VCA4D
VALUE CHAIN ANALYSIS FOR DEVELOPMENT

agrinatura for European Commission

Maize value chain analysis in Nigeria

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The information and knowledge produced through the value chain studies are intended to support the Delegations of the European Union and their partners in improving policy dialogue, investing in value chains and better understanding the changes linked to their actions

VCA4D uses a systematic methodological framework for analysing value chains in agriculture, livestock, fishery, aquaculture and agroforestry. More information including reports and communication material can be found at: https://europa.eu/capacity4dev/value-chain-analysis-for-development-vca4d-

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ACRONYMS

ABP	Anchor Borrower Programme
AFAN	All Farmers Association of Nigeria
AFEX	AFEX, Nigeria (commodity trading company operating a private commodity exchange in Nigeria)
ANSC	Advancing Nutrition in Staple Crop Value Chains (by GAIN)
APP	Agricultural Promotion Plan
APHLIS	African Postharvest Losses Information System
AUDA-NEPAD	African Union Development Agency-New Partnership for Africa's Development
BUK	Bayero University Kano
CBN	Central Bank of Nigeria
CBO	Community-based organisations
CO2eq	Carbon dioxide equivalents
crop eq	Crop equivalents (related to land use)
COVID-19	Coronavirus disease
CSO	Civil Society Organisations
DALY	disability adjusted life year
DCA	Development Credit Authority (US)
DFRRI	Directorate of Food, Road and Rural Infrastructure
DOPA	Digital Observatory for Protected Areas
DRC	Domestic resource cost
EU	European Union
EUD	European Union Delegation (Abuja)
FAO	(United Nations) Food and Agriculture Organization
FAOSTAT	FAO Corporate Statistical Database
FAW	Fall army worm
FCT	Federal Capital Territory
FIS	Financial Inclusion Secretariat
FMARD	Federal Ministry of Agriculture and Rural Development
FPO	Farmer Producers Organisation
FEWSNET	Famine Early Warning System Network
GAIN	Global Alliance for Improved Nutrition
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GR	Green Revolution Programme
HDI	Human Development Index
IAR	Institute of Agricultural Research
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
ICT	Information and communications technology
IFPRI	International Food Policy Research Institute
IGS	Intermediate goods and services
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organization
kg	Kilogram
KOTSCO	Kano-State-owned agricultural inputs distribution company

LCA	Life Cycle Assessment
LSF	Large-scale farmer
LGS	Loan guarantee scheme
MAAN	Maize Association of Nigeria
MAGPMAN	Maize Growers, Processors and Marketers Association of Nigeria
MOFA	Ministry of Food and Agriculture (Ghana)
MSF	Medium-scale farmers
MSME	Micro, Small and Medium Enterprises
MSMEDF	Micro, Small and Medium Enterprises Development Fund
₦ (or N)	Naira (national currency; exchange rate below)
NAFPP	National Accelerated Food Production Program
NAERLS	National Agricultural Extension and Research Liaison Services
NALDA	National Agricultural Land Development Authority
NACP	Nigeria Aflasafe Challenge Project
NASC	National Agricultural Seed Council
NEMA	Nigerian National Emergency Management Agency
NESREA	National Environmental Standards Regulatory Enforcement Agency
NFISIWG	National Financial Inclusion Special Interventions Working Group
NGO	Non-governmental organisation
NIRSAL	Nigeria Incentive-based Risk Sharing Agricultural Lending
NIS	Nigeria Industrial Standard
OFN	Operation Feed the Nation
Oil eq	Crude oil equivalents
PHC	Primary Health Centres
PM2.5eq	Particulate matter with diameter lower than 2.5 micrometre equivalents
SHF1	Smallholder farmer 1
SHF2	Smallholder farmer 2
SON	Standards Organization of Nigeria
USAID	United States Agency for International Development
USD ($)	US Dollar
USDA	United States Department of Agriculture
USMEFAN	Union of Small and Medium Scale Farmers of Nigeria
VA	Value added
VAD	Vitamin A deficiency
VAC	Vitamin A cassava
VAM	Vitamin A maize
VC	Value chain
VCA4D	Value Chain for Development
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure
VSLA	Village Savings and Local Association
WOFAN	Women Farmers' Association of Nigeria
WIN	Women Impacting Nigeria

Exchange Rate (December 2019)

US$1 = ₦ 360.00

EXECUTIVE SUMMARY

This Maize Value Chain Analysis has been undertaken in Nigeria as part of a number of studies commissioned under the Value Chain Analysis for Development (VCA4D) Project, a project funded by the European Union (EU) and implemented by Agrinatura, with the objective of generating evidence-based information for policy actions. The results are of interest to INTPA/F3, the European Union Delegation (EUD) in Nigeria, and the Federal Ministry of Agriculture and Rural Development (FMARD). The study included one field mission as COVID-19 made it impossible to undertake a planned second field mission. Below is a summary of the main findings.

Overview of Nigeria's maize value chain

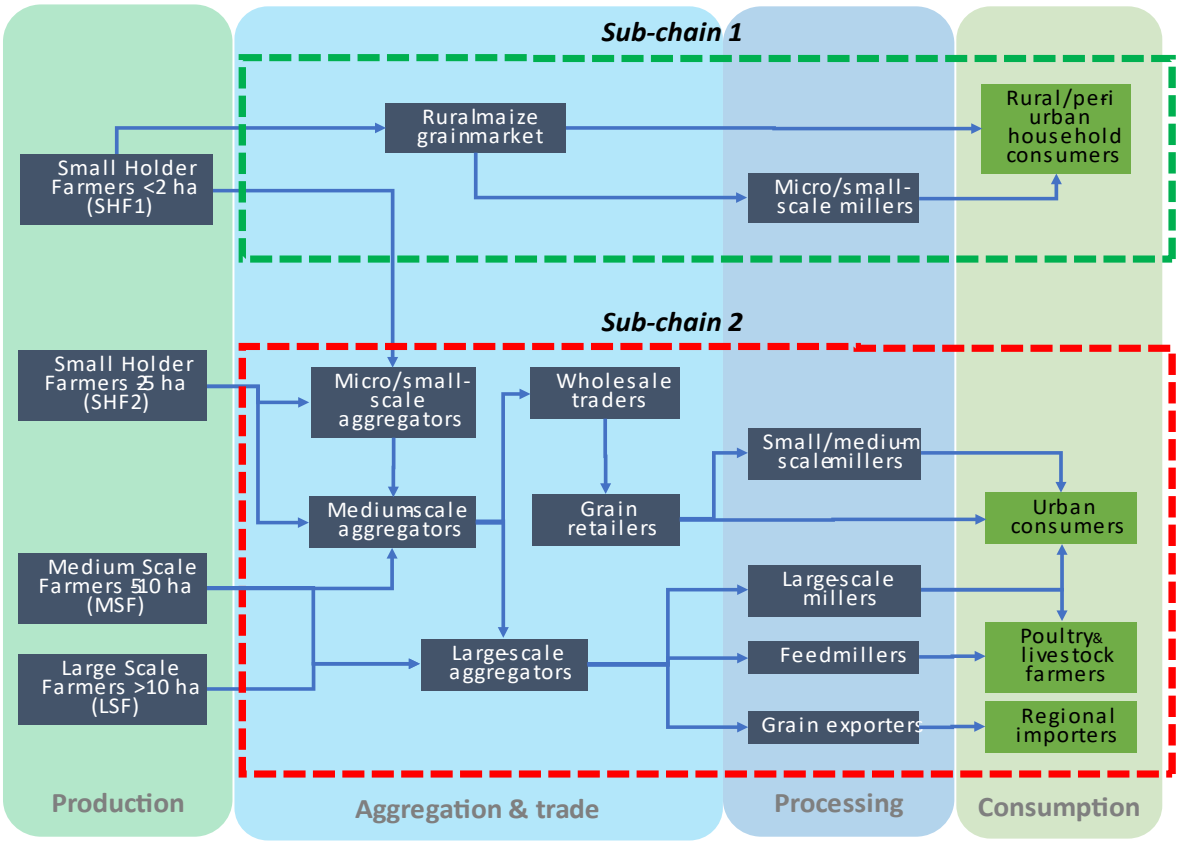
Maize is important in Nigeria's farming as well as food systems. The country has made giant strides in maize production (see Figure 5) and, as a result, has emerged as one of the leading maize producers in the world. With output estimated at over 12.5 million tonnes in 2019, Nigeria ranked second in Africa only to South Africa, which produced about 15.8 million tonnes of maize. Nigeria produces mainly white, non-genetically modified (non-GM) maize, which is generally preferred in the food systems in the country as well as in most African countries. As far as this variety is concerned Nigeria is the leading producer in Africa. Production is concentrated in the northern states, where average land under maize cultivation is much bigger than in the south of the country. Consumption patterns also differ a bit. In most of the northern communities, dry maize grains are milled and used for preparation of different meals. In the south, however, in addition to consumption of maize flour, fresh corn-on-cob is very popular. The very sizeable poultry industry in the country also utilises a significant share of the maize grain marketed by producers.

The production, transformation and marketing of maize grain is through two main sub-chains, briefly described below and depicted in Figure ES-1. **Sub-chain 1** is dominated by smallholder farmers who generally use very little or no yield-enhancing inputs (e.g. improved seed, fertiliser and pesticides) and are designated in this study as **SHF1** farmers. The SHF1 farmers usually sell directly to other households in the rural areas or to rural, micro-scale collectors/aggregators.

The key difference in **Sub-chain 2** is the involvement by large-scale aggregators who develop ties with smallholder farmers and provide inputs on credit to them with a commitment to buy grains equivalent to the credit extended. They are also able to buy any extra output the farmers are willing to sell. These systems have enabled the participating smallholders, designated in this report as **SHF2**, to become more productive and earn significantly higher maize-based household income. As a result of the support they receive from the large-scale aggregators, the SHF2 are able to record over 15% increase in yield and also expand their area under maize cultivation. Their delivery to the large-scale aggregators is through a network of village-based groups, and this shortens the supply chain, making it possible to obtain farmgate prices which represent 84% of the final grain market price (compared to 68% for the SHF1).

The other producers, who operate in Sub-chain 2, medium-scale farmers (**MSF**) and large-scale farmers (**LSF**). These farmers usually finance production from their own resources but are also able to access bank finance or credit under packages such as the Anchor Borrower Scheme implemented by the Central Bank of Nigeria (CBN).

FIGURE ES-1: TYPOLOGY OF KEY ACTORS AND FUNCTIONS IN MAIZE VALUE CHAIN IN NIGERIA



It is estimated that 52% of maize production in Nigeria is from SHF1. The share of the SHF2 in total maize output is 17%, whilst the MSF and LSF respectively contribute 19% and 12% of total maize output.

In terms of utilisation, about 10% of total maize output is consumed as fresh corn-on-cob which is roasted or boiled. This is especially popular in the south. Consumption by farmer households is estimated to be about 15% of total output and the feed milling and food processing industries utilize 32% and 23% of maize output respectively. Exports of maize grain into the sub-regional markets account for just about 5% of total output but postharvest losses (PHL) is about treble that, estimated at 15%.

What is the contribution of the maize VC to economic growth?

Profitability for the actors

The main findings from the economic analysis undertaken during the study and reported in Chapter 4. From the financial analysis reported in Section 4.2, it emerged that the operations of all actors in the maize value chain are profitable. Especially profitable is grain, where return on turnover ranges from just over 31% for SHF2 to close to 38% for LSF. Margins are tighter at the level of grain distribution, where the only operators posting

return on turnover (ROT) about 10% are the large-scale aggregators. The others post ROT of between 4.5% to 7.7%. At the transformation level, the estimated ROT is tightest among the feedmillers, estimated at 16%, which is not surprising because it is a highly competitive industry. Formal food processors obtain returns estimated at about 23% whilst the micro/small-scale millers record ROT of close to 20%.

Annual maize-based income for the SHF1 is estimated at N68,000 ($190), which is way below the national poverty line (N137,000 or $380). It has to be noted that the SHF1 usually allocate less than 20% of the area cultivated to maize production. The rest of the cultivated land is used for growing a range of other crops. In the northern states the other crops tend to be other cereals such as rice, sorghum and millet as well as legumes such as groundnuts. In the southern states they tend to grow more of the roots and tubers such as yam and cassava.

For the SHF2 producers, average annual maize-based income is about N252,000 ($700) which is high above the poverty line but lower than the annual national minimum wage (N360,000 or $1,000). On the average they allocate about 25% of the area cultivated to maize production and the significant increase in maize-based household income is not only due to expansion in area under maize cultivation. It is in part attributable to rising crop yields, lower postharvest losses, and increase in the producer prices they obtain as a result of selling through a shortened, formal marketing chain.

MSF producers, however, earn more than double that national minimum wage, obtaining an estimated N958,000 ($2,660) per annum. Their average area under maize cultivation is more than double that of the SHF2 and represents over 35% of their total area cultivated per household. They also adopt more intensive crop husbandry practices, which contribute to the yields they obtain being substantially higher. Due to the scale of their operations, they are able to sell directly to large-scale aggregators and grain wholesalers, enabling them to also benefit from producer prices which are significantly higher than what the SHF1 obtain. It is for these reasons that this category of farmers, who operate more in the northern states than in the south, perceive maize production as a commercial activity.

Contribution of the maize value chain to national economy

The value maize chain in 2019 generated total value added estimated at N1,502 billion ($4.17 billion), which is equivalent 0.9% of national gross domestic product (GDP) and almost 3.8% of the overall agricultural GDP in Nigeria. The components of the total value added is as below:

- Land/property income – 6.4%;
- Wages – 13.1%;
- Financial charges – 5.9%;
- Public finance – 7.4%;
- Depreciation – 9.7%; and
- Actors' net income – 57.5%

Maize VC contribution to public finances, foreign exchange generation

The chain contributes N107.6 billion to public finances in the form of taxes and local government levies but obtains inputs subsidies estimated at about N113 billion, implying net outflow of about N5.4 billion from the public purse into the value chain. It is noteworthy that the SHF1, who are under-capitalised have little or no access to the subsidized inputs and therefore do not benefit from the subsidies.

Maize grain exports in 2019 is estimated to have generated about $230 million but the imported intermediate goods and services utilized in the chain is valued at about $362 million. Nigeria is well able to fill this deficit in foreign exchange generation in the maize value chain if policy actions which constrain exports into the subregion are addressed. Being the leading producer of white, non-GM maize gives the country a competitive comparative advantage over major exporters in North and South America as well as South Africa which leads in the production of GM maize.

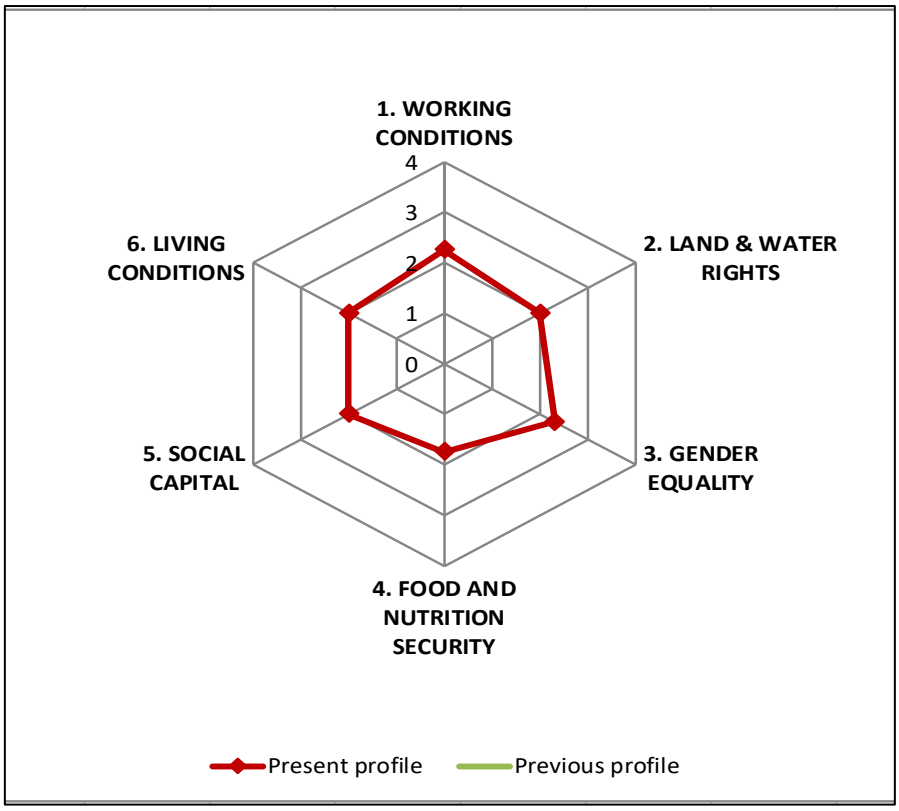
The value chain is well-integrated into the local economy as shown by its estimated rate of integration of 0.83. The domestic resource cost (DRC) ratio in the chain is also estimated at 0.19, which is well below unity (i.e. <1) and indicates that it has a comparative advantage and is viable within the global economy. However, the nominal protection coefficient is 1.09 meaning that the domestic value is higher than the international market price. This is an indication that players in the chain currently enjoy a certain level of protection.

Is this economic growth inclusive?

The value maize chain creates over 23 million jobs, mainly at the production level and also among the growing number of micro/small-scale millers who employ young low-skilled wage labourers. The value chain is also highly inclusive as evidence generated through this study shows that most of the income generated in the chain accrues to small and micro-scale actors including smallholder producers. Smallholder farmers, for instance, account for almost 69% of total maize production and about 63% of maize grain and corn-on-cob which is marketed in Nigeria. Furthermore, micro/small-scale millers account about 57% of maize grain which is processed into flour and other products for food. These enterprises employ the youth, especially in the north, and also women, particularly in the south. Income obtained by smallholder farmers and the micro/small-scale millers and other artisanal processors tends to be invested in the local economy and in children's education, healthcare, housing and other enterprises.

Is the VC socially sustainable?

Challenges such as limited access to resources, including finance for acquisition of inputs by farmers and as working capital for micro/small-scale processors hamper sustained growth in the value chain. Other challenges include the working environment and an apparent weak capacity of the multiple farmers' organisations to effectively represent their interests. This particular issue needs to be addressed if the emerging transactional relationships between farmers and off-takers is to be consolidated and scaled up as part of efforts to promote inclusion and sustainable growth in the value chain.



Working conditions

Nigeria has ratified several regional and international treaties including ICESCR and ICCPR, however the rule of law is weak and has not been able to prevent and/or contain systemic issues of ethnic, religious and gender-based discrimination and violence affecting areas where smallholder maize producers are located. This has disrupted their access to basic services and markets. Minimum wage applies only to federal workers in the formal sector and not to seasonally employed agriculture wage labour which depends on individual negotiation. Most contracts for agriculture are verbal - this makes the farm wage labourers vulnerable and liable to exploitation. Unequal wage rates for male and female labourers, where households that contribute to upstream production activities such as planting/rearing, weeding/nurturing and harvesting are generally non-paid family labour or paid labour. The mandatory safety and hygiene standards associated with maize processing/ mills are relatively high amongst larger industrial processing/ milling factories- they often have some form of health care on site, or link to provision off-site; no such protection measures were observed in small and medium scale processing units.

