gain
Global Alliance for Improved Nutrition

Large Scale Food Fortification Compliance in Nigeria:

State of the Nation Report, 2022

FEDERAL MINISTRY OF HEALTH

BILL & MELINDA GATES foundation

STANDARDS ORGANIZATION OF NIGERIA SON

NATIONAL AGENCY FOR FOOD AND DRUG ADMINISTRATION AND CONTROL NAFDAC

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Executive Summary

Nigeria suffers from extreme levels of micronutrient deficiencies affecting the health, death rates, brain and physical development of the majority of Nigerians (Ritchie, 2017). It has one of the highest levels of anaemic women in the world, at approaching 50 percent, and more than 10 million stunted children.

This level of nutritional shortfall saw the government move from 1993 to instigate a series of programmes to improve the nutritional and health outcomes for Nigerians. These included the large-scale fortification of food (LSFF), initially with iodine in 1997, and later with iron, vitamin A, zinc and a suite of vital vitamin Bs: starting from 2002 and further expanded in 2015.

However, in 2012, a study tested 293 food samples across sugar, cooking oil, wheat and maize flour, semolina and salt, and found compliance levels so low as to generate doubt about the value of the entire fortification programme, according to the authors (Ogunmoyela,2013).

These findings led to a surge in activity to improve compliance, spanning training of regulators, equipping and accreditation of testing laboratories, and, from 2017, a new multi-sectoral programme to drive compliance upwards in direct partnerships with private sector producers.

Piecemeal evidence continued to suggest the fortification of foods was having less impact in Nigeria than in other fortifying countries (Das, 2019), as the levels of anaemia, Vitamin A, and other deficiencies identified in spot studies continued at high levels (Harika, 2017).

Yet, as the LSFF programme continued to run without embedded monitoring and evaluation (M&E) reporting by regulators, difficulties remained in identifying obstacles to the efficacy of the programme. The absence of data also began to generate a self-defeating cycle, where the very lack of M&E evidence on the programme's benefits and obstacles created a vacuum in the case for government's prioritisation and funding of LSFF and of its monitoring and evaluation.

Thus, LSFF, which has been found internationally to be the most effective nutritional intervention in terms of ease, cost, speed and scale of impact (Das, 2019), has been deprioritised in Nigeria, behind a series of other nutritional initiatives (NMPFAN, 2020, Page 47).

The data vacuum has in the last three years driven donor-funded efforts to evaluate LSFF compliance and efficacy, which exist alongside various coincident surveys and peer-reviewed studies. However, the methodologies in these one-off external data series and individual studies have varied, resulting in different and sometimes conflicting conclusions on the progress of LSFF compliance and delivery in the country.

To assess this existing evidence, and the remaining data gaps, this State of the Nation review provides a multi-sectoral analysis of all the available data from the last 10 years, from 2012 to 2021. It analyses the studies' methodologies and findings, in order to understand the compliance levels that have been achieved to date. This report only reports on consumer reach and the efficacy of LSFF qualitatively and based on an interpretation of findings, due to limitations in the data available. Its key purpose and focus lies in establishing the progress achieved to date in compliance.

Based on a stakeholder workshop including regulators and nutrition-related organisations, interviews, and desk research, the report reviewed all supplied and retrievable data on the compliance of Nigerian fortifiable foods with the mandatory standards. This involved two layers of analysis to achieve viable comparisons of data that was gathered or estimated in different ways.

The report analysed the market share methods used in 7 of the 12 compliance reports. Three that evaluated the market share of home ingredients by surveying homes provided incomplete data that could not be applied to any other data set. One retail survey also assessed the market share of home ingredient brands in retail outlets. These four surveys made few estimation assumptions beyond normal sampling, but they only tested a sub-segment of fortificable foods, sold into homes as cooking ingredients, for instance as graded flour or table salt.

With less than 10 percent of wheat flour consumption in Nigeria (Bakery, 2019), for instance, consumed as flour for home cooking, the applicability of these market shares was limited.

A third, more complex, producer-based estimation sought to calculate the market share for all fortifiable foods based on the production capacity of the plants making the foods. However, it rested its final figures on several assumptions for which this review found no supporting evidence, and some conflicting evidence. Thus, the calculation provided a useful tool for following year-on-year changes, where estimation flaws were likely to be repeated, but delivered end-point figures that must be understood as having a low degree of confidence, or, put another way, a high margin of error.

The key estimation assumptions assessed in this report are for:
- The operating capacity, which is how much a plant is actually producing compared with its capacity;
- The compliance parity of home versus commercial ingredients, which account for the majority of all fortificable foods, but which were never tested; and
- The loss of compliance during food processing, which was assumed at zero.

On this basis, this State of the Nation review found that both the retail and producer market share methods provided insights, but neither could be interpreted as presenting compliance levels across all fortifiable foods with any reasonable degree of confidence.

This report, therefore, examined the compliance results from home ingredients alone, as a consistent sub-segment that can provide a sign-post to changing compliance levels, without seeking to convert that into market or industry-wide compliance levels, in the absence of the data necessary to do that.

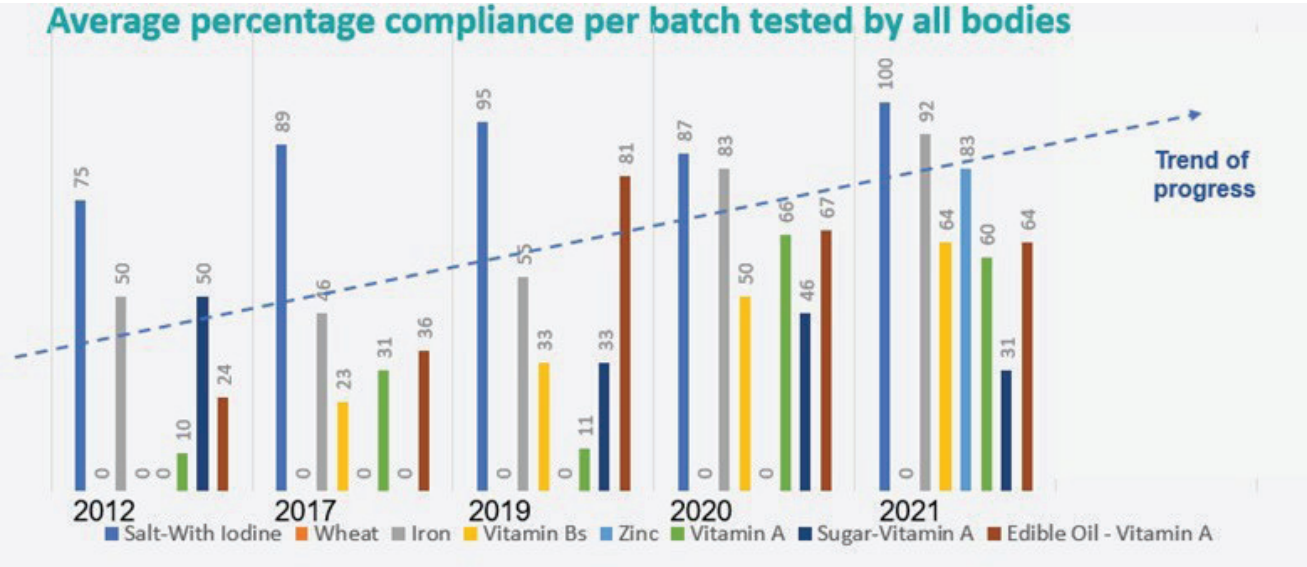
On this basis, it found that the fortification of table salt fell markedly after full compliance levels were reached in 2007, to 53 percent compliance at one point. But these levels have since recovered, rising to now almost complete compliance.

The Vitamin A vehicles - sugar, margarine, cooking oil and wheat flour have all grappled with issues of micronutrient stability. However, their compliance improved sharply up until 2019, but slumped in 2020 and 2021, when the Covid pandemic affected Vitamin A supply chains.

Iron compliance also improved, as did the vitamin Bs, while Zinc was found at compliant levels in 83 percent of samples in 2021, but with no earlier point of comparison.

However, all of the micronutrients except iodine in salt and iron in wheat flour continued to fall short of full compliance by a large margin, aligning with data on under-purchasing of fortificant premix. Generally, in home ingredients alone, compliance rose over the period, but relatively slowly, and to average levels of 60 to 65 percent.

Figure 1:



Bearing in mind that home ingredients account for only a small proportion or minority of consumption, and extra fortification is required for ingredients used in processed foods, this report concludes that food fortification is likely to be reaching consumers at levels that are far below the initial intent.

To resolve this shortfall, based on the analysis outlined in the reviews of data and in the report's conclusions, this report recommends:

1. Data Gathering and Analysis, on:

- The industry structure of fortifiable foods, particularly as B2B versus direct retail, to scale the significance of each channel for attention and policy priorities
- Compliance levels in B2B fortified ingredients, at origination and along the supply chain, including in processed foods, such as bread
- The fortifier-to-consumer supply chain, to understand duration and map issues affecting fortificant stability
- The impact of waivers that offer exemptions to mandatory fortification standards for particular product ingredients, assessing their impact on fortificant reach and market shares
- The impact of packaging on fortificant stability, including of processed foods,such as bread
- The most effective food vehicles for delivering micronutrients into low-income homes, in light of the reach of fortifiable foods and processed foods containing fortificable ingredients, and the same assessment for other viable staples, into low-income homes
- The impact of fortified foods on families' nutrition, though combined food and health studies, and the development of the data to demonstrate the existing and potential benefits of LSFF to Nigeria

2. Monitoring and Evaluation, through:

- The roll-out of digitisation, self-reporting, and a joint regulatory framework to remove pressure from regulator resources
- The development of a single methodology for compliance reporting and investigation
- The resourcing of regulators to produce quarterly monitoring reports at the four levels of importation; Nigerian production plants, including of processed foods; retail outlets; and homes.
- Review of the quarterly monitoring and evaluation reports by the National Fortification Alliance, and production of an annual analysis with policy recommendations to improve the compliance and reach of LSFF

3. Statute, through:

- The documentation of the industry knowhow needed to correctly fortify and development of appropriate standards and statute to make a knowledge officer compulsory
- The development of standards for fortified food packaging
- The adoption of a governance framework for LSFF monitoring and evaluation

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Introduction

Nigeria suffers from extreme malnutrition, with the second highest proportion of under-nourished children in the world. The National Nutrition and Health Survey (2018) estimated that 32 per cent of Nigerian children under the age of 5, equivalent to more than 10 million children, are stunted. This implies that close to 1 in every 3 Nigerian children suffers from chronic malnutrition. In addition, 10.5 percent of Nigerian children suffer from wasting, while 19.9 percent are underweight. These levels of malnutrition are driving morbidity and mortality and generating economic losses equivalent to an estimated 11 percent of GDP, according to UNICEF.

The scale of this nutritional deficit has made it into a policy priority over the last three decades, seeing the country embed supplementation programmes into its healthcare infrastructure; create one of the world's largest school meals programmes, and, since 1997, fortify its staple foods with vital micronutrients.

This nutrition programme has delivered gains. Yet, the nutritional challenges remain acute. Iron deficiency anaemia rates among children under five are estimated at 68.3 percent (WHO, 2016), 57.8 percent amongst pregnant women, and 49.8 percent in women of reproductive age (WHO 2016), indicating a severe public health problem. Vitamin A deficiency is also of concern, having moved little from the 29.5 percent of preschool children with low serum retinol levels in 2005 (WHO 2005).

Overall, only 64 percent of children in Nigeria are thriving without being stunted or wasted (NNHS,2018).

In the face of such an extreme and deep-seated nutritional shortfall, food fortification has been repeatedly found to deliver some of the most rapid and cost-effective improvements in nutrition and health.

Yet, a decade after the introduction in 2002 of mandatory fortification for flour, cooking oil, margarine and sugar, which followed five years after the mandatory fortification of salt, a key study found that compliance rates remained chronically low, with the authors observing that the levels of fortification were so poor that they called into question the country's entire fortification policy (Ogunmoyela, 2013).

This report sparked multiple changes in the way fortification in Nigeria has been approached, including attention to creating an enabling environment, with a substantial increase in the country's number of accredited laboratories, the training of regulators, development of additional standards, and the development of multi-stakeholder partnerships to drive up fortification compliance.

In particular, the drive for greater compliance saw a stepchange in 2017, with the launch of the Strengthening African Processors of Fortified Foods (SAPFF) Project, which brought together producers and technical experts funded by donors.

This programme has for the last three years, run producer CEO forums, it has developed online training content in fortification, assessed laboratory capacity, looked at regulatory overlap and designed new regulatory frameworks, and implemented multiple initiatives to drive up fortification compliance.

The purpose of this report is to now review all available data and reporting to determine the progress and successes of the food fortification initiatives of the last decade. A significant element of the review has been an examination of the available data sources to understand how they interlink and to draw a cohesive understanding of progress that surmounts any differences in study parameters or definitions.

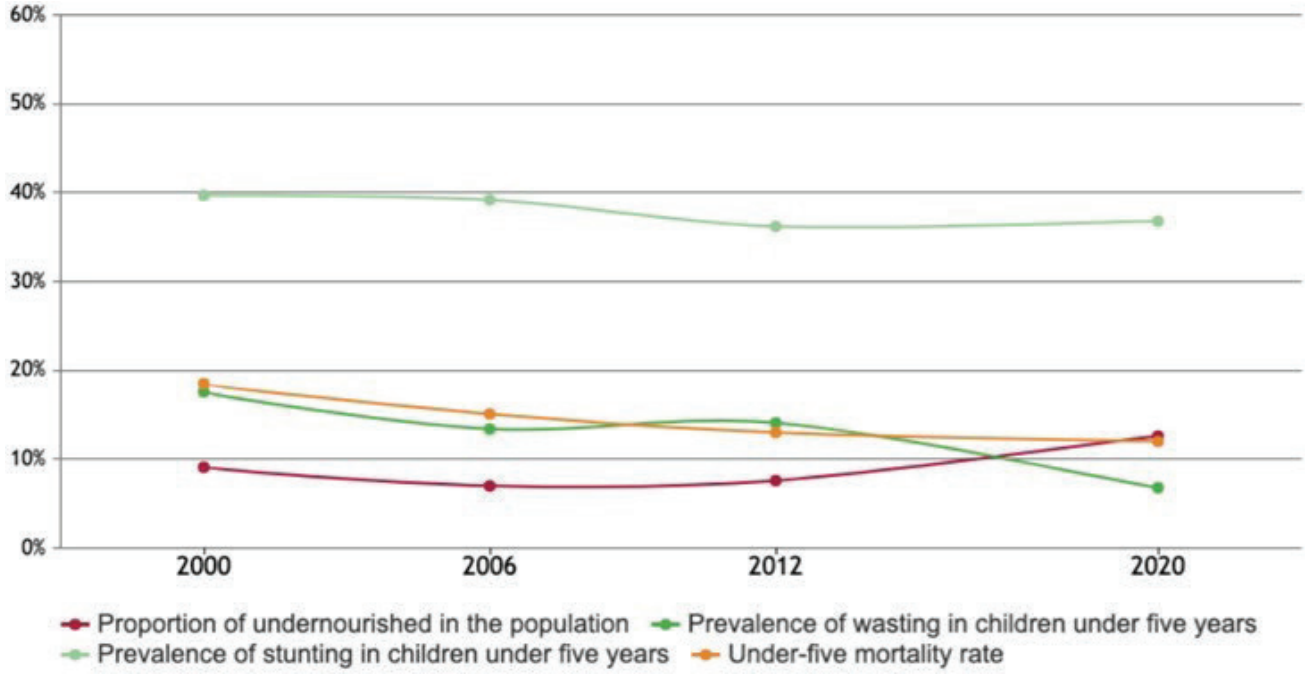
With the data reconciled, the report has then sought to understand where issues remain, insofar as the existing data can reveal remaining compliance issues, and to lay out an agenda for the 10 years ahead in improving and deepening the nutritional reach of Nigeria's fortified foods.

The Nutrition Gap

Nigerians suffer from two types of extreme malnutrition. The first is protein-energy malnutrition, caused by too little food and insufficient calories. The second is micronutrient malnutrition, caused by critical gaps in the range of foods and nutrients consumed. The two types of malnutrition tend to co-exist, together causing wasting, stunting and under-5 mortality. However, micronutrient malnutrition is far more widespread than energy malnutrition.

Insufficient vitamins and minerals in diets cause elevated rates of disease and death, as well as a permanent legacy of underdevelopment of the brain and body. The gravity of these impacts cannot be overstated, since Nigeria suffers from some of the highest levels of malnutrition in the world. Moreover, despite multiple nutritional initiatives the markers of malnutrition have barely reduced and in some cases have increased.

Figure 1: Trends in undernourishment, wasting, stunting and under-5 mortality



Source: Global Hunger Index 2020(Globalhungerindex,2020)

A key indicator of micronutrient deficiencies is maternal mortality. In 2012, which is where this study begins, the Mundi Index (Data Worldbank 2019) listed Nigeria as having one of the highest rates of under-5 and maternal mortality in the world with vitamin A deficiency (VAD) being a major contributory factor. By 2021, the index reported that the maternal mortality ratio (MMR) in several low-and-middle-income countries remained alarming, with some 34 percent of global maternal deaths occurring in Nigeria and India alone. It calculated Nigeria's maternal mortality rate at 917 deaths/100,000 live births.

The micronutrient deficiencies driving such mortalities are linked to poverty. In 2020, the World State of Food Security Report (FAO, 2020) published results showing that a fully nutritious diet costs five times more than a high-starch diet that provides enough calories, but is lacking in micronutrients. Thus, a large proportion of the Nigerian population can afford enough food for energy, but not for adequate nutrition to reach their full genetic potential or enjoy normal levels of immunity.

Moreover, as well as this cost differential, issues of geography and culture have meant Nigerians eat a less diverse diet than is healthy, based on foods that contain insufficient nutrients. The GAIN 2017 Re- port (GAIN, 2017) and NAFDAC's 2020 Report (GAIN, 2020) presented this evidence, based on a study of some twenty states in Nigeria. This has led to a series of critical nutritional shortfalls.

Globally, the World Health Organisation has rated the most dangerous nutritional risks, with deficiencies in Vitamin A, zinc, iron and iodine representing four of the six highest risks from malnutrition. Nigeria suffers from all four.

Table 1: Deaths and DALYs attributable to six risk factors for child and maternal undernutrition, and to six risks combined; countries grouped by income, 2004

Risk	World	Low Income	Middle Income
Percentage of deaths			
Childhood underweight	3.8	7.8	0.7
Suboptimal breastfeeding	2.1	3.7	1.1
Vitamin A deficiency	1.1	2.2	0.3
Zinc deficiency	0.7	1.5	0.2
Iron deficiency	0.5	0.8	0.2
Iodine deficiency	0	0	0
All six risks	6.6	12.7	2.1
Percentage of DALYs			
Childhood underweight	6	9.9	1.5
Suboptimal breastfeeding	2.9	4.1	1.7
Vitamin A deficiency	1.5	2.4	0.4

Zinc deficiency	1	1.7	0.3
Iron deficiency	1.3	1.6	1
Iodine deficiency	0.2	0.2	0.3
All six risks	10.4	15.9	4.4

Nigeria's High-Risk Nutritional Shortfalls

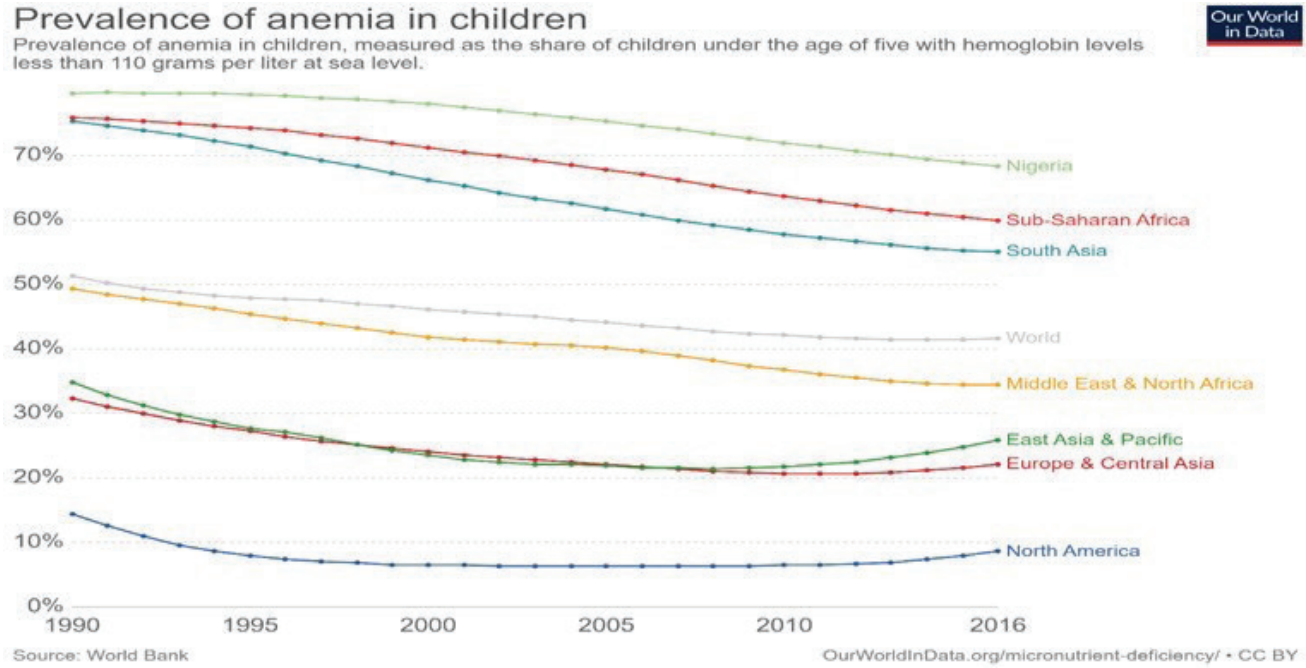
i. Iron

According to the World Health Organization (WHO), iron deficiency, which is a principal cause of anaemia, "affects more people than any other condition, constituting a public health condition of epi- demic proportions. More subtle in its manifestations than, for example, protein-energy malnutrition, iron deficiency exacts its heaviest overall toll in terms of ill-health, premature death and lost earn- ings"(WHO,2009).

Iron deficiency, and iron-deficiency anaemia, deplete energy, raise the risk of maternal and infant mortality, contributing to 20 percent of all maternal deaths, and increase ill-health among children. They also affect lifelong productive capacity by hindering cognitive development and hindering physical growth.

