in inland, lined, saline ponds (Federal Ministry of Agriculture and Rural Development 2008).

The current COVID-19 pandemic is affecting the global economy and impacts on private-sector led business and smallholder productivity and income will remain a question for some time. Considering the Nigerian economy will continue to grow, as predicted prior to the COVID-19 pandemic, new government policy interventions and improvements to national agricultural productivity will be needed to nourish the increasing population.

Photo credit: Brianna Bradley/WorldFish

Small-scale monoculture of a catfish pond in Oyo State, Nigeria.

Public and private sector engagement in nutrition-sensitive fisheries development

The Nigerian government displays enthusiasm for improving nutrition in Nigeria, and some programs are in place in the Federal Ministry of Agriculture and Rural Development (FMARD) to promote nutrition-sensitive agriculture—including aquaculture (SPRING, 2018). However, government extension workers are often overburdened and may not have the skills to promote nutrition-sensitive agriculture as there is no university curriculum (SPRING 2018).

Fish is also not clearly promoted in Nigerian diets. The government-issued food-based Dietary Guidelines for Nigeria was released in 1992 and reprinted in 2006 by the Ministry of Health's Nutrition Division, with support from the World Health Organization. Furthermore, the recommendations regarding fish are limited or no longer accurate. "Low- fat fish," such as tilapia, stock fish (cod), carp and catfish, are recommended for nutrition-related health problems, yet "fatty fish" like mackerel are recommended to be avoided—without any mention of other nutrient-rich small indigenous fish species, or nutrients other than fat content (Federal Ministry of Health 2006).

However, health and nutrition advocacy are at work via public sector involvement and partnerships with the private sector. Nigeria is a member state of the SUN movement, in which the Ministry of Health is engaged in policy development, advocacy, surveillance and business partnerships to promote national food and nutrition security strategies for pregnant and breastfeeding women. The SUN Business Network, convened by GAIN, currently has 87 businesses as part of its Nigeria network. The SUN Business Network recognizes the importance of private sector actors and creates an enabling space for harnessing dialogues toward improved nutrition. The enlisted businesses include food processing companies, small to medium enterprise agribusinesses, pre-mix and fortification suppliers, and farms (Scaling Up Nutrition 2018b). By joining the SUN Business Network, businesses commit to making a positive impact on nutrition in a way that aligns with the priorities of the government of Nigeria. Further research is needed on how agencies can engage with the fisheries private sector and local service providers to improve nutrition and health.

An open food market, with mainly women as vendors, offering many types of local fruits, vegetables, and spices.

Conclusion

Although Nigeria is the largest aquaculture producer in sub-Saharan Africa, a growing supply-demand gap and high fish imports emphasize Nigeria has yet to meet its production potential. Prioritizing tilapia and catfish monoculture leaves unexplored the potential of nutrition-sensitive, integrated production systems could contribute to nutrient diversification and profit generation among poor populations. Furthermore, investing in insect and plant-based fish feed for aquaculture could allow more domestically caught clupeids to be made available for human consumption (Ibiyo et al. 2018).

Research investigating the demand and social acceptability of value-added fish products made from by-catch and by-products can address postharvest losses from small-scale fisheries while illuminating the potential for fish to improve nutritional outcomes in Nigeria. It is apparent that there is demand for frozen and smoked fish among some population groups, but demand for other products, such as fish powder, products targeting women during pregnancy and breastfeeding, or fish snacks, has not been quantified. Research on the efficacy of fish-based products during the first 1000 days of life is needed to influence the use of fish among young children and women of reproductive age.

Promoting nutrition-sensitive fish production and consumption by the government has focused on production inputs to expand the aquaculture sector in efforts to shift economic investment toward agriculture. The National Aquaculture Strategy (2008) includes policies for postharvest processes to reduce losses, but implementing these policies has not been assessed. Nigeria lacks nutrition-sensitive policies and strategies at the national level that recognize fish as a diverse and rich source of multiple micronutrients, including iron, zinc, calcium, iodine, vitamin A and vitamin B12 as none of these nutrients in fish is mentioned in the Ministry of Health's Food-Based Dietary Guidelines for Nigeria. An update of the guidelines to take into consideration the nutritional value of fish could serve as a basis for future nutrition-sensitive policy formulation for the health and agriculture sectors.

Based on this review of the literature presented in this report, the following areas were identified for future research and actions:

- Expand and improve the knowledge-base on the current status of fish consumption and at the species level, disaggregated by state, sex, women of reproductive age, pregnant and breastfeeding women, children, youth, men and household income levels.
- Conduct a nutrient analysis, in raw and processed forms, of freshwater pelagic small fish species, including species with high potential for aquaculture.
- Identify appropriate, context-specific practices for using fish in initiating complementary feeding, in complementary foods and intra-household fish consumption.
- Evaluate the influence of cultural beliefs regarding fish consumption and adherence to such beliefs; determine how these beliefs influence fish in complementary feeding and intra-household allocation; and identify social behavior change communication for increasing fish consumption.
- Investigate the deterioration of fish in quantity as well as quality throughout the value chains.
- Identify ways to use fish by-products for value-added food products, such as fish powder in women's enterprises.
- Promote and expand nutrition-sensitive, integrated fish food systems, including replacing fishmeal and fish oil with plant-based and insect feed in aquaculture feed.
- Investigate the affordability of fish species, including micronutrient-rich ones from capture fisheries and aquaculture, by season, geography and market.
- Assess the effects of climate change on communities that depend on fish as well as on diversity of fish species, production and productivity, and nutrient content.

References

Abaje I, Ati OF, Iguisi EO and Jidauna GG. 2013. Droughts in the Sudano-Sahelian ecological zone of Nigeria: Implications for agriculture and water resources development. *Global Journal of Human Social Science, Geography, Geosciences & Environmental* 13(2):1–10.

Abdullah AY. 2011. National aquaculture development plan: A strategic framework for sustainable and profitable aquaculture development in Nigeria.

Adedeji OB and Okocha RC. 2011. Constraint to aquaculture development in Nigeria and way forward. *Journal of Applied Sciences Research* 7(7):1133–40.

Ademuyiwa MO and Sanni SA. 2013. Consumption pattern and dietary practices of pregnant women in Odeda Local Government Area of Ogun State. *World Academy of Science, Engineering and Technology International Journal of Food Science and Engineering* 7(11):489–93.

Adeogun M and Adebisi-Adelani O. 2016. Linkage between indigenous fish processing practices and sustainable fisheries development: A case study of Northern Nigeria. *African Journal of Applied Research* 2(2):73–83.