Land and water rights

Majority of the producers are smallholders with average land holding between 1.5 to 5 hectares acquired through inheritance or rent. Evidence suggests that the commercial maize growers' farms (over 10 ha up to 100+ ha in Kaduna and Katsina) are using own land holdings that may have expanded over time through consolidation of surrounding properties. The terms under which these landholdings have been governed by customary laws and informal arrangements. With family farms being broken down for inheritance, smallholders face fragmentation of land which makes farming low productive and

unviable. Acquiring new land requires substantial investment, and as most SHFs do not have formal titles to their land they have difficulties accessing credit from formal financial institutions that require due diligence on their investment. At present the land system is characterised by several actors including government, community leaders, families/ clans, lawyers, brokers and estate agents among others. Land title registration procedures are lengthy and cumbersome, hence most agreements are verbal, binding and honoured by both parties. Communal land allocation is seldom documented, therefore boundaries defining farm plots are uncertain and lead to conflicts. With regard to land rights, women have user rights in all states and can have title deeds in their names; customary rights do not confer women the right to use, control or transfer land.

Gender equality

In the maize VC, women are primarily involved in production activities primarily in seed storage, weeding, harvesting and storage at HH level. Petty trading at farmgate and/or local markets as well as artisanal or small-scale processing of maize products suitable for home consumption is also observed. As labour, women are particularly sought out for tasks that require dexterity, consistency and patience. In smallholders, social norms and reasons related to women's limited education, mobility, access to information, access to credit resource constrain active participation in downstream components of the value chain. Some women are also engaged in more skilled and technical roles, such as factory or farm supervisors, agronomists and sprayers. With regards to pre-production, production or artisanal processing activities, women benefit from a degree of autonomy. In many of the areas visited by the study team, women had access to extension services and input suppliers by virtue of participating in government or NGO development programmes. However, this did not mean they had control over these interactions. Decisions about farm production are still often made by men. Control over the income earned from maize production at SHF level is often linked to who is trading the maize. As transporting maize to markets is predominantly done by men, this often means it is they that receive payment rather than the woman who may have taken responsibility for the majority of the production process. Women often have small petty trading initiatives which bring in small amounts of money that remain under their control. Women farmers associations like WOFAN are actively promoting women's participation in rice and maize VCs by providing inputs and access to extension services.

Food and nutrition security

Maize is a major staple crop in Nigeria but there is competition between its direct consumption in households and use the feed industry. The smallholder farmers with limited access to resources (the SHF1) obtain very low maize-based income due to low productivity distress sale at the time of harvest when prices are low. Hence, this group of farmers are limited in their ability to reinvest maize-based income in scaling up food production. In contrast, the case of the SHF2 and MSF shows that improved access to resources can trigger increase in maize-based household income which increases the purchasing power of smallholders and also enables them to scale up production.

Diets in most smallholder households are primarily low in food groups providing protein and micronutrients[1]. They consist of maize and other cereals like rice, sorghum, millets as well as roots and tubers such as cassava and yam. The high cost of most animal protein sources limits access by poor households. As discussed in Section 7.2, eggs are comparatively lower cost than most other animal protein sources in Nigeria (very close to 40% cheaper than dried or smoked fish). Its consumption remains low with estimated per capita consumption of about 65 eggs per annum in 2018. Though this is well below the global average of about 145 eggs per person per year, it is still higher than the African average of about 45 eggs per person per year. Evidence from Zambia suggests that strategic investment in the egg value chain can boost output to levels which will drive down prices to levels which drive up consumption by poor households[2].

Food quality in local markets is another area of concern as is the problem of periodic food shortages which is sometimes triggered by crop failure, unstable market prices and large household sizes. Evidence discussed in this report shows that government policies such as export ban creates instability in maize output prices which negatively affects producers, especially the smallholder farmers. In addition, aflatoxin contamination is quite high in the maize subsector due partly to poor postharvest handling practices and a predominantly informal marketing system which offers no price premium for quality grains.

Social capital

There are several farmer producer organisations (FPOs) and professional associations at various intervention levels. At the national level, general purpose apex organisations such as All Farmers Association of Nigeria (AFAN) and Union of Small and Medium Scale Farmers of Nigeria (USMEFAN) focus on political services i.e. representation, lobbying and advocacy at the national level, whereas the second tier organisations are commodity-based and focus on economic services. However, it is not clear if these FPOs are established and governed by farmers, and how they benefit smallholder farmers. The legal status of most organisations is unclear[3]. Organisations like Women Farmers Advancement Network (WOFAN) provide special services to women farmers and are closer to NGOs in structure and activities than membership-based farmer organisations. Most smallholder farmers rely on their neighbouring farmers for information. Extension agents are more accessible to large scale farmers and also to the SHF2 who participate in schemes involving aggregators.

For market information SHF usually rely on information given to them by traders and their peers, and the effectiveness of this communication depends on the person they are interacting with. Large processors usually do not deal directly with producers, mainly

[1] Most Nigerian's basic diet is based on staple local food accompanied by a vegetable stew. The type of stew made and the quantity of meat, fish or vegetable added depends on the socio-economic situation of the household. Most low income households cannot afford to add meat and/or fish (Adegboye, 2016).

[2] Source: Onumah G et al. (2018) "Egg Value Chain Analysis in Zambia", Report for the European Union, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375-804), 192p + annexes.

[3] Agriterra, 2008. Farmer's organisations in Nigeria: an overview. https://www.inter-reseaux.org/wp-content/uploads/pdf_Mapping_Agricord_Nigeria_version_courte.pdf

because of the high cost of aggregating from a large number of producers selling small volumes. In addition, quality of grains supplied by the SHFs tends to be highly variable. They therefore tend to sell their produce to micro/small-scale aggregators who also sell to or act as agents for larger-scale traders. The involvement of multiple actors in the distribution chain leads to producer margins being squeezed, especially as quality premium is rarely shared with smallholders. SHF2 producers sell directly to large-scale aggregators, thereby eliminating the involvement of micro/small and sometimes medium-scale aggregators. They therefore obtain producer prices which are over 35% higher than what the SHF1 receive. The LSF and a few MSF also sell directly to large-scale processors on usually the terms as the large-scale aggregators.

As is the case with other VC actors there are issues related to land boundaries/tenure agreements, quality of inputs (seed germination), warehouse facilities in markets, etc. The study team did not get an opportunity to explore if large feed companies and/or millers involved in maize processing make any contribution to education and health care facilities in the local area as part of their corporate social responsibilities.

Living conditions

Only 2% of the population living in the Northeastern region, which consists of the major maize-producing states and smallholders, have access to safely managed drinking water. People living in the North Central – another major maize producing area - recorded the highest proportion of open defecators, while the lowest was recorded by people in the Northwest at 9%. People living in the rural areas are three times more likely to practice open defecation than those in the urban areas. 73% of smallholder households live in poverty with one quarter of those in extreme poverty (< USD1.25a day). Household size, distance and cost of treatment are the main reasons for unequal access to healthcare facilities in rural areas. These factors seriously affect women and children's access to basic healthcare, as a direct consequence of the patriarchal system. School fees, clothing and materials still a challenge for the poorest of the poor. Primary education is not always accessible in the rural areas and, along with limited access to healthcare, may prevent livelihoods from improving and the VC from becoming more efficient and inclusive.

The maize value chain can contribute much more if risks and challenges identified in the chain are addressed. These include the following:

- Lack of effective farmer producer organisations representing interests of smallholder farmers; the inability of smallholders to negotiate price and payment terms for produce sold directly with large milling companies and poultry feed factories illustrates the power imbalances between VC actors;
- The Minimum Wage Act does not apply to agricultural labour, hence promoting an informal farm labour wages based on verbal agreements;
- Hazardous working environment especially for youth engaged in small and medium scale milling activities;
- The traditional land tenure system that disallows smallholders from growing, and often forcing them to sell out their lands to larger farmers;
- Gender inequality (no access to land and credit and low decision power);

- Health care availability and affordability; and
- Lack of investment in vocational training.

Is the VC environmentally sustainable?

The environmental sustainability of the maize VC in Nigeria was analysed following a Life Cycle Assessment (LCA) methodology, considering three areas of protection: the impact on depletion of natural resources, the quality of ecosystems and human health. The total impact of the Nigerian maize value chain is calculated: 28,500 life year of a person lost by disease or mortality due to emissions from the production of maize products in 2019, disappearance of 318 species during one year due to emissions and land use, 491 million USD of surplus cost due to (mainly fossil) resource depletion. Part of this impact is due to 19.3 10^6 ton CO_2eq of greenhouse gas emissions from the VC in 2019. This is about 2.0% of the total greenhouse gas emissions during one year for the total population of Nigeria, but less than 1% of the human health and ecosystem damage and merely 0.01% of the fossil resource scarcity impact. Climate change contributes more than 63% to human health and 17% to ecosystems quality impact, mainly caused by carbon dioxide emissions from land use change and to a lesser extent from fossil fuel combustion, and nitrous oxide emissions from fertiliser production and use. Fine particulate matter formation contributes 31% to human health impact.

Land use contributes almost 77% to ecosystem quality impact. Cultivation and land use change, and (to a lesser extent) distribution are the life cycle stages that contribute most. Differences in climate change and land use impacts between farm types are mainly explained by differences in yield. The climate change and land use impacts of maize from smallholder farmers without support are higher than the impact of maize from the other type of farmers. These impacts are strongly related to the yield: lower yield means higher impact. The fine particulate matter formation and fossil resource use impact are on the other hand lowest for maize from the mainstream smallholder famers.

The results of the LCA partly confirm the importance of the environmental topics identified during the interviews with actors of the maize value chain in Nigeria: 1) Flooding, 2) Changing rainfall patterns, 3) Low soil fertility, 4) Food loss, 5) Deforestation, and 6) Fossil energy use/emission. These topics were therefore further analysed using yield gap analysis, food loss visualisation, and literature review. In the yield gap analysis, adequate fertiliser application is considered as the most limiting factor for reaching higher yields, but that there is an important interaction with other factors, such as flood control, improving soil quality, run-off/erosion control, pest and disease management, and weed control. The use of improved/hybrid seeds can further increase yields in the direction of attainable yields under the different climatic conditions in Nigeria. From the analyses, the following is concluded on the six identified environmental topics:

- **Flooding**: Serious flooding events have occurred in the past decades in Nigeria, not only regularly affecting people's wellbeing in the river areas, but also causes yield losses and land degradation. It is caused by increasing rainfall in Nigeria and upstream countries, and the presence of dams likely increases the flooding

intensity near the dams. Flood damage is an important factor for the low average maize yields in Nigeria.

- **Changing rainfall patterns**: The changing climate due to anthropogenic greenhouse gas emissions includes prolonged dry spells in Nigeria. This increases risk of pests and weeds that hamper the growth of the maize plants and limit the growth of the grains. Pests and weeds are also important factors for the low average yields in Nigeria. Using improved seeds and adequate amounts of fertilisers to reach higher yields is risky due to the water shortage and associated pests and weeds. Moreover, irrigation is not feasible in many areas.

- **Low soil fertility**: Inadequate soil management, soil erosion, and run-off are important causes of the low soil quality in Nigeria. This is another factor for the low maize yields. Techniques for improving soil quality depend on many factors, such as soil type, weather conditions, the slope of the land, flooding events, possibilities for crop rotations, and availability of organic fertiliser. It is therefore difficult to pinpoint the heart of this issue. Though field officers of the large-scale aggregators provide extension advisory services, there is no evidence that the information they provide differs from the generic advice offered by public extension agents. There is need to strengthen capacity across the board (i.e. for public and private sector agents) to deliver extension advice which is tailored to area-specific conditions including, for example, application rates for inorganic fertiliser. Similarly, it is crucial to promote practices which sustain soil health such as mulching, application of organic fertiliser and others which enable farmers to respond to the changing climate (as briefly discussed in Section 7.2).

  In terms of availability of organic fertilizer, it is highly variable across the country and there is a dearth of data on it. Not only is there a need for further research on this but also to improve understanding of the economics of adopting such options in addition to the environmental benefits.

- **Food loss:** The food loss visualisation shows that there are significant food losses throughout the maize value chain, but that most losses are caused during drying/storage of the maize grains. Conventional estimates of losses warehouses and other modern storage facilities ranges from under 1% to max 2%. In contrast, losses at the household level in Nigeria is in the range of 4.5% to 5.5%, implying that by transferring storage from household level to well-run facilities, the country could be saving over 440,000 tonnes of maize grain (close to 70% of the total volume of maize grain exported in 2019). A large part of the harvested grains and the crop residues is used as feed for animals. The food losses occurring in the value chain of the animal products is however out of scope of this study. Nevertheless, a considerable share of the environmental impact from cultivation and land use change found in the life cycle assessment is caused by the maize lost for both feed and food applications.

- **Deforestation**: Deforestation has been severe in Nigeria in the past 50 years and has caused loss of biodiversity, land degradation and large amounts of greenhouse gas emissions. Exponential population increase and subsequent demand for fuel wood and increased use of land for maize cultivation and other agricultural activities has been an important driver of this environmental issue. What part of the biodiversity loss and greenhouse gas emissions from land use change can be attributed to the maize cultivation in Nigeria is difficult to quantify. Nevertheless, the life cycle impact assessment results show this can be a significant part of the total environmental impact of the Nigerian maize value chain, but also that the mere occupation of land also contributes significantly, especially because of the low yields. Food losses indirectly cause a higher pressure on land compared to a situation with reduced food losses.

- **Fossil energy use/emissions**: Combustion of diesel and natural gas for maize cultivation, post-harvest handling, processing and transport contribute significantly to the overall environmental impact of Nigerian maize product. This is mainly because fossil resource combustion leads to carbon dioxide and fine particulate matter emissions, and to increasing fossil resource scarcity. Fertiliser production and use also contribute significantly as this causes greenhouse gas and ammonia emissions (which enhanced fine particulate matter formation).

Conclusion

Overall, the maize value chain shows great potential for sustainable and inclusive growth, including the potential to achieve the Federal Government's output target of 20 million tonnes per annum as well as related food and nutrition security objectives. To achieve this, the risks and challenges discussed in Chapter 7 and summarized in Table 30 need to be addressed through actions targeted at strengthening productive capacity of smallholders as well as the midstream and downstream segments of the value chain.

Among the key actions considered in this report is the need to enable smallholders to transition from low-input, low-yield SHF1 farmers to the more productive SHF2 farmers. This yields economic, social and environmental benefits, including significant increase in household income, taking smallholders out of poverty. This can be achieved through strategic investment in the midstream section of the VC. One option is promote strengthening and upscaling of the outgrower schemes developed by private large-scale aggregation companies. This is because these companies are well-placed to leverage financial resources with which they improve access to inputs for smallholders and also provide additional support services. Their linkages with smallholders and the governance structures which has emerged has enhanced their capacity to supply grain of consistent quality to the major grain transformers, especially the feedmillers who play an important role in sustaining the poultry industry.

An alternative but very similar option is to invest in aggregation facilities[4] which can be used by smallholders of all size to bulk and deliver their grains into commercially-run

[4] Kaduna State is already investing in required aggregation facilities.

storage facilities which are properly regulated, i.e. under a regulated warehouse receipt system (WRS). The big difference is that, by participating smallholders retain ownership of their stored grain and can use it as collateral to borrow for production purposes. This system has been successfully piloted for small-scale grain producers in Burkina Faso and for commercial deposit of export crops in Tanzania. NAERLS officials are familiar with the system and there has been attempts to promote it at the Federal level as part of the institutional infrastructure underpinning the operations of a nationwide agricultural commodity exchange. Nigeria has the key technical prerequisites for setting this system up but some key policy-related bottlenecks need to be addressed[5]. Strong farmers organisations are needed in both options.

Strengthening the midstream will enable Nigeria to better exploit the subregional grain export market. This is partly because the country has a competitive advantage over South Africa in the maize grain market in Africa as a whole. Unlike South Africa, Nigeria produces mainly non-GM white maize which is generally preferred by African consumers. Policy and programmatic actions to reduce postharvest losses will ensure that scaling up maize grain exports will not have deleterious effects on maize-related food security. This is because estimated volume of maize PHL is more than treble the current level maize grain exports. PHL reduction, however, requires not only efficient storage facilities but also promotion of marketing systems which are more rewarding to smallholders (as they are shorter) and also access to finance to ease liquidity constraints faced by farmers who decide to delay the sale of their crop. A WRS can make both possible.

Policy stability as far as the grain trading environment is concerned as important in sustaining exports. It is noteworthy too, that policy stability will also minimize downside price risks which militate against the activities of domestic traders and producers. The major difficulty in achieving this is the very strong voice of the feedmilling industry in contrast with other actors, especially the farmers.

At downstream level, the focus of action should be on support for micro/small-scale grain transformers in order to improve their working environment and enhance adherence to food safety standards. Most poor consumers rely on their services and their exposure to avoidable health risks needs to be minimized through enforcing realistic food safety standards. Furthermore, creating a safe and rewarding working environment will sustain the capacity to create jobs for the youth at this segment of the value chain.

1. INTRODUCTION

1.1 Background

This Maize Value Chain Analysis is being undertaken in Nigeria as part of a number of studies commissioned under the Value Chain for Development (VCA4D) Project funded

[5] The EU-funded Accessible systems to manage risks in family agriculture in Africa (CRIS CONTRACT 2011/260-875) provides lessons which are very relevant in pursuing this option in Nigeria.

by the European Union and implemented by Agrinatura[6]. The principal aim of the VCA4D is to generate evidence, largely quantitative data and analytical information, to underpin policy actions and interventions in the selected value chains. The choice of the maize value chain in Nigeria was made by the European Union Delegation (EUD) in consultation with the Federal Ministry of Agriculture and Rural Development (FMARD). The evidence generated may also be relevant in contextualising an investment made to support an initiative by a social enterprise in Nigeria to promote smallholder participation in the production and marketing of maize in Nigeria.

1.2 Methodology and scope of study

1.2.1 Study methodology

The team adopted mixed methods in undertaking the study. Data and evidence collection involved the use of various tools and resources including the following:

- Desk study involving review of literature, reports, relevant documents and online databases. Also reviewed are publications and reports (see references).
- Interviews with key actors at all stages in the maize value chain, including experts and resource persons on themes related to specific components of the study i.e. social, economic and environmental issues. The interviews, which were done during the first field mission, were either semi-structured or unstructured and centred around key issues in the value chain. A survey was also conducted, as reported below.

The team adopted a mix of analytical tools including the following:

a) Basic statistical analysis to underpin the functional analysis;
b) Basic accounting framework for the financial analysis of the operations of key actors;
c) Basic excel spreadsheets were used for the economic analysis including computing the total value added in the chain as well estimates of contributions to the national economy and assessment of the sustainability of the chain in the international economy;
d) Use of a standardised framework and scoring tool developed for the social analysis; and
e) Application of the Life Cycle Analysis (LCA) methodology and a proprietary software platform (SimaPro) in carrying out analysis of environmental sustainability and impact assessment.