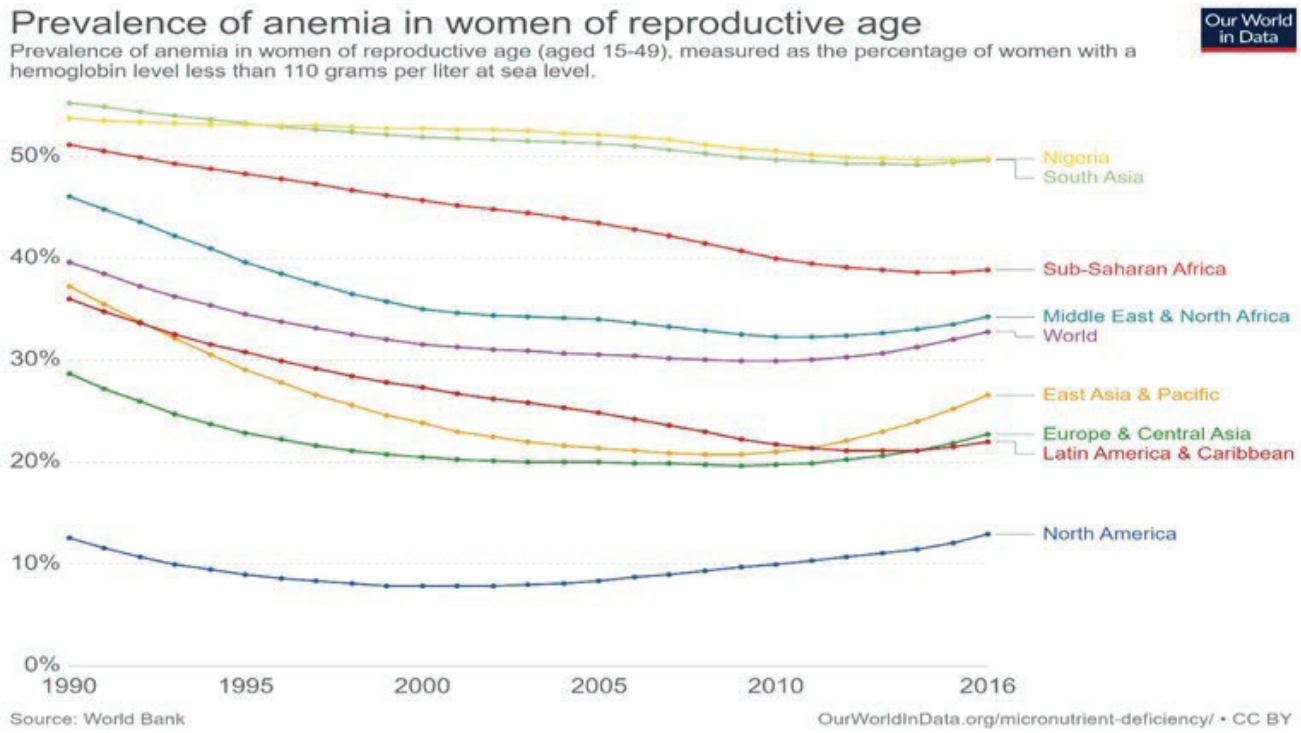
Globally, iron deficiency is the main cause for anaemia that afflicts around one third of the world's population. But Nigeria suffers from anaemia levels that are twice as high, reporting one of the highest levels of anaemia in the world, among both children, and women of reproductive age, as shown as the data from Our World in Data 2017 (WHO, 2017)

Figure 3: Prevalence of anaemia in Children



Source: Our World- in Data (WHO, 2019)

Figure 4: Prevalence of anaemia in women of reproductive age



Source: (Our World in Data, 2017)

In 2011, immediately prior to the period of this assessment 71 percent of Nigerian children under-5 had anaemia, and 50 percent of women of reproductive age. This represented an enormous health burden.

"The morbidity and mortality rate of the mother/child pair resulting from maternal anaemia is alarming," reported The Saving Mothers Report (2010–2013): "40% of maternal deaths in South Africa were associated with anaemia. Foetal consequences associated with anaemia in pregnancy include but are not limited to still-births, low weight babies, intrauterine growth restriction, and neonatal sepsis"(O- mote, 2020). Yet, by 2016, after 14 years of fortifying flours with iron, the prevalence of anaemia had fallen only marginally in Nigeria, from just over 52 percent in 2000 to just below 50 percent in 2018,according to the Saving Mothers Report (Omote, 2020).

ii. Vitamin A

Vitamin A is critical to the functioning of the immune system. Children with insufficient Vitamin A can become seriously ill and die from common infections, such as colds and diarrhoea. It is for this reason that Vitamin A deficiency accounts for a higher percentage of deaths than any of the other high-risk micronutrient deficiencies, causing almost six percent of under-five deaths in Africa and over 2 percent of all deaths in low-income countries, according to the WHO(GAIN ,2020).

The deficiency is also the world's leading preventable cause of childhood blindness. A 2002 review found that corneal opacity in which vitamin A deficiency was the main factor was responsible for 34 percent to 69 percent of preventable childhood blindness in Nigeria (Rabiu,2002).

Vitamin A deficiency is a factor, too, in anaemia, and contributes to maternal mortality, problems in pregnancy, skin conditions, infertility, and delayed growth.

In Nigeria, vitamin A deficiency is a public health problem that, in 2006, was found to be affecting 29.5 percent of children under-5, nationwide. However, the spread was uneven across the country, with the worst deficiencies among children in the dry savanna and humid forest, while the levels were lowest on the moist savanna. The level of deficiencies in rural and urban areas were broadly similar at just over 25 percent, but mixed rural/urban areas reported much higher levels, at over 32 percent (Maziya ,2006).

iii. Zinc

Zinc deficiency also depletes immunity, as well as impairing growth, increasing the risk of stunting, diarrhoea, respiratory diseases, and mortality during childhood. It also reduces fertility and contributes to preterm births in pregnancy. Its prevalence in Nigeria is far less documented than iron and vitamin A deficiency, but a 2014 study found 50 percent of the adults sampled suffering from zinc deficiency.

iv. Iodine

Iodine is critical to the creation of thyroid hormones. Iodine deficiencies prevent the development of the central nervous system, and cause miscarriages, still birth, preterm delivery, cretinism, postpartum hemorrhages, brain damage and other thyroid-related health problems, as well as thyroid swelling, known as goiter(DHS, 2018).

Granite areas of Northern Nigeria, where food is of generally poorer quality, have little iodine in the soil or water, and were described from the 1950s as a goiter belt, with goiter rates as high as 60 per- cent and a higher prevalence of cretinism(Jibril, 2016). Nwamarah et al.(Nwamarah, 2015) reported in 2016 that, in 1993, the national goiter rate in Nigeria was 20 percent and 20 million Nigerians were estimated to be affected by Iodine Deficiency Disorder. At the same time, the prevalence of iodine deficiency was 65.6 percent in South East, 41 percent in South West and 43 percent in North Western Nigeria(Nwamarah, 2015).

However, a study found adequate iodine levels among pregnant women in north-west Nigeria in 2015(Jibril, 2016), while another 2015 study in south-eastern Nigeria reported 59% IDD in 6–12-year-olds(N- wamarah,2015) while a review of literature from 2017 found three studies reporting 59 percent preva- lence amongst 6–12-year-olds in different areas of the country.

Thus, while UNICEF currently classifies Nigerian iodine levels as adequate based on a 2004-2005 study, the country's iodine adequacy remains variable by region, and over time(UNICEF, 2007).

v. Folic Acid

Inadequate folic acid during pregnancy increases the risk of neural tube defects, which are marked by malformations of the spine and brain, which is often formed outside the head. Two studies,in 2005, and again in 2008-2009, at Lagos State University Hospital (Lindsay, 2012) found more than half the children treated for central nervous system defects had neural tube defects.

vi. B Vitamins

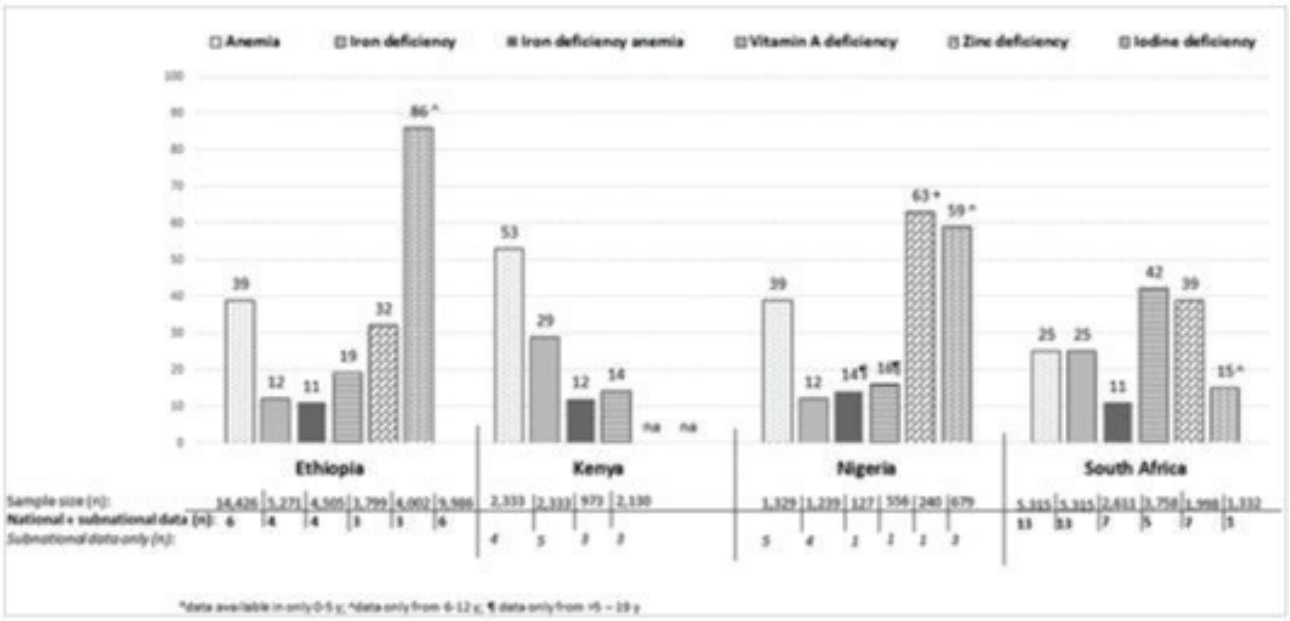
The other micronutrients that fall within the scope of this assessment are Vitamins B1, B2, B3, B6 and B12. The main food sources for Vitamin B1 (Thiamin), Vitamin B2 (Riboflavin), Vitamin B3 (Niacin) and Vita- min B6 are vegetables and cereals, which contribute more than 77% of the intake of the four vitamins in Nigerian diets, according to an assessment based on the 2003/2004 national food intake survey, which found B1, B2, B3 and B6 deficiencies most pronounced among the country's urban dwellers and lowest income groups(Harika, 2017). The vitamins are key to the functioning of the nervous system, energy levels, the reproductive system, body tissues, cell respiration and immunity. Deficiencies tend to occur alongside other Vitamin B deficiencies.

Vitamin B12, which is most easily consumed from dairy products and fish, but also comes from meat, and is crucial to processing iron and to foetal development and health, yet studies in Nigeria have found 36 percent of women with Vitamin B12 deficiencies, which can cause early miscarriage, retarded growth and neural tube defects(Vander Jagt, 2011). Nigerians in parts of the country where the con- sumption of foods from animal sources is limited because of cost or availability are most disposed to vitamin B12 deficiencies(Vander Jagt, 2011) but it is estimated that 71.3 percent of the entire Nigerian population is susceptible to vitamin B12 deficiencies. A review of multiple studies on micronutrient deficiencies in Nigeria, published in 2017(Harika,2017), found:

Based on levels of nutritional deficiencies such as these, the World Bank (2021) estimates an annual loss of more than $1.5bn in gross domestic product as a result of the raised health costs and lost productiv- ity caused by micronutrient deficiencies in Nigeria.

The deficiencies also set up extreme vulnerabilities and reinforce inequity, putting in place an exagger- ated health burden on society's poorest. This has played out even during the Covid-19 pandemic, with a snapshot of infection rates and death rates by state in July 2021 showing that Nigerians with Covid-19 in Edo, one of Nigeria's poorest states, have been four times more likely to die from the infection that those in Lagos. With VAD-compromised immunity, high levels of anaemia, and multiple other vulnerabilities, Nigeria's poorest remain comprehensively disadvantaged through poor nutrition.

Figure 6: Prevalence of Micronutrient Deficiencies In Children In Nigeria



Source: (Harika, 2017).

Table 2: Covid-19 infections and mortalities Nigeria July 2021				
Location	**Cases**	**Recovered**	**Deaths**	**Death Rate(%)**
Lagos	22562	21119	220	0.97
Oyo	6856	6734	124	1.8
Federal Capital Territory	6385	5934	82	1.28
Edo	4910	4723	185	3.76
Plateau	3724	3639	33	0.88

Source: (John Hopkins University, July 2021)

LSFF Framework

i. Regulation

The mandatory large-scale fortification of food began in Nigeria in 1993, with the mandatory fortification of salt with iodine(FACT, 2018).

In 2000, regulations were drawn up that were implemented in 2002 mandating the fortification of cook- ing oil and sugar with Vitamin A. The same regulations mandated the fortification of wheat, semolina and maize flour with micronutrients that were expanded in 2015 to include vitamins A, B1 (thiamine), B2 (riboflavin), B3 (niacin), B6, B9 (folic acid) and B12, iron and zinc.

The requirements for flour fortification laid out in the NAFDAC Act 2004 Food Fortification Regulations 2021, are as shown in the table below:

Table 3: Mandatory Macronutrients Requirements for Wheat Flour, Composite Flour, Maize Flour Wheat Semolina and Whole Maize Meal		
Vitamin A	Dry Vitamin A palmitate 250 CWS/SN/CWD	2.0mg/kg
VitaminB9	Folic acid Food grade	2.6mg/kg
Vitamin B12	0.1% CWS/SN/CWD	0.02mg/kg
Iron	NaFeEDTA(anhydrous in line with FCC)	40.0g/kg
Vitamin B2	Riboflavin Fine powder	5.0mg/kg
Zinc	Zinc oxide	50.0mg/kg
Vitamin B1	Thiamine Mononitrate	6.0mg/kg
Vitamin B3	Niacinamide	45.0mg/kg
Vitamin B6	Pyridoxine Hydrochloride	6.0mg/kg

Source: Food Fortification Regulations (2021)

Table 4: Levels of Mandatorily Fortified Foods with Vitamin A	
Vehicle	**Level of fortificant**
Sugar	25,000 iu/kg
Wheat and Maize flour	6,000 iu/kg
Margarine and Butter	26,000-33,000 iu/kg

Source: Food Fortification Regulations (2021)(GAIN ,2019).

The Standards Organisation of Nigeria has developed 24 standards covering large scale food fortification:

- 2000 Standard for Edible Refined Palm Oil and its Processed Forms
- 2000 Standard for Groundnut Oil
- 2000 Standard for Edible Cotton Seed Oil
- 2000 Standard for Maize Oil
- 2000 Standard for Soya Bean Oil
- 2000 Standard for Margarine
- 2004 Standard for Food Grade Salt
- 2007 Standard for Edible Palm Kernel Oil
- 2007 Standard for Coconut Oil
- 2007 Standard for Edible Sunflower Oil
- 2007 Standard for Sesame Seed Oil
- 2007 Standard for Edible Rape Seed Oil
- 2007 Standard for Degermed Milled Maize Products
- 2007 Standard for Plantation White Sugar
- 2010 Standard for Maize Grit
- 2015 Code of Practice for Fortificants Premix
- 2015 Standard for Wheat Flour
- 2015 Standard for Wheat Semolina
- 2015 Standard for Maize Flour
- 2015 Standard for Whole Maize Meal
- 2015 Standard for Composite Flour
- 2019 Standard for Fortificants Premix
- 2019 White Sugar Specification
- 2019 Brown Sugars Specification

ii. Regulators

Three regulatory authorities have engaged in monitoring and implementing large-scale food fortification in Nigeria with a custom-and-practice assignment of responsibilities that was initially proposed by the USI task force and which has since become institutionalised across LSSF regulation. This has seen regulation covered at:

- Factories, by the Standards Organisation of Nigeria (SON)
- Distributors/Retailers, by the National Agency for Food and Drug Administration and Control (NAFDAC)
- Households, by the Federal Competition and Consumer Protection Commission (FCCPC).

iii. LSFF Partnerships

The first mandatory food fortification in Nigeria was of salt, from 1997, as part of the country's Universal Salt Iodisation (USI) program. In 2001, the Iodine Global Network identified the absence of sufficient data to track progress and identify challenges in mandatory salt iodisation. With support from UNICEF, an Iodine Deficiency Disorder / Universal Salt Iodisation Taskforce (IDD/USI) was formed made up of regulators, government ministries, salt producers, donors and development partners, consumer associations and media. Coordinated by the Standards Organisation of Nigeria, the taskforce assessed iodine levels in edible salt, testing quarterly factory and wholesale samples, and annual market and household samples, and held quarterly reviews to resolve the challenges identified. The taskforce was highly ef- fective and saw Nigeria named as the first country in Africa, in 2007, to reach high levels of compliance for salt iodisation (Unicef, 2018).

The widening of fortification in 2002 to include sugar, cooking oil and flours, led to the creation in 2007 of the National Fortification Alliance (NFA) to coordinate mandatory fortification. The alliance was, likewise, composed of private sector manufacturers, industry associations, public and development agencies and has played an enablement role rather than a data review role. This has included setting standards through its Expert Consultative Committee, agreeing the ford fortification 'eye' logo to enable public recognition of fortified foods, and providing institutional and technical support to the reg- ulators to assist in compliance monitoring and in equipping and fostering the accreditation of testing laboratories, and to manufacturers in achieving best-practice quality control. Individual members of the NFA, such as GAIN, UNICEF and Helen Keller International, continue to play a very active role in driving and enabling food fortification. But the alliance, itself, does not have a quarterly meeting schedule and has been less of a driving force as a whole in recent years.

The Strengthening African Processors of Fortified Foods (SAPFF) is a donor-funded programme, supported by the Bill and Melinda Gates Foundation and the Dangote Foundation, and effected by technical experts Technoserve and a global food industry alliance Partners for Food Solutions. It has engaged a steadily widening number of industry partners in partnership to improve food fortification compliance, providing training, and working to create an enabling environment for industry compliance, including through attention to the quality and availability of micronutrient premix. The Flour Millers Association of Nigeria (FMAN) has played an active role in driving compliance by wheat millers in the country.

iv. Testing capacity/ laboratories

A key factor in securing LSSF compliance is the capacity to accurately monitor micronutrient levels in food vehicle samples. This capacity did not exist in Nigeria as food fortification was launched.

Once it became clear that capacity issues were constraining monitoring, and contributing to poor compliance, laboratory capacity was identified as a priority,

and GAIN worked with NAFDAC, SON, the Federal Institute of Industrial Research Oshodi (FIIRO) and other stakeholders to enhance the country's laboratory capacity. It began with an assessment of the capability of 10 laboratories - five in Lagos, two in Kaduna, two in Port Harcourt and one in Ibadan - to test for micronutrients, to implement quality control through reliable and comparable results; and to detect toxins, such as aflatoxins, pesticides, and heavy metals, in food samples.

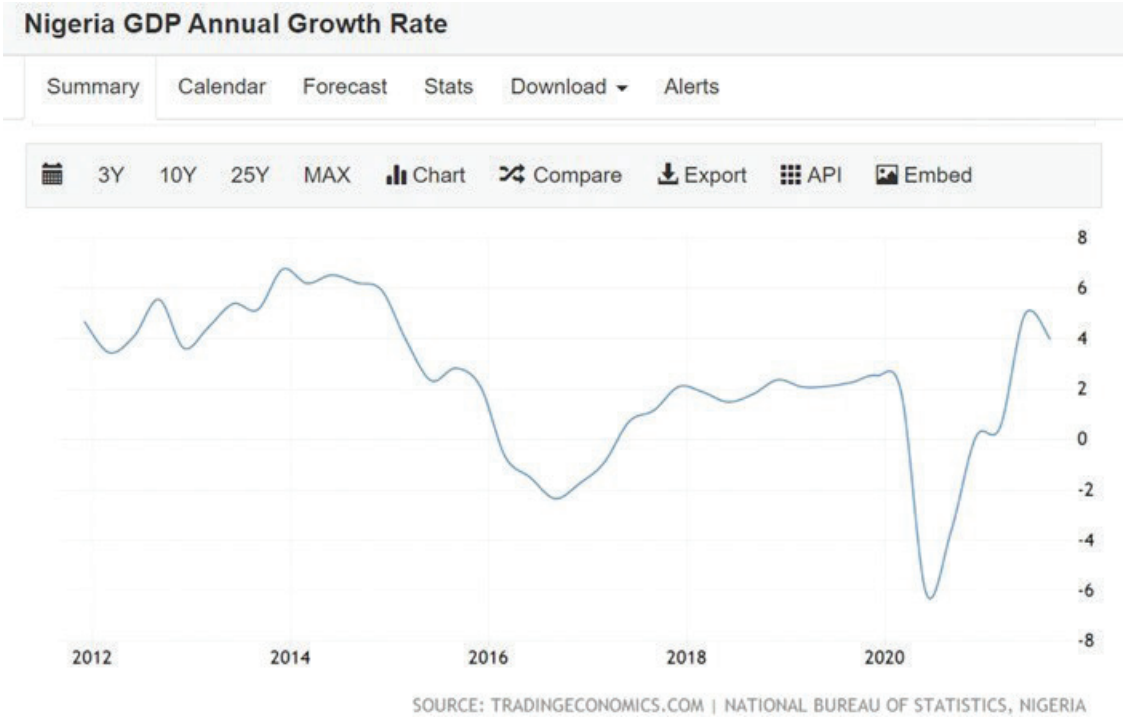
Only one of the laboratories was ISO 17025 accredited for Laboratory Competence, three were working towards accreditation, with one having achieved accreditation for some of its laboratory features, but four were entirely unaccredited. The review found unreliable power sources and back up, poor electrical wiring, faulty or redundant equipment, no records for equipment servicing, inadequately trained personnel, an absence of internal quality control, unsuitable premises, insufficiently sensitive testing equipment, and inadequate humidity and temperature controls and fume cupboards.

The review formed the foundation for a programme to build the capacity of personnel, equipment, pro- tocols, systems, surveillance, and data analysis to the level necessary to reliably and accurately assess fortification levels, food quality and food safety. Power backup was put in place, manuals upgraded, and the laboratories worked towards ISO 17025 accreditation.

Economic Context

Nigeria has the largest economy in Africa, and since 2013, the largest manufacturing sector, producing goods for much of West Africa. From 2012 to 2015, the economy was on a growth trajectory, but food production, substantially by smallholders, did not keep pace with the economic expansion and population growth, leading to a widening food deficit on rising food imports. A move to a free float of the Naira currency in 2016, together with falling oil prices with oil accounting for 70 percent of government revenues saw the country move into recession. However, after the initial price shock on the currency devaluation, it had moved back to positive growth by 2018.

Efforts to manage the country's trade deficit and currency reserves, and to stimulate and replace im- ported foods with locally grown crops, have since brought consecutive regulations on food imports, affecting many of the fortification food vehicles. In particular, the banning of packaged refined sugar and imported processed edible oil have had a significant effect on the fortifying food industries. Yet growth was substantially maintained until early 2020.