Adeoye D, Akegbejo-Samsons Y, Omoniyi T and Dipeolu A. 2012. Challenges and investment opportunities for large-scale aquaculture farmers in Nigeria. In IIFET 2012 Tanzania Proceedings.

Adewumi AA and Olaleye V. F. 2011. Catfish culture in Nigeria: Progress, prospects and problems. *African Journal of Agricultural Research* 6(6):1281–85. https://doi.org/10.5897/AJAR09.361

Adeyeye SAO, Oyewole OB, Obadina AO and Omemu AM. 2015. Evaluation of Microbial Safety and Quality of Traditional Smoked Bonga Shad (Ethmalosa frimbriata) Fish from Lagos State, Nigeria. *Pacific Journal of Science and Technology* 286(1):286–94.

Adeyeye EI and Adamu AS. 2005. Chemical composition and food properties of Gymnarchus Niloticus (Trunk Fish).

Ahmed YB and Eyo AA. 2009. Marketing and transport of processed fish from Lake Kainji to Southeast Nigeria. 24th Annual Conference of the Fisheries Society of Nigeria (FISON), October 2009, Akure, Nigeria.

Akinpelu O, Ayeloja A, George FA, Adebis, G, Jimoh W and Idowu S. 2013. Gender analysis of processing activities among commercial Catfish processors within Ibadan Metropolis, Oyo State South-Western Nigeria. *Journal of Aquaculture Research & Development:* 4(3):.

Akintola SL and Fakoya KA. 2017. Small-scale fisheries in the context of traditional post-harvest practice and the quest for food and nutritional security in Nigeria. *Agriculture and Food Security* 6(1):1–17. https://doi.org/10.1186/s40066-017-0110-z

Akintola SL, Fakoya KA and Olufemi OJ. 2017. Applying the small-scale fisheries guidelines: Status and strategies for Badagry coastal and creek fisheries. 14:635–56.

Allen K, Rachmi AF and Cai J. 2017. Nigeria: Faster aquaculture growth needed to bridge fish demand–supply gap. FAO Aquaculture Newsletter 57:36–37.

Amao JO, Oluwatayo IB and Osuntope FK. 2006. Economics of fish demands in Lagos State, Nigeria. *Human Ecology* 19(1):25–30.

Amos TT. 2000. Sustainable polyculture fish practices in Kano State of Nigeria: An economic analysis. Ahmadu Bello University, Zaria.

Andrew AK, Michael M, & Mandha J. 2017. Nutritive profile of sun dried fermented Mud Fish (Clarias Anguiliaris) and Tiger Fish (Hydrocynus Vittatus) locally known as Abil Alier sold in markets in South Sudan. *Food Science and Nutrition Studies* 1(1):1.

Babalola DA, Bajimi O and Isitor SU. 2015. Economic potentials of fish marketing and women empowerment in Nigeria: Evidence from Ogun State. *African Journal of Food, Agriculture, Nutrition and Development* 15(2):.

Béné C, Neiland A, Jolley T, Ovie S, Sule O, Ladu B, … Quensiere J. 2003. Inland fisheries, poverty, and rural livelihoods in the Lake Chad Basin. *Journal of Asian and African Studies* 38(1):17–51. https://doi.org/10.1177/0021909603038001O2

[CIA] Central Intelligence Agency. 2018. Africa: Nigeria. www.cia.gov/library/publications/the-world-factbook/geos/ni.html

Dauda A and Yakubu S. 2013. Fish consumption and knowledge of fish farming among inhabitants of Dutsin-Ma Local Government Area, Katsina State, Nigeria. *Nigerian Journal of Fisheries* 10.

[DFID] Department for International Development and [FAO] Food and Agriculture Organization. 2002. Sustainable fisheries livelihoods programme. Case Study: Nigeria. Rome: FAO.

Ekwochi U, Osuorah CDI, Ndu IK, Ifediora C, Asinobi IN and Eke CB. 2016. Food taboos and myths in South Eastern Nigeria: The belief and practice of mothers in the region. *Journal of Ethnobiology and Ethnomedicine* 12(1). https://doi.org/10.1186/s13002-016-0079-x

Emmanuel O, Chinenye A, Oluwatobi A and Kolawole P. 2014. Review of aquaculture production and management in Nigeria. *American Journal of Experimental Agriculture* 4(10):1137.

Ene-Obong HN, Sanusi RA, Udenta EA, Williams IO, Anigo KM, Chibuzo EC, … Davidson GI. 2013. Data collection and assessment of commonly consumed foods and recipes in six geo-political zones in Nigeria: Important for the development of a National Food Composition Database and Dietary Assessment. *Food Chemistry* 140(3):539–46. https://doi.org/10.1016/j.foodchem.2013.01.102

[FAO] Food and Agriculture Organization. 2007. Fishery profile: Country report: The Federal Republic of Nigeria. Rome: FAO. ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FI_CP_NG.pdf

[FAO] Food and Agriculture Organization. 2016. FAO/INFOODS Global food composition database for fish and shellfish, version 1.0 - UFiSh1.0. Rome: FAO.

[FAO] Food and Agriculture Organization. 2017a. FAO/INFOODS Food composition database for biodiversity version 4.0 - BioFoodComp4.0. Rome: FAO.

[FAO] Food and Agriculture Organization. 2017b. Fishery and aquaculture country profile: Nigeria. Fisheries and Aquaculture Department. Country Profile Fact Sheets. Rome: FAO. www.fao.org/fishery/facp/NGA/en#CountrySector-Overview

[FAO] Food and Agriculture Organization. 2018. The state of world fisheries and aquaculture: Meeting the Sustainable Development Goals. Rome: FAO. ftp://ftp.fao.org/docrep/fao/011/i0250e/i0250e.pdf

[FAOSTAT] Food and Agriculture Organization of the United Nations Statistics Division. 2013. Crops. www.fao.org/faostat/en/#data/QC

[FAOSTAT] Food and Agriculture Organization of the United Nations Statistics Division. 2017. Country indicators: Nigeria. www.fao.org/faostat/en/#country/159

Fasola O, Abosede O and Fasola FA. 2018. Knowledge, attitude and practice of good nutrition among women of childbearing age in Somolu Local Government Area, Lagos State. *Journal of Public Health in Africa* 9:42–46.

Fawole OO, Ogundiran MA, Ayandiran TA and Olagunju OF. 2007. Proximate and mineral composition in some selected fresh water fishes in Nigeria. 9:52–55.