1.2.2 Geographic focus of the study

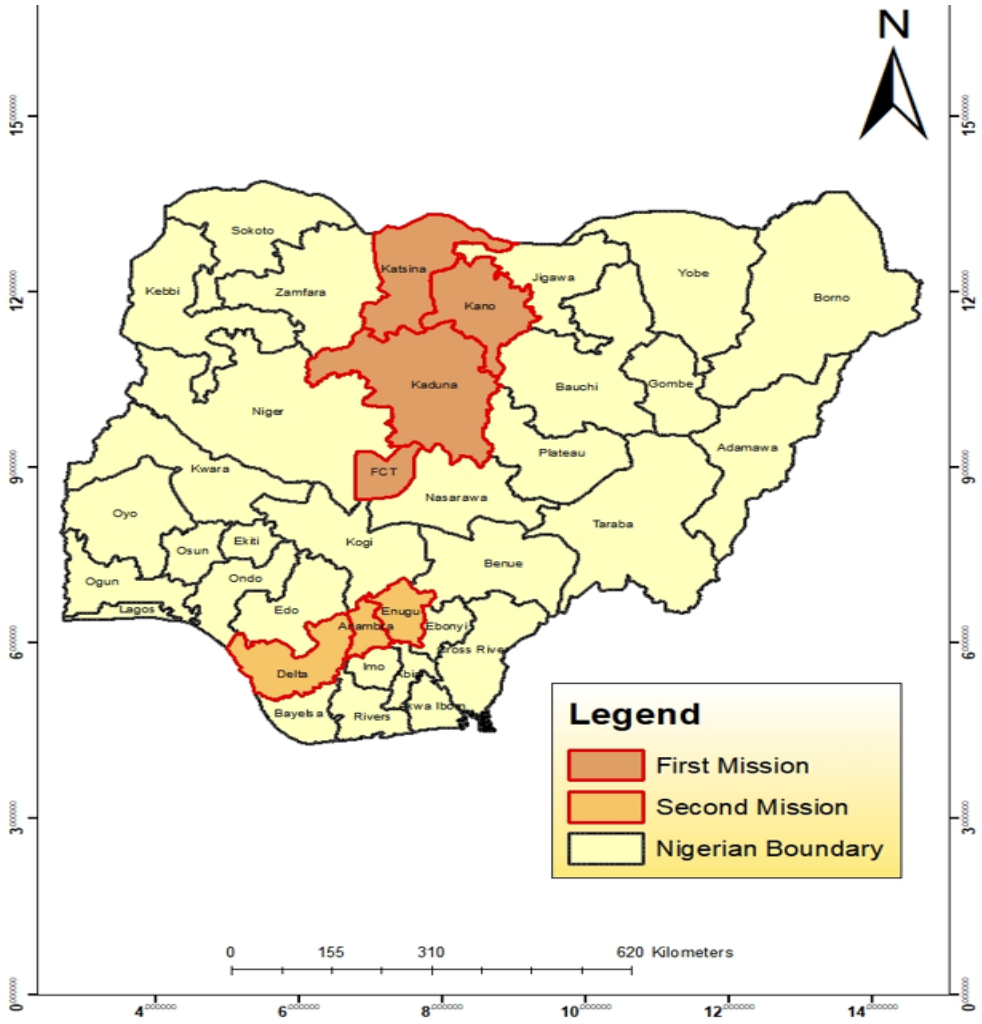
Though the study has a federal perspective, including analysis of secondary data on the state of the VC. However, due to time and resource limitations, the decision reached in consultation with the EUD in Abuja, to focus on six major maize grain producing states shown in Figure 1. The focal states include three in the north, namely: Kano, Katsina and Kaduna. During the first mission in February 2020, the team visited these states and collected primary data through semi-structured interviews and consultations with key

[6] Agrinatura is a grouping of European universities and research institutions involved in agricultural development in developing countries.

stakeholders. The three states were also included in a survey covering different categories of producers, aggregators, traders and processors. Actors in the following three southern states were targeted: Enugu, Anambra and Delta.

The team also held consultations as well as interviewed key officials in Abuja in the Federal Capital Territory (FCT). Also consulted are representatives of Lagos-based private companies which are major players in the maize VC.

FIGURE 1: MAP OF STATES IN NIGERIA COVERED IN MAIZE VCA4D STUDY, 2020.



1.2.3 Timeframe and analytical scope of the study

The team originally intended to set 2018 as the cut-off year for analysis because at the time of the first mission in February 2020, it was presumed that it will be too early to obtain reliable published data on the performance of the sector, including production and price data. However, delays which occurred as a result of the COVID-19 pandemic made it possible to obtain official data for 2019, which has therefore been adopted as the

cut-off or reference year in this report. Despite this boundary in terms of timeframe, the team utilises data and information for 2020, from secondary sources as well as what was generated during the survey to specifically analyse the impact of the pandemic on the maize VC.

The focus of the analysis is on the sub-chains which fall completely within the national borders of Nigeria. It covers maize grain production and utilisation, including its direct transformation into animal feed as well as food products. The actors and their activities, which include production, aggregation and processing, are depicted in Figure 19.

Maize seed is taken as an intermediate good used by producers in the maize grain value chain. Hence, its contribution in terms of vaue added is taken as indirect. The same goes for other intermediate goods and services (IGS) which are analysed. These include the supply of inputs such as fertiliser, pesticides and herbicides (for weed control) as well as services threshing, storage and transport. Providers of intermediate goods and services are shown in Figure 19.

1.2.4 Stakeholders consulted

The first mission occurred from 1st to 15th February 2020. Overall the two-week mission was very fruitful and enabled the team to obtain important data and information relevant to the study. However, gaps remain which we propose to fill through activities prior to and during a second mission. The first official meeting was a briefing session involving EUD officials in Abuja (Frank Okafor and Temitayo Omole). Other stakeholders consulted included those below:

a. **Maize producers:** Different categories in 6 states.
b. **Government:** FMARD, Abuja; ADP, Kano; ADP, Katsina; the National Agricultural Seed Council (NASC); National Environmental Standards Regulatory Enforcement Agency (NESREA); National Agricultural Extension and Research Liaison Services (NAERLS); and Institute of Agriculture Research (IAR).
c. **Education institutions:** Federal College of Agricultural Produce Technology, Kano; BUK, Kano
d. **NGOs/representative organisations:** All Farmers Association of Nigeria (AFAN); Maize Growers, Processors and Marketers Association of Nigeria; Poultry Association of Nigeria; Women Innovators Network (WIN); Women Farmers Advancement Network (WOFAN); National Farmers and Agri-produce Suppliers Association; and the Saminuka Farmers and Grains Suppliers Association.
e. **Private companies:** Sovet International Co. Ltd. (feed millers), Kano; KOTSCO (Kano-state-owned agricultural inputs distribution company); Narudeen Concepts and Services Ltd., Saminuka (grains traders); Northern Nigeria Flour Mills, Kano; Solar Farm Ltd. (Lagos-based power generating company targeting small, and medium-scale grain millers).

f. **Babban Gona stakeholders:** farmers, including two youth; former members who exited for various reasons; a Last Mile Distributor; and field staff, included those at one of their collection centres.
g. **Markets:** Dawanu International Grains Market near Kano; Katstina Central Market (meeting with small/medium-scale grain millers); and Saminaka Grain Market.
h. **Others:** Nigeria Incentive-based Risk Sharing Agricultural Lending (NIRSAL) Agency; and Kano-Office of the International Institute of Tropical Agriculture (IITA).

1.2.5 Survey of stakeholders

The survey was carried out in Kano, Kaduna, Katsina, Anambra, Delta, and Enugu states. The selected states covered both the Northern and Southern regions of Nigeria. The selected locations also represent the maize-production belt in the country, where most maize value chain activities are predominant.

Sampling procedure
Multi-stage sampling was used in the survey. In the first stage, a total of six (6) states were purposively selected in the maize belts across the country. The second stage involved the selection of several sublocations, areas with a preponderance of maize value chain actors (producers, processors, aggregators). The sublocations include communities and clusters in both rural and urban areas. A stratified random sampling technique was employed to ensure proper targeting of actors across the various typology defined in the brief note. The actors were stratified according to the farm sizes and/or scale of operations, and then a random sample was selected within the stratum. A comprehensive list of actors in the different clusters was collated.

A tentative breakdown of targeted samples by typology per state is presented below:

- 40 Farmers: SHF1 – 10; SHF2 – 10; MSF – 10; and LSF – 10.
- Aggregators/traders = 25 respondents (Small-scale – 5; Medium-scale – 5; Large scale – 5; Grain wholesalers – 5; Grain retailers – 5; and Grain Exporters – 5).
- Processors/Millers: Small scale – 5; and Medium-scale – 5.

Data Collection Procedure
Primary data was collected through the administration of questionnaires on maize grain producers, processors, and marketers. A mobile data collection system - Open Data Kit (ODK) Application - was used to elicit information from our target respondents in the identified locations. This system was employed to ease data collection, capture the GPS coordinates of various locations appropriately, and also minimize errors in the data collection and entry processes.

A total of five (5) enumerators, one (1) supervisor, and two (2) extension agents were recruited for the data collection exercise per state. A pre-testing exercise was carried out to ascertain the validity of the questionnaires. The data collection exercise was carried out in five (5) days per state. Enumerators administered four (4) questionnaires each on

the first day and three (3) questionnaires per day for the next four (4) days – resulting in a total of four hundred and eighty (480) questionnaires across the six (6) states.

Selection and Training of Enumerators

The enumerators were recruited based on experience in data collection procedures and methods in agriculture or Agri-related fields. A college degree and knowledge of the use of the android-based device were prioritized in the recruitment process. The selected enumerators were trained on how to administer the questionnaires using an android device through the ODK application. The questionnaires were pre-tested during the training.

The training involved brainstorming and simulation exercises to ensure proper understanding and ability to administer the questionnaires within the context of the survey correctly. Clear instructions were also given on how the survey instrument should be administered, including taking the enumerators through each of the questions in the questionnaire and how to answer respondents' questions and/or concerns.

Outcome of survey and challenges

Substantial data was collected during the survey. However, major data quality issues emerged which hampered analysis. For that reason, the team had to rely on important secondary sources, including official statistics, in carrying out the analysis reported in this report.

Among the challenges which were identified as having contributed to measurement and reporting errors during the survey is the fact that the enumerators may have been over-burdened due to the volume of the questionnaire administered across widely-dispersed and remote locations. Language barriers were also a problem, especially in terms of variability in the informal units of measurements/metrics used across the different locations. It was also apparent that some respondents were unable to provide accurate data on incomes and size of operations because they rely more on memory recall than on proper records. This is especially the case among smallholder farmers as well as micro/small-scale traders and grain transformers.

1.3 Reporting

After the first field mission, the team briefed some officials of the EUD in Abuja and subsequently held an online briefing session with the PMU. All members of the team participated in these meetings.

2. OVERVIEW OF THE MAIZE VALUE CHAIN IN NIGERIA

2.1 Introduction

Maize is one of the most important staple crops in Nigeria. As shown in Table 1 it is by far the largest cereal crop (per volume of output) produced in the country. In this chapter we provide an overview of the maize value chain in Nigeria, starting with a review of trends in production in the country in Section 2.2. This is followed by in Section 2.3 with discussion of utilisation of the crop, including its prominence in the country's food systems which are quite diverse. Maize is also a key ingredient in the production of feed for poultry, livestock and aquaculture. Its use as an industrial raw material is growing in importance, including utilisation by flour millers of varying sizes, food manufacturers and also by the breweries. The main constraints, risks and other factors affecting the performance of the subsector are briefly discussed in Section 2.4 of this chapter.

TABLE 1: CEREALS PRODUCTION IN NIGERIA (MILLION TONNES) – 2015-2019

Crop	Average output (2015-2019)	Output (2019)	Average Share of total cereal output (%)
Maize	11.136	12.59	42.32
Rice (paddy)	8.060	8.43	28.33
Sorghum	6.362	6.66	22.39
Other cereals	1.786	2.07	6.96
Total	27.344	29.75	100

Source: Authors' computation from FAOSTATS

2.2 Maize production in Nigeria

2.2.1 Nigeria is a leading maize producer in Africa

Nigeria is one of the top producers of maize in the world. The official estimate of total output of the grain in Nigeria in 2019, which is about 12.6 million tonnes[7], places the country only marginally below Canada which is ranked 10th in terms of volume of maize grain produced per annum. Total global output in 2019 is estimated at about 1,148 million tonnes. Production is, however, dominated by a few countries, with the top five countries accounting for almost 69% of global output. The leading producers are the USA (30.1%), China (22.7%), Brazil (8.9%), Argentina (4.4%) and Ukraine (3.1%).

In Africa, Nigeria ranks second only to South Africa, which produced about 15.8 million tonnes of maize, placing it eighth in the global league of producers, with its share global output estimated at about 1.4%[8]. Nigeria's total maize output in 2019 exceeds that of the next largest African producer, which is Ethiopia, by almost 50%. It has to be noted that about 83% of South Africa's maize output is from genetically modified (GM) planting materials (Mawasha et al. 2019), whereas Nigeria produces non-GM maize and can, therefore, be considered as the leading producer of non-GM maize in Africa. Admittedly, South African maize output and yields rose significantly following the adoption of GM varieties. However, this has not made it possible for South Africa to take advantage of

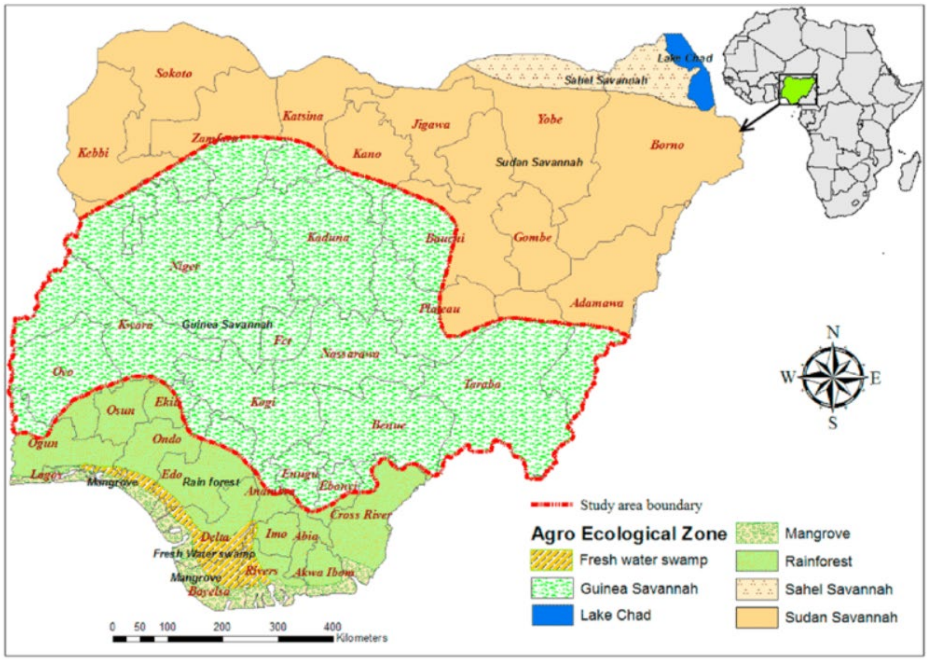
[7] Source: FMARD/NAERLS (2020).
[8] Source: https://knoema.com/atlas/topics/Agriculture/Crops-Production-Quantity-tonnes/Maize-production

potential export market opportunities in Southern and Eastern African countries, largely because most countries in Africa prefer non-GM varieties (Mawasha et al. 2019).

2.2.2 Geography of maize production in Nigeria

It is one of the few crops which grows across the whole of Nigeria. It thrives under the different agro-climatic conditions in the country depicted in Figure 2. It should be noted that the six states covered in this study are from the three of largest agroecological zones (i.e. by size of geographical area). These are: Sahel Savannah (Kano and Katsina – both in the North); Guinea Savannah (Kaduna to the north and Enugu in the South West); and the Rainforest Zone (Anambra and Delta).

FIGURE 2: AGROECOLOGICAL MAP OF NIGERIA



Source: Adenle A.A and C. I. Speranza (2021)

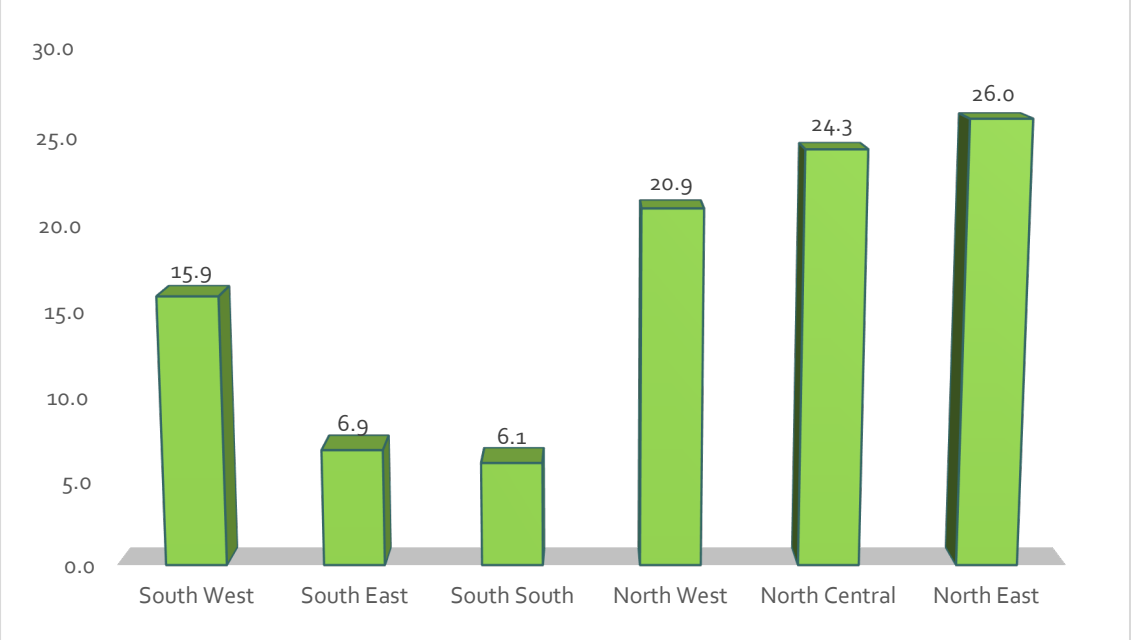
- The **Rainforest Zone** is the wettest regions and has a bi-modal rainfall distribution and high annual rainfall, which on the average is above 2000mm per year. It is also the most forested area in the country and supports cultivation of perennial crops, which are also cash crops, such as oil palm, cocoa, kola nut and rubber as well as being a source of timber. In addition to maize, the food crops produced in this zone include banana, plantain, yam, cocoyam, sweetpotato, rice, groundnut, cowpeas and beans.

- The **Guinea Savannah**, the largest ecological zone, has a unimodal rainfall distribution with the average annual rainfall of about 1050 mm. Its vegetation is varied, with a mix of trees and rather tall grass but gets dryer northwards. Economic trees sheanut trees, mango, tamarind etc. grow well in this zone. Crops cultivated in this zone include maize, cassava, cotton, groundnut, sorghum, and millet. The zone is also noted for livestock.

- The Sudan Savannah has relatively low average annual rainfall of 657.3mm and usually experiences dry seasons for about six months. The vegetation consists of shorter grasses and trees. The major crops cultivated in this zone include maize, groundnuts, sorghum, millet and cotton. Livestock also thrives in the zone partly because it is part of the tsetse fly-free belt of West Africa.

As shown in Figure 3 below, Northern Nigeria dominates maize production, contributing overall to over 70% of total national output. The North-East leads in the production of the crop, contributing about 26% of total annual output, followed by the North Central with about 24% and North West with close to 21%. The South West which tops production in the South contributes about 16% of national output.

FIGURE 3: GEOGRAPHICAL BREAKDOWN OF MAIZE PRODUCTION IN NIGERIA (2019)



Source: Authors based on data from NAERLS (2020).