However, the final 18 months of the period under review brought radical new challenges for all businesses as a result of the global Covid-19 pandemic. Amid border closures, lockdowns, stay-at-home orders and social distancing regulations in the majority of countries globally, supply chains were disrupted in ways never seen before. The sales of many service providers collapsed, staffing became an issue, and Africa, alongside the rest of the world, witnessed unprecedented levels of salary cuts and redundancies.

TechnoServe carried out a repeated survey in April and July 2020 across food producers partnered with the Strengthening African Processors of Fortified Foods (SAPFF) programme to gauge the impact of the pandemic on their production. It found that Nigerian producers entered the pandemic, and a period of seaport closure, with around three months' supplies of raw materials and, specifically, with around three months' supply of the premixes used to add micronutrients to the fortified foods. As ports opened and the supply chain improved again, they then received forward orders. Thus, the immediate impact on the quality of food fortification was not severe(Technoserve, 2020).

However, by early 2021, global supply chain issues were affecting the premixes arriving with Nigerian food producers in multiple ways, reported Technoserve, being "through;

- Local currency devaluation,
- Limited sources for raw materials,
- The concentration of premix suppliers in specific geographies,
- Increases in air freight and shipping costs, and
- Uncompetitive local premix supply(Technoserve, 2020)."

Together, these factors strained the availability of flour premixes and pushed up their prices by 38 percent to 100 percent, as reported by Technoserve: "In 2019, the price of premix from local and im- port sources was N4000 and N 3500 naira, respectively. As at the end of 2020, locally blended premix ranged from N5500 - N8000 per kg," reported Technoserve in its survey findings(Technoserve, 2020).

In interviews, TechnoServe reported supply shortages in imported premix, which could be attributed to fluctuations in incorporation rates, reliance on sub-par products, and possible utilisation of old stock of premixes with potentially lower potency micronutrients due to conditions of storage. The impact of this was greatest on Vitamin A, which is the least stable of the micronutrients used in food fortification, breaking down at a rate of several percentage points a week when poorly stored.

However, levels of vitamin B3 and Iron remained largely compliant, while the levels of iron fortification rose, even as vitamin A levels dropped.

The pandemic also caused some acceleration in staff turnover that had already been an intermittent problem in achieving full compliance, as staff departed who had been responsible for the calibration of hoppers during flour production and for other parts of the technical implementation. A key driver of such knowledge gaps has been acquisitions that have led to staff changes that have removed trained personnel. Against this backdrop, Technoserve had already identified knowledge management as an issue and created online training, but reported that Covid-19 somewhat increased the turnover in skills.

Overall, such comprehensive disruption affected compliance levels in 2020 and more so in 2021 and raised new issues around premixes.

At the same time, Covid-19 also disrupted the supply chain to consumers and reduced consumer spending power, in a combined impact that saw many turn to agriculture and more food creation in the home(Pricewaterhousecoopers,2020). This is likely to have led to some reduction in the consumption of processed foods, the scale of which remains to be assessed.

Compliance Data Analysis

The structure and methodology of this report are driven by the understanding that four pillars need to be in place for large-scale food fortification to succeed. As a sequential set of circumstances, these are that:

1. The food vehicle is reaching a substantial portion of the population;
2. Industry compliance with fortification standards is high;
3. The level of fortification of products arriving into homes is high, meaning nutrient stability is achieved;
4. The health impact is demonstrable.

This report specifically addresses pillar 3, compliance levels, in order to reconcile apparently conflicting data in that area.

However, where the data analysed also throws light on food consumption, consumer reach, micro- nutrient stability, and industry structure, these are also covered insofar as they generate insights into compliance issues, or into the significance of compliance issues.

To conduct this review, the report has drawn on the following data sources:

- Regulators' data
- Programmatic testing data
- Household consumption and expenditure surveys
- National/subnational dietary intake surveys
- Food frequency questionnaires.
- Retail market surveys
- Peer-reviewed journal articles
- Salt industry data
- Food industry data
- Agricultural data
- Bakery surveys
- Technical guidelines
- Stakeholder interviews.

The available compliance data was not plentiful, which has meant that this review has analysed all avail- able sources, despite the fact that there was no universality in their data protocols. This has required an analysis of the intersection and relationship between each data set and the adoption of the most viable metrics for data comparison, in order to facilitate insights into the relative compliance achievements over time.

The desk review of available data, being tests that have analysed the micronutrient content in the man- datory fortified foods as well as associated data sets around the market shares of fortified foods and micronutrient breakdown, identified 12 data sets, being:

1. 2012 GAIN
2. 2015 FACT, GAIN
3. 2016 flour stability study, Lagos
4. 2016 NSSP
5. 2016 JIRT paper
6. 2017 FACT, GAIN
7. SAPFF Years 1 to 5 - 2017-2021
8. 2018 Demographic & Health Survey
9. 2019 NAFDAC Market Level Assessment
10. 2019 Ipsos Market Survey
11. 2020 Iodine Global Network
12. 2021 FQA, SoN

Wherever possible, this review drew additional data from peer-reviewed articles or other sources, as cited in the references.

When working with the identified data sets, reconciling the data presented, which were based on different methodologies, sometimes required a qualitative versus a quantitative analysis, with the data gathered and presented as:

1. The 2012 GAIN analysis measured sugar (42), cooking oil (94), flour (95) and processed food (62) samples from markets and factories across 36 states for Vitamin A and iron levels, giving results in four bands of: compliant without any allowance, compliant within a 50% variance, non-compliant, and not detectable. The report does not give the results for the processed foods tested (Ogun- moyela, 2013).

2. The 2015 GAIN FACT analysis was a fortified foods coverage assessment that surveyed 1,902 households in Kano and Lagos states on what foods they consume and the fortifiable foods they consume. It then tested 2,797 fortifiable home ingredient samples to establish the fortification levels, but no processed foods, reporting the home ingredient results as unfortified, inadequately fortified, adequately fortified or over-fortified, by percentage of samples, and with no market share calculations or brand shares (FACT, 2015).

Table 7: Summary of Food Samples Analyzed

Food samples	Kano (IN)	Lagos (IN)
Salt	731	645
Wheat flour	110	15
Semolina flour	23	233
Maize flour	33	2
Sugar	238	264
Oil	256	247

3. This 2016 peer-reviewed study took flour samples from 12 bakeries in Lagos, measuring their Vitamin A content at the start and then storing them and remeasuring at fixed intervals to document the decline in Vitamin A over time (Florence, 2016).

4. In 2016, the International Food Policy Research Programme (IFPRP) published the results of a study into child malnutrition in Kwara State, which is one of Nigeria's poorest. The study surveyed 414 households and mapped which brands of fortifiable foods they were consuming. It also tested the brands and reported the number eating fortified foods. The results do not show the specific compliance results (Kuku-Shittu, 2016).

5. A 2016 paper in the Journal of Industrial Research and Technology tested 40 samples of flour from four maize and wheat flour brands for microbes and Vitamin A and iron fortification, giving results as the mean average level of fortification across all samples (Solomon, 2016)

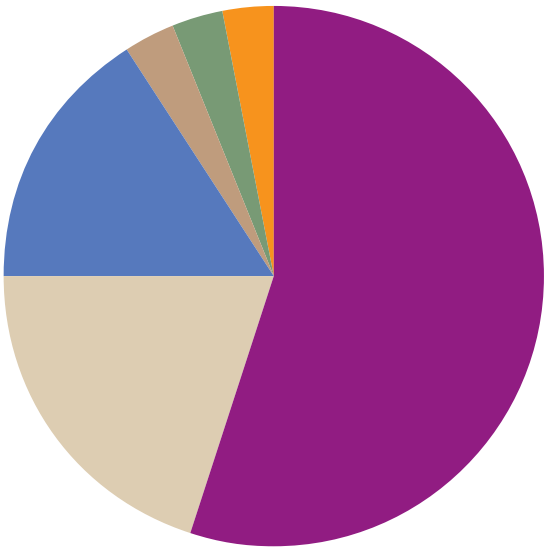
6. The 2017 FACT GAIN analysis was a fortified foods coverage assessment that surveyed 1230 households in Ebonyi and Sokoto states on what foods they consume and the fortifiable foods they consume. It then tested up to 12 samples of each brand of fortifiable food to establish the fortifi- cation levels, reporting the average level of Vitamin A and iron found across all samples. It did not give any break-outs of compliance levels or brand compliance (GAIN, 2017).

7. Strengthening African Processors of Fortified Foods (SAPFF) Years 1 to 5 - 2017-2021. This programme was built to engage producers in partnerships to facilitate and elevate food fortification compliance. The program began with a baseline survey of brand samples for compliance and tested samples each year, as more partners came on board, and then much more widely in 2020 and 2021 in order to identify any remaining needs for support (Technoserve, 2017-2021).

8. 2018 Demographic & Health Survey, conducted by the National Population Commission, surveyed households in 1163 clusters on all aspects of lifestyle and nutrition, and covered the presence of iodised salt in households. It did not evaluate compliance levels, but only the presence of iodine in the salt in households (NPC, 2018).

9. 2019 IPSOS market report surveyed 3978 retail outlets across 24 states, spanning supermarkets, mini-supermarkets, wholesalers, grocery stores, shops and kiosks, to map the turnover and sales of brands and unbranded fortifiable foods. It then divided the total turnover that it identified for each tier, for instance for shops and kiosks, by each subtotal of a brand's sales in that tier to compute the market share per brand per tier (IPSOS, 2019).

Retail Outlet Distribution %



10. 2020 Iodine Global Network assessment of salt and iodine in processed foods in Nigeria and estimated intakes per head(IGN, 2020).

11. 2021 NAFDAC market level assessment, identified 347 brands of fortified foods and tested the leading brands of each food vehicle - salt, sugar, margarine, cooking oil, wheat and maize floors and semolina - for their micronutrient content and compliance to standards (NAFDAC, 2021).

12. 2021 Factory-Level Assessment, Standards Organisation of Nigeria tested 70 brands of fortifiable home ingredients, spanning cooking oils, salt, sugar and wheat flour, at the factory level, assessing compliance based on the average result of multiple samples (SoN, 2021).

Data Protocols

The studies selected for analysis sought to establish the level of producer compliance in the mandatory fortification of foods, either as their core focus, or as a subsidiary or contextual investigation within research into broader issues of health, poverty and nutrition.

Seven of the 12 studies additionally estimated the market share of the foods that were found to be compliant, as a means of converting the test data into a meaningful measure of its impact on consumers. Thus, if a market dominant producer was compliant, that might, alone, deliver 50 per cent or more of a fortifiable food as complaint.

This double equation of compliance testing and market share calculations provided two layers of en- quiry in seeking to make data sufficiently comparable to plot a clear or consistent trend of progression from the limited numbers of surveys.

Market shares in homes

Looking first at the market share methodologies, just three of the analysed studies, in 2015, 2016 and 2017, sought to establish the market share of different fortified food brands through surveys of consumers, in either spot samples (Kuku-Shittu, 2016), or in broader, randomised studies (FACT 2015, FACT 2017).

However, this brand share data remained partial, for different reasons.

The 2016 IFPRI report surveyed 414 families on the fortifiable brands they used, presenting Table xx below. However, the report explains (as note 5) that some families held multiple brands, without saying how many, and thus affecting market shares. More importantly, the findings do not indicate whether any smaller or unbranded foods were recorded, whereas the FACT survey 2017 found the vast majority of fortifiable home ingredients in homes were repackaged and unbranded, making it improbable that the data from IFPRI represented the total presence of fortifiable ingredients. The data was not, therefore, viable as a basis from which to derive consumer-end market shares.

Table 7.5: Summary of Food Samples Analyzed

Commodity	Main Brand Names	Number of Households Consuming	Fortified (y/n)	Included Micronutrients
Vegetable Oil	Ororo Kuli	259	No	
	Kings	105	Yes	Vitamins A and E
	Gino	110	Yes	Vitamins A and E
	Turkey	30	No	
Sugar	Dangote	246	Yes	Vitamin A
	St. Louis	67	No	
Margarrine	Blue Band	191	Yes	Vitamin A, D and E
	Simas	54	Yes	Vitamin A and D
Flour	Dangote	104	Yes	Vitamin A
	Honeywell	49	Yes	Vitamin A
	Golden Penny	44	Yes	Vitamin A

Source: Authors

The much broader FACT reports surveyed over 1,000 households each, but the 2015 survey, in final presentation form in 2019, did not share its market share findings or methodologies, but gave only topline summaries of how much fortifiable food was reaching homes, and how much of it was fortified. This offered no scope for any insights or derived data into the market share of brands.

By contrast, FACT 2017 has not produced a final presentation, but its underlying data sheets provide detailed data on the brands reaching homes and their percentages. However, as mentioned above, most of the samples were found to be unbranded, reaching the home a spoonful or jarful at a time. Moreover, while the market share of some few brands could have been derived, there was no matching data availability on compliance per brand, with the fortification levels per micronutrient given as a sin- gle average figure for all samples tested.

On this basis, none of the three consumer-based market share methods were comparable, or usable across other test data. However, they produced specific qualitative and quantitative insights that are used in the analysis provided in this report.

Market shares in retail outlets

In 2019, NAFDAC, working with GAIN, set about assessing the market share much more comprehensively, at the retail level, by commissioning a wide-ranging survey from IPSOS of 3,978 retail outlets across 24 Nigerian states.

This survey of market share was not hindered by the immediate presence or absence of products on shelves, as some analysts have suggested, because it combined an examination of shelf space with detailed interviews with store owners on their sales and supplies over the last three months. This was not a perfect process, as few Nigerian retail owners keep full ledgers, so many of the shares were from memory or experience. However, for store keepers whose entire working life is focused on sales, recalling how many boxes of one brand sells versus another is not too great a stretch in knowledge.

However, the limiting factor on this market share methodology was that it only assessed retail sales and compliance for fortifiable home cooking ingredients, for example packets of graded flour or table salt.

The value of monitoring this market segment alone is diminished by the fact that Nigerian families do not tend to use ingredients such as wheat flour, for instance, widely in home cooking, meaning that around 90 percent of the flour that reaches them (see page 18) is consumed as ready-made bread, biscuits, pasta, noodles, and cakes. These foods were not assessed at the retail level, meaning the NAFDAC study's market shares provided strong estimates of the relative brand positioning for home cooking ingredients alone, but not for Nigeria's fortified foods as a whole.

Market share by producer

The third type of market share calculation was undertaken by TechnoServe within the SAPFF programme. This method sought to identify market shares for the whole fortified market by estimating the shares of total production for each producer and brand.

This was a harder exercise than estimating retail sales, as there was no reference to shelf space or products in-store, and no interviews with producers on turnover figures and volumes. For this reason, the method used an estimation technique based on three assumptions.

Assumption 1: production levels

To calculate companies' production levels. This method began with the available data on the capacity of large producers' plants. These total capacities span production for both the retail market, as directly packaged home ingredients, and for the business market, as, for instance, 50kg bags of flour for com- mercial bakeries.

However, plants never operate at 100 percent of capacity, needing downtime for maintenance, cleaning, shift changes and many other factors. In the US, for instance, in 2019, the average operating rate of wheat millers, being the percentage of capacity used, was 82.3 percent (Sosland, 2020). In Nigeria, operating rates have tended to be far lower. One review of studies from 1985 to 2008 found the ca- pacity utilisation, or operating rate, of Nigerian manufacturers ranging from just 21 to 30 percent of installed capacity (Adeyemi,2016). However, management consultants KPMG reported, in 2016, that the capacity utilisation of wheat millers in Nigeria averaged 50 per cent (KPMG, 2016).

A further consideration in this estimate is that operating rates are also widely variable from one producer to another, there being no universality about this measure of efficiency. For instance, Cordros (2019) reported on the seasoning business within Dangote's salt business, Nascon: "We estimate that total capacity utilisation based on the 3.74MT/yr was 38% in 2018".

However, in the absence of specific producer data, TechnoServe estimated that the operating rate of each plant across all food types was 70 per cent. This introduced a large margin for error. For example,if a cooking oil producer was actually operating at the rate found in the peer-reviewed review of literature above (Adeyemi, 2016) of 25 percent, the 70 percent operating rate estimate would overstate their production level by nearly threefold.

To get each brand's market share calculation, this method then computed each plant's estimated production as a percentage of the government's estimate of total production for that food.

This generated anomalies in the Technoserve calculations, such as large producers accounting for all production, where smaller producers certainly existed, and the market shares of the large producers adding up to more than total national production.

Assumption 2: retail and B2B compliance parity

This estimation technique confined itself to home ingredient tests, in the same way the NAFDAC model did. But it then assumed that these results for home ingredients could be applied across the entire production spectrum. This implied an assumption that home ingredient compliance necessarily behaved the same way as B2B ingredient compliance.

In considering the degree to which this generated meaningful data, or may have been misleading, there are three considerations at play:
i. is there any evidence that B2B and processed foods demonstrate the same levels of compliance as home ingredients,
ii. what proportion of the market is taken by home ingredients, do they account for most sales, in which case the impact of any different compliance levels from B2B ingredients might be minimal,
iii. if home and B2B ingredients do begin with similar fortification levels, do they then deliver micronutrients at the same rate: specifically, home ingredients are fortified and packaged, but processed fortified foods are fortified, packaged, unpackaged, exposed to light, air and heat during processing, and often exposed to further light and air in their final form - is there evidence that this does not reduce micronutrients, or evidence that more micronutrients are added to these B2B ingredients to cover for these processing losses?

i. B2B compliance

Across all the surveys identified, just one took 17 samples of flour in use by bakeries (Uchendu, 2016), and found a pre-storage compliance rate in Vitamin A content - that is, before it had time to break down of just 23.5 per cent. This was far lower than the lowest compliance level recorded for retailed wheat flour over the period of this review, even after storage, which was the 50 percent recorded in the Gain, 2012 study (Ogunmoyela,2013).

One other, earlier study, that coincided with Ogunmoyela, 2013, more closely in timing, investigated Vitamin A fortification levels in baking flour and bread (Uchendu, 2012) testing four brands of bakery flour and found that none of them were compliant, nor did any of them fall within 50 per cent of the compliance level. The average levels of vitamin A were running at 28.5 percent of the mandatory re- quired level.

These points of reference on B2B fortified ingredients give substantial reason to believe B2B compliance could be lower than home ingredients compliance, which would render any extension of home ingredient compliance percentages to all fortified foods an over-statement of compliance levels.

However, the acute problem is the paucity of available data and tests on fortified B2B ingredients, which represents a profound and absolute limiting factor on determining the overall level of food for- tification compliance in Nigeria.

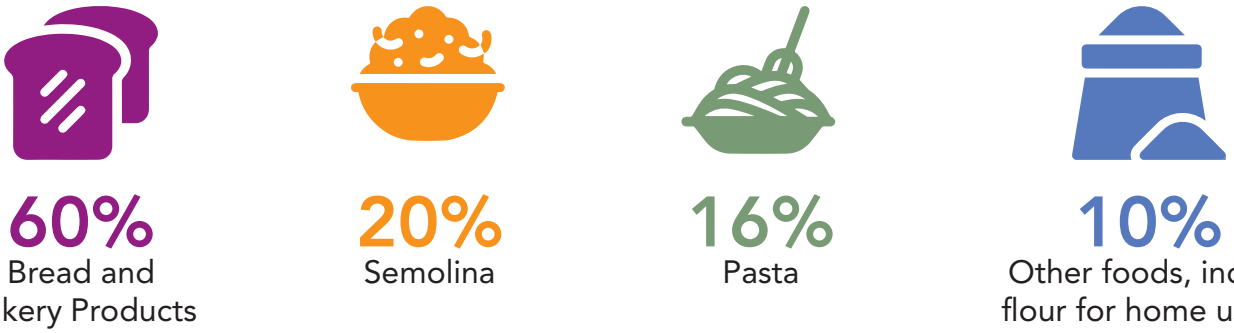
ii. scale of unmeasured B2B segments

Where data exists on the proportion of all fortifiable foods that arrive with consumers as home ingredients, that proportion is small.

For instance, the US Department of Agriculture in its Foreign Agriculture Service (USDA, 2019) reports that: "Seventy percent of the flour milled from wheat goes into bread production; pasta and other wheat flour-based products (including semolina) account for the balance."

The Bread and Bakery Market (BBM, 2021) reports that 60 percent of wheat use in Nigeria is for bread and bakery products, 20 percent for semolina, 10 percent for pasta, and 10 percent for other foods, which include flour for home use.

Figure 13: Wheat consumption by end-use (2019)



Source: (Bread and Bakery Market, 2021)

Processed foods account for the majority of consumption for other fortifiable commodities too. For instance, the IGN report on the salt content and iodisation of processed foods found that over 97 per- cent of Nigerian households had iodised salt in their home. But while it found adults getting 60 percent of their Reference Nutrient Intake (RNI) of iodine from the average 4.6g of household salt a day they consume, they get 76 percent of their iodine RNI from the salt in the average 180g a day of bread that they consume. Thus, just as with flour above, the iodisation of the bulk commercial salt used in bread is more instrumental in its reach to consumers than in the table salt that has been tested to date.

To put this in context, if:

1. the wheat tests on less than 10 percent of end-use wheat demonstrate 90 percent compliance, and
2. the relationship between Gain, 2012 and Florence 2016 between home wheat compliance and bak- ery wheat compliance hold, at more than a two-fold difference,

THEN
3. The actual level of wheat-industry wide compliance in that event would be: 0.9 x 45% = 40.5% + 0.1 x 90% = 9% = 49.5%

Thus, far beyond the significance of brand shares in the home ingredient market, or compliance in that one sub-segment, sits the need to test B2B samples, which account for the majority of the country's fortified foods.

iii. Processing stability

Unfortunately, the picture is rather worse than the market share of home ingredients and sole B2B data might suggest, as those B2B samples were taken pre-processing. In the earlier study, Uchendu (2012) found that none of the four bakery flours tested met today's man- datory requirements, with average Vitamin A levels of 28.5 percent of the mandatory standard.

However, the study raised a further issue. It cited a series of studies that found that baking bread reduced the Vitamin A levels by 20 to 30 per cent, which would further reduce bread and other food compliance. Thus, to achieve the same levels of compliance as home ingredients, commercial flours need to begin with 20 to 30 percent more micronutrients.

Yet, there appears to be an additional quality control issue in processed food fortification, with the Nigerian study finding a much greater depletion of Vitamin A during baking than the previous cited studies. Across the four samples, the average depletion was 81.7 percent, with the initially most forti- fied flour delivering Vitamin A to the bread it was used in.

Table x: Initial vitamin A content of wheat flour			
Sample flour	**Age(days)**	**Initial vitamin A content (i.u/kg)**	**% breakdown in baking**
A	10	8.134.3	87.7
B1	12	8,720.0	60.6
C	18	10,112.4	100
D	23	7,064.4	78.4
B1 Saponification method used			

Table x: Vitamin A content (i.u/kg) of fresh bread	
Sample fresh bread	**Vitamin A content (i.u/kg)**
A	998.7
BB1	3,438.1
CB	0.0
DB	1,524.0

The study's authors observe that this micronutrient instability is dictated by the way in which the Vitamin A is added, and that such high levels of depletion raise a further issue of quality control, beyond the pre-baking compliance levels, around stability.