[FEWS NET] Famine Early Warning Systems Network Nigeria. 2019. Despite forecasts for favorable rainfall, well below-average harvests again expected in northeast Nigeria.

[FMARD] Federal Ministry of Agriculture and Rural Development. 2008. Nigeria: National Aquaculture Strategy.

Federal Ministry of Health. 2006. Food-based Dietary Guidelines for Nigeria. A guide to healthy eating. Federal Ministry of Health, Abuja.

[GHI] Global Hunger Index. 2018. Nigeria: Global Hunger Index. www.globalhungerindex.org/nigeria.html

Gomna A and Rana K. 2007. Inter-household and intra-household patterns of fish and meat consumption in fishing communities in two states in Nigeria. *British Journal of Nutrition* 97(01): 145. https://doi.org/10.1017/S0007114507201734

Gona A, Woji G, Norbert S, Muhammed H, Liverpool-Taste LSO, Reardon T and Belton B. 2018. The rapid transformation of the fish value chain in Nigeria: Evidence from Kebbi State. www.foodsecuritylab.msu.edu/

Hicks CC, Cohen PJ, Graham NAJ, Nash KL, Allison EH, D'Lima C, … MacNeil MA. 2019. Harnessing global fisheries to tackle micronutrient deficiencies. *Nature* 574(7776):95–98. https://doi.org/10.1038/s41586-019-1592-6

[HLPE] High-Level Panel of Experts. 2017. Nutrition and food systems: A report by the High Level Panel of Experts on food security and nutrition of the Committee on World Food Security. Rome.

Ibiyo L, Kayode R, Oresegun A, Olugbenga B and Joshua F. 2018. Chemical composition of clupeids fish as alternative replacement for foreign fish meal in fish feeds in West Africa region. *Animal Husbandry, Dairy and Veterinary Science* 2(4):1–3.

Igoni-Egweke QN. 2018. Analysis of value addition in commercial Catfish (Clarias Gariepinus Heterobranchus spp.) production in Rivers State, Nigeria. Federal University of Technology, Owerri. Ijarotimi OS and Ogunsemore MT. 2006. Weaning foods and their impact on child-feeding practices among low-income Nigerian mothers. *Food and Nutrition Bulletin* 27(4):327–34.

Ikeyi PA. 2017. A Study of the Medical and Socio-Economic Impact of Food and Nutritional Taboos Practiced in Enugi State, Eastern Nigeria. In Medical Sociology & Community Health (Vol. 07, p. 4172).

Institute of Medicine. 2005. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington, DC: The National Academies Press. https://doi.org/10.17226/10490

IPSOS Healthcare. 2016. Food consumption and spending in Nigeria (2016). www.thebottomofthepyramidstudy.com/home/

IPSOS Healthcare. 2017. Food consumption and spending in Nigeria (2017). www.thebottomofthepyramidstudy.com/home/

King M. 20031. Artisanal containers and transportation for smoke-dried fish in Nigeria. 16th Annual Conference of the Fisheries Society of Nigeria (FISON), November 4-9 2001, Maiduguri, Nigeria.

Kinyoki DK, Osgood-Zimmerman AE, Pickering BV, Schaeffer LE, Marczak LB, Lazzar-Atwood A, … Hay SI. 2020. Mapping child growth failure across low- and middle-income countries. *Nature* 577(7789):231–34.

Kolawole OD, Williams SB and Awujola AF. 2010. Indigenous fish processing and preservation practices amongst women in Southwestern Nigeria. *Indian Journal of Traditional Knowledge* 9(4):668–72.

Kolding J, Van Zwieten P, Marttin F and Poulain F. 2019. Freshwater small pelagic fish and their fisheries in the major African lakes and reservoirs in relation to food security and nutrition. Rome: FAO. www.fao.org/publications

Leung W, Busson F and Jardin C. 1968. Food composition table for use in Africa. www.fao.org/3/X6877E/X6877E00.htm#TOC

Liverpool-Tasi LSO, Sanou A and Reardon T. 2018. Demand for imported-frozen versus domestic-traditionally processed fish in Africa: Panel data evidence from Nigeria. www.foodsecuritylab.msu.edu/

Lo M, Narulita S and Ickowitz A. 2019. The relationship between forests and freshwater fish consumption in rural Nigeria. *PLoS ONE* 14(6):1–15. https://doi.org/10.1371/journal.pone.0218038

Matemilola S and Elegbede I. 2017. The challenges of food security in Nigeria. *OALib* 04(12): 1–22. https://doi.org/10.4236/oalib.1104185

Matsue N, Daw T and Garrett, L. 2014. Women fish traders on the Kenyan Coast: Livelihoods, bargaining power, and participation in management. *Coastal Management* 42(6):531–54.

Miller JW and Atanda T. 2011. The rise of peri-urban aquaculture in Nigeria. *International Journal of Agricultural Sustainability* 9(1):274–81. https://doi.org/10.3763/ijas.2010.0569

[NBS] National Bureau of Statistics. 2009. National Poverty Rates for Nigeria: 2003-04 (revised) and 2009-10, 04.

[NBS] National Bureau of Statistics. 2015. General Household Survey, Panel (GHS-Panel) 2015–2016. Ref. NGA_2015_GHSP-W3_v01_M. www.microdata.worldbank.org

[NBS] National Bureau of Statistics. 2015. Living Standards Measurement Survey (LSMS) 2015 [Dataset]. http://microdata.worldbank.org/index.php/catalog/2734

[NBS] National Bureau of Statistics. 2017. Nigeria's fish production. www.proshareng.com/admin/upload/reports/NigeriaFisroductioessed.pdf

[NBS and CADP] National Bureau of Statistics and Commercial Agriculture Development Project. 2010. 2010 NBS / CADP Baseline Survey Report.

[NBS and UNICEF] National Bureau of Statistics and the United Nations International Children's Emergency Fund. 2017. Multiple indicator cluster survey 2016-17: Survey findings report, 538. www.unicef.org/nigeria/NG_publications_mics_201617feb2018.pdf

[NPC and ICF] National Population Commission and ICF International. 2014a. Nigeria Demographic and Health Survey 2013. Abuja, Nigeria and Rockville, USA: NPC and ICF International.

[NPC and ICF] National Population Commission and ICF International. 2014b. Nigeria Demographic and Health Survey 2013. Abuja, Nigeria and Rockville, USA: NPC and ICF International.