The share of national output contributed by the top five producing states is 28.%, these states being Kaduna in the North-West, Niger and Plateau in North-Central and Gombe and Borno in the North-East. The leading maize producing state is Kaduna and it accounts for about 7.4% of total national output.

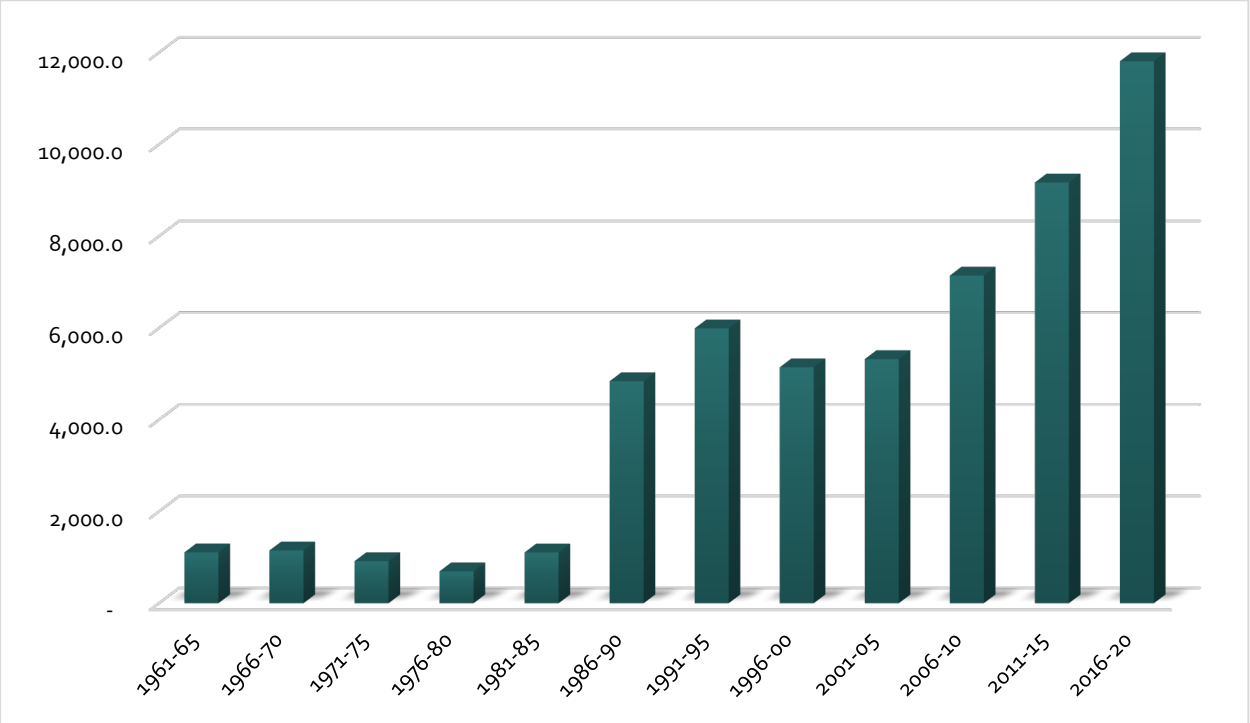
2.2.3 Typology of maize producers in Nigeria

Smallholder farmers who have limited access to improved maize varieties as well as yield-enhancing inputs, tend to obtain significantly lower yields than larger-scale commercial farmers. One of the objectives of the VC study is to examine some initiatives which aim to increase productivity among smallholder maize producers. Furthermore, consistent with the generic objectives of the VCA4D, the study will assess profitability of all actors in the maize value chain as well as overall assessment of the economic, social and environmental sustainability of the chain. A detailed description of farmers and other actors in the maize value chain is reported in Chapter 3.

2.2.4 Trends in maize output in Nigeria

Rise in productivity coupled with substantial expansion in area under cultivation have resulted in a steep increase in total maize grain output in Nigeria as shown in Figure 4 below. During the half-decade (1986-90) maize output more than trebled to over 4.8 million tonnes per annum, from an average of 1.107 million tonnes per annum in 1980-85. Since then growth in maize output has generally trended upwards at an average rate of about 5.1% from 2000 to 2020. Output reached about 4.0 million tonnes in 2000 but rose to over 7.5 million tonnes in 2008 and continued to rise to about 12.7 million in 2018. The Federal Government is, however, targeting annual output of about 20 million tonnes by 2025, though there is no evidence to suggest that there is a deficit in the supply of the grain in the country.

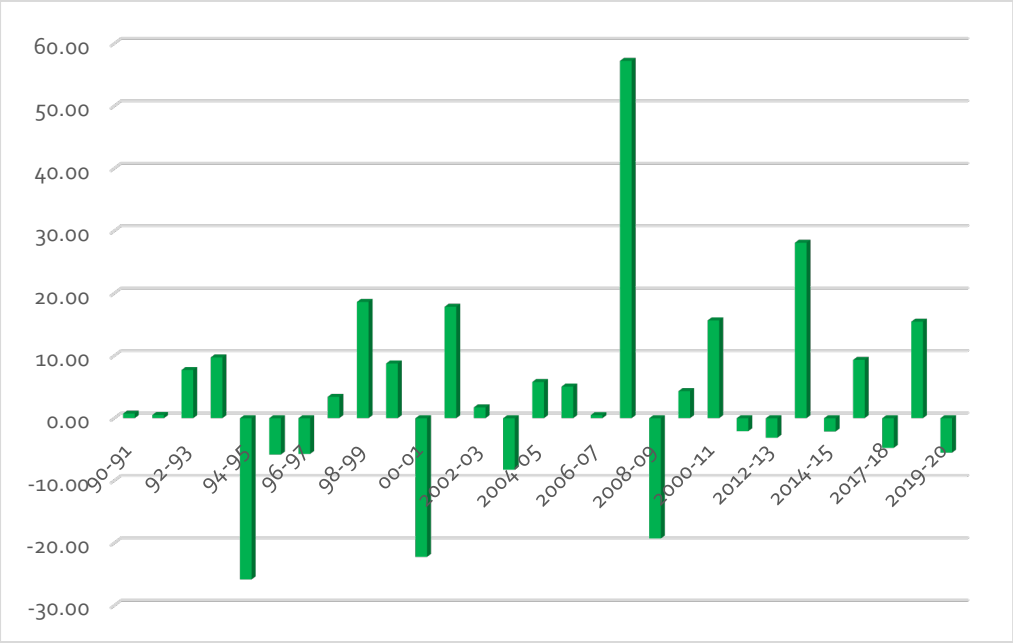
FIGURE 4: NIGERIA MAIZE PRODUCTION – 1961-2020 (' TONNES)



Source: Authors based on data from NAERLS/FAOSTATS.

The impressive growth in maize output is due in part to rising farm productivity. Data published by NAERLS (2020) indicate that maize yields remain rather low and vary across the states, ranging from 1.68 tonnes per hectare in the Edo in 2019 to as high as 2.92 in Nasarawa. The federal average yield is estimated at about 2.1 tonnes per hectare, which is over 60% higher than levels obtained in 2000, when the average yield per hectare for maize was about 1.25 tonnes per hectare. The current yields are still well below attainable levels of about 7.0 tonnes per hectare noted by Shehu et al. (2018).

FIGURE 5: GROWTH RATES (%) IN MAIZE OUTPUT IN NIGERIA (1991-2020)



Source: Authors based on data from NAERLS/FAOSTATS.

It is noteworthy that maize output growth in the country has been rather erratic, as shown in Figure 5. There are almost as many positive rates of growth recorded over the period (15) as negative rates (11). The supply uncertainty created by this situation affects industrial offtakers, especially the feed milling industry on which the poultry subsector depends. They appear, however, to have sufficient policy clout to get the Federal Government to respond to perceived deficits through *ad hoc* (short-term) actions which encourage imports whilst restricting exports. In similar fashion, Government tends to impose restrictions on imports, especially from regional markets, when output exceeds domestic absorption capacity.

2.3 Utilisation of maize in Nigeria

Nigeria is self-sufficient in maize production, being an overall net exporter of the grain. According to official data from the USDA, though an average of about 160,000 tonnes of maize grain was imported by the country in 1976-85, imports virtually dried up thereafter until 2008 when an estimated 50,000 tonnes was imported. From 2009 to 2019, an average of 250,000 tonnes of maize grain was imported. In 2019 official total maize imports is estimated at 250,000 which is slightly less than 2% of total output. During that year, Nigeria exported an estimated 670,000 tonnes of maize, mainly into markets in the sub-region.

A substantial portion of maize produced in Nigeria is lost at various stages during harvesting and postharvest handling. The level of losses differs across the states, reaching 18% in states such as Anambra. Aggregate postharvest losses in the maize subsector is estimated at about 15% of output[9]. In 2019 this, in volume, will be just over

[9] https://www.aphlis.net/en

1.9 million tonnes and valued at about US$685 million (€615 million). Utilisation of maize output is summarized in Table 2 below.

TABLE 2: UTILISATION MAIZE IN NIGERIA (2019)

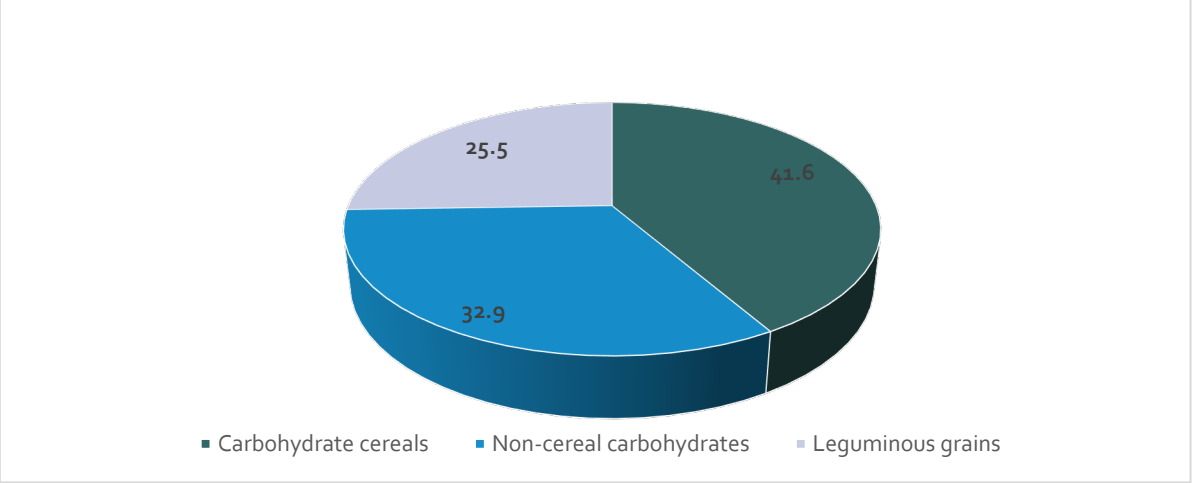
Crop	Volume (millions of tonnes)	Share of output (%)
Fresh boiled corn-on-cob	1.29	10.3
Grain consumed by producer households	1.89	15.0
Feed grain market	4.02	31.9
Food grain market	2.82	22.4
Exports	0.67	5.3
Postharvest loss	1.90	15.1
Total	12.59	100.0

Source: Authors' computation from data from NAERLS/FAOSTATS/USDA.

2.3.1 Maize in Nigeria's food systems

Nigeria has a very diverse food system, with cereals and non-cereal carbohydrate food sources accounting for almost 60% of foods consumed by households (shown in Figure 6 below. As further shown in Figure 7, maize is not only the most consumed cereal but tops cassava as an energy source contributing 20.1% and 16.6% respectively in terms of recall by households of the most common foods they consume.

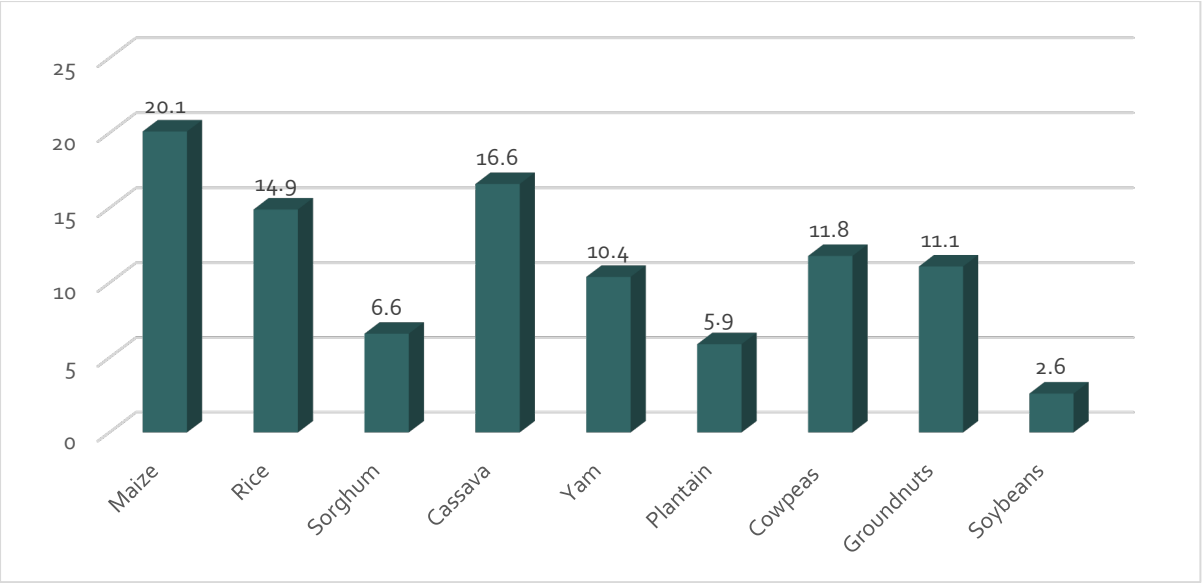
FIGURE 6: COMMON FOODS CONSUMED BY HOUSEHOLDS IN NIGERIA



Source: Survey reported in Cadoni P. and Angelucci F. (2013)

Maize consumption is predominantly in the form of milled flour and grits which are used in preparing porridge and other traditional meals such as *tuwon masara*. The milling is done by community-based informal micro and small-scale millers as well as major flour mills such as the Northern Nigeria Flour Mills Ltd in Kano which sell their products through supermarkets and a network micro-retailers and street hawkers. A large number of micro/small maize millers also operate within communities or at the markets. They sometimes carry out toll-milling, where households take maize grain to them for milling for a fee. However, others operating in the markets also buy maize grain which they mill and package in unbranded plastic materials for sale close to the mills.

FIGURE 7: FOOD CROPS CONSUMED BY HOUSEHOLDS IN NIGERIA



Source: Survey reported in Cadoni P. and Angelucci F. (2013)

Figure 7 shows dominance of carbohydrate-rich foods in the food systems in Nigeria, contributing to high incidence micronutrient deficiency, especially of Vitamin A Deficiency (VAD. Ilona et al. (2017) noted the incidence of VAD is high across different agro-ecological zones and also do not differ much between urban and rural areas. VAD is a major contributor to childhood blindness in Nigeria (Rabiu and Kyari 2002) and also increases the risk and severity of diarrhea, leading to childhood deaths (Abolurin 2018).

It is in response to the high incidence of VAD that initiatives have been launched to promote cultivation and consumption of biofortified crops such as vitamin A maize (VAM) and vitamin A cassava (VAC) by HarvestPlus and the Advancing Nutrition in Staple Crop Value Chains (ANSC) Project, which is being implemented by the Global Alliance for Improved Nutrition (GAIN). Progress remains slows partly because, for instance, in Northern Nigeria white maize varieties are preferred in the traditional maize-based foods. Hence, demand for yellow maize flour remains low, even though micro/small millers are able to mill the VAM varieties as shown in Figure 8.

It appears that promoting the consumption of VAM has more prospects in the Southern states where it is likely to be consumed as snacks in the form of boiled or roasted corn-on-cob. This snack, which accounts for a substantial 10.2% of total maize output in Nigeria, is particularly popular in the South. Indeed, about 25% of maize produced in the south (about 820,000 tonnes) is consumed in this form. This is almost half of total maize output from neighbouring Benin, which reportedly exports dried maize grain to Nigeria through informal channels. Anecdotal evidence obtained during the study indicates that there is a preference for yellow corn-on-cob. Popcorn is also growing in popularity as a snack throughout the country.

FIGURE 8 : MILLING YELLOW MAIZE IN LERE IN KADUNA STATE

Source: GAIN Project field study (2021)

2.3.2 Use of maize in the feed industry

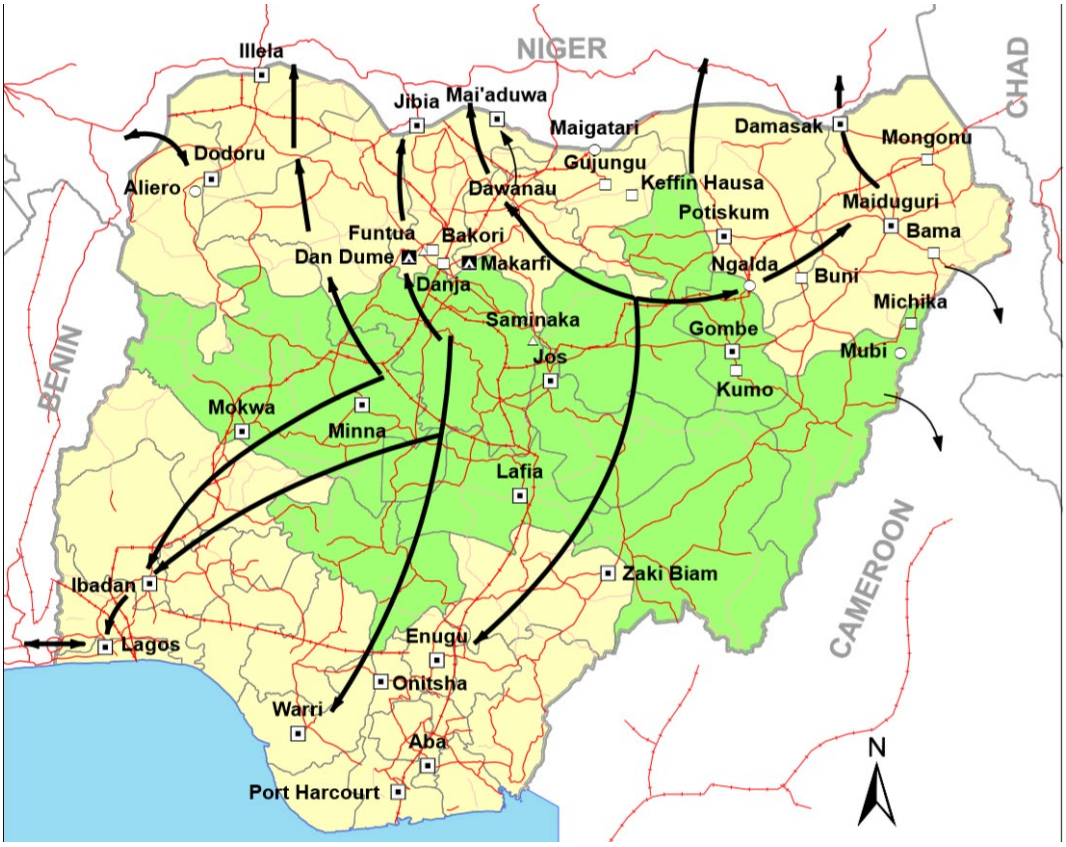
Maize utilisation in the production of animal protein accounts for close to 32% of total national output of the grain. The bulk of maize taken up by the feed-mills goes into feed for poultry. The FAO (2018) estimates the country's poultry population at over 180 million – about 30% layers, which produce over 21 billion eggs per annum. The remaining 70% of the poultry population are broilers. Poultry feed-millers formulate feed from whole grains as well as maize bran (with the germ) which is sourced from the food flour millers. It is anticipated that consumption of eggs and poultry meat will almost double levels in 2015 by 2030. This implies that demand for maize, by the feed milling industry, which is concentrated in the South, will rise significantly.