Together with the evidence of lower opening compliance from the sole test data available, the dominant scale of the commercial flur market, and the additional issues around processing depletion, this report concludes that any calculation based on home ingredients alone cannot, therefore, and does not capture food fortification compliance in Nigeria in any meaningful way.

Assumption 3: market reach

The impact of this figure on perceptions of total compliance was also increased by additional estimates on consumer reach presented as percentages of the Nigerian population that could access compliant foods, with that access being presented as in excess of 90 percent for some foods.

An analysis of the assumptions underlying the reach calculator is beyond the purview of this report, as no other study offered a reach calculator, so there is no requirement or potential for data reconciliation.

However, as a chain, based on the assumptions above, the method reported, say, 90 percent access, in a sum that would have been only 65 percent access if just half the production facilities were running at an actual 35 percent operating rate, as had been observed in other studies. Or that same access figure would have been further reduced to 16.1 percent in the event home ingredient compliance was twice as high as commercial ingredient compliance,and in the event that commercial ingredients were depleted by just 20 percent during baking or food processing.

It is worth emphasising that in the absence of verifiable data, it is a norm to make a reasoned estimate. In this case, such estimates can give meaningful indications of how significant each producer is in achieving total compliance, and, more helpfully, how compliance is changing over time. This is because flaws in an estimation technique, such as the over-estimation of operating rates, will be repeated as the same flaw from period to period, such that any change in figures can be interpreted as a genuine change in, in this case, compliance, rather than a change in errors.

However, a normal statistical device, in order to stop data from being over or under-interpreted, is to also indicate the degree of confidence, or the standard deviation, or other measures of the margin of error or reliability, attached to such estimates.

The Technoserve estimates were a practical device that proved markedly useful in tracking producer progress year on year. But the fact that SAPFF did not indicate the potential for estimation errors, or what statisticians call variance, has led to widespread over-interpretation of the data to conclude that Nigerian food is now fully fortified.

In fact, this data could not be presented as demonstrating a satisfied compliance agenda in the ab- sence of any supporting research or evidence for the 70 percent operating rate, for the universality of home ingredient and B2B compliance, or for micronutrient resilience during food processing. None of these three assumptions enjoy supporting evidence, and in this review the only available data appears to conflict with these assumptions.

Market Share Comparability

Both of the main market share calculations used to date relied on testing home ingredients only, raising problems in their application to the whole market. The SAPFF methodology also introduced estimates on production levels to get market share. However, a final area of investigation on these calculations is their inter-relation. Does either method offer validation for, or discredit, the other calculation?

In fact, to map the shares reported under the producer-end methodology and the retail-end method- ology, one against the other, two things are necessary:
i. it must be possible to separate out the proportion of total production sold as retail home ingredients.
This is because a company can and will have very different market shares in retail home ingredients and in B2B sales to food processors. For example, in 2019, Nigeria investment Bank Cordross (2019) initiated reported:

"NASCON and Royal Salt are the biggest players in the Nigerian salt industry, accounting for 60% and 25% of market share, respectively. While, NASCON is the undisputed leader (78-80%) in the bulk salt sub-segment, Royal Salt controls the refined salt market."

It then went on to detail some of the companies' different market shares, such as in edible salt, and seasoning.

Thus, where the SAPFF took all salt production and the total plant size as the measure of market share, the NAFDAC market shares for salt in just the retailed table salt market will almost always be different than the total production share of all salts.

The only way to compare the shares, one measure to the other, is to know how much of that salt plant's production was going as retailed table salt, and have that as a percentage of all retailed table salt. That figure should then be a starting point for alignment with the market share found in the retail sales too.

However, even then, there will need to be some further mapping, as comparison will require:
ii. the mapping of items that shift brand (and/or market segment) along the value chain.
Take sugar: some, but not all, bulk B2B sugar is sold to repackers, who repackage it and brand it. So these retail sales will not appear in the retail sales of the initial (fotifying) producer, but they will exist and impact the initial producer's production end market share.

Yet, if all of that producer's B2B sales were added to its direct retail sales at the start, to capture the sub-stream that gets sold as a B2B sale and repackaged back into the retail market, that addition would also capture all sugar sold to biscuit manufacturers and soda makers too, thereby inflating the initial producer's retail share.

Thus, some products will arrive branded in the retail market by the original millers, while some will be branded by bulk purchasers and repackagers. To relate the two market shares, all these transitions from one subsection of the market to another and one brand to another would need to be mapped. Moreover, these crossovers are dynamic, with repackagers sourcing from different suppliers over time, meaning the impact of the produce that changes track down the value chain would be constantly changing.

In sum, these two measures can never give the same results and nor can they be used as verification one on the other without considerable, in-depth and constantly changing, contextual information. This is because they measure a dynamic value chain at different points, and with only very partial information at the production end.

Compliance Comparability

Just as there has been no standard for the calculation of market share across the 12 studies reviewed, so there has been no standard for the compliance measurement. Most of the studies reviewed used a range around the mandatory levels as the standard for compliance. There has been some variance in this range in some studies, but this has been marginal.

Some of the studies did not give data per sample, and instead offer percentages of samples that fell into categories, like underfortified, or no detectable fortification. Some, such as FACT 2017, give only a single average level of a micronutrient, such as iron, as the outcome from many hundreds of tests.

In deciding how best to compare data across these differing methodologies, it is worth revisiting the purpose of this study, which is to review compliance progress over the period. The best sight of this can be gained by finding a comparison method that is viable for the largest number of data sets.

Only three data sets provided results with brands for the reviewers, being the NAFDAQ, SoN, and SAPFF data sets. Thus, applying one or other calculation of market share to these three studies would have excluded the data from the other 9 studies.

For this reason, the final data analysis investigating change over time, based progress on the percentages of sample sets that were found to be compliant, as an indicator of the percentage of producers who were appearing to have become compliant.

This compliance mapping is, however, by force of available data, an analysis of a small sub-segment of the fortified foods market and industry, in that all the analysed test results were from home ingredients.

However, by drawing in qualitative and quantitative data wherever it adds insights, and organising a comparison from survey to survey based on the percentage of samples that were compliant, this report seeks to achieve the best possible pointer to progress.

Other Lateral Data on Compliance

While the absence of testing around B2B products has left a notable blind spot in understanding compliance records, the most recent estimates from SAPFF on total premix consumption in the country indicates that it is running far lower than would be needed to fully fortify all the estimated fortifiable food production across both retail and B2B.

This could offer a partial clue on compliance levels. While the calculated levels appear to have been based on initial fortification to mandatory levels, with no overage for processing losses, these micronutrients are not manufactured within Nigeria, so the fact that the volume of their imports is only enough to satisfactorily fortify 60 percent of some of the fortifiable foods sold in the country is, of itself, an absolute limiting factor.

It is not possible, on the face of it, for compliance to be running at more than 61 per cent for wheat and sugar, or 88 per cent (query below) for cooking oils.

Only the salt industry is importing sufficient micronutrient premix.

Market Gap: Fortification Addressable Market vs Current Utilization				
	Wheat Flour	**Edible Oils**	**Salt**	**Sugar**
Est. total addressable market (potential consumption/annum)	2,280 MT Premix	47.2MT VAP	65.5MT of KIO	351MT Vitamin A Palmitate
Est. Current Consumption/annum (supply)	1,368 MT Premix	415.1MT VAP	64-65MT of KIO	214MT Vitamin A Palmitate
Sufficient for Compliance of:	60%	Error? 88%?	98%	61%

Home Ingredients Data review

Consumption

Salt is present in almost all Nigerian homes and is thus a strong vehicle of fortification in terms of consumer reach. The Fortification Assessment Coverage Toolkit (FACT) report conducted by GAIN in 2015(FACT, 2015) found 98.4 percent of households consuming salt in Nigeria's wealthiest state of Lagos.

The later FACT Report in 2017(GAIN, 2020), carried out in Ebonyi and Sokoto, which are two of Nigeria's five poorest states, likewise found salt used in 1,221 homes of 1,224 surveyed. However, there was no salt in 21.8 percent of these homes at the time of the survey, suggesting that while salt reaches almost all homes, its presence in some homes is intermittent.

In 2020, on the basis of sales through 1,550 retail outlets across 20 states, IPSOS calculated that salt reached 73 percent of Nigerian retail outlets (GAIN, 2020).

Moreover, salt is used quite heavily in terms of individual consumption levels, with a 2016 literature re- view assessing sodium intake across sub-Saharan Africa reporting that the highest intake of any in SSA was found in Nigeria, at over 10g a day(Oyebode, 2016). Studies included in that same review, likewise, found Nigerian children consuming more salt than the recommended levels for adults.

Market Structure

There has been no large-scale salt processing in Nigeria, despite widespread deposits. Only small amounts of salt are derived as a cottage industry from salt springs in Awe (Plateau State), Abakaliki (Ebonyi State) and Uburu (Imo State), and rock salt in Benue State(Foraminifera, 2016), or made in the home.

As a result, almost all salt is imported, either ready-packaged, or in bulk as raw salt, which is then re- fined by bleaching edible salt and adding iodine.

Raw salt, brought into the country principally from Brazil, Namibia and Egypt, remains one of Nigeria's largest imports by tonnage, but it is brought in for industrial use – for leather tanning, dyeing and bleaching, the production of pottery, soap and chlorine, and for wide use in the chemical industry - as well as for human consumption.

The two market dominant Nigerian salt refiners are Dangote Group subsidiary the National Salt Com- pany of Nigeria (NASCON), and Royal Salt, which together refine over 80 per cent of Nigeria's salt. In 2019, according to security industry analysts Cordros Securities (Cordros, 2019), NASCON accounted for a 60 per cent share of the edible salt market and Royal Salt for 25 per cent. However, NASCON led with a 78 per cent to 80 percent market share in the bulk salt market, while Royal Salt led in the refined salt market for home consumption.

In 2019, NASCON was increasing its refined salt market capacity by 250,000 tonnes, but prior to the expansion,it held a market share of 25 per cent to 28 percent of the refined salt market, Cordros re- ported(Cordros, 2019).

Of the food-grade table salt consumed by households, almost all of it is branded salts that are import- ed and iodised in Nigeria, with the FACT 2017 report finding just 0.3 percent of the salt in homes being home-made or locally made(GAIN, 2017). Of the salt bought by Nigerian households, the largest suppliers are Nigerian refiners and repackagers Royal Salt and Dangote Salt, which each sell salt under multiple brand names, with the leading brands by market share, reported by IPSOS in 2019(IPSOS, 2019)as shown in the table below:

Table 5: Market Share of salt brands in the retail (consumer-facing) market

Salt Brand Product	Salt Type	Origin	Labelling	Market Share
Dangote Refined and iodized salt	Table Salt	Local	Labelled	25.6
Royal Salt	Edible iodised salt for industrial use	Local	Labelled	24.2
Dangote edible iodized salt	Edible iodised salt for industrial use	local	Labelled	22.9
Mr. Chef - Pure refined	Table Salt	Local	Labelled	14.3
Uncle Palm iodized salt	Table Salt	Local	Labelled	3.4

Source: (IPSOS in 2019)

The 2015 FACT survey (FACT, 2015) of households in Ebonyi and Sohoto states also found the same three table salt brands to be market dominant, accounting for 98.2 percent of all salt consumed, where the brand was known. However, the survey also found that consumers were unable to identify the brand of half of the sale bought, and that 55 percent of salt found in the home was no longer in its original packaging, with salt frequently repackaged along the supply chain.

Table 6: Household survey of salt brands bought, 2015				
Name of Salt Brand bought	**percentage of respondents**	**Origin**	**Labelling**	**Market Share**
Don't Know	50%	Local	Labelled	25.6
Uncle Palm Salt (Royal Salt)	30.5%	Local	Labelled	24.2
Dangote Salt	13.8%	local	Labelled	22.9
Mr Chef Salt	4.8%	Local	Labelled	14.3
Other named brands	1.8%	Local	Labelled	3.4

Source: 2015 FACT survey(FACT ,2015)

Table 7: Packaged Versus Repackaged Salt				
Bought in original package	49.7 %	Local	Labelled	25.6
Bought repackaged	50.1%	Local	Labelled	24.2

This repackaging down the value chain has been identified as a factor disrupting the success of iodisation, with IFRI observing in its 2016 NSSP report: "Salt and iodine deficiency disorder is still a problem. This was attributed to the fact that iodized salt is often sold in open receptacles although attempts are being made to require packing of quantities that are 50 mg or higher" (Kuku-Shittu, 2016).

The Compliance Decade

The degree of salt fortification compliance in Nigeria has been relatively volatile, fluctuating over time and by region. Presented as a swift and early success, Nigeria achieved iodine sufficiency through food fortification by 2007, before then losing ground in its compliance levels.

Citing the 2009 and 2010 IDD Newsletters of the International Council for Control of Iodine Deficiency Disorders, Jibril et al report(Jibril, 2016): "By 2003, the national household coverage of iodized salt was 97.3% and Nigeria was the first African country declared iodine sufficient in 2007. Soon after that, the level of salt iodization dropped to < 75%."

In 2018, the then Head of Nutrition oa the Federal Ministry of Health, Dr. Chris. Isokpunwu, reported that salt iodisation coverage had actually fallen as low as 53 percent after 2007.(Isokpunwu, 2018). This significantly lower level of compliance and reach appears to have persisted for some years, with the Fortification Assessment Coverage Toolkit (FACT) Study 2015 finding only 11.8 percent of the salt in Lagos homes under fortified or not fortified at all, aligning with a compliance rate of 88.2 percent, but 59 percent of the salt found in Kano homes under fortified or not fortified (FACT, 2018).

Table 8: Fortification status of salt in Lagos and Kano homes, 2015					
Location	**Unfortified (%)**	**Inadequately fortified (%)**	**Adequately fortified (%)**	**Over Fortified (%)**	**Total (%)**
Kano	23.3	35.7	28.0	13.0	100
Lagos	8.5	3.3	11.8	76.4	100

Source: (GAIN, 2017)

A year later, the International Food Policy Research Institute (IFPRI) published a study on Kwara State, which is one of the ten poorest states in Nigeria (Unicef, 2007) with more than 70 percent of the population estimated to be living on less than a dollar a day (Kuku-Shittu, 2016), in which it found iodised salt reaching 70.7 percent of households(Jibril, 2016).

Together, these studies paint a consistent picture of a significant decline in fortification after 2007, until at least 2015, with the impact apparently greater in poorer areas than in the richer areas of Lagos.

However, by 2018, Dr. Chris. Isokpunwu reported that coverage levels were back up to 91 percent(Isokpunwu, 2018). Likewise, the 2018 Demographic and Health Survey(GAIN, 2020) reported that 97 percent of the households in Nigeria were using iodized salt. This level of reach was much higher than other studies from around the same time, but the DHS did not test salts for compliance levels, so a substantial proportion of these salts may still have been under fortified.

"The 2018 NDHS tested for the presence of iodine in household salt in the form of potassium iodate. Salt was tested for the presence or absence of iodine only; the iodine content of the salt was not meas- ured. All households were asked if they had salt and, if so, if that salt could be tested. In total, 4% of households had no salt and 3% had salt that was not tested. Salt was tested in 94% of households, and among households in which salt was tested 97% had iodised salt."

However, the 2020 IGN Study Report on iodine levels in processed foods reported test results from the Standards Organisation of Nigeria that rose from an average compliance level of 80 percent in 2015 to 94.6 percent by 2019. These findings were from local processors refining imported crude salt.

Table 9: Percentage compliance with salt iodine level by salt factories from 2015 - 2019					
Year	**2015**	**2016**	**2017**	**2018**	**2019**
Percentage(%)	80	91.5	89.1	98.2	94.6
Source: Standards Organisation of Nigeria, 2020(IGN, 2020). Annual monitoring data based on average monthly iodization compliance data obtained from the laboratories of local salt-producing companies for iodized salt at factory level in the last five years. (The crude imported salt is refined and iodized locally)					

These same processors were also the target from 2017 of the SAPFF programme to improve industry compliance, administered by TechnoServe. From inception, TechnoServe conducted periodic testing of these leading salt producers with the test samples coming through as fully compliant.

However, in 2019, a market analysis by NAFDAC, conducted by GAIN, threw up new red flags. The NAFDAC, 2020 survey began with a countrywide market share survey by IPSOS that identified 55 brands of salt. NAFDAC tested 42 percent of the salt brands identified by IPSOS, gathering results for 23 of the brands, and found only 17 of these 23 salts, or 74 percent, in the standard range for iodisation(GAIN, 2020). Four of these non-compliant salts were fortified, but at levels below the minimum standards, while two of the salts were not iodised at all. Yet, of these six non-compliant brands, five had been imported in their packaged form and sold in that form, as imported brands.

Thus, where Technoserve (Technoserve, 2021) had found full compliance across large Nigerian refiners, and the Standards Organisation of Nigeria had seen its testing of a wider range of large Nigerian pro- cessors and importers also move towards comprehensive compliance, testing at the market level by NAFDAC, and of imports, found compliance wanting, because non-compliant imported salt was still reaching retail outlets.

Thus, a picture has emerged over the decade where Nigerian producers achieved early compliance, but slipped backwards before returning to full or near-full compliance on partner engagement and compliance monitoring.

But, in the marketplace, packaged imports arriving into retail outlets in 2019 were not fully compliant, making testing at ports of entry a live issue.

Meanwhile, in the home, several factors appear to have been hindering iodine compliance, being non-compliant imports, the repackaging of products that is affecting the stability of iodine, and the possibility of some black market salts reaching homes: thus iodine compliance in this next phase may require particular attention at the market level.

Additionally, in August 2020, the Iodine Global Network published a study looking at salt and iodine levels in processed foods in Nigeria. The study was designed to consider whether bouillon could con- tribute meaningfully to further raising iodine levels in the country.

In this context, the IGN reported that up to 75 percent of salt intake in developed countries now come from processed foods. In Nigeria, according to Howard(IGN, 2020), more than 90 percent of house- holds consume bouillon, with an average consumption of 2g-8g per day.

Nigerians are also increasingly consuming other high-salt foods, notably noodles, roasted nuts, bread, biscuits, sauces and soups, beefy snacks, sausage rolls, and tomato paste, all of which can or should be providing fortified iodine.

With data showing consumers consuming iodine from salt in bread and other processed foods, as well as from table salt, it is clear that some consumers will now be getting iodine at levels that exceed the recommended dietary allowance (RDA) for iodine intake of 150 micrograms (µg)/day in adults, 220 µg/ day in pregnant women, and 290 µg/day in breast-feeding women, while others are still deficient.

However, iodine does not present a sensitive upper limit with the Linus Pauling Institute (NPC,2019) calculating an adult upper limit of 1,100 mcg per day (and an upper range for children and adolescents running from 200-900 mcg per day). Long term intakes above 1,100 mcg per day for iodine-sufficient adults "may increase the risk of thyroid disorders, including iodine-induced goiter and hypothyroidism".

However, the analysis by IGN found that multiple sources were together leading to intakes that were on average above the RDA, but at levels that were not at all close to 1,100 mcg per day.

Table 10: Typical Serving sizes, Average daily Intake and Sodium, salt and iodine content of household salt and the selected Processed Food Products

Food product	Serving Size (g)	Average Daily Intake (g)	Sodium content (% product weight)	Salt Content (% product weight)	Estimated Iodine Content if all salt iodized (µg)
Household Cooking Salt	N/A	4.3	39	100	90
Instant Noodles	70	6.3	1.7	4.3	9
Bread	30	180	0.7	1.8	113
Bouillon	3.3	3.4	26	65	77

Source: (IGN, 2020)The IGN, 2020, report also raised the issue of uneven iodine results, with a 2016 study by Onyekwelu, Ezeagu and Igbedioh reporting adequate iodine intake amongst school age children in Enugu State of Nigeria. But Kayode et al (2019) reporting the results of a study in which pregnant women in Lagos State were found to have insufficient iodine intake, while non- pregnant women had sufficient intake. The IGN report noted that the range of results further reinforced the need for a national survey to determine iodine levels among different population groups in different regions of the country.

This is made more important bearing in mind the opening differences and the far heavier loads of iodine deficiency in the country's goiter belt in the south-east(GAIN, 2017).

However, recent studies do point to a rise in Iodine Induced Hyperthyroidism (IIH) which is a common disorder associated with salt iodization following chronic iodine deficiency(Onyeaghala, 2016) IIH is initially marked by excessive energy and weight loss and is relatively easily resolved by stopping the source of excessive iodine.

But, symptoms can become more serious if left unaddressed. In the Nigerian context, which has moved from initially high levels of deficiency to effective iodisation, ensuring IIH does not present new nutritional issues will require healthcare training for early identification and management. The persistence of iodine deficiencies in some specific populations and regions further raises a second-generation mitigation challenge of fine-tuning iodine intakes.

Sugar

Consumption

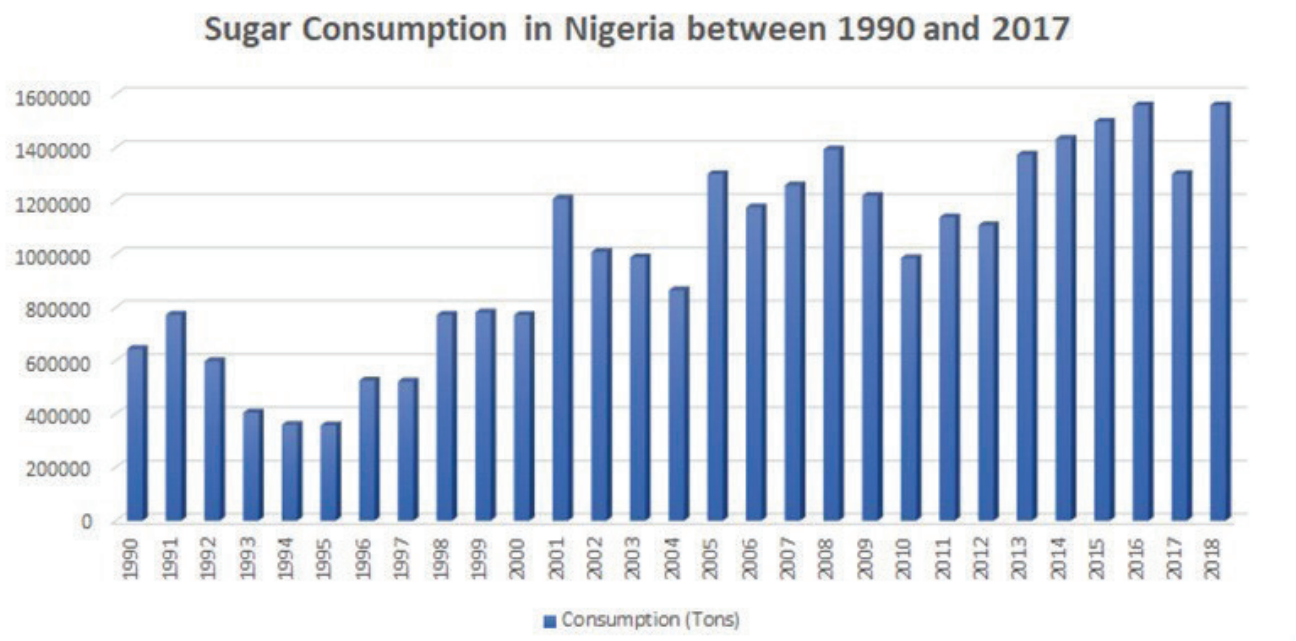
Nigeria's total sugar consumption has more than doubled since the 1990s to reach around 1.6m tonnes a year by 2020, but much of the rise has been driven by population growth with per capita consumption remaining fairly low, at around 7kg to 8kg per person (Technoserve, 2021).This is less than half the sugar consumption of countries such as Kenya, where per capita consumption is around 16kg a year, and compares with the global average of 36kg per person.