Nwafili Sylvanus A and Gao TX. 2007. Structure and dynamics of fisheries in Nigeria. *Journal of Ocean University of China* 6(3):281–91.

O'Neill ED. 2013. A value chain analysis of the tuna industry in Ghana. University of Algarve, Portugal.

Ogundari K. 2017. Categorizing households into different food security states in Nigeria: The socioeconomic and demographic determinants. *Agricultural and Food Economics* 5(1):.

Ojewola GS and Udom SF. 2005. Chemical evaluation of the nutrient composition of some unconventional animal protein sources. *International Journal of Poultry Science* 4(10):745–47.

Ojimelukwe PC, Ekong KS and Akachukwu D. 2017. Effect of different processing methods on the nutrition composition and sensory properties of Ethmalosa fimbriata. *American Journal of Agriculture Science* 5(6):232.

Olopade OA, Taiwo IO and Dienye HE. 2017. Management of overfishing in the inland capture fisheries in Nigeria. *Journal of Limnology and Freshwater Fisheries Research* 3(3):189–94.

Oluwatobi AA, Mutalib HA, Adeniyi TK, Olabode JO and Adeyemi A. 2017. Possible aquaculture development in Nigeria: evidence for commercial prospects.

Omobepade BP, Adebayo O, Amos TT and Adedokun BC. 2015. Profitability analysis of aquaculture in Ekiti State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 11(1):114–19.

Onuorah CE and Ayo JA. 2003. Food taboos and their nutritional implications on developing nations like Nigeria: A review. *Nutrition & Food Science* 33(5):235–40.

Papineni S, Gautam G and Olubunkola O. 2016. Baseline report: Feed the Future Nigeria Livelihoods Project. Washington, DC. Personal contact. (n.d.).

Polidoro BA, Ralph GM, Strongin K, Harvey M, Carpenter KE, Arnold R, … Williams A. 2017. The status of marine biodiversity in the Eastern Central Atlantic (West and Central Africa). *Aquatic Conservation: Marine and Freshwater Ecosystems* 27(5):1021–34.

Ramesh S. 2013. Aquaculture: Evidence from China and Nigeria. *Developing Country Studies* 3(11):30–51.

Reed W. 1967. Fish and fisheries of Northern Nigeria. Kaduna: Ministry of Agriculture, Northern Nigeria.

Salin Krishna R and Gabriel Arome Ataguba. 2018. Aquaculture and the environment: Towards sustainability. Sustainable Aquaculture. Springer, Cham, 2018. 1-62.

Scaling Up Nutrition. 2018. Nigeria overview. https://scalingupnutrition.org/sun-countries/nigeria/

Selig ER, Hole DG, Allison EH, Arkema KK, McKinnon MC, Chu J, … Zvoleff A. 2018. Mapping global human dependence on marine ecosystems. *Conservation Letters* (May 2018):1–10.

Sowunmi AA. 2007. Fin-fishes in Yorùbá natural healing practices from southwest Nigeria. *Journal of Ethnopharmacology* 113(1):72–78.

SPRING. 2018. Assessing drivers of malnutrition in Nigeria: A report on findings from Kebbi, Niger, Benue, and Cross River to inform food security investments. Arlington, Virgina: SPRING. www.spring-nutrition.org

Stadlmayr B, Charrondiere R, Enujiugha V, Bayili R, Fagbohoun E, Samb B, … Burlingame B. 2012. West African food composition table [Table de composition des aliments d´Afrique de l´Ouest]. www.fao.org/docrep/015/i2698b/i2698b00.pdf

Thacher TD, Bommersbach TJ, Pettifor JM, Isichei CO and Fischer PR. 2015. Comparison of limestone and ground fish for treatment of nutritional rickets in children in Nigeria. *Journal of Pediatrics* 167(1):148–54.

Thilsted SH, Thorne-Lyman A, Webb P, Bogard JR, Subasinghe R, Phillips MJ and Allison EH. 2016. Sustaining healthy diets: The role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy* 6:126–31. https://doi.org/10.1016/j.foodpol.2016.02.005

Vivekananda J, Wall M, Sylvestre F and Nagarajan C. 2019. Shoring up stability, 104. www.adelphi.de

Williams SB, Kareem RO, Adiegu CP and Dipeolu AO. 2012. Resource-use efficiency among selected fish farms in Lagos State. *Journal of Agricultural Sciences* 3(2):85–94.

Williams SB, Kareem RO and Ojolowo OA. 2012. Economic analysis of catfish production in Ile-Ife, Osun State, Nigeria. *Journal of Human Ecology* 40(1):1–7. https://doi.org/10.1080/09709274.2012.11906518