Livestock farming, which is predominant in the Savannah agroecological zones, is less dependent on maize as the primary energy source for the animals. There is rising demand for maize from the growing aquaculture industry. Growth in the poultry industry is projected to be rapid in the coming years. However, this will be realised only if supply of maize, the key feed ingredient, matches rising demand from the poultry and aquaculture industries.

2.3.3 Maize marketing in Nigeria

Figure 9 shows the geographical direction of flow of maize grain in Nigeria. These flows are influenced mainly by the end-markets into which the crop is sold. The main end-markets are for: fresh corn-on-cob, feed grain markets, food grain markets, and the regional markets for dry grains.

FIGURE 9: MAP OF NIGERIA SHOWING FLOW OF MAIZE GRAIN AND MARKET



Source: FEWSNET/USAID, 2019.

Corn-on-cob:

Boiled or roasted corn-on-cob is far more popular in the Anecdotes suggest that the bulk is consumed as a snack. Close to 65% of the estimated 1.29 million tonnes of the fresh maize market is in the Southern states. Due to its rather short shelf-life, the maize consumed in this form in the South originates from producers in the region. The remaining 35% of fresh maize which is consumed in the North is supplied by Northern producers. Hence, cross-regional trade flows in fresh maize is rather marginal.

Market for feed and food grains

The feed grain market is the main driver of the flows in dry maize grains across the regions in Nigeria as depicted in Figure 9 The bulk of the maize in this market segment goes into the poultry industry, which is concentrated in the South. Data from the 2016 National Livestock Survey estimate that about 70% of poultry production in Nigeria is concentrated in the Southern and Central states – the South accounts for 57% and the central state have 13% share of total production. Production in the North East represents 14% of total production whilst the North West accounts for 16%. Though demand for feed

grain is concentrated in the South, the Northern states account for about 75% of maize grain supply into the feed industry. This explains the southward flow of grains, including from Kaduna, into southern markets around Ibadan and Lagos. Other major markets in the south include Onitsha, Enugu and Port Harcourt. The supply of dry maize into the food grain is again dominated by the Northern states, which account for about 79% of the total volume marketed.

Maize grain exports

The bulk of the of the dry maize grain which is exported by Nigeria originates the Northern states. The trade is dominated by medium-scale grain trading companies and the centre is in the Kano State, with the Dawanau Market being the biggest physical grain trading market in West Africa. Maize from Northern Nigeria are exported into sub-regional markets in Niger, Chad, Mali, Burkina Faso and Cameroun. Maize grain also flows between markets in Nigeria and Benin, concentrated mainly in the South West.

2.4 Risks in the maize value chain in Nigeria

Growth in maize output and productivity in Nigeria is being hampered by a range of risks and other constraints. The prevalent risks, summarized in Table 3, are discussed in this section.

TABLE 3: TYPOLOGY OF COMMON AGRICULTURAL RISKS IN AFRICA

Categories of agricultural risks	Types of risks
Natural risks *originate from the crop production environment.*	Weather risks e.g. drought, floods, erratic rainfall and hailstorms.
	Biological risks: crop and livestock diseases and pests; .
Market risks *arise from imperfections in inputs and output markets.*	Examples of inputs market risks uncertain access to inputs, variability in inputs quality and volatility in prices.
	Uncertain access to remunerative markets; volatility in output prices (affect both producers and consumers).
Human health risks *affect availability of family/non-family labour*	Including endemic diseases (e.g. malaria), epidemics (e.g. Ebola) and pandemics (e.g. COVID-19).
Policy and regulatory risks *can cause volatility in prices and/or uncertainty in transacting.*	Includes macroeconomic policies which drive up inflation and affect interest rates and exchange rates. Unpredictable agricultural trade policies.
Security risks *which may be localised or national.*	Civil strife and/or breakdown in law and order affecting the security of farmers and traders.

Source: Authors from AUDA-NEPAD (forthcoming)

2.4.1 Weather risks

Maize production in Nigeria is predominantly rainfed, with irrigated (dry season) production occurring almost exclusively in the *Fadamas* in the major river basins. As a result, producers are vulnerable to weather risks such as flooding, drought and erratic rainfall. According to a report by NAERLS/FMARD (2020), in 2019 major flooding occurred in three states, namely: Bauchi, Imo and Lagos. Crop losses reported in these states could reach as high as 45% of the expected output. Drought was reported only in Oyo and

Kwara States, with estimated loss levels at about 20%. These two weather risks are analysed in more depth in Section 6.2 of this report.

Erratic rainfall – in the form of delayed rains at the onset of the rainy season; short dry spells during the season; and/or late rains during the harvest season – is increasing in frequency as rainfall patterns are reported by farmers to be changing (further discussed in Section 6.2). There is no official data on the impact of this weather risk in 2019, but it emerged during consultations with farmers in the Northern States that it is making field drying of maize and other cereals difficult, leading to increased risk of mycotoxin contamination, especially a rise in the incidence of aflatoxin infestation (see Box 2.1 in Section 2.4.4).

Another weather risk, which is reported by NAERLS/FMARD (2020) is hailstorm. However, its incidence is reported only in the Plateau State, where it caused crop losses of up to 60% in 2019 in some communities.

2.4.2 Plant pests and diseases

Pests such as fall army worm (FAW) and stemborer are among the pests which most affect maize cultivation in Nigeria. According to the report by NAERLS/FMARD (2020), FAW was the most widespread, affecting states in all the agroecological zones. Based on the official data, we estimate average maize output loss in the Northern states at about 29% and about 25% in the Southern states. The most severely impacted states in 2019, with crop losses estimated at about 50% and above, include Lagos, Abia, Kogi and Ogun. The application of pesticides is the main control measure adopted by most farmers. However, NEARLS recommends seed dressing as another effective control measure and also reports that some farmers in Jigawa use *neem tree leaves* as a bio-pesticidal control.

Stemborer was reported in 14 of the states in 2019. From the official data we estimate that average yield loss due to stemborer was about 18% in the Northern states and 20% in the South. The following four states in the North recorded moderate to high levels of both FAW and stemborer-related crop losses: Kogi, Katsina, Plateau and FCT. In the South, this occurred in three states: Akwa-Ibom, Cross River and Eboyi.

Infestation by weevils is also widespread but its severity appears to be rather low in terms of preharvest losses. For instance, in Osun State, where the level of losses is reported to be high, average crop loss is officially estimated at 10% or lower. The parasitic weed striga, which can be controlled through crop rotation, was also reported to have affected maize output in 2019 only in the Kogi State where its severity was reportedly mild (or low).

The plant diseases which were reported by the NAERLS/FMARD (2020) to have affected the maize subsector include downy mildew, which led to losses of up to 20% in Adamawa. Maize streak was reported in Adamawa and Ekiti, with losses estimated about 10%. This disease can be controlled by means of good agricultural practices including planting early in the season when viral inoculum loads are low.

Maize leaf curl (or leaf roll back) had mild effects in Nasarawa (causing losses estimated about 15% of anticipated output) but severe impacts in Lagos State where some farmers were reported to have recorded almost 90% loss of output. This disease is associated with drought and its incidence is, therefore, predicted to increase with climate change (Entringer et al. 2014). Good agricultural practices can be used to control it (NAERLS/FMARD 2019).

2.4.3 Market risks

Inputs markets risks

Farmers consulted pointed to three main risks in maize inputs markets: access, costs and quality variability. A GIZ (2018) report concluded that lack of inputs is the second most important challenge smallholder farmers face, with close to 40% of farmers surveyed citing it as such. Lack of fertiliser is particularly cited by the farmers. The only other challenge which tops lack of inputs is limited access to credit. For most smallholders access inputs is uncertain, especially for those who rely on government for supply of subsidized inputs. NAERLS/FMARD (2020) reports that only 11% of farmers surveyed received inputs from Government in 2019, dropping even lower to 5% in 2020. Their report shows that, as a result, there is low level of utilisation of inorganic fertilizer but also very marginal application of organic fertilizers such as manure from cattle, small ruminants and poultry. Use of recycled seed is also predominant.

Interestingly, among cereal farmers, the use of herbicides to control weeds is quite high, with more than 55% of farmers (55%) surveyed using this method. This may be partly due to limited use of tractor services for cultivation – only 19% of the respondents surveyed by NAERLS used tractor services in 2019. At the same time farm labour costs are reported to be high, between N2,000 to N3,500 per day depending on the location.

High cost of inputs was cited by most farmers consulted during this study as a major factor limiting their ability to utilize yield-enhancing inputs. Furthermore, even when the price of inputs is subsidized, they face major challenges buying the inputs because of lack of credit, an issue which is discussed further in Section 2.5.2. The limited capacity of target farmers to take up subsidized inputs may be one of the reasons why a phenomenon which occurred in Ghana may also be happening in Nigeria. A government-backed study in 2020 found the correlation between subsidized fertilizer supply and maize yields in Ghana to be rather weak ($r = 0.47$), thus, raising questions about the effectiveness of its fertilizer subsidies programme (MOFA-IFPRI, 2020).

Variability in the quality of inputs is a major problem for maize farmers, especially in acquiring certified seed. This emerged during consultations with farmers, seed companies and the National Agricultural Seed Council (NASC). These stakeholders all confirmed that uncertainty about the quality of seed on the market is discouraging adoption of improved varieties and, therefore, hampering efforts to boost maize yields. At the time of the field mission in early 2020, the NASC was in the process of developing a barcode system. As shown in Figure 10, maize seed packages have barcodes for identifying and tracking supply sources in order to curb the distribution of “fake seeds” in the open market.

FIGURE 10: NASC BAR-CODED SEED PACKAGE

Source: Study during visit to offices of the NASC.

Output market access uncertainty and price risks

Most smallholder farmers do not cite access to markets as an important problem in Nigeria and, indeed, according to a survey conducted for GIZ (2018) no farmer cited it as a challenge. This is most likely because they are usually able to sell their produce through informal marketing channels. However, from the field consultations, it was evident that one of the key motivations for farmers participating in schemes involving grain aggregators (see Section 3.3) is the opportunity to sell into the formal market segment where they may obtain price premiums and other ancillary services.

However, most maize farmers in Nigeria face the risk of volatility in output prices. Price volatility in this case does not refer to seasonal price trends as depicted in Figure 11, which usually influence marketing decisions by producers and buyers. For instance, prices usually bottom-out in September which is the peak of the harvest in the Northern states in which maize production is concentrated. Hence, most producers try to avoid selling during this period, except when household consumption and other needs puts them under pressure. Buyers on the other hand, aim to buy the bulk of their requirements during the September-October period if they have sufficient working capital to do so. The risk referred to here is the variation from historical average levels from one season to another (i.e. inter-seasonal price variation). Figure 12 shows this downside price risk which maize farmers faced in Nigeria in Nigeria between the 2018 and 2019 marketing seasons.

FIGURE 11: AVERAGE INTRA-SEASONAL TRENDS IN MAIZE PRICE IN NIGERIA

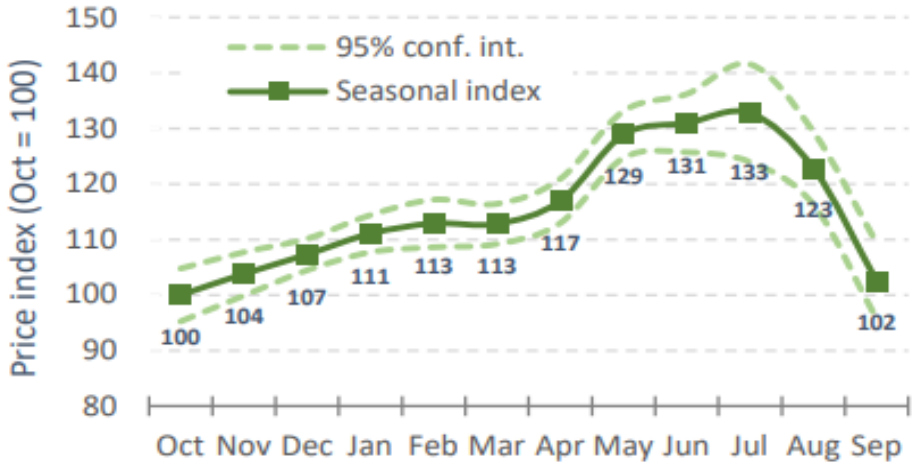
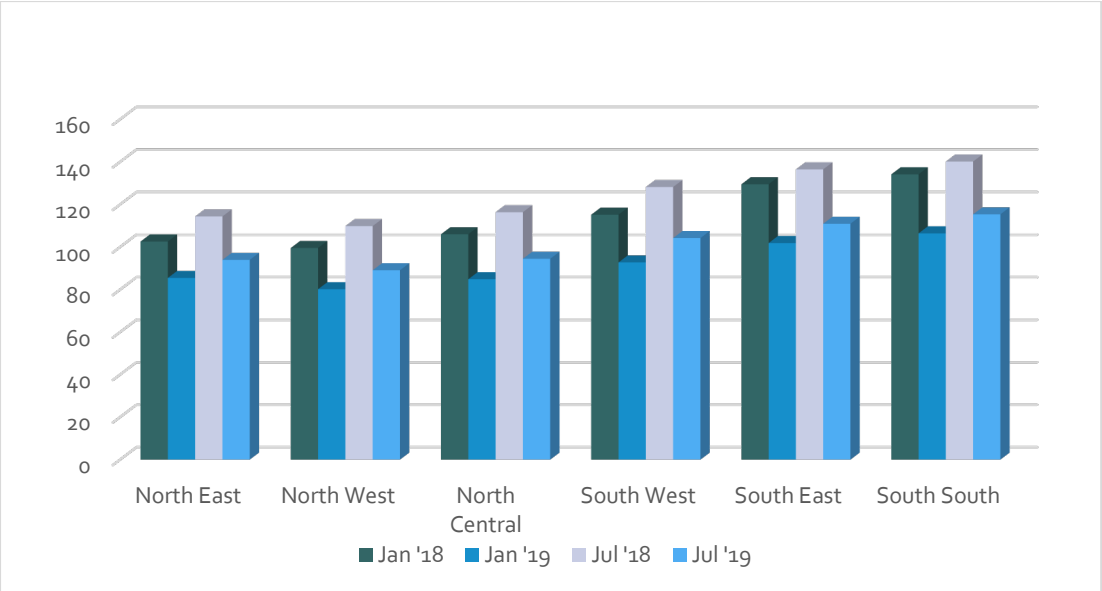


FIGURE 12: MAIZE PRICES IN NIGERIA 2018-19 (NAIRA PER KG)



Between the 2018 and 2019 marketing seasons, average maize prices fell by about 9% across all the states. Maize prices fell in nominal terms in both January and July. The steepest decline occurred in the North West and South East, where prices fell by 10.3% and 10.8% in nominal terms. The price fall occurred despite marginal decline in output by about 1.3% between 2018 and 2019, implying that prices should either have remained stable or risen slightly. Policy actions, discussed briefly in Section 2.4.5 contributed to this development. In Nigeria, as in most African countries, there is dearth for price hedging instruments. Consequently, producers and others who hold stockpiles of grains stand to lose when there is a fall in prices. The response of farmers to such developments is usually to reduce planting in the next season, potentially triggering future supply shortfalls and/or price shocks.

2.4.4 Human health risks

Human health risks can affect farmers and the supply of farm labour in the communities. Some of these may originate from activities within the value chain. For instance, it was noted in Section 2.2.3 that the rising incidence of late rains during the harvest season is increasing the risk of aflatoxin contamination in Nigeria. Reports indicate that about 60% of maize grain in Nigeria has high levels of aflatoxin, which is one of the world's most carcinogenic substances. As noted in AgResults (2020), its high prevalence in the country is partly because most actors in the maize value chain, both farmers and consumers, are not aware of its dangers and the solutions which are available. An effective biocontrol system has been available in the country for over a decade but uptake by farmers remains low (Box 2.1).

Box 2.1: The Nigeria Aflasafe Challenge Project (NACP)

A biocontrol measure has been developed by Ibadan-based International Institute of Tropical Agriculture (IITA). It involves field application of a natural product – **Aflasafe** – to reduce aflatoxin contamination and make crops such as maize grain safe for consumption. Its adoption was promoted under the NACP under a multi-donor project implemented from 2013 to 2019. Lack of finance was identified as one of the barriers to adoption by farmers because they needed credit to acquire other inputs (e.g. fertiliser) in addition to Aflase. Furthermore, it emerged that farmers received little or no price incentives for supplying maize grain with aflatoxin levels below stipulated regulatory limits. This occurred even though reports suggest that feedmillers and food manufacturers offer premium prices for aflatoxin-safe grains.

Source: AgResults (2020).

On the regulatory side, the Nigerian Industrial Standard (NIS) codes developed by the Standards Organization of Nigeria (SON) prescribes maximum levels of aflatoxin acceptable for maize grain in the country. For instance, NIS-253:2010 for maize grains stipulates a maximum of 4 ppb of aflatoxins, which is further tightened under NIS-253-723:2015 which sets a maximum 2 ppb. A review by Nayaran et al. (2020) concluded that Aflasafe can reduce aflatoxin concentration by over 80%, bringing it in compliance to the levels set by SON. However, most smallholder farmers have been hesitant to adopt it because of inputs finance challenges and lack of attractive price premiums. Furthermore, it is apparent that, as is the case in many African countries, regulators have not enforced the limits set for a number of reasons, including inadequate levels of staffing and equipment.