Table 11: Sugar consumption, source and cost, 2011 to 2018

Year	Consumption (Million Tons)	Production (Million Tons)	Importation (Million Tons)	Average Unit price ($/MT)	Importation cost (million $)	per capita
2011	1.13	0.035	1.10	595	657	7.6
2012	1.11	0.011	1.10	471	517	6.6
2013	1.37	0.010	1.37	377	518	8.1
2014	1.43	0.012	1.43	441	632	8.6
2015	1.50	0.013	1.48	372	552	8.7
2016	1.56	0.025	1.56	330	516	9.1
2017	1.30	0.049	1.29	357	459	7.6
2018	1.56	0.030	1.22	277	337	6.8

Source: National Sugar Development Council (Technoserve, 2021)

Figure 7: Sugar consumption in Nigeria between 1990 and 2017



Source: National Sugar Development Council(Technoserve, 2021)

With much lower sugar consumption than elsewhere, the 2016 NSSP(Kuku-Shittu, 2016) survey in Kwara State found that: "Sugar was consumed mainly as a sweetener for pap and tea, but very often in small quantities."

In 2017, in Ebonyi and Sokoto states, the FACT survey (GAIN, 2017) found that 14 percent of the households interviewed did not use sugar at all, and of those that did, 43 percent reported their most recent sugar purchase was bought as a spoonful. Moreover, 84 percent of those who said they used sugar had none in the house at the time. Thus, less than 15 percent of the 1,224 homes visited had sugar in the house at the time they were surveyed (GAIN, 2017).

Recent reports further suggest that sugar consumption has been declining. The US FDA reported in May 2021 that per capita sugar consumption was falling and cited the Nigerian National Bureau of Statistics as reporting that half of Nigerian households had reduced their food spending in the second half of 2020, at the same time as the devaluation of the Nigerian currency led to higher sugar prices with nearly all crude Nigerian sugar imported.

Some of the trade is illegal, however. Northern Nigeria accounts for 65 percent of sugar consumption, reports the USDA FAS, as urban consumers, and particularly middle-income earners, in the southern states move to avoid sugar on health concerns. Yet sugar trading in the north is currently hindered by insecurity, whereas "the unofficial trade is still active," reported FAS in May 2021(USFA, 2021).

Producers

Of Nigeria's approximately 1.6m tonnes of sugar consumption, just 70,000 tonnes are grown locally as sugar cane. The government has a National Sugar Policy in place designed to raise local production, which has been driving production growth of up to 50 percent a year, but remains far short of its initial target of sugar self-sufficiency by 2023. Thus, up until 2021, more than 95 percent of Nigeria's sugar continues to be imported as raw sugar that is refined locally.

The importing of refined and packaged retail sugars has been banned since 2013, and there are sugar quotas on crude sugar, which is one of the country's five largest imports by volume. But, in 2021, importing refined sugar into the country's free trade zones was also banned and several months later, it was announced that only three companies would be allowed continued access to foreign exchange to import raw sugar, as the country sought to further reduce the pressure on its currency reserves. However, these three importers have dominated the market for some years. Ofonyelu reported in 2014 (Ofonyelu, 2014) that Dangote Sugar Refinery (DSR), BUA Sugar Refinery (BSR) and Golden Pen- ny Sugar Refinery (GPSR) together accounted for over 95 percent of Nigeria's sugar refining, with DSR accounting for 60 percent of total industry output, BSR 31 percent, and GPSR 6 percent.

However, the shortfall in local production and ongoing import quotas have meant the country's sugar refining capacity remains significantly under-utilised. In 2014, Ofonyelu(Ofonyelu, 2014) reported that about 10 percent of DSR's refining capacity was idle, which is a normal margin at full capacity, but BSR and GPSR were operating at 45 percent and 12 percent of their installed refining capacity.

By 2021, the USDA Foreign Agriculture Service newsletter reported that sugar refining capacity further increased from 2.75m tonnes in 2019 to 3.4m tonnes in 2020, but was operating at less than 70 percent capacity (USFA, 2021).

Reports the FAO: Of the four largest mills, Savannah Sugar Company is owned by Dangote Sugar and processes local cane sugar, so is situated in the Adamawa State close to the sugar plantations. The three other major mills are concentrated in the Central East part of the country (FAO, 2013).

In addition to the three main domestic refiners, there were also local brands that were historically im- porting refined sugar that they repackaged. These included Dogan's, which has held a significant share of the retail market, and McNichols, which sells sugar under the Family brand (Asoko, 2018). These producers now purchase from the domestic refiners, sometimes buying fortified sugar, and sometimes unfortified sugar, and blending them to meet the fortification standards.

However, imports still feature across the retail landscape. Measuring the brands found in retail outlets across 20 states in 2019, the IPSOS survey carried out as part of the NAFDAC market survey found 74 percent of the sugar brands on sale were

produced locally, but 26 percent were directly imported in their retail packaging.

Reported Asoko Insight in 2017: "Once sugar reaches the retail market, it faces the challenge of being undercut by cheaper black market imports, according to John Maniatis, General Manager of Golden Sugar Limited, who cited the recent rise in the illegal importation of processed sugar as another significant challenge for sugar manufacturers"(Asoko, 2018).

His comments echo the reporting by IFPRI in 2016, that: there are two major challenges facing the country with regards to vitamin A food fortification: being the continued importation of non-fortified edible vegetable oil, and of sugar(Kuku-Shittu, 2016).

Compliance

Sugar was assigned for mandatory fortification with Vitamin A in 2002. A decade later, (Ogunmoyela, 2013) found in 2012, on testing 42 sugar samples collected from producers and major markets across Nigeria, that the mean average level of vitamin A was just 4,486 IU/kg compared with compliance range of 12,500 to 20,000 IU/kg, with half the samples below the minimum compliance range.

By 2015, there appears to have been some improvements in compliance. Of the testable samples of sugar and household's reports of which tested brand they last bought, even where it was now absent, the FACT 2015 survey (FACT, 2015) found that 66.3 percent of the identified samples and brands in Lagos were compliant, and 72.4 percent of the samples and brands in Kano State.

Yet, in sugar more than in any other commodity, the results required a great deal of in-filling, with just 28 homes having sugar that was still in its original packaging, 27 of them with visible writing and logos, of 1,196 sugar-using households.

Of all the sugar reported as consumed, the study could neither test nor identify over 65 percent of the sugar consumed in Kano, and around 35 percent of the sugar consumed in Lagos State.

The scale of the repackaging also raised concerns about the stability of Vitamin A once exposed to the air, through storage in open packaging and repeated repackaging(FACT, 2015).

Results started to come through more strongly, however, after the Standards Organisation of Nigeria began regular factory level testing in 2015.

In Kwara State, IFPRI(Kuku-Shittu, 2016) found 246 households consuming Dangote sugar that was ad- equately fortified and 67 consuming St Louis sugar that was not, in a sample of 414. This would suggest that more than half of households were consuming fortified sugar.

FACT 2017 (GAIN, 2017) also found higher levels of sugar compliance, reporting a mean level of Vita- min A across all samples tested of 21418, compared with the 25000 IU/kg mandatory level.

However, NAFDAC's 2019 survey(GAIN, 2020) of market-level products once again raised the prospect of widespread non-compliance, reporting that 58 percent of the sugar brands analysed were non-com- pliant. Based on the brand market shares used in the report from the IPSOS study of retail outlet sales, this amounted to 43 percent of the retail sugar sold being non-compliant.

Table 12: Retail market share and fortification status of main sugar brands, 2019

Brand	Colour	Market share (%)	Fortification status
Family	White	19.5	Adequately Fortified
Dangote	White	17.8	Fortified Below Std
Family	Brown	17.4	Fortified Below Std
Bua	White	9.1	Fortified Below Std
Golden Penny	White	7.8	Adequately Fortified
Family sugar cubes	White	7.3	Fortified Below Std
Dogan's	White	6.7	Adequately Fortified

Source: NAFDAC's 2019 survey(GAIN, 2020).

All of the samples had been fortified and packaged locally, according to NAFDAC, which raised a new compliance challenge, since the surging non-compliance was by local producers, and predated any impact from Covid-disrupted supply chains.

Table 13: Fortification and labelling status of retail sugar samples

Food	Labelling	% of brand products fortified	% adequately fortified	% fortified below standard	% of brand products not fortified	Total % of brand products analyzed
Sugar	Not labelled as fortified	21	0	21	0	21
	Labelled as fortified	79	42	37	0	79

Source: NAFDAC's 2019 survey(Kuku-Shittu, 2016)

However, in measuring Vitamin A compliance, its instability in food vehicles means it will normally register the highest levels of compliance at the factory level, with compliance in the marketplace fall- ing as the vitamin A content declines, and hitting

its lowest levels in homes in a deterioration that is accelerated if the food vehicle is exposed to light or air, which sugar manifestly is in the supply chain to Nigerian consumers, with the majority bought by the spoonful (FACT, 2017).

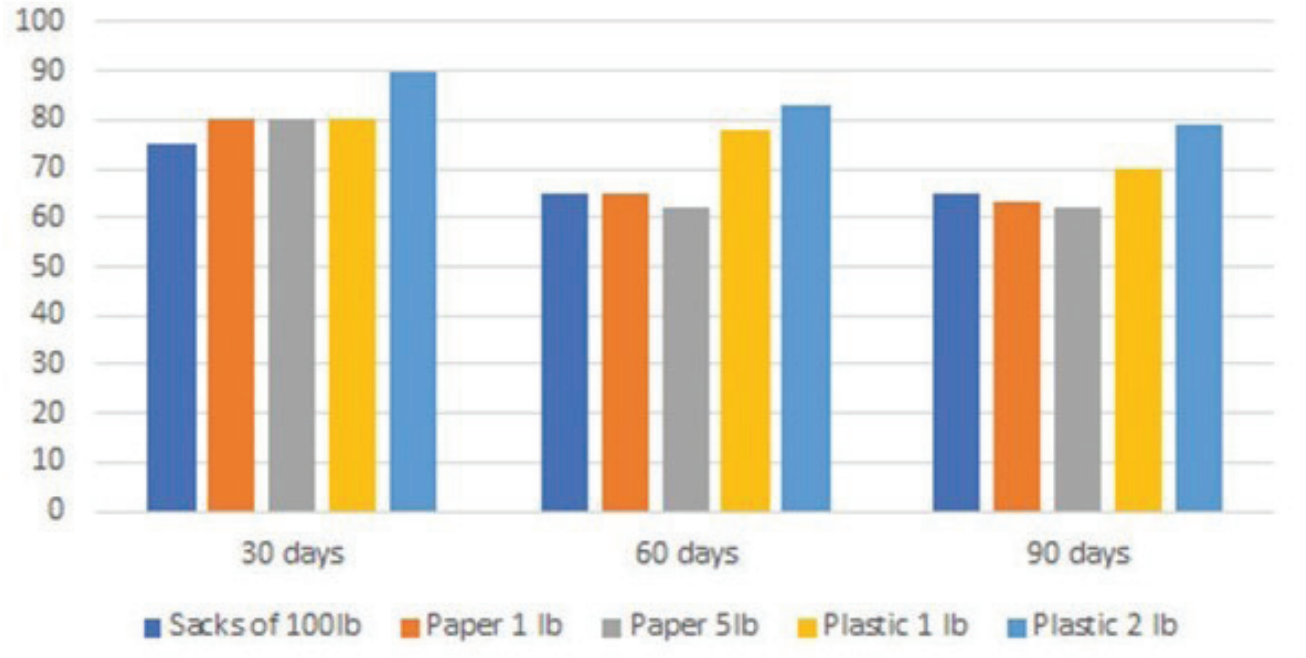
Sensitivity of Vitamins							
	Light	Oxidizing agents	Reducing agents	Heat	Humidity	Acids	Alkalis
Vitamin A	+++	+++	+	++	+	++	+
Vitamin D	+++	+++	+	++	+	++	++
Vitamin E	++	++	+	++	+	+	++
Vitamin K	+++	++	+	+	+	+	+++
Vitamin C	+	+++	+	++	++	++	+++
Thiamin	++	+	+	+++	++	+	+++
Riboflavin	+++	+	++	+	+	+	+
Niacin	+	+	++	+	+	+	+
Vitamin B6	++	+	+	+	+	++	+ +
Vitamin B12	++	+	+++	+	++	+++	+++
Pantothenic Acid	+	+	+	++	++	+++	+++
Folic Acid	++	+++	+++	+	+	+	++
Bictin	+	+	+	+	+	++	++
+ Hardly or not sensitive ++ Sensitive +++ Highly sensitive							
Source: F. Hoffman - La Roche Basel							

Studies suggest the degree of this deterioration might be relatively slow in Nigeria based on its climate, with the vitamin A content of fortified sugar having been found to fall by just 8 per cent in hot-dry climates, such as Nigeria's, after three months of storage, but by a further 13 points in the next three months. However, this assumes containers that protect the vitamin from light and air.

Table 14: Impact of the environment and storage on Vitamin A levels, as percentage of retained vitamin A, compared to original levels, at each testing point			
Environment	**Months of storage (12.5 lb bags)**		
	3	6	9
Cold-humid	90	77	66
Hot-dry	92	71	63
Temperate-humid	83	69	43
Hot-humid	80	62	40
Source: (Morales de Canahui, 1996)			

Most Nigerian branded packaging is Vitamin A retentive, but as the FACT 2017 reported in detail, very little sugar arrives in homes in its original packaging, which will necessarily push down its vitamin A content, through light, heat, and oxidisation. The quality of premix will also affect the rate of vitamin A breakdown: with the deterioration likely to be accelerated if premix has been stored for any period, or stored poorly.

Figure 8: Effect of storage on stability of vitamin A in fortified sugar packaged in different materials, measured as percentage of retained Vitamin A compared with original content levels



Source: (GAIN, 2017)

Based on the breakdown of Vitamin A over time, DSM recommends an average being the amount to add over the recommended content level for Vitamin A of some 10 to 20 percent over compliance levels.

In this regard, many of the problems of compliance in sugar appear to have originated in local production. TechnoServe, working closely in partnership with the large sugar producers from 2017 under SAPFF, found in its first sets of compliance tests, taken as a baseline in 2017, that of the two out of four large producers tested, both were fortifying sugar, but neither were producing sufficiently fortified product by a margin of more than 55 percent, with a mean average Vitamin A level of just 5740 IU / kg.

However, tests of three of four large producers in 2019 found one of the three testing at well above the compliance level, and while sugar samples from the other two producers were inadequately fortified, they were still carrying Vitamin A of a mean average of 19,100 IU / kg, representing a notable improvement.

The picture improved again across SAPFF producers in 2020. Of the two producers tested, one was adequately fortified and one was not, but both producers were fortifying at above 20,000 IU/kg.

However, the Covid-19 pandemic appears to have severely disrupted the supply of both Vitamin A and of imported premixes to Nigeria.

Of 19 sugar samples gathered by TechnoServe from April to July 2021, only 8 were compliant, and across the 11 that weren't, Vitamin A levels had crashed. Three of the 19, or 15.8 percent, had no de- tectable Vitamin A, and of the other eight under-fortified samples, only two had anything over half the required levels of Vitamin A with most at 5 percent to 20 percent of compliance levels.

The SON 2021 Factory Level Assessment similarly found a marked retreat in compliance, with only one of five factory samples compliant,and all the other four under-fortified.

Based on the known rate of breakdown in Vitamin A in sugar, and the relative absence of any 'overage' margin with producers from 2017 to 2019, according to the TechnoServe sample data, the inadequate fortification recorded by NAFDAC from marketplace samples in 2019 would be the expected outcome. It aligns relatively closely with the lack of any allowance for Vitamin A breakdown in storage.

However, at the factory level from 2020, Vitamin A fortification compliance in sugar also plummeted, and might reasonably be expected to appear in the marketplace at far below the 50 per cent compli- ance that was achieved in the market during 2021 and into 2022.

This progression thus raises two issues.
As a long-term focus and potential correction, it may be necessary to adjust factory levels of Vitamin A fortification to compensate for Vitamin A breakdown along the supply chain. But judging this correctly could benefit from more insight into the average time to elapse from production to human consump- tion along the Nigerian consumer supply chain.

The second and more immediate issue relates to the pace and scale of compliance breakdown, in terms of factory-level fortification levels, in the face of the supply shocks caused by the Covid-19 pandemic. Consideration could usefully be given to ways of extending or backing up the quality and availability of premix in the face of disruptions from the main sources.

Technoserve reported in its review of premix supplies that: "All the sugar refineries in Nigeria import the Vitamin A palmitate for the preparation of the pre-blend. The two major suppliers are BASF and DSM." Consideration should be given to market signalling or support on any future occasion where these supplies fail.

Cooking Oil

Consumption

The requirement to fortify cooking oil has been in place since 2002, with cooking oil used in most Nigerian homes for baking, frying, and other food preparation, as well as to make soap, detergents, and margarine. The consumption of edible oils has been rising, as wealthier consumers move away from animal fat on health grounds(Proshare, 2021).

Overall, FAOSTAT reports that Nigerians consume an average 12.5g kg of cooking oil a year, compared with a global average of 20 Kg per person, amounting to total consumption of around 1m tonnes, according to Proshare(Proshare,2021).

The FACT 2015 study in Kano and Lagos found 98 percent of homes using cooking oil on an average daily basis. But most of it appears to have been locally produced, often unbranded, crude, 'red oil'. In 2017, a further FACT survey in Ebonyi and Sokoto found the same, with red palm oil accounting for 62.7 percent of consumption(FACT, 2015).

Beyond being unfortified, red palm oil typically has a short shelf life and can cause long term health problems, according to Ebere et al., with traditional methods of production and inadequate storage raising its levels of FFA, moisture, acid, and peroxide(Ebere, 2018).

Table 15: Oil consumption by type, Sokoto and Ebonyi, 2017

Type of cooking oil used by household	percentage of users
Groundnut oil	18.0
Red palm oil	62.7
Sunflower oil	0
Coconut oil	0
Palm kernel oil	0.1
Soya bean oil	0
Rape seed oil	0

Cottonseed oil	0
Maize oil	0
Sesame seed oil	0
Vegetable oil	17.5
Other	0.40
Source: (GAIN, 2017)	

Industry Structure

Nigeria ranks as the fourth-largest producer of palm oil globally, accounting for 3 percent of global production. However, most of its oil-producing crops are grown by subsistence farmers. The Nigerian Institute for Oil Palm Research (NIFOR) estimates that upstream palm oil production amounts to around 0.98m tonnes.

The second largest source of domestic edible oil, at 0.4m tonnes a year, is groundnut oil crushed from an estimated 1m tonnes of unshelled groundnuts. Other oils like Soybean, Cottonseed and Sesame oil contribute another 0.1m tonnes of cooking oils, according to a 2021 report from Proshare(Morales de Canahui, 1996).

However, processing is the most fragmented of all the sectors delivering fortified foods in Nigeria, with no one oil refiner dominating the market, and the market share of even the largest domestic refiners running at around 6 per cent to 8 per cent in 2017, according to SAPFF records.

TechnoServe reports in interviews that this is because the barriers to entry, in terms of capital and technology, are relatively low compared to sugar refining or wheat flour milling. Another factor is the ready availability of the primary raw material, the oil seeds, which are locally grown in communities at levels from subsistence to medium scale.

Indeed, in the early years of the review period, the cooking oil market was dominated by home-made oil, with the FACT 2017 study in Obonyo and Sokoto finding a majority of households, at 51 percent, making their own cooking oil instead of buying fortified manufactured oils. Then, of the remainder, 94 percent reported buying repackaged oil.

The 2016 study carried out in Kwara state (Kuku-Shittu ,2016)found that manufactured oils were purchased based on market availability, with households facing challenges in accessing branded food items, with no supermarkets, and markets that did not operate daily. With such limited retail challenges, four oil brands dominated, being Ororo Kuli, Gino, Turkey and Kings.
However, foreign brands, such as Turkey and King, have since largely disappeared, following the 2018 ban by the government of access to the interbank exchange

market for importers of foreign-produced vegetables and palm oils. The move was designed to promote the local production of palm oil, but has also led to some increase in smuggling (Ebere ,2018).

Yet it has also seen local brands such as Devon's and Golden Penny grow their market share, with NAF- DAC finding five local cooking oil brands with market shares of more than 10 percent each in 2020, and all of them fortified.

Table 16: Largest local edible oil brands by retail market share

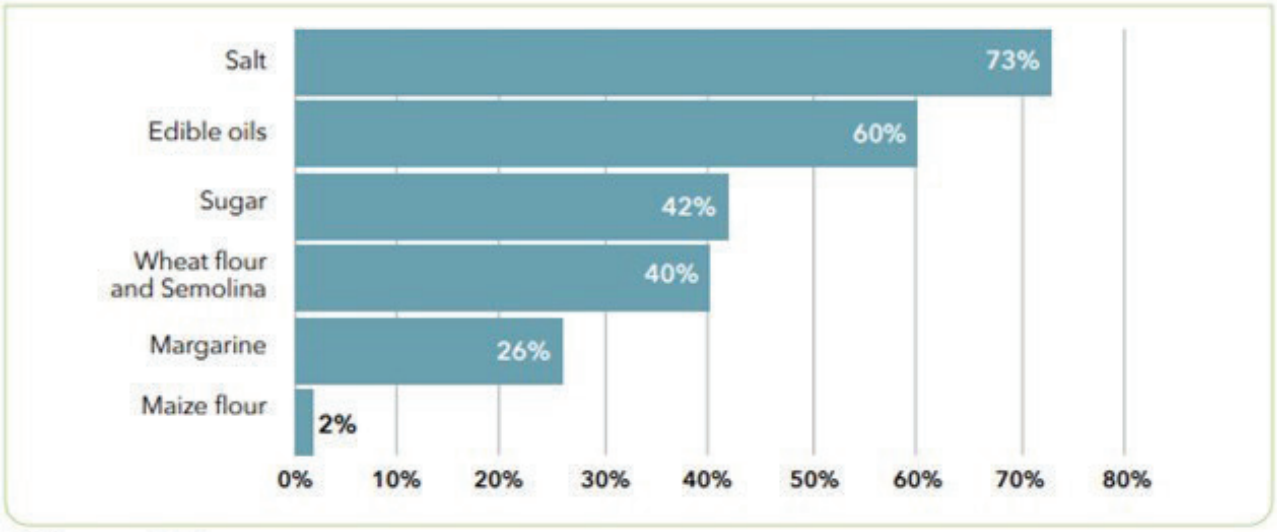
Brand	Food type	Market share	Fortification status
Devon King's	Palm olein	22.7	Fortified
Sunola	Soybean oil	14.7	Fortified
Laziz	Oil blend	12.5	Fortified
Power Oil	Palm olein	12.4	Fortified
Winner	Soybean oil	11.4	Fortified

Source: (NAFDAC 2021)

However, the number of retail cooking oil brands remains the largest of all the food vehicles, with NAF- DAC reporting in its 2019 market survey: "Overall, 347 brands of products from all the food vehicles were found across the country, out of which oil again had the highest number of different brands (122), thus posing an extra task on regulatory monitoring of fortification compliance(NAFDAC, 2021)."