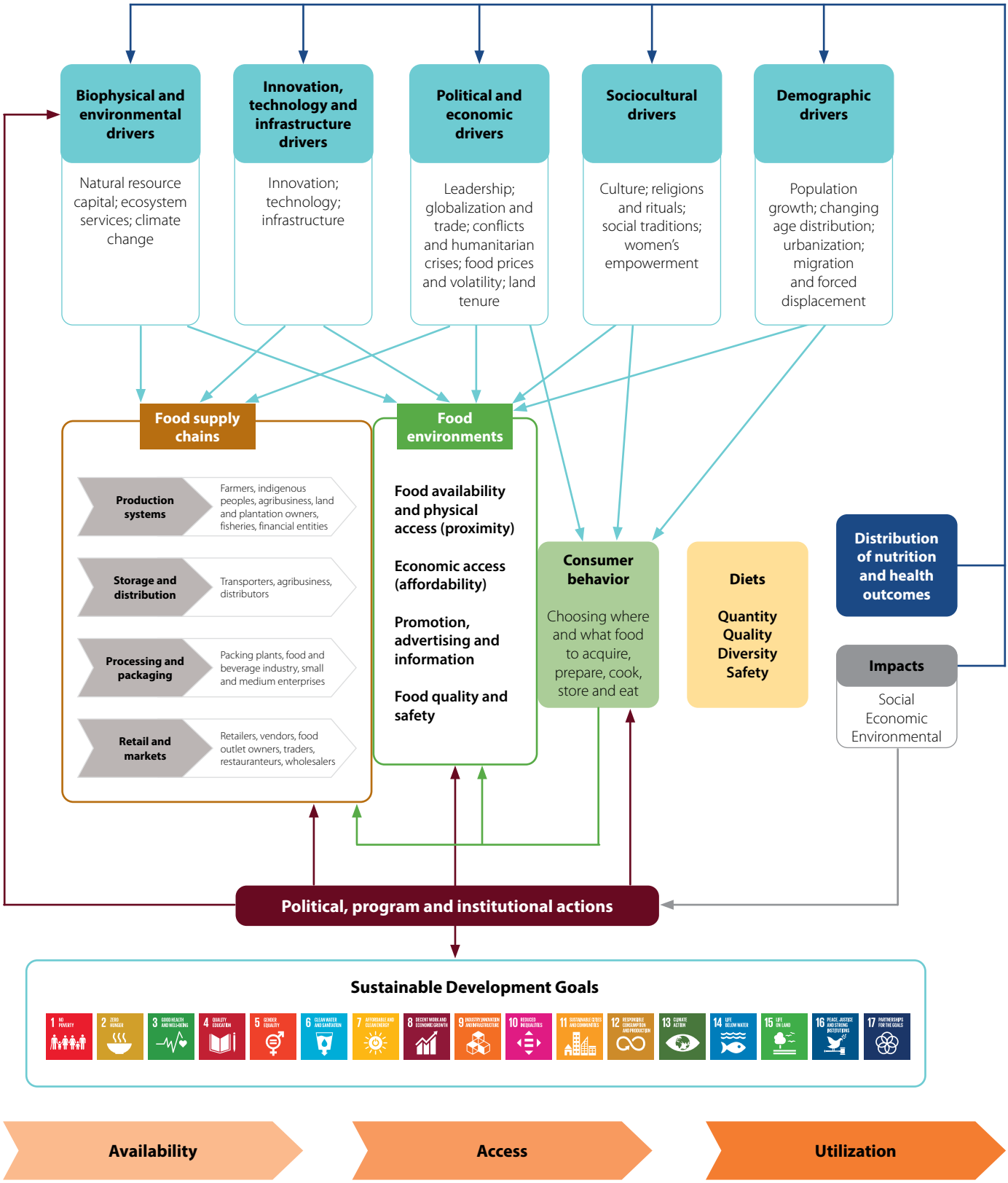
World Bank. 2016. World Bank Data – Nigeria. Accessed on http://data.worldbank.org/country/nigeria

WorldFish. 2017a. CGIAR Research Program on Fish-Food Systems (FISH). Penang, Malaysia.

WorldFish. 2017b. WorldFish in Nigeria: Factsheet. Penang, Malaysia: WorldFish. Factsheet: 2017-17.

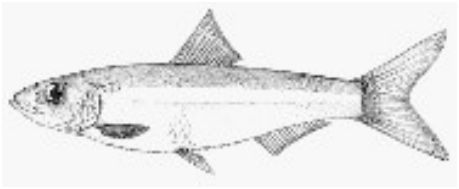
WorldFish and BOP. 2018. Niches for female entrepreneurs in fish value chains in Nigeria. Penang, Malaysia.

Appendix A. HLPE conceptual framework of food systems for diet and nutrition

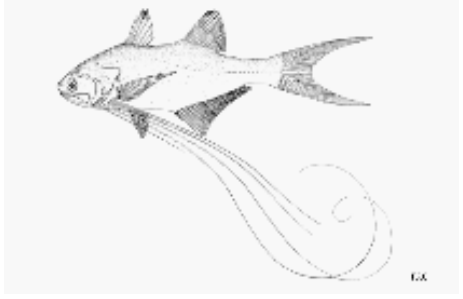


Source: HLPE 2017.

Appendix B. Common finfish and other aquatic animals consumed in Nigeria

Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Clupeidae	Bonga (*Ethmalosa fimbriate*)	At maturity: 17–18.5 cm Maximum: 45 cm; male/unsexed	 Durand J-D
	Saltwater sardines (*Sardinella* spp.)	Range: 11–19.5 cm Maximum: 30 cm; male/unsexed	 Etrusko25 own work, public domain, https://commons.wikimedia.org/w/index.php?curid=7893223
	Freshwater sardines (*Pellonula* spp., *Sierrathrissa leonenses*)	Maximum TL: 9.3 cm; male/unsexed	 Picture by FAO
Alestidae	Silver minnow, silversides (*Micralestes* spp.)	Maximum TL: 6.8 cm; male/unsexed	 Picture by Mody K
Mochokidae	Catfish (*Synodontis* spp.)	Maximum SL: 10.5 cm; male/unsexed	 Hippocampus-Bildarchiv
Pristigasteridae	Shad (*Ilisha Africana*)	Range: 13–18 cm Maximum SL: 30 cm; male/unsexed	 Klimpel S

Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Claroteidae	Silver catfish (*Chrysichthys nigrodigitatus*)	Female: 14 cm; male: 18 cm Maximum: 65 cm; male/unsexed	 Hippocampus-Bildarchiv
	Brackish water catfish (*Chrysichthys auratus*)	Range 8–19 cm Maximum TL: 57 cm; male/unsexed	 Picture by KMFRI
Cynoglossidae	Sole (*Cynoglossus browni*)	Maximum SL: 40.2 cm; male/unsexed	 Picture by FAO
Sciaenidae	Croakers (*Pseudotolithus elongatus, Johnius argentatus*)	At maturity: 19.1 cm Maximum TL: 47 cm; male/unsexed	 Picture by FAO
Carangidae	Longfin crevalle jack (*Caranx fischeri*)	Maximum FL: 53 cm; male/unsexed	 Wirtz P
	Atlantic bumpers (*Chloroscombrus chrysurus*)	At maturity: 12.4 cm Maximum TL: 65 cm; male/unsexed	 Picture by NOAA\NMFS\Mississippi Laboratory

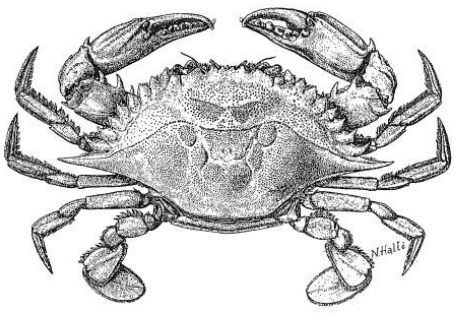
Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Cichlidae	Tilapia (*Oreochromis niloticus*)	Maximum: 60 cm; male/unsexed	 Stiassny MLJ
	Tilapia (*T. guineensis*)	At maturity: 13.5 cm Maximum: 30 cm; male/unsexed	 Melandri G
	Tilapia (*Hemichromis bimaculatus*)	Average: 7.5 cm Maximum: 13.6 cm; male/unsexed	 Nilsson K
Polynemidae	Threadfins (*Galeoides decadactylus*)	At maturity: 11.6 cm Maximum: 50 cm; male/unsexed	 Picture by Wirtz P
	(*Pentanemus quinquarius*)	At maturity: 15 cm Maximum TL: 35 cm; male/unsexed	 Picture by FAO