COVID-19 and its impact on maize value chain in Nigeria

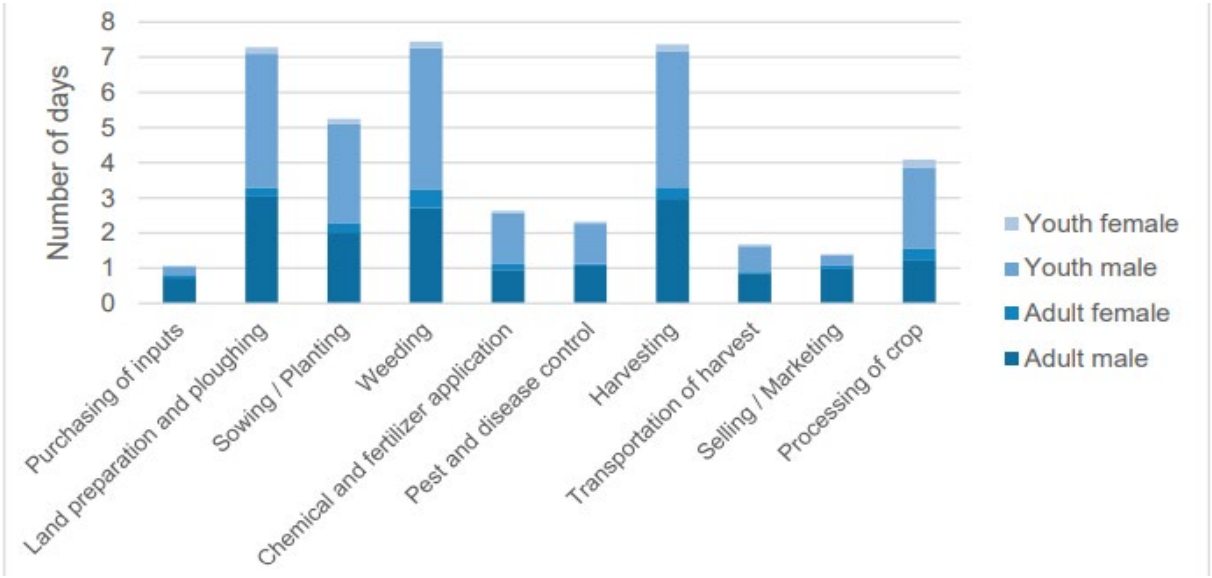
The COVID-19 pandemic affected every country, including Nigeria and the maize value chain, though the effects occurred in 2020 rather than 2019, which is the focus of this study. Nevertheless, the team briefly assessed its impacts considering the scale of its incidence. All the farmers surveyed during the study responded that they were aware of the COVID-19 pandemic but none reported incidence in their households. The impacts reported were therefore less from the direct health effects but rather the effects on

farmers' livelihoods due to disruptions to production and marketing systems. The disruptions occurred due to government-imposed restrictions to control the spread of the pandemic.

In maize value chain, restrictions on movements made it very difficult for youth from the Northern states to return to their communities for farming purposes. Most of these youth migrate to southern cities such as Lagos, Ibadan and Port Harcourt to work in the informal sector as "bike riders" and temporary labourers. They return during the planting season to invest in farming and/or offer non-family labour to other farmers.

As Figure 13 shows labour demand during the planting season is very high, especially for activities such as land clearing, ploughing, planting and weeding. Hence, the reduced labour mobility which occurred during the "lockdowns" hampered farming activities, especially in the northern states.

FIGURE 13: ESTIMATED LABOUR DAYS PER STAGES IN MAIZE PRODUCTION IN NIGERIA



Source: GIZ (2020)

Maize marketing was also disrupted because even though movement of cargo vehicles was not restricted, transporting maize along the regular trade routes was hampered by two factors. One was increase in police stops instituted to enforce lockdown restrictions delayed cargo deliveries. Second, because informal trade involves physical sampling, the restrictions on human movement slowed down transactions as traders could not move around freely. Grain prices therefore declined in the major producing regions whilst supply-linked price spikes were recorded in the main urban markets. Respondents (mainly smallholder farmers) also reported decline in remittances from urban-based family members. The combined effect of these developments was a fall in farmers' purchasing power, which made it difficult for them to acquire farm inputs. Close to 100% of the farmers surveyed reported that they did not benefit from credit packages set up by the Federal Government to ease COVID-related liquidity constraints that farmers faced. This is also consistent with results of field surveys by GIZ (2020), which estimate a

decrease of about 5% of cultivation by farmers in 2020 compared to 2019. Maize is among the crops they anticipate will experience a fall in output in 2020.

2.4.5 Policy and regulatory risks

It is apparent that policy on grain trade is influenced by two competing objectives: one is to protect domestic producers by restricting formal and informal imports; and the other is to protect consumers and, especially, the poultry industry from price hikes. Over the 2018/19 season, the Federal Government implemented a trade policy which was meant to restrict, in particular, informal imports from regional markets. However, the restrictions did not apply only to inflows but also to regular informal exports into regional markets. Consequently, rather than being buoyed up, grain prices declined in the Nigerian market, especially in the major northern markets such as Dawanau International Market. During a visit by the study team to this market, it was very evident that that business confidence had nose-dived among traders and other service providers due to the slump in regional export trade. This unintended effect of the restriction on inflow of agricultural produce into the country can be explained on the basis of the fact that, normally, regional maize exports from Nigeria exceed imports. Data reported in Section 2.3 shows that maize exports in 2018 exceeded imports almost 2.7 times. Hence, the restrictions created an inventory overhang which pushed down prices (confirmed in Section 2.4.3 and illustrated in Figure 12).

In 2020, on the other hand, the Federal Government, through CBN, officially sanctioned importation of about 250,000 tonnes of maize by major poultry feedmilling companies. This was to cushion prices for the industry as well as consumers in general in response to shortages triggered by COVID-19. However, as explained in the preceding subsection, the short-term increase in the prices of food crops, including maize, was the result of disruptions in distribution logistics rather than a shortfall in domestic supply. The expectation, therefore, is that unless regional exports pick sufficiently to counter the impact of the inflows, maize prices may be depressed beyond the 2020/21 marketing season and further dampen investment in production of the crop.

As noted by Cadoni and Angelucci (2013) these policy actions, which tend to be rather *ad hoc* and difficult to predict by market actors), often have unintended adverse impacts, including on long-term growth in strategic agricultural value chains such as maize. They reported that between 2005 and 2010, the Federal Government imposed four imports bans and two export bans. In all these actions, there is no evidence that the expected outcomes were achieved; a pointer to the need for streamlining this policy and applying different policy levers which are more transparent and market-friendly as well as minimise the risk of these adverse impacts occurring.

Another area of concern observed by the team has relevance for food safety. Growth in micro/small-scale milling is occurring in especially the northern states visited, for instance in Katsina and Kaduna. This is important in meeting the needs of a large number of consumers who cannot afford processed maize products from the large-scale mills, which are mainly sold by the supermarkets. The option of buying or toll-milling maize by micro/small-scale ensures that most households who may be considered poor have

access to maize-based food products. The risk they face, however, is that of consuming food which may be contaminated due to lack of enforcement of relevant hygiene standards during processing by micro/small-scale processors. This is depicted in Figure 14 below, which increases the risk of contamination.

FIGURE 14: SMALL-SCALE MAIZE MILLING/PROCESSING IN KADUNA STATE

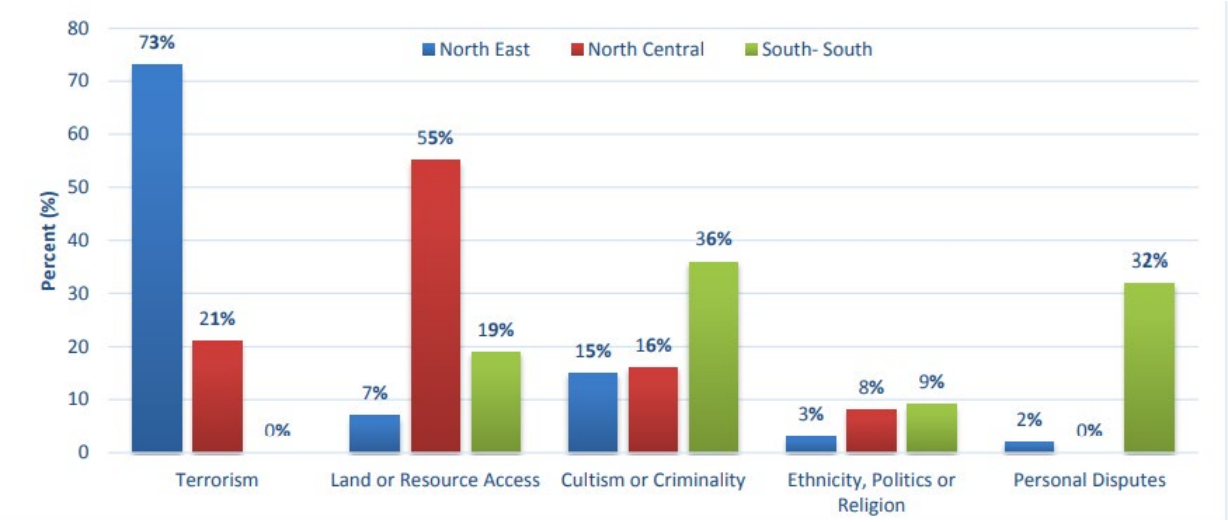
Source: Authors.

There are also indications that the type of milling equipment used increases the risk of contamination with heavy metals, which pose health risks. Furthermore, erratic power supply means most of these mills use generators which produce high levels of emissions with adverse environmental impacts as well as posing long-term health risks for the employees, who are predominantly young men. Regulatory oversight is exercised mainly at the large-scale millers. The same framework may not be appropriate for the micro/small-scale millers but there is need to enforce basic standards which will minimise food safety risks. The working conditions at the micro/small-scale mills are hazardous to the workers. Hence, basic health and safety protection needs to be adopted to minimise this risk.

2.4.6 Security risks

During the field mission by the team, insecurity emerged as one of the risks cited by farmers and actors such as traders in the maize value chain. In particular, in Kaduna and Katsina, some farmers indicated that they are sometimes reluctant to cultivate fields which are not close to their communities because of fears about being attacked. Others also stated that they did not harvest their crop because of similar fears. These events are not only affecting output in states which are leading maize production but also the livelihoods and wellbeing of the farmers. Ayinde et al. (2020) identify the causes of insecurity in some parts of Northern and also Southern Nigeria in Figure 15. Among these are conflicts over land and other resources which, as they observe, becomes intense in the Northwestern states between pastoralists and farmers during the planting season as cattle stray into farmlands. Other security threats include armed banditry and kidnapping.

FIGURE 15: PRIMARY CAUSES OF CONFLICT EVENTS IN NIGERIA (2010-17)



2.5 Constraints in Nigeria's maize value chain

Growth in maize output and productivity in Nigeria tends to be hampered by a range of risks and other constraints, which are summarized in Table 2.3 above.

2.5.1 Limited access to public extension services

Most of the farmers consulted during the field visit by the team and subsequent surveys complained about the low level of interaction with agricultural extension personnel. It emerged that low staffing levels contributed to this problem. Based on official statistics published by NAERLS (2020), the ratio of field extension agents to farmers in Nigeria in 2019 is estimated about 1:1,500 compared to 1:600 in Ethiopia in 2018 (PARM 2018). A survey by NAERLS (2020) reported that almost 90% of public extension services personnel complain about funding difficulties. Data they report shows that, on the average, less than 55% of budgets submitted by the extension departments is approved and funded by federal and state authorities. Release of approved funds is another challenge and, for instance in Ebonyi State in 2019, only 10.3% of the budget requested for extension activities was funded. The report also indicated that almost 40% of extension departments in the states had no reports on the level of funding they received.

Extension is delivered mainly by means of visits to farmers, implying that transportation difficulties, about which 70% of the personnel complained, hampered interaction with farmers. Use of ICTs for extension delivery is low, largely because of lack of training for the field staff. Insecurity arising from kidnapping and the activities of insurgents is also cited by the field extension agents as impeding interactions with farmers.

There are also complaints about adequacy of the extension materials provided. It is apparent that the focus remains on adoption of general agronomic practices, including uptake of new varieties, row planting and application of fertiliser and pesticides. Not much attention is paid to the promotion of practices which conserve the environment. This is despite the fact that evidence published by NEARLS and discussed in Section 2.4

clearly shows that the incidence of weather and other environment-related risks is increasing.

As a result of inadequate provision of extension services by the public sector, many initiatives involving NGOs, donor-funded projects and private actors have set up parallel extension advisory services. This was, for instance, evident in programmes to promote uptake of Aflasafe by maize farmers (AgResults 2020). There is evidence that private actors who set up such systems and/or engage NGOs to provide such services, tend to pass on the additional overheads to farmers participating in their programmes.

2.5.2 Lack of finance

Of the smallholder farmers interviewed during this study, only those participating in programmes involving major grain aggregators reported receiving credit. Over 60% of them reported having accounts with banks and microfinance institutions including community banks. About 70% of the farmers have also received remittances from relatives and traders with whom they are transacting via mobile phone platforms. The inability of the farmers to access finance from formal sources implies that most of them rely on their own resources for farming or depend on financial support from their relations. The youth interviewed in the northern states, such as Kaduna and Katsina, raise funds for farming through engaging in "piecemeal" work or providing taxi services using motorbikes in southern cities such as Lagos, Ibadan and Port Harcourt. They return to home to farm during the planting season.

Almost all of the farmers complained about lack of finance as the main obstacle in their farming activities. This is consistent with reports from surveys conducted on behalf of GIZ (2018), in which farmers rank lack of finance as the biggest challenge they face. This is happening despite high profile agricultural finance initiatives including the Anchor Borrower Scheme run by the Central Bank of Nigeria (CBN). None of the farmers consulted, including medium-scale farmers had benefit from this scheme. None of them also benefited from inputs credit programmes operated by the Nigeria Incentive-based Risk Sharing System for Agricultural Lending (NIRSAL). This is consistent with survey results published by NAERSL which report that in 2019 no smallholder farmer received credit from a federal government programme. They add that a small fraction (4%) obtained credit from cooperatives and even smaller number accessed subsidized inputs distributed by the state governments.

A USAID-funded Loan Guarantee Scheme (LGS), run by the Development Credit Authority (DCA), was established in 2013 to encourage Nigerian commercial banks to offer credit to actors involved in promoting the use of Aflasafe in maize production. It turned out during the latter part of 2016 that the programme could not be sustained partly because of the high borrowing costs – lending rates in the country were high and the participating banks also had to pay a service fee to take advantage of the guarantee – a cost which was passed on to the borrowers. Consequently, about 35% of the aggregators who participated in the project dropped out. A private sector-based system which has emerged and is making finance accessible to aggregators and farmers linked to them is described in Box 2.2.

Box 2.2: Interlocked transactions between aggregators and farmers

Central to this scheme are private grain aggregators such as Babban Gona and AFEX, who have emerged as leading players in the maize grain trade in Nigeria[10]. These actors aggregate grains from farmers and sell to major industrial processors such as breweries, feedmillers and food manufacturers. Due to the transactional relationship, they have with the major grain end-users they are able to secure finance on competitive terms, including low-cost credit lines provided under donor-funded projects. They are also able to access local funding schemes including CBN's Anchor Borrower Scheme and NIRSAL.

In turn, they are able to acquire quality seeds, fertilisers, pesticides and herbicides which they distribute on credit to farmers participating in their outgrower schemes. This is usually provided as a package and supported with the provision of in-house extension advisory services. The participating smallholders are, therefore, able to acquire yield-enhancing inputs as well as adopt farming practices which enable them to increase yield and to supply quality output on a consistent basis.

Repayment of the inputs credit is by means of produce supplied to the aggregators. In some cases, the repayment is based on barter terms (pre-determined volume of output for inputs received). The participating farmers can sell more than the required volume but that is bought at prevailing market prices. Some of the participating farmers interviewed perceived the credit repayment terms as not being sufficiently transparent. Other models allow farmers to sell at market prices to the aggregator and are paid after netting off their credit – an option which farmers consider to be more transparent.

Source: pers. comm with officials of various aggregators and processing companies

2.5.3 Postharvest challenges

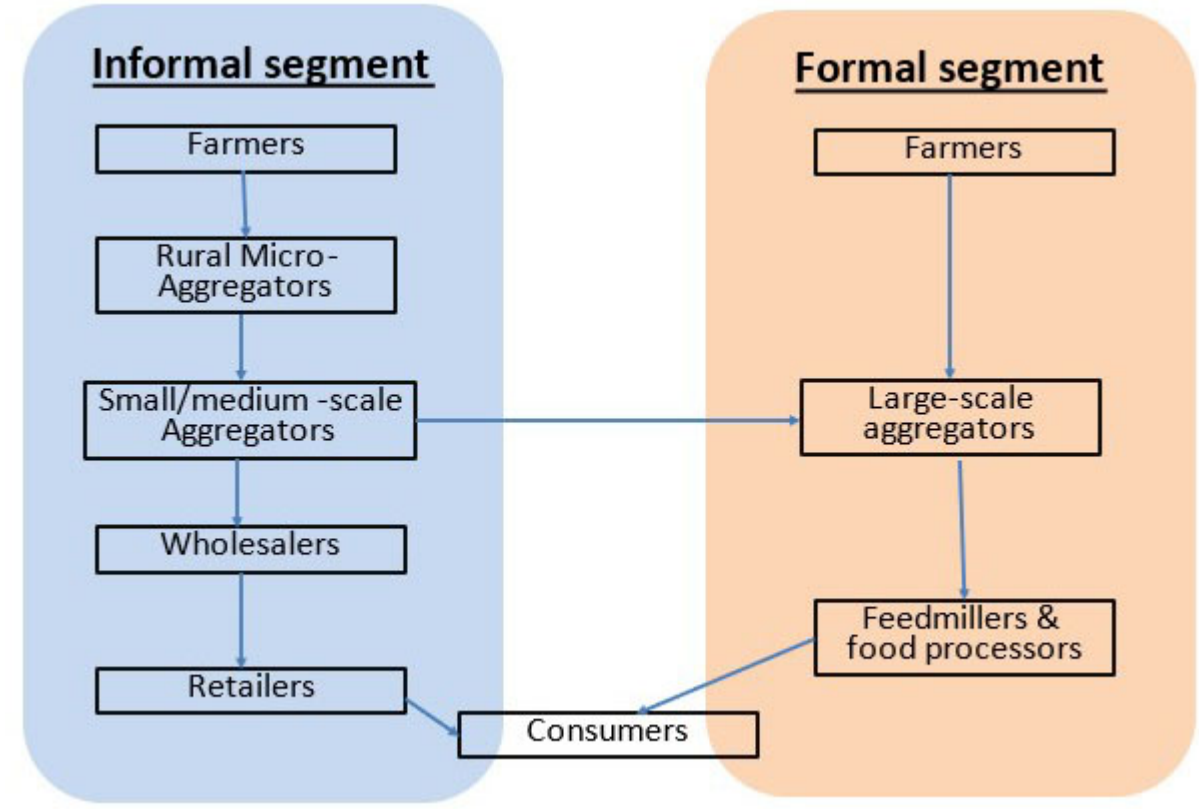
Figure 16 depicts the maize grain marketing chain in Nigeria. Quite clearly, the informal market segment is longer with more intermediaries. This leads to increase in distribution margins as well as producer margins being squeezed. No clearly-defined quality standards are enforced in the informal marketing segment and this is a major factor militating against the adoption of postharvest handling practices which assure consistent supply of quality grains. Furthermore, the systems for measuring grains are not standardised, creating deep perceptions of "cheating" on weights, and encouraging practices, including admixing grains with materials which increase weight and compromise quality.

In contrast, the much shorter formal segment has smallholders delivering directly to large-scale aggregators through community-level organisations led by community-based leaders. The leaders are responsible for mobilising members and ensuring deliveries against credit commitments. The large-scale aggregators also run aggregation centres through which deliveries are made to their field staff. Grain delivered by the farmers has

[10] Other large-scale aggregators were identified by the team, especially in the Kaduna and Kano States. They have storage facilities with capacity of over 10,000 tonnes and work with over 15,000 smallholder farmers.

to match quality and packaging standards set by offtakers (e.g. feedmillers and food processing companies). By shortening the distribution chain and also trading in quality grains, the participating farmers have an opportunity to obtain premiums.

FIGURE 16: SEGMENTED MAIZE MARKETING CHAIN IN NIGERIA



Source: Authors

Again, in the informal market segment, farmers are the main actors responsible for grain storage even though they are ill-equipped for it because they lack efficient storage facilities in their homes or on the farms. Wholesalers also store grains, most of the time in rather basic facilities at the physical markets. The intermediaries between farmers and wholesalers usually do not hold stocks beyond a few weeks and mainly engage in procuring and transporting grains to other buyers. This is partly because liquidity constraints make it difficult for them to procure substantial volumes at a time. It is largely because of this that smallholder farmers have to shoulder responsibility of storing the bulk of grains produced, contributing to high postharvest losses.