The IPSOS market survey conducted as part of the NAFDAC report, however, did reaffirm the importance of cooking oil as a fortification vehicle based on its consumer reach, with branded cooking oils reaching around 60 percent of Nigerian retail outlets.

Figure 9: Level of Penetration by proportion of retail outlets



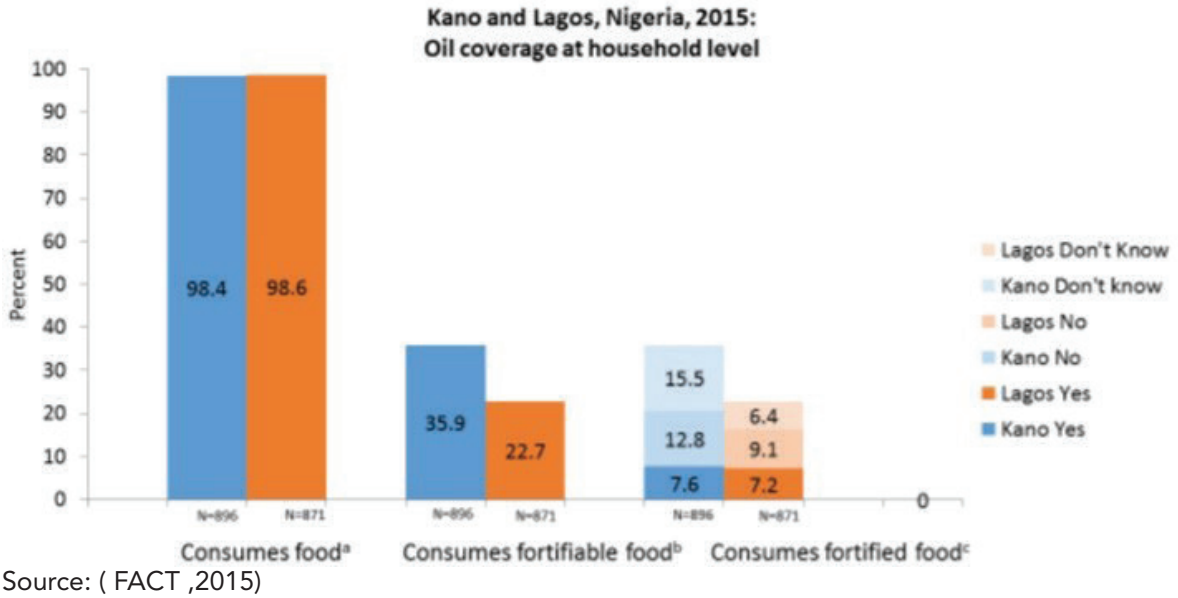
Source: (IPSOS, 2019)

Compliance

Ogunmoyela et al.(Ogunmoyela, 2012)found in 2012 that there was very little fortification compliance in edible oils, with no detectable Vitamin A in 43.2 percent of samples and a further 32.6 percent testing at below the fortification range. Technological constraints and poor calibration of premix levels were cited as possible causes.

Such low levels of fortification generated a disjuncture too in the 2015 FACT survey(FACT, 2015) in Kano and Lagos, with 98% of households consuming oil daily, of which only 22 percent to 36 percent was processed and thus fortifiable. But only just over 7 percent of households in both states were actually consuming fortified oil.

Table 17: Fortifiable and Fortified Oil Consumption, Kano and Lagos



Source: (FACT ,2015)

A 2016 study in Kwara state confirmed ongoing and severe Vitamin A deficiencies, in a state that UNICEF listed in 2007 as one of the poorest states in Nigeria (Kuku-Shittu, 2016) It also found, some 14 years after mandatory fortification was adopted, that two of the four largest branded oils consumed in the state remained unfortified.

As late as 2017, the FACT report in Ebonyi and Sokoto revealed that 91.8 percent of households were buying oil that was not in its original package and had no fortification logos, but which was instead being bought in every kind of packaging and size from jerry cans to whisky bottles(GAIN, 2017).

Table 18: Quantity of edible oil purchased by household per unit volume

Quantity bought per unit	fraction of total consumers (in %)
Litres	4.8
Centilitres	0.3
Spoonful	4.4
Gongoni (small derica)	14.1
Gongo (milk tin)	13.3
Seven-up bottle (small bottle)	15.0
Whisky bottle (big bottle)	22.6
Small jerry can (2 litre)	3.4
Medium jerrycan (4 litre)	4.6
Big jerrycan (10 litre)	1.5
Source: (GAIN, 2017)	17.5

The same year, in 2017, as Technoserve sampled 11 local branded cooking oils to form a baseline for a new set of partnerships with producers to improve compliance, it found just two of the brands compliant, and just two more less than 20 percent below the mandatory fortification level. All the other seven samples contained detectable vitamin A, but at levels that were far below requirement.

Of just three oils tested in the same programme in 2018, two were compliant. But by 2019, the improvement was clear, with seven of 9 tested brands fully compliant. The goal of full compliance had not yet been achieved, but there was clearly a stepchange in fortification success in cooking oils.

The NAFDAC 2019 study similarly found a leap forward, testing 28 local brands and finding only 4 unfortified. Thus, it found 86 percent of the cooking oil on sale was

fortified, but it was unable to determine the exact level of fortification, to confirm compliance levels.

It also found, however, that more than half of the edible oil products were not labelled with fortification logos, in a problem that it similarly found across maize flour, salt and sugar.

The sharp improvement in oil fortification in 2019, following the bans in imported oils and the partner work under SAPFF, offered real hope of full compliance by 2020. But, instead, Covid-19 disrupted production in almost every way. By 2021, Technoserve found that of 28 samples, nine were below for- tification standards.

Of 28 samples tested by GAIN at factory level in 2021, similarly, eight were unfortified and two were fortified below minimum levels, leaving only 18 compliant, or 64 percent.

The issues that arose during 2021 with premix and supply changes are likely to have had some impact on edible oil compliance, but, altogether, over the period of review, compliance rose markedly. From 2012 to 2017, compliance was running at less than 25 percent. But from 2019 to 2021, and despite the impact of Covid-19, that range moved to 64 to 77 percent. This shift lifted the reach and efficacy of the Vitamin A food vehicle with the greatest reach in Nigeria.

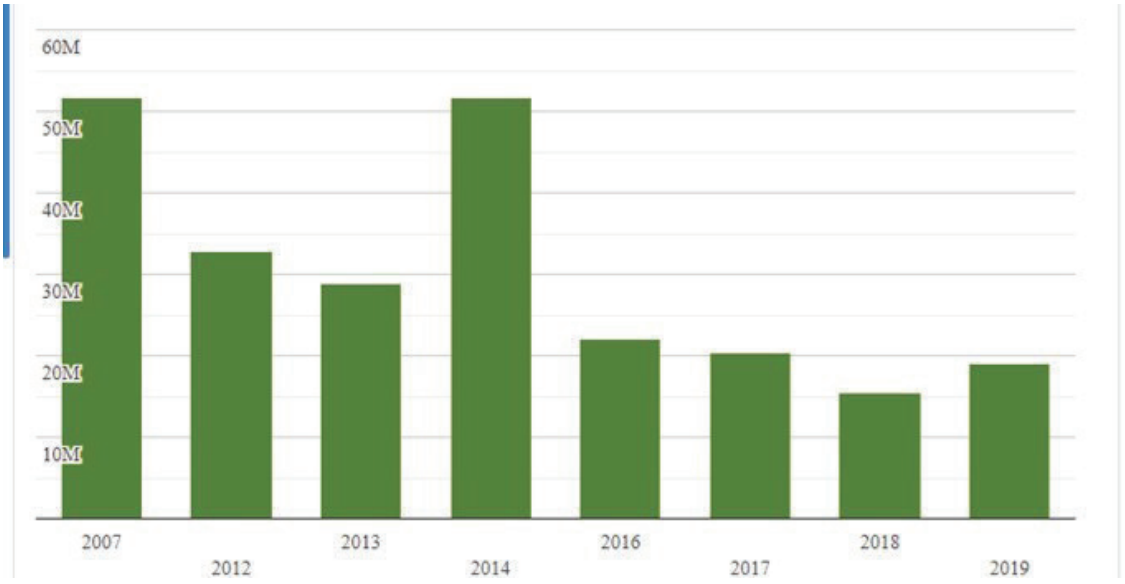
Margarine

Consumption

Margarine is a butter substitute made from liquid vegetable oils through hydrogenation that is availa- ble in more than a quarter of Nigerian retail outlets, according to the IPSOS 2019 survey. It's relatively low reach is driven by average spending capacity. In 2020, the Nigerian National Bureau of Statistics found that 40 percent or 83 million Nigerians live in poverty, yet margarine is considered a luxury food by comparison with staple food items(Ekwujuru, 2021). For most Nigerians, the local alternative is shea butter.

Most of Nigeria's margarine is imported, with margarine imports valued at $19m in 2019. Imports of margarine fell sharply from 2015, after the government restricted access to foreign currency in order to boost the manufacture of local goods, reported Akwagyiram of Reuters in 2019 (Akwagyiram, 2019). Margarine consumption was also depressed after 2014 by the economic downturn caused by low crude oil prices, which made commodities like margarine much more expensive, reported Akwagyiram, 2019 (Akwagyiram, 2019), (Keats, 2018).

Figure 10: Nigerian Margarine Imports



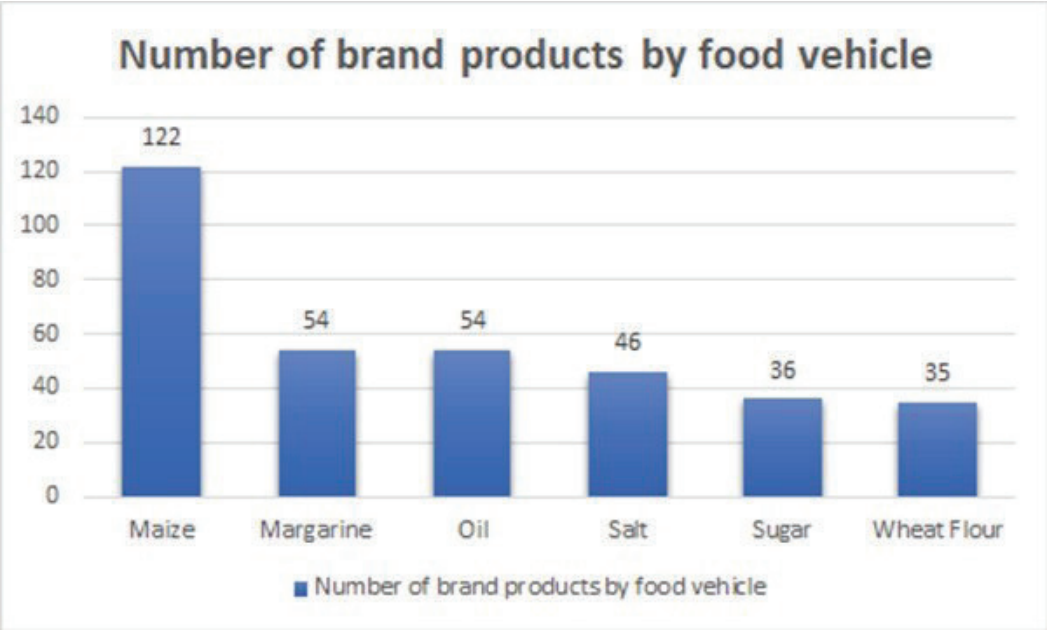
Source: (Trend Economy , 2021)

However, NAFDAC's 2019 market survey found 74 percent of the margarine brands on sale in retail outlets across 20 states were still imported (Trend Economy, 2021).

Industry structure

Nigeria's margarine market is relatively fragmented for a processed food sector, with IP-SOS identifying 55 brands in the market in 2019.

Figure 11: Number of brand products by food vehicle



Source: (IPSOS & NAFDAC , 2019)

At the beginning of this report's review period, Unilever Nigeria Plc was the dominant Nigerian manufacturer of margarine. The sale of Unilever's Nigerian spreads business to Netherlands-based investment company Sigman Bidco, in 2018, maintained its former brand BlueBand with a leading brand position. However, in 2017, Ekwujuru and Chianumba(Ekwujuru, 2021) identified over 15 margarine and butter brands competing for market dominance.

Three of these brands, Flora, Blue Band and Stork, were being manufactured locally. But the other top three household brands, Topa, Sima and Golden Gate, were being imported.

Compliance

Margarine was required to be fortified with 26,000 to 33,000 IU per kg of Vitamin A from September 2002.

However, very little data has been gathered and disseminated on margarine compliance in the nearly 20 years since then. Margarine was not assessed by Ogunmoyela et al in 2012(Ogunmoyela, 2013) nor was it included in the GAIN FACT assessments of 2015 and 2017.

The first evidence on margarine compliance in the review period was testing undertaken for the NSSP, 2016 study, which found 91.5 percent of the households surveyed consuming one of the three top brands of margarine.

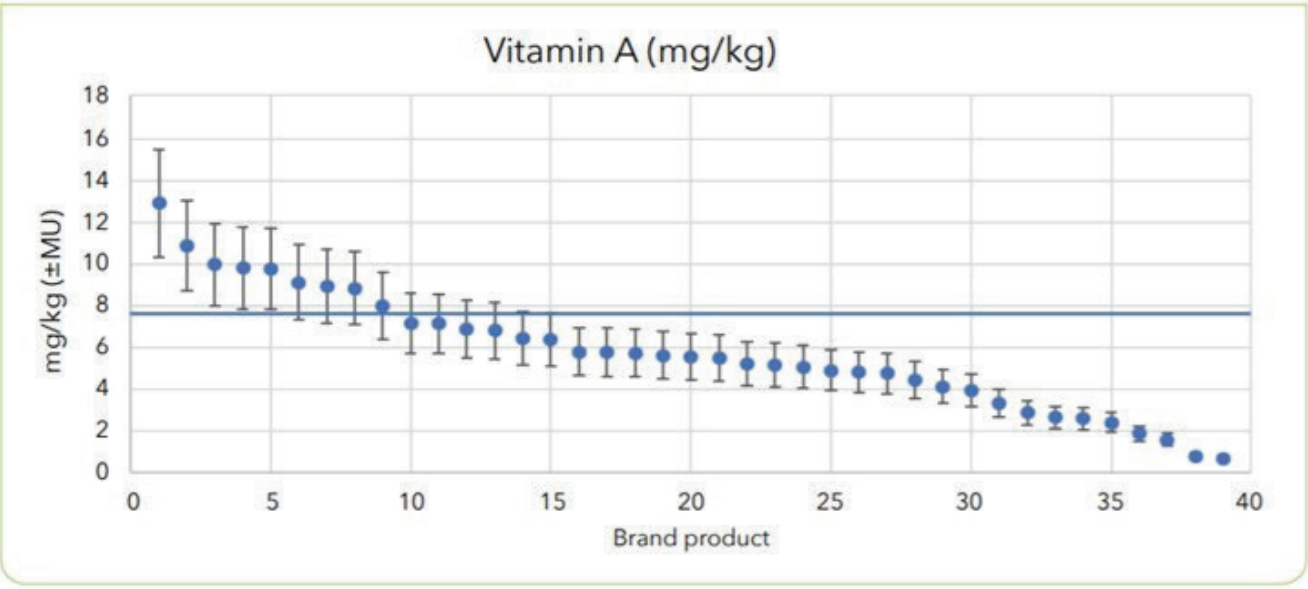
Table 19: Number of households consuming the leading fortified margarine brands			
Main brand	**number of households**	**Fortified (y/n)**	**included micronutrients**
Blue Band	191	Yes	Vitamin A, D and E
Simas	54	Yes	Vitamin A and D
Shea Butter	51	No	
Source: NSSP 2016 (Kuku-Shittu, 2016)			

Moreover, margarine has not fallen within the remit of SAPFF, and, therefore, now stands as a demonstration of compliance levels without the partner engagement that began in 2017 in flour, edible oils, sugar and salt.

On this basis, NAFDAC 2019 reported testing 39 margarine brands, of which 29 were imported and 10 were local. Of the local brands, the survey found only four were sufficiently fortified to be compliant. Of the 29 imported brands, just 5, or 17.2 percent, were adequately fortified.

Overall, at a combined fortification compliance rate of just 23 percent, margarine has emerged as a food vehicle in need of attention and review, in order to understand the prolonged shortfall in compli- ance levels, through now nigh on 20 years of regulation.

FIgure 12: Average nutrient content by margarine brand product with measurement uncertainty (MU) against standard minimum (7.8mg/kg)



Source: (NAFDAC, 2021)

Table 20: Percentage of analysed margarine by fortification status and origin				
Margarine Origin	**% of brands by source**	**% by source adequately Fortified**	**% by source Fortified below Standard**	**Total Number of Brands**
Imported	74	18	82	28
Local	26	40	60	10
Source: (NAFDAC, 2021)				

Bearing in mind that three-quarters of the margarine in Nigeria is imported, the shortfall may also reflect differing mandated Vitamin A levels in other markets. At 26,000 - 33,000 iu/kg, Nigeria falls at the upper end of the global range of national standards, with many other markets requiring fortification in the range of 25,000-35000 iu/kg, but nations such as Belgium, Denmark, El Salvador, Mexico, Netherlands, Panama, Portugal and Turkey all requiring fortification at 20,000 IU/kg or below, generating considerable production geared towards that lower requirement.

Mandatory Fortification of Margarine with Vitamin A&D		
Country	**Vitamin A (IU/kg)**	**Vitamin D (IU/kg)**
Belgium	22,500 - 27,000	2,500 - 3,000
Brazil	15,000 - 50,000	500 - 2,000
Canada	≥33,000	≥5,300
Chile	30,000	3,000
Colombia	3,180 - 7,950	480 - 1,200
Denmark	25,200	
Ecuador	20,000 - 30,000	2,000 - 4,000
El Salvador	15,000	
Guatemala	15,000 - 50,000	
Honduras	35,000	
India	≥30,000	
Indonesia	25,000 - 35,000	2,500 - 3,500
Malaysia	25,000 - 35,000	2,500 - 3,500
Mexico	20,000	2,000

Netherlands	≥20,000	≥3,000
Panama	20,000	1,500
Peru	30,000	3,000
Portugal	18,000	
Singapore	≥28,000	≥2,200
Sweden	≥30,000	≥3,000
Taiwan	≥45,000	
Turkey	20,000	1,000
U.S.A.	33,000	2,080
UK	24,000 - 30,000	2,800 - 3,520

Source: Raunhardt. O, and A. Bowley. Mandatory Food Enrichment Nutriview. Supplement to 1/1996 issue.

Another factor in the poor compliance of margarine, particularly in imported brands, may be transport and storage times, with Vitamin A levels typically falling by over 20 per cent during six months of stor- age at average Nigerian temperatures.

Table 21: Retention of Vitamin A in commercial margarine

Brand	Initial Level (IU)	After 6 month storage and various temperatures	
		5 degrees Celsius	23 degrees celsius
A	15,900	14,700	13,600
B	14,200	13,400	12,700
C	13,500	12,400	11,500
D	12,300	12,100	12,300
E	12,400	12,100	10,900

Source: Bauernfeind, J.C. 1978. The Technology of Vitamin A. Hoffman-La Roche. Basel, Switzerland (Cited in DSM Fortification Guide)

However, insofar as the initially poor compliance for margarine may have been due to Vitamin A instability and/ or the importing of margarines fortified to fulfil lower requirements elsewhere, the Covid-19 disruption led to a sharp and further deterioration. The SON Factory Level Assessment of 2021 tested just two local brands at the production plant. One was below standard. The other had no detectable fortification.

Overall, margarine emerges as an unmonitored sector with serious compliance issues.

However, despite the shortfall in fortification levels, margarine NAFDAC 2019 found it more comprehensively labelled as fortified than other food vehicles, with 81 percent of samples labelled(Kuku-Shittu, 2016).

Table 22: Percentage of brand products labelled as fortified by food vehicle

Food vehicle	Labelled as fortified	Not labelled as fortified	Total
Maize flour	47	53	100
Margarine	81	19	100
Oil	42	58	100
Salt	41	59	100
Sugar	57	43	100
Wheat flour	89	11	100

Source: (NAFDAC, 2021)

In addition, 74 percent of margarine brands complied with the fortification labelling logos and 67 percent with fortification statements, although there was a considerable shortfall in the labelling of nutrient content, which was done on just 37 percent of the samples.

This labelling compliance was notably stronger across local brands than imported ones. However, it is a notable irony that the least compliant food vehicle emerged as the most comprehensively labelled as fortified.

Table 23: Percentage of margarine labelled as fortified by source

Margarine source	% Labelled as fortified	% Not labelled as fortified
Imported	80%	20%
Local	85%	15%

Source: (NAFDAC, 2019)

Flour – Wheat, Semolina and Maize

Consumption

Nigerians were consuming about a third of the global average wheat consumption per person, at 23kg per head, according to KPMG, in 2016(KPMG, 2016) However, the country's wheat consumption is growing, with the US Department of Agriculture Foreign Agricultural Service forecasting wheat consumption of 4.9m tonnes in 2021/2022, up 10 percent on the previous year, and amounting to closer to 40kg per head.