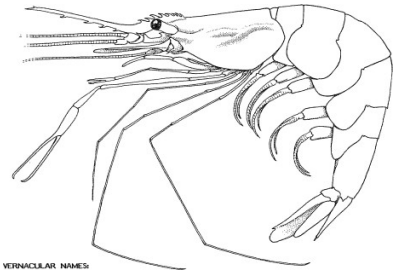
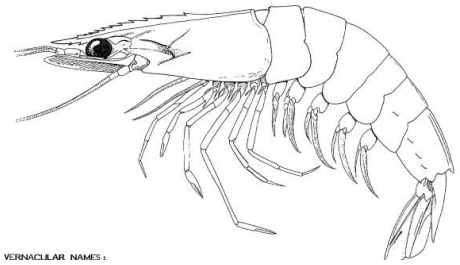
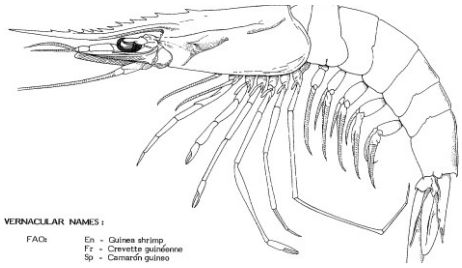
Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Citharinidae	Moon fish (*Citharinus citharus*)	Range: 18–35 cm Maximum: 58 cm; male/unsexed	 Nightingale A
Lutjanidae	Red snapper (*Lutjanus agennes*)	Grows to a length of 75 cm but commonly to 50 cm	 Picture by Rodrigues NV
	African brown snapper (*Lutjanus dentatus*)	Maximum TL: 150 cm; male/unsexed	 Picture by Camrrubi JF
	Gorean snapper (*Lutjanus goreensis*)	Maximum TL: 80 cm; male/unsex	 Picture by Fakoya KA
Cyprinidae	Common carp (*Cyprinus carpio*)	Range 25–36 cm Maximum TL: 120 cm; male/unsexed	 Lovshin L.
	African tigerfish (*Hydrocynus vittatus*)	Maximum: 105 cm	 Wikipedia

Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Serranidae	Groupers (*Epinephelus aeneus*)	Range: 50–60 cm Maximum TL: 120 cm; male/unsexed	 Picture by Dammous S
Bagridae	Silver catfish (*Bagrus docmak*)	Range: 20–25.9 cm Maximum: 127 cm; male/unsexed	 de Vos L
Latidae	Nile perch (*Lates niloticus*)	Average: 121–137 cm; unsexed	 Bursell JJ
Arapaimidae	Bony tongue fish, African bony tongue fish, African arowana (*Heterotis niloticus*)	Average: 40 cm Maximum: 100 cm; male/unsexed	 Laleye P
Clariidae	African catfish (*Clarias gariepinus*)	At maturity: 30.8 cm	 Source: Larsen JH
	Catfish (*Heterobranchus bidorsalis*)	Maximum: 150 cm	 Spring Continental Harvest Ltd
	Catfish (*Heterobranchus longifilis*)	Range: 64–150 cm Maximum: 150 cm	 Spring Continental Harvest Ltd

Commonly consumed finfish			
Family	**Name (species)**	**Length**	**Source**
Mormyridae	Elephant snouts (*Gnathonemus petersii*)	Average: 23–25 cm Maximum: 35 cm; male/unsexed	 Moreau J
	Elephant snouts (*Gnathonemus longibarbis*)	Maximum: 36 cm; male/unsexed	 de Vos L
	Cornish jack (*Momyrus rume*)	Average: 33 cm Maximum: 150 cm; male/unsexed	 AquaNet
Ariidae	Marine catfish (*Arius gigas*)	Maximum TL: 165 cm; male/unsexed	 Picture by Hippocampus-Bildarchiv
Gymnarchidae	Trunkfish (*Gymanarchus niloticus*)	Maximum: 167 cm; male/unsexed	 KMFRI
Haemulidae	Bigeye grunt (*Brachydeuterus auratus*)	At maturity: 14.8 cm Maximum: 30 cm; male/unsexed	 Picture by FAO
Sphyraenidae	Barracuda (*Sphyraena afra*)	At maturity: 87.0 cm Maximum TL: 205 cm; male/unsexed	 Picture by JJPhoto

Note: CL: MULTIFAN-CL; SL: Standard length; TL: Total length

Commonly consumed aquatic animals			
Family	**Name (species)**	**Length**	**Source**
Ostreidae	Mangrove oyster (*Crassotrea gasar*)	2.5–5+ cm	 Williams AB, NIOMR
Potamididae	Periwinkles (*Tympanotonos fuscatus*)	Approx. 2.5 cm	 Zell H
Lucinidae	Bivalves (*Lucina leloeuffi*)	Average: 5.5 cm	No picture available
Solecurtidae	Bivalves (*Solecurtus afroccidentalis*)	Average: 6 cm	No picture available
Portunidae	Crabs (*Callinectes amnicola*)	Maximum CL: 7.5 cm; male/unsexed	 Picture by FAO

Commonly consumed aquatic animals			
Family	**Name (species)**	**Length**	**Source**
Palaemonidae	Estuarine, white shrimps, "crayfish" (*Nematopalaemon hastatus*)	Maximum TL: 7.5 cm; male/unsexed	 Picture by FAO
	African river prawn (*Macrobrachium vollenhovenii*)	Average: 10–15 cm	 Koffi Mexmin Konan
	Brackish water prawn (*M. macrobrachion*)	Maximum: 13.5	 Koffi Mexmin Konan
Penaeidae	Southern pink shrimp (*Penaeus notialis*)	Maximum: 19.2 for females; 17.5 for males	 Picture FAO
	Guinea shrimp (*Parapenaeopsis atlantica*)	Common TL: 9–14 cm for females; 6–9 cm for males	 Picture by FAO

Note: CL: MULTIFAN-CL; SL: Standard length; TL: Total length

Table 6. A non-exhaustive range of fish species documented to be consumed in Nigeria, listed by families with small fish species to families with larger species.