In the formal segment, a substantial part of grain output is stored off-farm, in modern grain storage facilities operated by aggregators. It is apparent that investment in storage infrastructure by traders/aggregators is increasing, especially in major grain marketing centres such as the Dawanau International Market and at Saminuka. Though most of the investment is in flatbed warehouses, some aggregators have opted for the cocoon storage system shown in Figure 17 below (left). The storage infrastructure being developed is mainly for proprietary storage only and any third-party storage service provided is relatively for short periods. The Kaduna State Department of Agriculture is,

however, constructing warehouses (shown in Figure 17 – right) as part of its investment in the development of aggregation facilities. Groups of smallholder farmers are the main target users of the warehouses.

FIGURE 17: DIFFERENT GRAIN STORAGE FACILITIES IN THE KADUNA STATE (2020)

Source: Study and Kaduna State Department of Agriculture

Postharvest losses in maize value chain in Nigeria

Across the maize value chain in general, postharvest losses (PHL) remain high due to the dominance of the informal segment. The estimated PHL for the VC in 2019 was about 15%, which equates to just over 1.9 million tonnes. This loss is more than double the estimated average annual volume of maize grain exported by Nigeria. It also exceeds total average annual maize production in Benin by almost 20%. A conservative value of total maize PHL in 2019 is about US$685 million (€615 million). It is also projected that the maize grain lost could have met the food energy requirements of over 9 million people[11].

Based on data published by APHLIS, it is evident that the highest level of PHL, which is about 34% of total losses, occurs during harvesting and field drying. Just over 21% of PHL occurs during further drying of the grain, whilst 25% is at the household storage stage. Losses during shelling and transportation are estimated at about 7% and 13% of total PHL respectively. Improving harvesting practices as well as encouraging storage in more efficient facilities will enable the country to reach its commitment of reducing PHL by 50% by 2025 from levels in 2015 – in line with the African Unions Declaration in Malabo in 2014 (Commitment 3b which is specific to targets for reducing PHL by African countries).

This objective is already being achieved in Nigeria under the aggregator schemes described in Box 2.2 above. As shown in Figure 16, there are also flows of grains from the informal to the formal grain marketing segment, involving bulking by smaller-scale intermediaries who sell to large-scale aggregators. The latter have modern storage facilities and manage grain marketing in a way which reduce postharvest losses.

A recent investment by the Kaduna State Department of Agriculture has the potential of contributing to improvements in postharvest handling and marketing in the grains value

[11] Source: https://www.aphlis.net/en

chains. The State has constructed aggregation centres which offer drying, cleaning and storage services (warehouse shown in Figure 17 above). Also provided are properly calibrated weighing scales and grading equipment which ensure that weights and quality are determined through a transparent process. From these centres it is possible for smallholders to aggregate and sell either directly to large-scale aggregators or other offtakers involved in processing. This is likely to improve their margins.

2.5.4 Other environmental challenges

Among the factors cited by farmers and other stakeholders as militating against sustained growth in maize yields in Nigeria is low soil fertility. This is attributed to ineffective soil management practices as well as soil erosion, which is increasing in terms of incidence and severity as a result of flooding.

Deforestation is another environmental challenge facing maize farmers, due in part to increased land utilisation for agricultural and other purposes, including housing. Timber logging and use of fuelwood (including charcoal) are among factors driving deforestation. In addition to these is the combustion of fossil energy resources partly because of unreliable power supply from the national electricity grid. Hence, in addition to using fossil fuels for transporting maize grain, most of the processing activities, especially at the micro/small-scale levels involve the use inefficient diesel generators. Even some of the large-scale grain processing companies rely on diesel generators which are 30-40 years old for about 20% of the energy required for milling. Furthermore, the use of nitrogen fertiliser contributes to emissions and to climate change. These environmental challenges are discussed in more depth in Chapter 6.

3. FUNCTIONAL ANALYSIS OF MAIZE VC IN NIGERIA

3.1 Introduction

The main analysis in this study starts with the functional analysis, which defines the boundaries within which the range of actors and the functions they perform are examined. It entails mapping and describing the main actors, their activities and operations in the chain as well as an overview of the main products, production systems and product flows. The main areas covered in this chapter include a general description of the value chain system, including the identified sub-chains and flows of the output; a description of the typology of actors in the value chain; and an analysis of value chain governance and coordination.

3.2 General description of Nigeria's maize value chain

3.2.1 Sub-chains in Nigeria's maize value chain

The maize value chain consists of two main sub-chains, a delineation which is based on the type of producers, end products supplied to consumers and the type of marketing channel which is predominant. Figure 19 shows Sub-chains 1 and 2.

Sub-chain 1 consists of mainstream smallholder farmers (the SHF1), who cultivate less than 2 hectares of maize. Their output is sold into the rural communities in which they live and this includes fresh corn-on-cob as well as dry maize grains. The quantities sold in the rural markets are usually small, matching the type of local demand. The fresh corn-on-cob, which is sold in the rural markets tends to be roasted or boiled, usually by women vendors. Produce from the SHF1 also enter into Sub-chain 2 through the activities of micro/small-scale rural aggregators, who usually buy small quantities of dry grain or fresh corn-on-cob (shown in Figure 18) and sell to other aggregators.

FIGURE 18: DRY MAIZE GRAIN AND BAG OF FRESH CORN-ON-COB FOR SALE IN RURAL MARKET

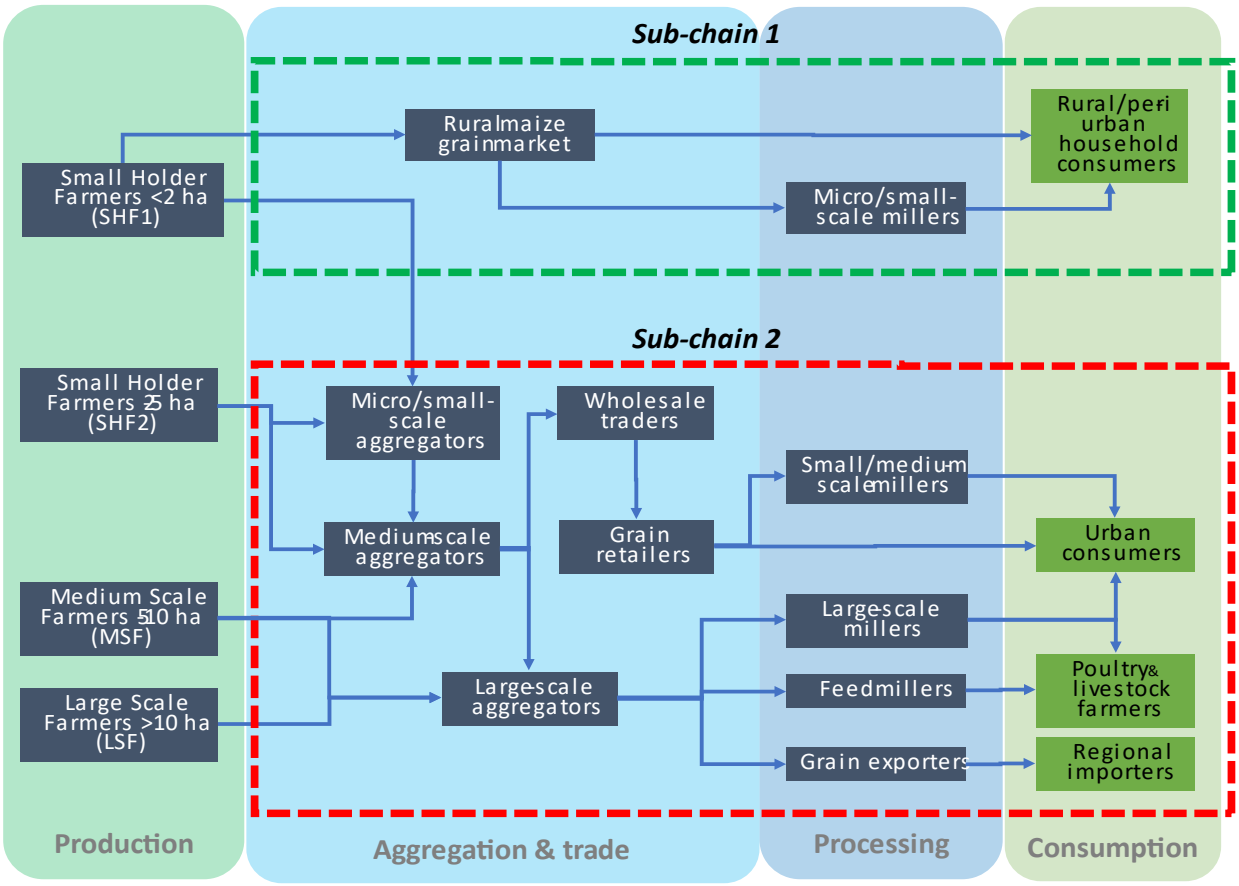
Source: Authors

The dry maize grain sold in the rural markets and/or retained by farmers for household consumption is usually milled by community-based micro/small-scale millers, an example of which is shown in Figure 14 above.

Sub-chain 2 is quite diverse in terms of the types of producers. They include SHF1 producers whose produce, as stated above, enters this sub-chain through trade involving micro/small-scale rural aggregators. There are also SHF2 producers, who are mainly smallholder farmers participating in various outgrower schemes under which they

receive support from the aggregators to whom they are linked. On the average they cultivate between 2-5 hectares of maize. Other producers in this sub-chain are medium-scale farmers (MSF), cultivating between 5-10 hectares of maize and the large-scale farmers, whose average area under maize cultivation is over 10 hectares and may go as high as 100 hectares and above, especially in northern states such as Kaduna.

FIGURE 19: KEY ACTORS IN NIGERIA MAIZE VALUE CHAIN



Grain aggregators play a crucial role in Sub-chain 2, including performing a critically-needed spatial transformation function, transporting maize from the rural areas where production is concentrated to the major urban and regional export markets. As shown in Figure 9, dry maize grain is often transported over very long distances (e.g. over 840 kilometres from Kaduna to Lagos). Many of the large-scale aggregators also have storage facilities, enabling them to provide an important temporal marketing function, ensuring year-round availability of supply even though production is seasonal. In addition to these two marketing functions, the large-scale aggregators play a critical role in facilitating access to production finance for SHF2 (see Box 2.2).

The main end-users of dry maize grain in Sub-chain 2 are feedmillers servicing the poultry and livestock industry, food manufacturers/millers, breweries and importers in the sub-regional markets (e.g. Mali and Northern Cameroon).

3.2.2 Flow of maize grains in Nigeria

Table 4 shows the that the smallholder farmers produce the bulk of the maize output in Nigeria. The combined production by SHF1 and SHF2 farmers represents 68.7% of total maize output. The MSF and LSF producers account for 18.9% and 12.4% of total output respectively. It must be noted that most of these two categories of producers farm in the northern states, where the topography and agro-climate are conducive to mechanized commercial grain production.

Smallholders together contribute close to 63% of total marketed maize output, which includes fresh corn-on-cob. However, their share of the dry maize grain marketed in the country is lower, estimated at about 56.5%, partly because of higher levels of sale of fresh corn-on-cob as well as of home consumption and postharvest losses. Total share of MSF and LSF producers to the sale of dry maize grain is about 43.5%, an indication of their commercial focus on targeting that market.

FIGURE 20: PRODUCTION AND UTILISATION OF MAIZE IN NIGERIA (2019)

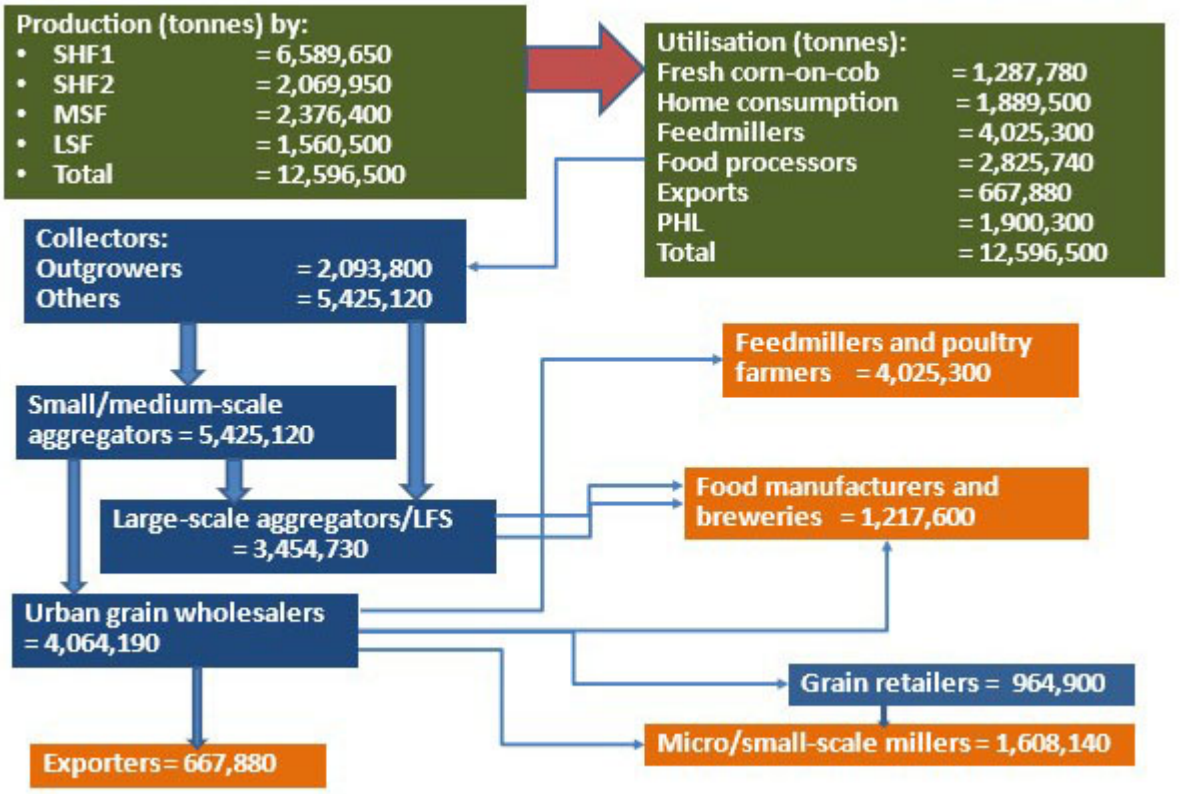


TABLE 4:MAIZE PRODUCTION AND MARKETING BY DIFFERENT CATEGORIES OF FARMERS IN NIGERIA (2019)

YIELD/PRODUCERS	SHF1	SHF2	MSF	LSF	Total
Estimated number of producers	2,440,600	281,600	72,600	3,500	
Average area planted with maize per household (hectares)	1.5	3.5	9.35	100	
Total area planted with maize (hectares)	3,660,900	985,600	678,800	346,760	
Estimated yield per hectare (tonnes)	1.8	2.1	3.5	4.5	
Average output per household/enterprise (tonnes)	2.7	7.4	32.5	450	
Total output per category of farmers (tonnes) – of which:	6,589,650	2,069,950	2,376,400	1,560,500	12,596,500
- Volume of marketed fresh maize (equivalent in tonnes of dry grains)	1,159,000	128,780	-	-	1,287,780
- Volume of marketed dry maize grain (tonnes)	2,893,720	1,351,270	1,913,000	1,360,930	7,518,920
- Volume of maize grain consumed by household (tonnes)	1,317,930	310,500	190,100	70,970	1,889,500
- Estimated volume of postharvest loss (tonnes)	1,219,000	279,400	273,300	128,600	1,900,300
OTHER DETAILS:					
Contribution to total maize output (%)	52.3	16.4	18.9	12.4	
Contribution to marketed maize output including fresh corn on cob (%)	46.0	16.8	21.7	15.5	
Contribution to marketed dry maize grain (%)	38.5	18.0	25.4	18.1	

Figure 20 shows the flow of maize to various end-users in Nigeria. It is noteworthy that about 15.1% of maize output is lost at postharvest. Of the remainder, which is consumed at the household or marketed, about 12% goes into the fresh corn-on-cob market. Almost 38% of the dry maize grain goes into the feed industry (to feedmillers and poultry farmers) and another 26% to breweries, millers and other food processing companies. Producers retain close to 18% of output for household consumption and about 6% of the marketed dry maize grain is exported into regional grain markets.

Figure 20 further shows that a sizeable proportion of maize output in Nigeria, about 54%, is sold to the to breweries, millers and other food processing companies. These end-users, in principle, need to enforce strict grain quality standards during procurement. However, the large number of informal actors in the maize trade and distribution system makes this quite challenging. This issue is further discussed in Section 3.4.

3.3 Typology of actors in the maize value chain

The key actors in the maize value chain are the upstream producers, the midstream aggregators, distributors and traders and the downstream processors. These are briefly described in this section.

3.3.1 Upstream: maize producers

Maize producers in Nigeria are categorized mainly on the basis of the average size of their farms and consist of: mainstream smallholder producers (SHF1); and smallholders who receive support under various schemes (SHF2) and are therefore able to scale up area planted and also to obtain higher yields. The other two categories are medium-scale farmers (MSF) and large-scale farmers (LSF).

Mainstream smallholder farmers (SHF1)

The mainstream smallholder producers (SHF1), who account for over 52% of total maize output in the country (Table 4). They are the most under-resourced of the maize producers and cultivate less than 2 hectares, with an estimated area under maize cultivation of about 1.5 hectares. The farm sizes of SHF1 producers in the northern states tend to be larger, closer to 2 hectares but for those in the south, the range is more between 0.5-1 hectare. The average yield they obtain, estimated at about 1.8 tonnes per hectare, is lower than the overall average of 2.1 tonnes per hectare. This is mainly because of the agronomic practices they adopt, which is quite basic. Most SHF1s combine maize production with cultivation of other cereals such as rice, soya, groundnuts, cowpea and millet as well as roots and tubers such as yam and cassava. In general, less than 20% of the area that the SHF1 cultivate is allocated to maize. In the northern states, the SHF1 allocate most of the remaining 80% of the cultivated land for the production of cereals and legumes whilst in the south the allocation is skewed in favour of roots and tubers. Furthermore, the resources available to them, including family labour, tends to be spread among the different crops they cultivate. This is one of the reasons why the yields they obtain for the crops is often below achievable levels.

According to farmers surveyed during the study, crop diversification is an important risk management strategy as it enhances household food and income security in the event one of

the crops fails and/or there is a sharp drop in prices for one crop or the other. They rely mainly on retained seeds for planting and rarely buy from the seed market. This, they explained, is not only due to lack of finance but also their suspicions about the performance of the certified seed sold in the market. Though they tend to be the target of subsidized inputs, there is no evidence from the survey that they access and use any form of fertiliser and pesticides even though the application of herbicides for weed control is quite widespread, especially in the southern states. Drying and other postharvest handling practices tend to be quite basic – sometimes the grains are dried on roadsides or on the bare ground. Storage is also in traditional cribs or in homes and packaged in old bags. It is for this reason that they experience a higher level of PHL (about 18.5%) compared to the chain-wide average of about 15.1%.