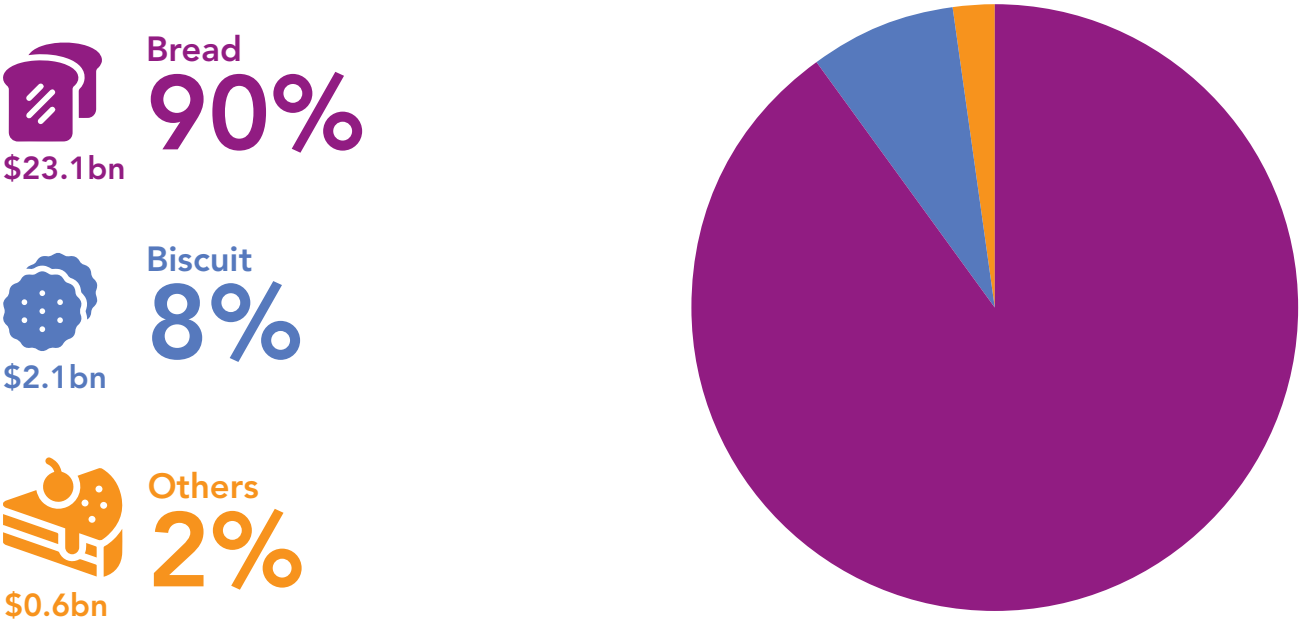
This growth is being driven by expanding demand for bread, semolina, durum pasta and other wheat flour-based products.

In rural Nigeria, semolina dominates wheat consumption, while in urban areas, most wheat is consumed as bread and biscuits, with Nigerians consuming an average of 10.5kg of bread a year, equating to an average of one slice of bread per day, typically eaten with tea for breakfast. This consumption of bread is now relatively widespread, with white sugar bread now one of the country's more widely consumed staple foods.

Figure 13: Wheat consumption by end-use (2019)

Source: (Bread and Bakery Market, 2021)

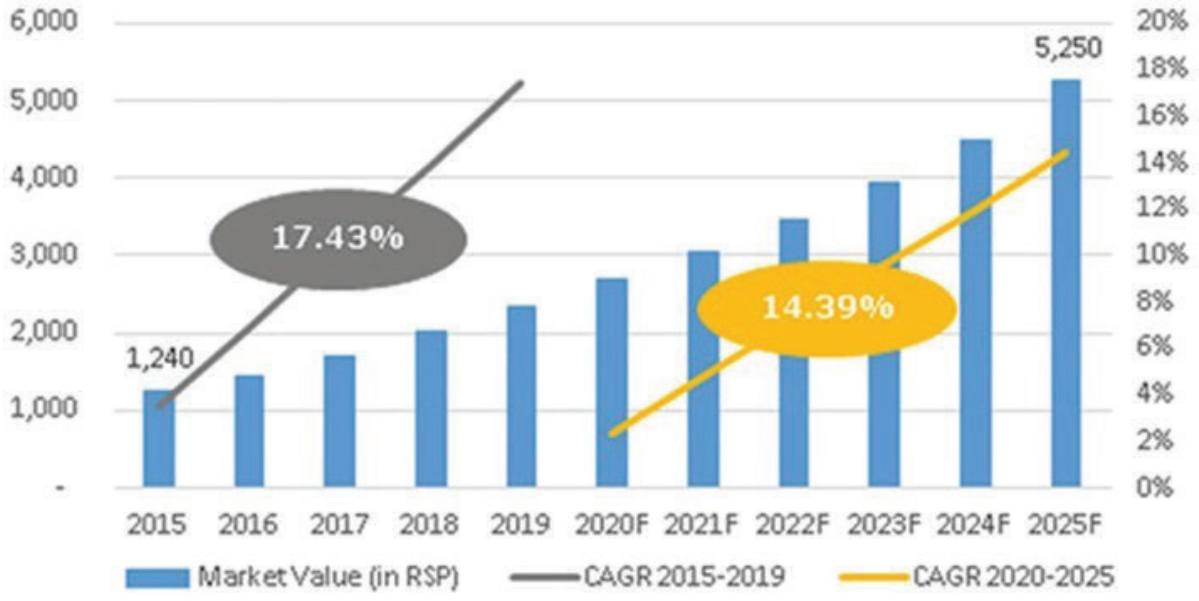
Figure 14: Market share of bakery products (2015)



Source: (Bread and Bakery Market, 2021)

Of the individual wheat products, pasta is growing the most rapidly. However, its consumption is concentrated in urban areas, with the 2017 FACT (GAIN, 2017) study in Sokoto and Ebonyi showing very limited consumption of noodles or other pasta.

Figure 14: Nigeria Pasta market value



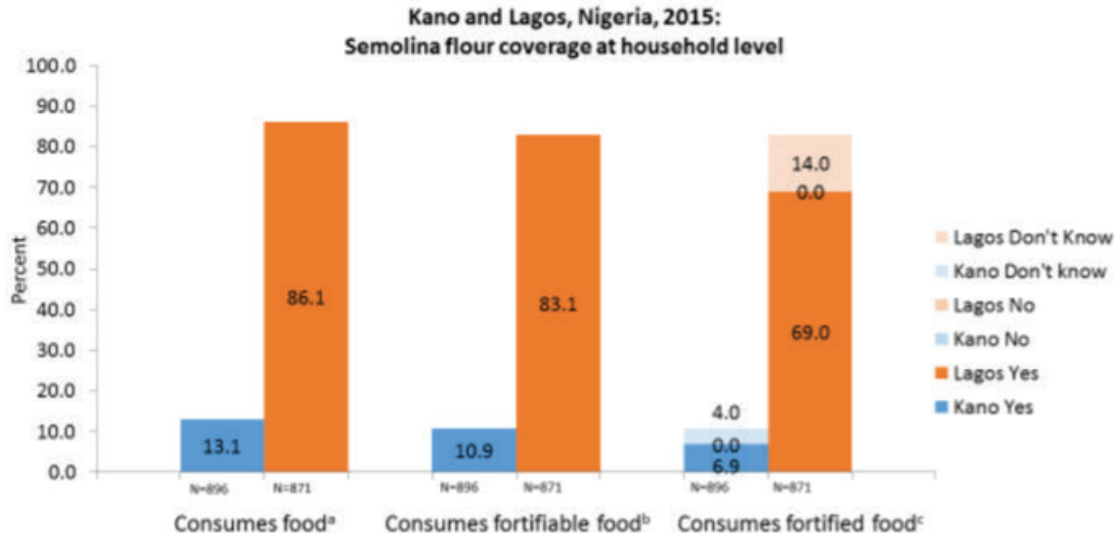
Source: (wm-strategy, 2021)

For direct wheat flour consumption, the same FACT 2017 study(GAIN, 2017) found just 220 of 1,224 homes using wheat flours, of which 145 used semolina, and just 75 used graded wheat flour. Four fifths of homes reported that they don't use wheat flour at all. However, the same study's survey of food consumption by the caregiver in the previous 7 days, found that wheat bread was one of the most con- sumed items,

by 209 respondents or 17 percent of the homes in two of Nigeria's five poorest states. It also reported the sporadic and sometimes widespread consumption of a wide range of wheat-based products, such as chin-chin, egg rolls, spaghetti, meat pies, donuts, spring rolls, cakes, and biscuits.

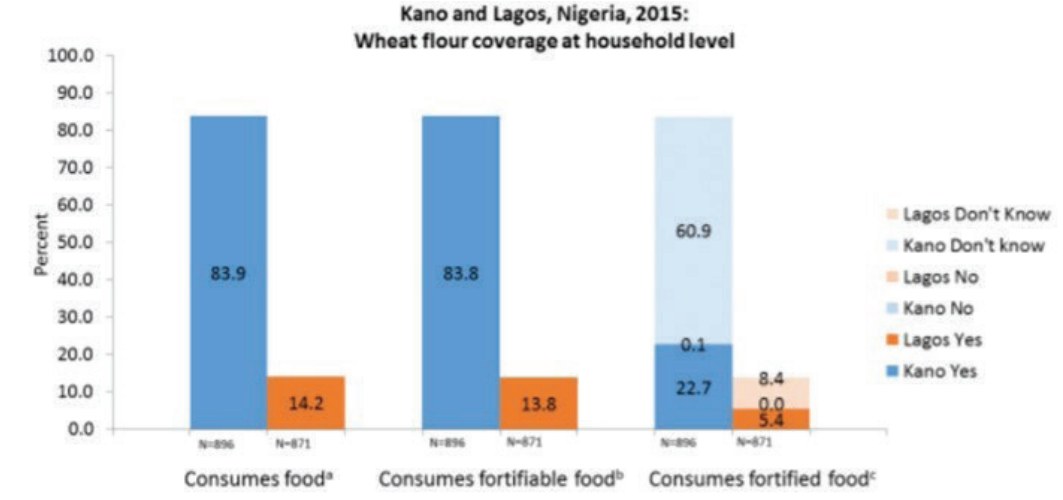
Wheat consumption also seems to vary by region, with the earlier FACT 2015 recording almost complete household penetration for graded wheat flour in Kano state, but only 14.2 percent of Lagos households with graded wheat flour in their homes(FACT, 2015). Conversely, semolina had very high reach into Lagos homes, and low reach in Kano, suggesting that between the two, most homes con- sume wheat in one form or another in these relatively higher-income states.

Figure 18: Semolina flour coverage at household level in Kano and Lagos



[a]Households prepare the food at home; [b]Food was not made at home and is assumed to be industrially processed; [c]"Yes" refers to households that provided a sample or, if not available, reported consuming a brand that was confirmed by laboratory analyses to contain the nutrient above the intrinsic level; "Not fortified" refers to households that provided a sample or, if not available, reported consuming a brand that was confirmed by laboratory analyses not to contain the nutrient above the intrinsic level; "Don't know" refers to households that could not be classified because no sample or reported brand was available. Households that did not consume a fortifiable food are not shown.

Figure 19: Wheatflour coverage at household level in Lagos



[a]Households prepare the food at home; [b]Food was not made at home and is assumed to be industrially processed; [c]"Yes" refers to households that provided a sample or, if not available, reported consuming a brand that was confirmed by laboratory analyses to contain the nutrient above the intrinsic level; "Not fortified" refers to households that provided a sample or, if not available, reported consuming a brand that was confirmed by laboratory analyses not to contain the nutrient above the intrinsic level; "Don't know" refers to households that could not be classified because no sample or reported brand was available. Households that did not consume a fortifiable food are not shown.

Source: (FACT , 2015)

Nationally, semolina flour is a common staple, consumed as a dough ball with soup, or used to make pastries or puddings. Across 20 states, in 2019, the NAFDAC market survey found that semolina flour was the most purchased wheat flour, followed by plain white flour:

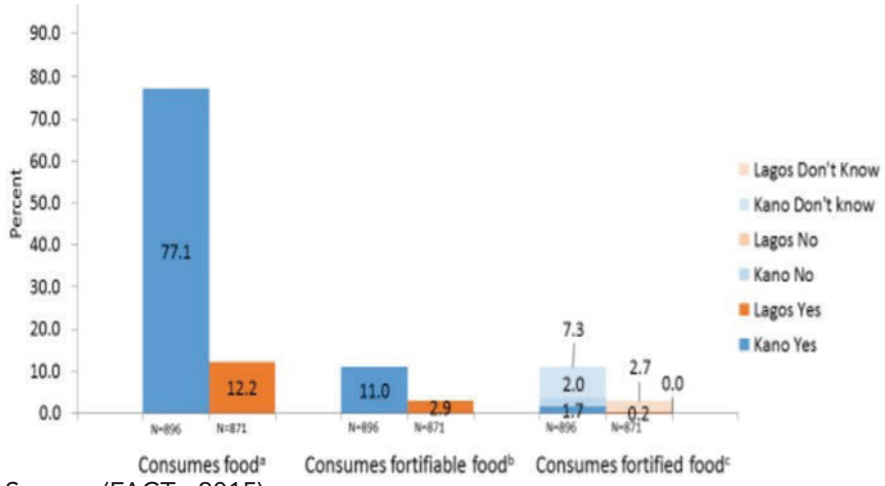
Table 24: Retail market share of flour types in Nigeria in 2019	
Wheat Flour Type	**Market share (%)**
Semolina	46
All purpose flour	42
Whole Wheat flour	9
Bread flour	3
Cake flour	0
Self Raising flour	0
Source: (NAFDAC, 2021) market survey	

FACT 2017 also found rural households buying semolina flour in larger units than other commodities, with 30.8 percent buying it in 1kg bags, and most often in its original packaging, preventing some of the issues of exposure to light, air and heat that are depleting the vitamin content of sugar, cooking oil, and other wheat flours.

Overall, wheat and semolina were found by IPSOS in 2019 to reach 40 percent of Nigerian retail outlets, which were assessed down to the smallest roadside stalls, while processed maize flour reached just 2 percent.

Of the 1224 households surveyed in Sokoto and Ebonyi states in 2017, 685, or 56 percent, said they prepared foods with maize flour. But only just over 10 percent of this maize flour was bought, with the rest prepared at home (GAIN,2017).

Figure 15: Maize flour consumption by proportion of households



Source: (FACT , 2015)

Thus while USDA FAS 2021(USDA, 2021) reports maize consumption of 12.1m tonnes a year, with maize as a common staple as "corn flour, confectionery, roasted corn, boiled, or prepared as porridge", very little of this consumption is either processed or fortified.

Production

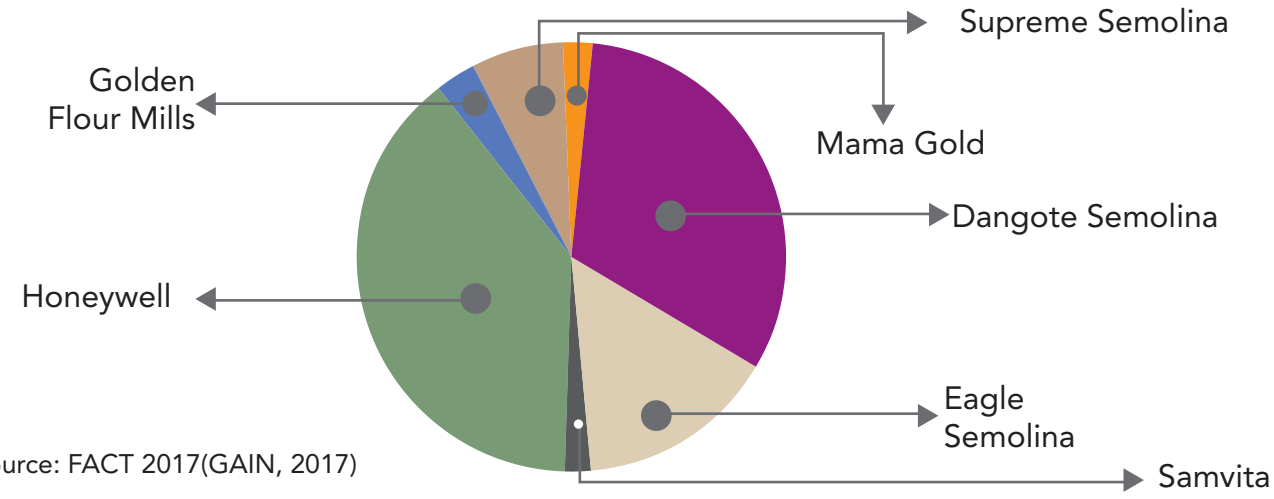
Nearly all the 4.9m tonnes of wheat consumed each year in Nigeria is imported. Domestic wheat production has been growing, but still accounts for only around 1 percent of consumption, at an estimated 55,000 tonnes in 2020/2021.

However, the government has recently introduced foreign exchange restrictions that are curbing import growth and spurring the expansion of domestic grain production. Imports are still rising, but with costs also rising, most millers have switched to lower quality grain that they are mixing with a propor- tion of higher quality supplies.

The government has also been incentivising bread manufacturers to mix locally grown cassava flour with wheat flour, offering a 12 percent tax rebate to bakers who use composite flour. But the initiative faces technical challenges. According to USDA FSA in 2021, analysts "do not foresee the GON imposing an import ban or restrictions on wheat, considering the major challenges confronting wheat production in Nigeria." However, the central bank governor in March reiterated the bank's commitment to increase domestic wheat production and reduce imports by 60 percent over the next 2 years, reported FAS, 2021.

The imported wheat is then milled locally into white flour, semolina and whole wheat flour by predominantly large and mid-sized millers. The top three manufacturers of semolina flour in Nigeria are Mama Gold Pure White Semolina produced by Crown Flour Mills, a subsidiary of Olam International, Semolina produced by Honeywell Flour Mills Plc, and Semovita produced by Golden Penny Nigeria Plc.

Other manufacturers include, Standard Flour Mills Limited, Lago; Mercury Mills Limited, Ogun State; Life Flour Mill Limited, Sapele, Delta State; and Valleumbra Flour Mills Limited, Enugu; Nigeria Eagle Flour Mills, Oyo State; and Dadaka International Flour Mill, Gombe State, which plays in the regional market.



Source: FACT 2017(GAIN, 2017)

The same manufacturers also dominate in graded, premium, confectionary and wholemeal wheat flours, with mills using only 5 to 8 percent of mill capacity to produce semolina. The larger part of milling capacity, at around 70 per cent, is used to mill white flour that is sold predominantly as business-to-business (B2B) 50kg bags to bakeries and other manufacturers.

As with cereal consumption, it is also maize that dominates Nigeria's cereal production, at around 11m tonnes a year, reports the USDA FAS, although production has been curbed recently by height-ened insecurity in the country's corn belt across Nasarawa, Kaduna, and Katsina States. But nearly all of Nigeria's maize for human consumption remains locally grown and processed in the home.

Compliance

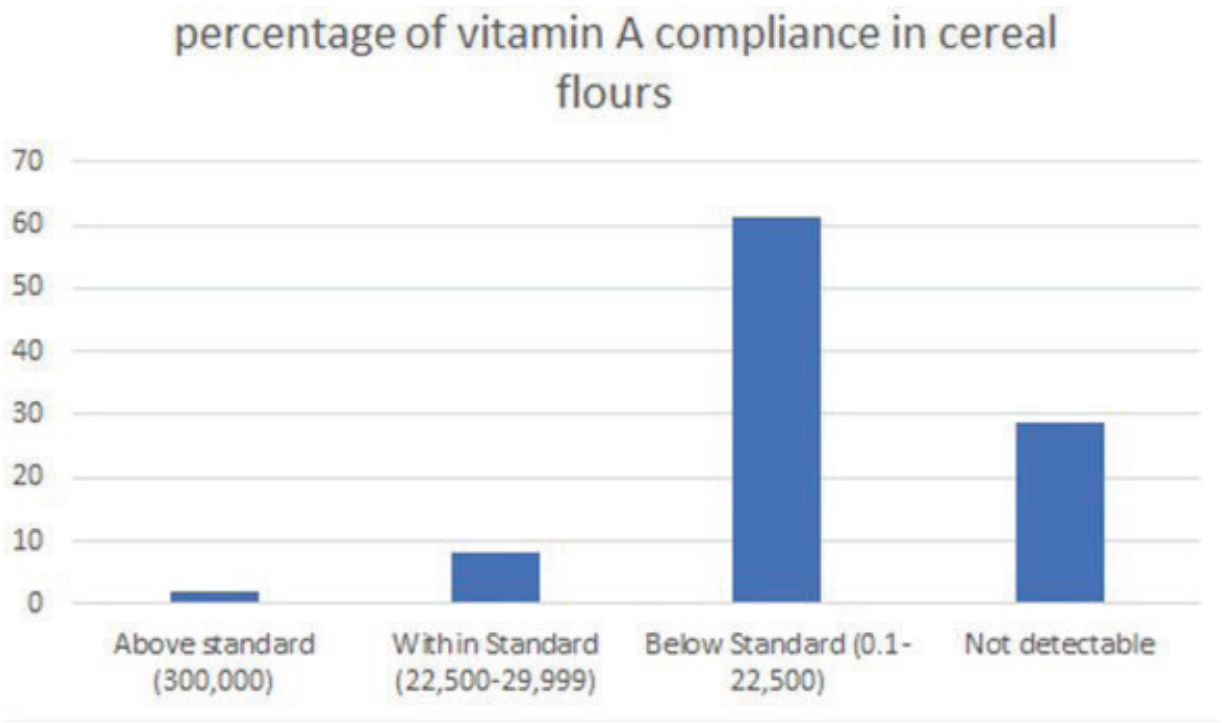
Flours, uniquely, are fortified with a suite of nutrients, whereas salt, sugar, cooking oil and margarine act as vehicles for a single micronutrient. In 2002, Nigeria issued regulations mandating the fortification of flour with Vitamin A, Iron and an array of B vitamins - B1 (thiamine), B2 (riboflavin), B3 (niacin), B6, and B12. In 2015, this set was expanded to include zinc and folic acid (Vitamin B9).

However, after the first decade of flour fortification, there was very little evidence on the levels of compliance, seeing KPMG reporting, even by 2016, that there was "no real data on the proportion of flour in Nigeria that is fortified with added vitamins."(KPMG, 2016)

In fact, by then, a handful of studies had been done. But the findings were not very positive. Ogunmoyela et al. reported in 2012 that "of the 95 flour samples, less than 33.3 percent were compliant at even a 50 percent acceptable range for vitamin A [that is at 15,000-30,000 IU/kg}(Ogunmoyela,2013).

Iron compliance was no better, with compliance of 50 percent for wheat flours, 18.2 percent for maize flours, and zero for semolina. The apparent non-compliance for semolina is made more surprising in that it is produced by predominantly large producers, who are the same producers who dominate in the production of whole wheat and white flour, meaning that some of the same producers were forti-fying wheat flour, but not fortifying semolina.

Figure 17: Level of Vitamin A compliance in cereal flours (2012)



Source: Ogunmoyela et al.(Ogunmoyela, 2013)

Overall, these results demonstrated so little fortification that Ogunmoyela et al(Ogunmoyela, 2013) concluded: "These results call for a critical and holistic review of the fortification strategy in Nigeria".

The FACT 2015 survey (FACT, 2015) subsequently found that of the wheat and semolina flours consumed, they were either fortified, or their fortification status was unknown - there was hardly any flour that was tested that was found unfortified.

However, without ascertaining the level of fortification, these findings tied with the very low unfortified levels found by Ogunmoyela et al in 2013(Ogunmoyela ,2013).

NSSP, 2016, (Kuku-Shittu, 2016) likewise, found all the brands it tested to contain Vitamin A, but with- out sight of the level of fortification.

Table 25: Fortification status of wheat flours in Kwara State, 2016

Flour type/ brand	Number of households	Fortified (Y/N)	Included micronutrients
Dangote	104	Yes	Vitamin A
Honeywell	49	Yes	Vitamin A
Golden Penny	44	Yes	Vitamin A

Source: NSSP, 2016 (Kuku-Shittu,2016)

The 2017 FACT measured for the average level of iron in the wheat samples it tested, but didn't test for Vitamin A or any other measure of compliance.