Appendix C. Relevant stakeholders within fisheries, nutrition and health sectors

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
Development Agency	Department for International Development, United Kingdom (DFID)	Nutrition, health	Northern Nigeria	Supports the following: • family planning for women • maternal and newborn child health • sanitation, hygiene and water projects • driving delivery of nutrition for growth	
Development Agency	United States Agency for International Development (USAID)	Multiple	National	• A focus on rice, aquaculture, maize, cowpea and soy production, linking farmers to specialized markets, to increase overall competitiveness, incomes and employment in the agricultural sector	**Stephen M. Haykin** Mission director Plot 1075 Diplomatic Drive Central District Area, Abuja Abuja Phone: +234 803 900 9300 Email: abujainfo@usaid.gov
Financial Institution	World Bank	Agriculture, aquaculture, fisheries	National	• Based on an assessment of PROFish, World Bank invested in the West African Regional Fisheries Program and South West Indian Ocean Fisheries Governance and Shared Growth Program	
Government	Federal Department of Fisheries (FDF)	Fisheries, aquaculture	National	• Prepares policy, programs and technical support to develop fisheries under the Federal Ministry of Agriculture and Natural Resources	FCDA Secretariat Area 11, Garki Abuja Phone: +234 9 314 4665
Government	State Departments of Fisheries (SDF)	Sea and inland fisheries	National, state	• Management measures, mainly technical and input controls, and, to some extent, output controls and economic incentives • Backed by federal law	
Government	Federal Ministry of Agriculture and Rural Development (FMARD)	Agricultural policy, program and support	National	• Includes the Federal Department of Fisheries and supports work at the state level	
Government	African Regional Aquaculture Centre (ARAC)	Aquaculture development	Africa, regions south of the Sahara	• Research support and training for aquaculture development	

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
Government	Ministry of Health	Population health and sanitation	National	• Issued food-based Dietary Guidelines for Nigeria in 1992 and reprinted in 2006 • Partners with Scaling Up Nutrition • Supports policy development, advocacy, surveillance and business partnerships of health agencies	
Government	Federal Ministry of Budget and National Planning		National	• Issued the National Policy on Food and Nutrition in Nigeria, which established the National Committee on Food and Nutrition and the National Council on Nutrition, led by the vice president of the Government of Nigeria	
Government	Scaling Up Nutrition	Multisectoral nutrition governance, advocacy, policy	National	• National Health Strategic Development Plan • National Policy on Food and Nutrition • National Plan of Action • Kickstarts nutrition development plans with government ministries and development partners • Advocates and creates coherent policy for pregnant women and mothers • Strengthens nutrition surveillance	**Chris Osa Isokpunwu** Head of nutrition Ministry of Health
NGO	Tilapia Aquaculture Developers Association Nigeria (TADAN)	Aquaculture	National	• Affiliated with FISON • Development of sustainable tilapia farming frameworks in collaboration with stakeholders including academia, feed suppliers, equipment manufacturers, seed and genetic scientists, consulting and technology transfer organizations, supermarkets and food processing companies along the value chain	Desk Officer (TADAN) c/o FISON National Headquarters Wilmot Point Road Victoria Island, Lagos Lagos State Phone: +2348033135761 +2347032753592 +2348032482115
NGO	Nigerian Union of Fishermen and Seafood Dealers (NUFAS)	Fisheries, aquaculture, small-holder fishers	National	• Strategizes to achieve self-sufficiency in fish and other aquaculture products by supporting fishery extension services (training and microcredit) to improve the productive efficiency of fishers, aquaculture pond land management, and program of re-seeding of natural fishpond and waterbodies with adequate fingerlings to boost food production	Phone: + 234-083-234178
NGO	Catfish Farmers Association of Nigeria (CAFAN)	Aquaculture	National	• Initiated production and training program for fish crackers as a local alternative to imported prawn crackers in Oyo State as a way to reduce imported fish products • Promotes fish farming, particularly for youths	

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
NGO	Fisheries Society of Nigeria (FISON)	Fisheries	National	• Responsible for promoting and coordinating activities in the fisheries subsector of the Nigerian economy with research and development, human resource capacity building, education and dissemination of information, as well as promoting corporate investments and partnership inside and outside of Nigeria	
NGO	Committee of Fisheries for the West Central Gulf of Guinea (FCWC)	Fisheries and small-scale fishers	Subregional	• Fisheries policy, governance and institutional arrangements • Conservation and sustainable resource use • Improved livelihoods of small-scale fishers and other operators • Monitoring, control, surveillance and compliance of illegal, unreported and unregulated fishing • Research in fisheries and related disciplines • Results-based management	
NGO	HarvestPlus	Nutrition, food security, micronutrients, agriculture	National	• Promotion of vitamin A-rich cassava • Supports the National Root Crops Research Institute to develop vitamin A cassava in partnership with the International Institute of Tropical Agriculture • Commercializes vitamin A cassava into common products on the national market • Makes vitamin A cassava stems, tubers and ready-to-eat products available to consumers • Advocates and integrates biofortification for national nutrition and agricultural policies	**Paul Ilona** HarvestPlus country manager Nigeria c/o IITA Idi-Ose, PMB5320, Ibadan Email: p.ilona@cgiar.org Phone: +234 8034035281 x2591
NGO	Helen Keller International (HKI)	Health, nutrition, eye health	National	• Alleviates malnutrition by implementing programs in local food growth, improving maternal and child nutrition practices, with emphasis on vitamin A • Combats neglected tropical diseases with drug treatment and better practice of hygiene and sanitation	
NGO	Save the Children	Health, nutrition, livelihoods, education, emergencies	National	• Implements the Working to Improve Nutrition in Northern Nigeria program that initiates the development of the framework and justification of a bill on nutrition funding for Jigawa, Katsina, Kebbi, Yobe and Zamfara states • Advocates for infant and young child feeding practices in households • Health Workers' Capacity Project: improving the delivery and quality of health services to mothers, newborns, and children under 5 in Lagos, Gombe and Kaduna by building capacity for 5000 frontline health workers • Campaign to end child marriage by 2030	