This meant that the baseline survey done by TechnoServe, in 2017, under the SAPFF program offered the first insight for five years into the compliance levels of flour manufacturers. The 2017 sampling of 13 wheat flour brands found just six of them, or 46 percent of them, with sufficient iron to be compliant, and of the seven with too little iron, six, or another 46 percent, were at less than half the mandated levels of fortification. This represented an even poorer result than in 2012, when Ogunmoyela et al found 50 percent compliance on iron fortification(Ogunmoyela, 2013).

The SAPFF baseline testing also delivered the first data on Vitamin B3 (Niacin) compliance, which it tested for as a 'marker' of the full array of B vitamins. Only three of the 13 brands were compliant on Vitamin B3, and all three of them were also compliant on Iron. The other three brands that were compliant on Iron all had Vitamin B3 levels within 30 percent of the mandated level.

The Vitamin A results were also poor. There was no Vitamin A detected at all in six of the 13 samples. This level of non detection, at 38 percent of the brand samples, marked a considerable deterioration from Ogunmoyela et al's 2012 findings, when no Vitamin A could be detected in 28.6 percent of all cereal flour samples(Ogunmoyela, 2013).

Again, the Iron-compliant samples recorded the best levels of Vitamin A – four of the six iron-compliant samples were Vitamin A compliant too. Thus, as a base-level study, these first SAAPF tests appeared to show only around half of wheat flour brands using premix to meet the mandatory fortification stand- ards, and several of those producers with calibration issues.

By 2019, when Technoserve (Technoserve, 2021) tested 9 wheat flour brands, it found five to be iron-compliant, or 55 percent. Moreover, half of these brands had been non compliant two years earlier, suggesting real progress. But Vitamin B3 compliance remained poor, with just one of the nine samples falling within 15 percent of the mandated 45mg and the rest showing substantially lower levels of Nia- cin. Meanwhile, only three of the nine samples were compliant on Vitamin A, and two still showed no detectable Vitamin A.

Thus, the dial had moved, but non-compliance was still widespread.

In this, the outperformance by iron, which continued through all subsequent testing too, was boosted by wheat's natural iron-rich qualities, with the cereal typically containing from 2mg to 5mg of iron per 100g (Free, 1940).

However, the premixes in use in Nigeria also tend to have higher iron levels, with Technoserve's testing of premix samples in the SAPFF program delivering the indicative results such as those given below:

Table 26: SAPFF indicative test results for flour premix in Nigeria

Sample type(premix)	Total Folates g/Kg	Iron g/Kg	Zinc g/Kg
Flour Premix Sample 1	3.64	75.9	84.6
Flour Premix Sample 2	3.491	65.3	99
Flour Premix Sample 3	3.76	72.9	90.8
Flour Premix Sample 4	3.656	74.7	88.6
Flour Premix Sample 5	4.11	64.6	82

Source: (Technoserve, 2021)

Iron is also far more stable in flour than Vitamin A, with Beyene, 2012, finding that "iron losses were negligible from storing fortified flour for up to 45 days at 20-25°C and 50-60% relative humidity" (Abebe, 2012).

This marked stability for iron contrasts sharply with the findings of Uchendu and Atinmo, 2015, on Vitamin A, when they tested 17 samples of wheat flour from 12 bakeries in Lagos. Using an acceptable compliance range of 50 percent to 100 percent of the requirement, they found that only 23.5 percent of the samples were Vitamin A compliant pre-storage, but after storage that fell to 5.9 percent. They also documented a swift break-down in the micronutrient, with mean levels of Vitamin A in the same samples falling by almost 50 percent from one month of storage to two months, and to 35 percent of the month 1 level after three months (Florence, 2016).

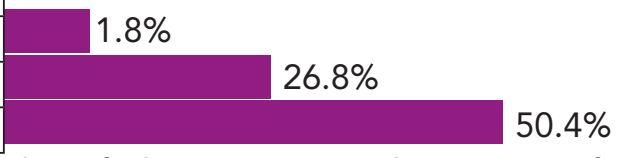
This is particularly significant considering the timelines in storage and sale that are normal in Nigeria's retail distribution. In this regard, the FACT, 2017 survey held from April that year, recorded that only 50.4 per cent of the specimens it tested for their micronutrient content were produced in 2017 and thus in the previous three months. The rest had been produced in 2016 or 2015, or their date of production could not be established.

Based on the rate of breakdown found in Lagos, this would mean that of all wheat more than half of all flours in Nigeria are under-fortified by the time they are consumed, simply by virtue of the Vitamin A breakdown along the supply chain to the consumer. Achieving compliance by the time of consumption would require far greater levels of fortification at the production level, typically of twice the mandatory final requirement.

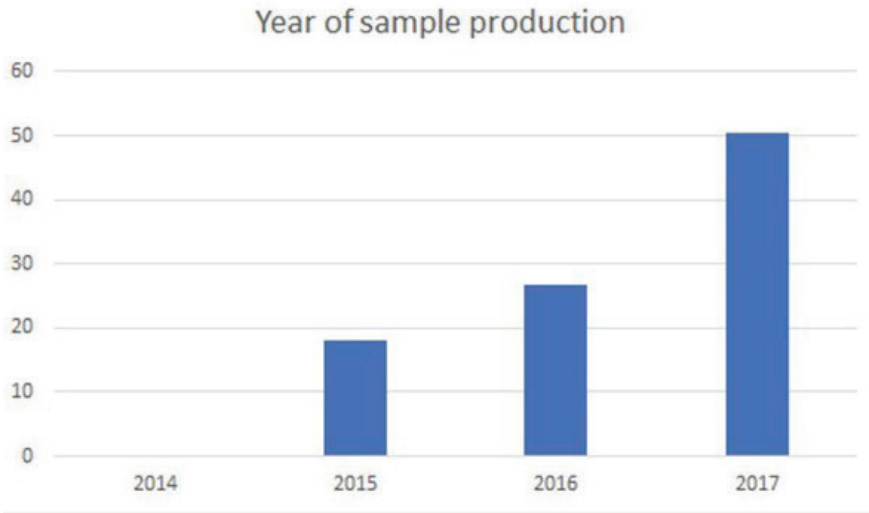
Figure 20: Wheat samples from April 2017, year of production

Table needs correcting - error on 2015:

2014	2014	0
2015	2015	10
2016	2016	145
2017	2017	273
9997	Refused	0



Not surprisingly, therefore, with such swift deterioration underway, tests for the 2019



Source: Fact 2017 (GAIN, 2017).

NAFDAC market survey found 100 percent of samples of 39 brands of wheat flour contain Vitamin A, but all of them at below compliance levels.

These included flours with very substantial market shares.

TABLE 27: Market share of leading retail wheat flour brands, 2019

Brand product	Food type	Market share	Fortification Status
Golden Penny Semovita	Semolina	19.3	Fortified below standard
Dangote Semolina	Semolina	15.6	Fortified below standard
Golden Penny	All purpose	11.6	Fortified below standard
Dangote All purpose	Semolina	8.8	Fortified below standard
Honeywell Semolina	All purpose	8.4	Fortified below standard
Bakewell	Whole wheat flour	8.4	Fortified below standard
Golden Penny	All purpose	5.3	Fortified below stand-ard

Source: IPSOS (GAIN, 2019) and NAFDAC 2019

In this, the guidelines set by premix and vitamin manufacturers appear to have been

consistently disregarded at the producer level. Citing F. Hoffmann-La Roche and unpublished data gathered in Basel, vitamin manufacturer, DSM, in a guide to Vitamin A stability produced together with USAID, recommends the vitamin should be added to wheat flour at 20 percent over the mandated level in order to adequately cover the losses in processing and during storage (Abebe, 2012).

These allowances do not take into consideration the timeline needed for Nigeria's retail supply chain, or the repackaging, poor storage, or other issues around light exposure and oxidisation.

Yet the TNS 2019 survey found four of nine wheat flour samples at below compliance level, and of the three that were compliant, two were less than 5 percent above the mandated level: meaning that all bar one sample would have reached homes at below the mandated level.

Based on the rate of deterioration of Vitamin A content found in fortified flours in Nigeria by Uchendu and Atinmo in 2016, the 'overage' would need to be far higher than 20 percent to secure satisfactory compliance results in the marketplace and the home (Abebe,2012).

By 2020, the general micronutrient compliance results for flour were better again, however, with TNS reporting that of six brands reviewed, 5 were iron-compliant, and the sixth had levels of iron running at over 75 percent of the mandated level. Full iron compliance appeared to be moving into reach (Florence, 2016).

There was also a marked improvement in Niacin levels, with three of the six brands adequately fortified, and the other three all at over 50 percent of the mandated level. Likewise, Vitamin A compliance had improved, with four of the six brands compliant, and only one of the six with Vitamin A levels of less than half the mandated level. All the samples had detectable Vitamin A.

These results presented perhaps the best marker of progress to date, and as more data became available, the opportunities to identify and correct challenges were also increasing.

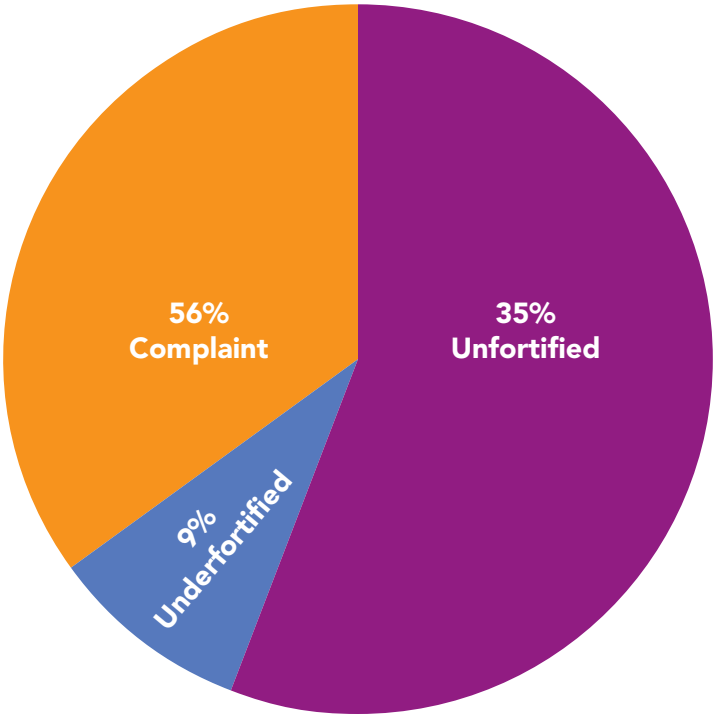
However, the strength of the 2020 results from TNS were something of a high point, it turned out, be- cause at that point the Covid-19 pandemic kicked in and began disrupting supply chains. This affected global Vitamin A production and prices, and both the quality and the availability of vitamin premixes for fortification in Nigeria.

As a result, in 2021, Technoserve found that 80 percent of ten brands sampled in March fell far below Vitamin A compliance levels, as did 50 percent of ten brands sampled in April, and 60 percent of 15 brands sampled in July (Technoserve, 2021).

The 2021 factory-level survey carried out with the Standards Organisation of Nigeria similarly found that of 23 wheat flour brands tested at factory level, 2 were unfortified

and 8 were under-fortified.

Figure 21: GAIN 2021 FLA survey of wheat flour: Vitamin A compliance.
As Vitamin A compliance appeared to retreat, in 2021, iron compliance held up,



however, with TechnoServe reporting just 3 samples as non-compliant in the 25 taken in March, April and July, making for 88 percent compliance. At the same time, it found 16 compliant samples of 25 for Vitamin B3, or 64 percent (Technoserve, 2021).

The 2021 SON survey also found better results again for iron, with only one non-compliant sample of 23. The SON survey also tested wheat flour brands for zinc compliance, and found compliance to be fairly high too, at 19 of 23 samples, or 83 percent.

It additionally added some first data in the gap around the monitoring of maize flour, testing four brands of maize flour. The results showed the difference that comes without regular data sights and monitoring, for even as wheat flour moved to over 80 percent compliance on most measures, three of the four maize flours tested had no Vitamin A at all, and were also under-fortified in Iron and Zinc, while the other one was under-fortified in Vitamin A, but compliant in Zinc and Iron(Florence,2016). Overall, the run of surveys from 2019 showed some real improvement in wheat flour compliance, with micronutrient compliance coming in at over 80 percent across the board from levels of a quarter that or less five years earlier.

However, Vitamin A has emerged as the problem child of flour compliance. Its lack of stability and sen- sitivity to light and air have been further compounded, too, by some supply issues.
Vitamin A is not manufactured within Nigeria and is imported. This saw supplies

affected by the global border closures and disrupted supply chains, with sufficient Vitamin A arriving in Nigeria for much of 2020, but shortages and spiralling prices emerging in 2021. Managing these supply-side issues merits further analysis, as supply disruptions are possible ahead, and not necessarily through any global economic shock: these could include foreign exchange shortages, with the Vitamin A used in Nigerian food fortification imported, but not yet affected by the widening limits on imports(Pricewaterhousecoopers, 2020).

Covid-19 and industry acquisitions also increased staff turnover within the food producers exacerbating the problems caused by poor knowledge management. This saw knowhow on hopper settings further strained leading to some increases in calibration issues within plants, raising documentation and knowl- edge management obligations as issues for regulators.

Conclusions

Compliance Progress

This review of data has established a stepchange in the compliance levels in fortifiable home ingredi- ents from 2017, when the SAPFF programme commenced.

The exception in that progress was sugar, for which compliance declined. However, the non-compliant test results for sugar were almost all recorded for imported retail (black market) sugars, in 2019. It was only on the supply chain difficulties in Vitamin A, caused by the Covid-19 pandemic, that sugar compliance fell across the board.

Table x: Change in mean average compliance (make as bar chart)		
	12 to 17	**19 to 21**
Salt - with iodine	82	93.5
Wheat	85%	15%
Iron	48	87.5
Vitamin Bs	23	57
Zinc		83
Vitamin A	20.5	45.7
Sugar - Vitamin A	50	38.5
Edible Oil - Vitamin A	30	70.7

In wheat, the average percentage of compliant home ingredient samples more than doubled between the two timespans, 2012-2017 and 2019-2021, across all tested micronutrients, being iron, vitamin B3, and vitamin A. Likewise, cooking oil compliance more than doubled, despite setbacks, alongside wheat, on the pandemic Vitamin A shortages, while salt iodisation climbed back up towards its previous 2007 peaks.

Overall, and despite all the different statistical methodologies, the compliant percentages of each sam- ple batch rose very significantly between the two periods.

The importance of M&E

However, the results were starkly different for products excluded from monitoring and the remit of the multi-sectoral partnerships as demonstrated by the NAFDAC 2019 and SoN 2021 data on the compli- ance performance of margarine, and maize flour.

When NAFDAC tested 38 margarine brands from retail stores in 2019, just 23 percent, or 9 brands, were adequately fortified. The problem was most severe for imported margarines, with 82 per cent fortified below standard, but domestically produced

margarines also performed poorly, with 60 per cent fortified below standard. SON tested just two margarine brands at the factory level in 2021 and found one fortified below standard and the other with no detectable fortification. The same SON study produced the first results for maize flour too, and found three out of four brands without any detectable vitamin A, and just one of the four with vitamin A below standard.

These results were as bad or worse than the 2012 study that triggered new rounds of action to secure compliance for cooking oil, sugar, wheat and salt, and speak powerfully to the impact of monitoring and evaluation on compliance. Without published and transparent M&E data, compliance appears to become minimal.

This has been similarly shown with salt iodisation. Its early success in Nigeria was supported by quar- terly and annual data gathering and quarterly data reviews and saw it achieve 97 percent coverage. But when M&E was stopped, compliance slumped to only 53% coverage - the task having been pre- maturely deemed complete.

In this regard, the National Fortification Alliance now operates in an unstructured fashion and meets irregularly, but it might be an appropriate vehicle through which to build a permanent and transparent multi-sectoral review process, in liaison with the now fully enabled regulators.

There is also a case for interim direct funding of transparent and published M&E by the regulators in order to secure much-needed data, and a consequent reprioritisation of food fortification. According to the WHO, and as cited in this report on page 12, Vitamin A, zinc, iron and iodine deficiencies cause over a third of the low-income country years of life lost to early death and disabilities. Yet Large-Scale Food Fortification is entirely absent from the government's current nutrition priorities on constrained resources (NMPFAN, 2020, page 47).

At base, the difficulties in mapping LSFF compliance and progress and in reconciling different statis- tical formats have arisen because the M&E has been ad hoc and driven by external partnerships and donor programmes. The regulators have not yet funded and organised compliance data, do not deliver quarterly or even annual reports on compliance, and do not disseminate or share any compliance data, even with international bodies.

In this, governance issues have been identified as a contributory factor to the absence of reporting, and digitisation has also now been developed to aid data gathering, but enhancing the commitment to LSFF and to compliance M&E will require concerted case-building to demonstrate its benefits, and thus secure its prioritisation, as well as resourcing to make such data gathering is viable, in a resource-strained context.

Critical data gaps

This review has also revealed a critical gap in data, monitoring and compliance around B2B food for- tification, for instance in the flour or salt used to make biscuits or pasta, or the sugar used to make gingerbread and waffles.

In the absence of this information, two separate methodologies set about estimating the market share of different producers and brands based on home ingredients alone, where evidence suggests home ingredients and commercial ingredients have not behaved in the same way, and that home ingredient results or market shares cannot be deemed to represent the whole market.

In commercial data, specifically, there are three critical gaps.
The first is around the industry structure, showing, for instance, the end-use of cooking oil, and spe- cifically, the proportion of output from cooking oil fortifiers that is being sold as retail brands and the proportion that moves into a B2B supply chain. In the absence of this data, retailed home ingredients have repeatedly been taken to represent the entire fortified foods market, where in some cases, such as wheat flour, they account for as little as 10 percent of the wheat flour market and consumption.
The second vital area of enquiry in delivering the targeted fortificants is around the processing losses of fortificants and the quality of their stability, in order to drive any corrections in achieving compliance in end-use consumption.

A further area that is distorting existing LSFF data is the fortification waivers in place on some of the fortifiable ingredients for processed foods, allowing the food producers to use unfortified ingredients. This report was unable to access any impact assessment of the waivers, across the proportion or volume or reach of foods waived, and the consequent reduction in reach of the fortifiable food vehicles.

However, for any methodology taking a fortifier's plant's entire output as its share of fortified food pro- duction, situations where a large part of that plant's output is unfortified on waiver would necessarily distort any calculation of compliance by market share, as well as any estimates of consumer reach and, ultimately, health impact.

Moreover, the impact of waivers is material to an understanding of the potential benefits from any one food vehicle. For example, the FACT 2017 survey found just 15 percent of homes used retail-purchased sugar. In many markets, consumers take in most sugar from soda drinks. Thus, where soda drinks are waived from fortification, the reach of sugar may be marginal. A full investigation of the sugar supply chain from producer to human consumption would be necessary to validate these theories.
Fortificant stability obstacles

Another 'red flag' issue raised through this review is the absence of allowance for the well-documented issues of Vitamin A instability. Very few producers are adding the 'overage' at the start to ensure that enough Vitamin A remains in the products as it reaches consumers.

Moreover, Vitamin A breaks down on exposure to light and air. This raises issues around packaging. For instance, transparent packaging accelerates Vitamin A depletion. Yet this has not been investigated and no standards exist on ingredient packaging to ensure the fortificants reach consumers intact.

There is also very little documentation on Nigeria's supply chain from plant to consumers, either directly or via brakeries and other food processors. Yet the two studies cited in this report that tested Vitamin A breakdown over time found that two-thirds or more of the fortificant had disappeared after three months of storage. Moreover, the FACT 2017 survey found that almost half of the wheat flours in homes were more than three months' old, meaning they would have required more than 65 percent overage to be compliant by the time of consumption.

If the aim is to deliver fortificants to consumers, producers may need to consider the duration of stor- age that ingredients must be prepared for. This could be further supported with standards laying out the degree of overage needed for prolonged storage.

It may also be the case that the sub-segment of fortified foods delivered as home cooking ingredients are the least suitable as food vehicles. The FACT 2017 found most sugar being sold by the spoonful and the vast majority of wheat flour dispensed from larger containers into home-made receptacles. The opening of the previous packaging and sometimes repeated repackaging via retail outlets exposes ingredients to air and will oxidise many of the fortificants.

Thus, once enquiry is undertaken, it may be that bread and pastas, and other more stable fortified foods, will become the policy focus over the sub-segment of home ingredients.

Fortification know-how

As well as the lack of allowance for Vitamin A breakdown, factory level compliance has been hindered by turnover in calibration know-how on acquisitions or staff turnover. This could well be addressed through regulatory coverage and penalties for producers who remove calibration expertise without replacing it, and a statutory focus on knowledge management.

Vehicle reach

A final issue that comes through in the review is the sparsity of available data on the reach of the food vehicles to consumers and the scope for improved vehicles, based on their reach into Nigerian homes. For instance, over 97 percent of households in the 2017 FACT survey were using bouillon, whereas fewer than 15 per cent had sugar in the house at the time of the survey.

Overall, there is very little sight of how much of each food vehicle is reaching low-income Nigerians. A consumer end-use survey has been underway during 2021 and will throw far more light into the con- tribution and utility of each food vehicle. But this review found just enough data to suggest the vehi- cles do need review to achieve the highest possible reach for fortified micronutrients into low-income homes.

Recommendations

This report recommends three urgent areas of action, in order to improve LSSF compliance in Nigeria.

1. Data Gathering and Analysis, on:

- The industry structure of fortifiable foods, particularly as B2B versus direct retail, to scale the significance of each channel for attention and policy priorities
- Compliance levels in B2B fortified foods, at origination and along the supply chain,including in processed foods, such as bread
- The fortifier-to-consumer supply chain, to understand duration and map issues affecting fortifi- cant stability
- The impact of waivers on fortificant reach and market shares
- The impact of packaging on fortificant stability, including of processed foods,such as bread
- The reach of fortifiable foods and processed foods containing fortificable foods, and the same assessment for other viable staples, into low-income homes, in order to identify the most effec- tive food vehicles for delivering fortificants into low-income homes
- The impact of fortified foods on families' nutrition, though combined food and health studies, and the development of the data to demonstrate the existing benefits to Nigeria of LSSF and its potential benefits

2. Monitoring and Evaluation, through:

- The roll-out of digitisation, self-reporting, and a joint regulatory framework to remove pressure from regulator resources
- The development of a single methodology for compliance reporting and investigation
- The resourcing of regulators to produce quarterly monitoring reports at the four levels of impor- tation; Nigerian production plants, including of processed foods; retail outlets; and homes.
- The quarterly review of the quarterly monitoring and evaluation reports by the National Fortifica- tion Alliance, and production of an annual analysis with policy recommendations to improve the compliance and reach of LSSF

3. Statute, through:

- The documentation of the industry knowhow needed to correctly fortify and development of appropriate standards and statute to make knowledge officer compulsory
- The development of standards for fortified food packaging
- The adoption of a governance framework for LSSF monitoring and evaluation

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