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
NGO	Vitamin Angels (VA)	Nutrition, health	National	• Grants local nonprofits, clinics and community organizations vitamin A, multivitamins and pre-natal supplements to improve the health of children and mothers	
NGO	Nutrition International (formerly Micronutrient Initiative)	Micronutrient supplementation	National	• Supports the Ministry of Health and National Primary Health Care Development Agency with Maternal Newborn and Child Health Weeks events to provide vitamin A supplementation to children • Collaborates with the state ministries of health, state Primary Health Care Development Agency and partners to reach hard-to-reach communities with vitamin A supplements to children • Addresses barriers to adherence and uptake of iron, folic acid and zinc supplementation • Monitors iodization at factory, market and household levels	35, Justice Sowemimo Street Off TY Danjuma Street Asokoro, Abuja Phone: +234 9292 0096 Email:miafrica@micronutrient.org
NGO	Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance (ACDI/VOCA)	Agribusiness, food security, agriculture, livelihoods, nutrition	National	• Transforming Irrigation Management in Nigeria: Contracted with the Federal Ministry of Water Resources to improve irrigation in support of farmer productivity and market services availability in northern Nigeria • Establishment of the Farmers' Management and Service Delivery Centre at each irrigation scheme to initiate strong forward and backward links along the value chains	Email: BKrueger@acdivoca.org
NGO	Action contre la Faim (ACF)	Food security, nutrition, health, water, sanitation, hygiene	Borno, Jigawa, Abuja	• Humanitarian assistance in the North East Boko Haram conflict by distributing food to displaced persons and host families, providing essential sanitation and hygiene supplies, and supporting good nutrition practices to children, pregnant and breastfeeding women • Partners with Save the Children, Ministry of Health, UNICEF	
NGO	CARE	Food security, livelihoods, nutrition	Borno, Yobe	• Operations initiated by the Lake Chad conflict to alleviate hunger • Provides assistance in livelihood restoration • Supports women affected by gender-based violence	Email: ngacare@care.org

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
NGO	Catholic Relief Services	Agriculture, food security, health, water and sanitation	National	• Supports agriculture-based livelihoods project to empower poor farming households in Northwest Nigeria with agricultural production, incomes, nutrition, water, sanitation and education • Strengthening Cassava Seed Systems improves farmers' revenue and food security by providing high quality stems and seeds through a traceable value chain • Emergency response in Yobe State providing antimalarial programs and distributing emergency food via USAID Food for Peace funding • Emergency response launch of shelter and agriculture assistance to restore livelihoods in Borno State	
NGO	Focus1000	Nutrition, health, children's health	National	• Leads the civil society platform of Scaling Up Nutrition in Nigeria, Liberia and Sierra Leone	
NGO	International Medical Corps	Nutrition and food security, water, sanitation and hygiene, health care, gender support, crisis	National	• Emergency food assistance for children under 5 in Sokoto and Borno States • Stabilization centers are available for severely malnourished children to receive medical attention • Infant and young child feeding practices education for mothers and caretakers • Partnered with the World Food Programme to distribute supplementary food to people in Borno State • Member of the Core Group Polio Project to eradicate polio • Vaccinates children under 5 against polio in Borno and Kano states • Supports increasing availability and accessibility of health care facilities with collaboration with the State Ministry of Health • Access to safe water and sanitation facilities in Borno State • Improvements in infrastructure and hygiene "awareness reminders" • Rehabilitation of waste management facilities • Psychosocial support and women-friendly spaces to survivors of Boko Haram crisis • Gender-based violence awareness to men and services for women and girls	
Program	Assessment Capacities Project	Humanitarian crises	Borno, Adamawa, Yobe	• Supports the humanitarian community with needs assessments • Completes country thematic assessment reports	

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
Program	Strengthening Partners, Results, and Innovations in Nutrition Globally (SPRING)	Nutrition, food security, dietary diversity, behavior change	National	• Works at the national level to implement community infant and young child feeding counseling and nutrition programming to reach orphans and vulnerable children with complementary social and behavior change communication approaches	**Philomena Orji** Chief of party SPRING/Nigeria Email: porji@spring-nutrition.org
Program	Global Program on Fisheries (PROFish)	Fisheries and aquaculture	National	• Promotes and facilitates the positive impacts of fisheries and aquaculture to reduce hunger and poverty by government level implementation via World Bank investments and international partnerships • Provides information and strategy in creating sustainable fisheries and aquaculture	
Research	Nigeria Institute for Oceanography and Marine Research (NIOMR)	Fisheries and other aquatic resources	Eight coastal states	• Promotes improved fish smoking kiln "Magbon-Alade" • Proposal of catfish canning, for domestic and foreign markets, currently in piloting • Works with the FDF	
Research	National Institute for Freshwater Fisheries Research (NIFFR)	Capture fisheries and aquaculture research	Inland water bodies	• Management, research and sustainable exploitation of inland water fisheries resources • Carried out a nationwide survey on the fishery in 2001 to inventory fish species, production and marketing potential • Drafted the first fisheries law and regulation guide for fisheries	
Research	Federal University of Technology, Department of Fisheries	Fishers, fish farmers	National	• Involved in collaborative, national and international research in fisheries in fish biodiversity, conservation, stock assessment, and fish population dynamics	
UN	United Nations International Children's Emergency Fund (UNICEF)	Nutrition, health	National through partners	• Supports federal ministries, NGOs and private sector integration, management and implementation	
UN	Food and Agriculture Organization of the United Nations (FAO)	National	National through partners	• Provides strategic support to national development programs and strategies aimed at reducing poverty, improving food security and management of natural resources	

Type	Name	Thematic areas	Geographic coverage	Activities	Contact
UN	International Fund for Agricultural Development (IFAD)	Agriculture	National, rural	Ongoing projects in multiple states: • Rural Development: Climate Change Adaptation and Agribusiness Support Programme in the Savannah Belt • Agricultural Development: Value Chain Development Programme	**Benjamin Odoemena** country programme officer Email: b.odoemena@ifad.org
UN	World Food Programme (WFP)	Food security, livelihoods, nutrition, emergencies, aquaculture	North East, national	• Transfers operational know-how • Provides technical support to strengthen food security data collection • Enhances the emergency response (including through food distribution) • Provides safe and reliable air transport services	Email: wfp.abuja@wfp.org
UN	United Nations Development Programme	SDGs, humanitarian crises	International	• Livestock distribution, tools, fertilization and farming training inputs to strengthen agriculture livelihoods and family nutrition in Borno State • Strategizing groundnut and rice value chain improvements with the Global Environment Facility in partnership with the Federal Ministry of Agriculture and Rural Development	United Nations Development Programme Anambra State House, 19, T.Y Danjuma Street, Asokoro, Abuja Email: registry.ng@undp.org

WorldFish

About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving 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. Headquartered in Penang, Malaysia and with regional offices across Africa, Asia and the Pacific, WorldFish is a member of CGIAR, the world's largest global partnership on agriculture research and innovation for a food secure future.

For more information, please visit www.worldfishcenter.org