They usually sell small volumes of grains to consumers and micro/small-scale aggregators in their communities and their marketing strategy is often dictated by how pressing their household consumption needs are. For instance, the need to pay school fees, meet health care bills and/or prepare for major festivities and social events. Consequently, even where they have the means to store, they may not hold stocks until producer prices reach optimum levels unless they receive remittances from family and other relations.

Supported smallholder maize farmers (SHF 2)

The SHF 2 farmers cultivate between 2-5 hectares, the average area under maize cultivation being 3.5 hectares. They are able to acquire and utilise inputs such as improved seed, fertiliser, pesticides and herbicides, usually as a package provided by large-scale aggregators running outgrower schemes. They have better access to extension advisory services, usually provided by field agents of the aggregators. However, most of these farmers continue to grow a diverse range of crops and spread out resources to other crops which are not included in the outgrower schemes. On the average about 22-25% of their cultivated land is allocated to maize and they tend to apply the inputs they obtain on the other crops they grow. Consequently, though the average yield they obtain (about 2.1 tonnes per hectare) is over 15% higher than what is recorded by the SHF1 producers, it is still well below levels obtained by medium-scale farmers.

At harvest they are usually required to deliver, to the aggregators, maize grain equivalent to the cost of inputs they have received. This is usually on pre-determined "barter-type" terms (package of inputs for stipulated volume of maize grains). However, they can also sell any extra grain they have for sale to the aggregators during the harvest season. This transaction is based on prevailing market prices. The ability to sell between 50% to 60% of their output immediately after harvest, implies that they store less in relatively inefficient on-farm or household-level facilities. Hence, PHL is comparatively lower, estimated on the average at about 13.5%. This reduction in PHL implies that the SHF2 households have more maize grain to sell and/or consume.

Commercial maize farmers

This group of producers consist of MSFs and LSFs and most of them farm in the northern savannah states where they can engage in intensive mono-cropping on an extensive scale. The MSFs cultivate between 5-10 hectares and their average area under maize cultivation is about 8 hectares which, on the average, represents about 35-45% of the total land area they cultivate.

They tend to hire tractor services and rely significantly on non-family labour for production and harvesting. Though many of them rely on their own savings or capital provided by family members, some reported having obtained inputs credit from microfinance institutions (MFIs) and a few from banks. Some of them also reported having large-scale grain traders/wholesalers pre-financing their production. They are therefore better-placed to acquire inputs from the market, including subsidized fertiliser. They also obtain higher yields, about 3.5 tonnes per hectare, partly because of intensive crop husbandry practices.

They usually market their crops directly to large-scale aggregators and/or grain wholesalers but may sometimes also do so through medium-scale aggregators. They also sell between 50% to 60% of their maize output immediately after harvest either to defray inputs credit or in fulfilment of informal contractual obligations with grain wholesalers who pre-finance their production. As is the case with the SHF2, this reduces the storage burden and associated losses. However, unlike the SHF2, they have relatively better household-level storage and as a result the overall average PHL for this group of producers is about 11.5%.

The LSF are usually well-capitalised producers who own tractors and other farm equipment, retain farm workers, complemented with seasonal hiring of temporary labourers during the planting and harvesting seasons. Farmers in this category cultivate over 10 hectares but there are many in northern states, such as Kaduna and Katsina, who cultivate over 100 hectares of maize each year. Due to the intensive agronomic practices they adopt, the yields they obtain are comparatively high, about 4.5 tonnes per hectare on average, though some reported yields of over 7 tonnes per hectare, especially when they plant some of the improved varieties released by the NASC. Grain shelling is mechanized and storage occurs in modern warehouses, which many of them own. As a result, the PHL they record is the lowest, estimated at about 8.2% compared with 11.5% for MSFs and 13.5% for SHF2 producers.

Due to the scale of their operations, the LSFs usually supply directly to the major offtakers. Many of them, therefore, combine crop production with marketing as large-scale aggregators, including exporting into the sub-regional markets.

3.3.2 Midstream: maize aggregators and traders

Grain aggregators, wholesalers and traders ensure that maize grain which is not consumed by producers or kept as carryover stocks are supplied to offtakers (processors or exporters) and/or non-producing households consuming the grain. At the base are **micro/small-scale aggregators or rural collectors** who buy a few kilos up to about 10 bags of maize grain (of 100 kg) at a time. They either sell to other aggregators or consumers in the villages without any form physical transformation. Usually, they trade with their own capital and/or credit raised through informal savings and credit schemes or from MFIs. The trade in rural communities is almost entirely cash-based and does not involve the extension of any form of trade credit by suppliers to buyers. It is the liquidity constraints resulting from this which limits the scale of operation of the micro/small-scale rural aggregators.

Medium-scale aggregators trade volumes of between 1 tonne to 7.5 tonnes per lot. They sell mainly to large-scale aggregators or grain wholesalers in the informal grain markets. As is the

case with the micro/small-scale aggregators, the medium-scale aggregators procure on cash basis but are sometimes compelled to provide trade credit of between 1-3 weeks when they supply to grain wholesalers and large-scale aggregators. Most of them have little or no access to trade finance from banks and MFIs. Their working capital is therefore either internally-generated or sourced from the large-scale aggregators and grain wholesalers with whom they trade. This is why they are sometimes described as "agents" of the large-scale traders. Due to the severe working capital constraints these medium as well as micro/small-scale aggregators face, they are unable to offer any other support services to smallholder farmers. Only the large-scale aggregators are able to provide that sort of support.

Large-scale aggregators usually trade in lot sizes of 30 tonnes (1 truckload) and above and supply mainly to feedmillers or flour mills. The bulk of their trade with smaller-scale aggregators as well as large-scale farmers is on a cash basis. They may, however, benefit from short term trade credit, varying between 1-3 weeks, and for which they offer price premiums. A similar system exists in terms of supplies to processing offtakers. A major advantage the large-scale aggregators have over the other traders is their ability to obtain working capital finance from the banks as well as access government/donor-funded credit lines. As reported in Box 2.2 above, they utilise the funds acquired to finance inputs supply on credit to the SHF2. They also provide complementary services including extension advisory services and supply of packaging materials. The recovery of credit advanced as well as cost of services provided is assured through interlocking transactions involving the delivery of pre-determined volumes of output to the aggregator. Notable examples of such aggregators include Babban Gona and AFEX (which also operates a commodity exchange). There are other aggregators of similar size, especially in the three northern states visited during the study[12].

The large-scale aggregators have sizeable storage infrastructure (exceeding storage capacity of 10,000 tonnes) and may also have a fleet of cargo trucks. Some of them also have field personnel who are responsible for mobilising and building the capacity of participating SHF2 producers.

Grain wholesale traders operate not only in major grain markets but also in the "grains sections" of urban informal markets. They tend to stockpile maize grain in relatively small warehouses holding about 50 tonnes, which they sell to grain retailers and/or supply to offtakers as well as institutional buyers, including schools, hospitals, etc.

Grain exporters are aggregators or wholesalers who sell into the domestic market but also export maize grain into major regional markets. The main destination countries to which Nigeria maize is exported are Mali, Niger, Burkina Faso, and Cameroun. However, some traders interviewed in Kano indicated that they also sell into major grain markets in Ghana and Cote d'Ivoire, depending on the supply situation.

Grain retailers usually sell to household buyers who tend to purchase 1-2.5 kilos of maize grain, which is processed at home or by community-based mills. Often, these traders sell a range of grains, including cowpeas, rice, sorghum, and millet.

[12] Contacts to some of these actors can be provided.

3.3.3 Downstream: offtakers/processors of maize grain in Nigeria

The main maize grain offtakers large-scale enterprises such as the large-scale millers engage in feedstock production for poultry and the livestock industries and/or producing food flour for human consumption. Though the feedmillers dominate this part of the maize value chain, there is evidence that demand from breweries and food flour manufacturers is growing rapidly due to the growing involvement of supermarkets in the food trade in the country.

These offtakers usually buy in truckloads with an average weight of 30 tonnes per delivery. In most cases, no formal contract is required for delivery and prices are negotiated based on prevailing levels in the open market. They however pay premiums for quality and often require zero-interest trade credit, with settlement taking place after 4-6 weeks. Though lack of formal contracts lower entry barriers for new suppliers, the comparatively more stringent quality standards which apply as well as the trade credit required tends to exclude those lacking access to working capital. This is where the large-scale aggregators have a competitive advantage.

A rapidly growing number of micro/small-scale millers have entered the Nigerian market, especially in the northern states. Those in rural and peri-urban communities tend to mill for a fee for households which take their grains to the millers. Payment is usually in cash but may sometimes be in kind, in the form of maize bran, which the millers sell to poultry and livestock farmers. Other micro/small-scale millers in urban areas buy and mill maize grain and sell the flour to consumers. They may also sell maize grain which consumers can buy and request them to mill for a fee. Anecdotes suggest that micro/small-scale millers may account for over 50% of total maize flour marketed in the country[13].

3.3.4 Service providers and other actors in the maize value chain

The key service providers in the maize value chain, depicted in Figure 21, include:

- **Maize seed producers and distributors:** some reports indicate that landraces account for less than 10% of total maize seed cultivated in Nigeria. This low cultivation is because of a long history of promoting the distribution of improved seed to farmers in the country. However, the indications are that most of the available "improved seeds" were released over 30 years ago and tend to be recycled by farmers. The performance of the bulk of maize seed, especially in terms of yield, therefore tends to be questionable. The National Agricultural Seed Council (NASC) reports that there are 314 registered seed suppliers in Nigeria. Among these are:
  - **Breeder seed producers:** mainly research institutions such as IITA.
  - **Foundation seed producers:** the main institution mandated to produce this is the Institute of Agriculture (IAR) at Zaria. Private companies such as Premier Seed also report that they engage in primary research to produce foundation seed.
  - **Certified seed producers and distributors:** large-scale private seed companies dominate production and distribution of certified seed from the foundation seed. Their limited outreach to farmers, especially the SHFs, as well as the variable performance of seed, which is further undermining farmers' confidence in improved seed, has encouraged public organizations such as IAR to extend their operations into

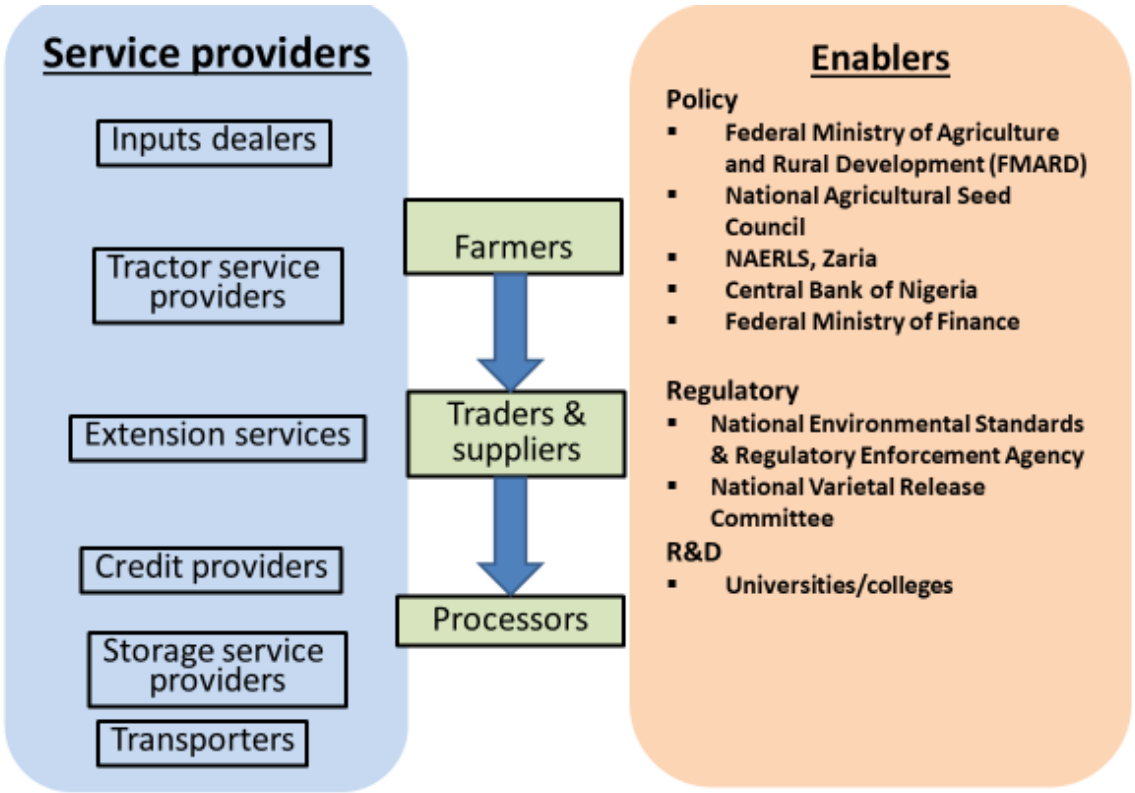
[13] Gerd Kriek, Managing Director, Northern Nigeria Flour Mills, Kano, *pers. comm* (13th February 2020).

certified seed production. There are also reports that this situation has also prompted some private actors, including Babban Gona, to go into seed production. NASC is also promoting Community Seed Development organisations, in collaboration with the state-level Agricultural Development Programmes (ADPs), to ensure the supply of viable seed to farmers.

- **Distributors of fertiliser and other inputs:** there is a range of private companies involved in this trade, which also includes state-owned enterprises such as KASCO, which is owned by Kano State.

- **Other service providers:** include private tractor service providers who tend to compete with state-run companies offering similar services with support from the Federal Government. Reports indicate that the sustainability of the latter is often doubtful. The private sector dominates the provision of transport and storage services. In the case of the latter, many large-scale grain traders tend to own warehouses of varying storage capacity. Limited access to finance is a challenge that is common not only to SHFs but also to other players in the maize grain value chain. It is one reason which interlocked transactions appear to be common, especially at the production level in the chain.

FIGURE 21: SERVICE PROVIDERS AND ENABLING INSTITUTIONS IN NIGERIA'S MAIZE VALUE CHAIN



- The **policy and regulatory agencies** whose impact on actors in the maize value chain are listed in Figure 3.4. Among the key agencies is the National Agricultural Seed Council (NASC), which is responsible for regulating the release of improved planting materials. As part of this remit, the NASC is to roll out a bar-coding system which is expected to address the problem of counterfeit seed. However, it admits that if this initiative is to succeed then seed supply capacity has to be boosted and also the seed market streamlined as there are too

many dealers. Reports at the time of the study indicated that there were over 310 seed companies, making regulatory oversight difficult.

During consultations with officials of the NAERLS, it emerged that the agency has an elaborate system for provision of extension advisory services, including producing materials which guide field agents in their work. However, most farmers surveyed in the course of this study mentioned that access to extension is limited. There is also the problem of multiplicity of actors providing extension. This is partly in response by private enterprises, NGOs and donor-funded projects to the apparent weakness in the public extension system (see Section 2.5.1 for further details). Furthermore, it was noted that there is little coordination among the different actors involved in extension provision. This is an issue that the NAERLS needs to address.

Actors mentioned two policy interventions as having had an impact on the domestic grain market. First was an unanticipated authorisation of grain imports, especially targeting feedmillers. Farmers and traders consulted reported that this was driving down grain prices at a time when seasonal increase during the lean season is expected. The other was the border closure by the Federal Government, which was intended to protect domestic producers from unauthorised imports from neighbouring countries.

It appears though that the unintended impact has actually been to cause prices for most agricultural produce to either stagnate or fall – as noted for maize grain in Section 2.4.3. Other agricultural export crops such as cowpea and dried hibiscus flowers were reported to have been hit harder by the border closure. Though many of the farmers and traders consulted were aware of these policy-related challenges there did not appear to be any concerted effort to raise it with the Federal Government. This cannot be attributed to lack of farmers' representative organisations. The team identified many of such organisations and indeed met with some of them. However, it appears that there is insufficient coordination of activities among the organisations and the involvement of farmers at the grassroot level was rather weak, hence, blunting their voice – this issue is further discussed in Chapter 5 (Social Analysis).

3.4 Maize value chain governance and coordination

As stated earlier, the maize marketing chain has two distinct segments with very different characteristics: the informal and formal markets. These are briefly discussed in this section.

3.4.1 The informal maize grain segment with market governance

The informal market segment is based on a *laissez-faire* market governance system and transactions are driven mainly by spot prices. It virtually bars no actor from entry and can, therefore, be perceived as highly inclusive. However, lack of transaction-defining rules appears to be creating inefficiencies which impact negatively on the entire value chain. For instance, there are no enforceable commodity standards e.g. quality standards and therefore no premium earned for grain of high quality. The pricing regime is based on fair average quality (FAQ). This system does not encourage farmers to adopt postharvest handling practices which improve the quality of the grains they produce. Quality variability bars SHF1 and many micro/small-scale aggregators from accessing the remunerative but quality-sensitive markets dominated by large-scale food processors and feedmillers.

Standardised volume measures do not exist in this market segment and grain is measured by volume (*mudu* or bag), which differ in weight depending sometimes on location and familiarity with parties with whom players are transacting. One effect of this system is to create a perception among transactors that their counterparties are cheating, leading to trade practices such as intentional admixture of grains with foreign matter to gain weight being quite common. Traders therefore have to invest significant resources in cleaning and sorting grains before delivery to quality-sensitive buyers.

This governance system is trust-based and usually does not involve formal contracts. However, as demonstrated in the case of transactors in the formal segment, contracting with a credible party sometimes opens up opportunities to secure access to resources including finance. Dominance of cash-based trade can also have its disadvantages. For example, enabling small/medium-scale aggregators and grain wholesalers to buy on credit makes it possible for to build up inventories quickly and to supply to large-scale offtakers. On the other hand, extension of trade credit by wholesalers in urban markets is, quite often, the means by which under-capitalised traders manage entry into business. These options tend to be rare, except between close relatives and parties with whom long-term transactional relationships have been developed.

As illustrated in Figure 16, the informal market segment has multiple players, leading to multiple handling between producers and consumers. This leads to trade margins being rather tight even though the gap between farmgate and wholesale/retail prices tends to be wide, creating the impression that this segment is dominated by middlemen who cheat all other actors.

3.4.2 The emerging formal maize grain segment

An interesting dynamic in the maize value chain is the emergence of the formal distribution segment. It has emerged partly because of opportunities to supply the major offtakers with quality grains on a consistent basis. The system centres around an actor which has visible market power, in this case a major offtaker such as a feedmiller, food manufacturer or brewery, defining and enforcing terms under which suppliers can deliver to it. The entry requirements bar most actors, but the hierarchical control exercised, especially by large-scale aggregators, offers some benefits.

Though there may not be firm contracts, supply terms are specified and include minimum volumes which can be delivered, applicable quality parameters and payment terms. Crucially, the credibility of the major end-users (large-scale grain transformers/processors) makes it possible for the aggregators to leverage working capital finance including, for example, invoice discounting. They also become well-placed to access other forms of concessional financing, making it possible for them to finance SHF2 producers (see Box 2.2). The need to assure consistent supply has prompted them to invest in postharvest handling and storage facilities which is reducing the level of postharvest losses in the segment in which they operate. One of the main challenges limiting upscaling of this model is the perception among some farmers that the terms under which they are tied to the aggregators, especially terms for repayment of inputs credit, are not sufficiently transparent and fair.

Despite the strategic importance of their role in inclusive growth in the value chain, exemplified by how they enable smallholders to transition to the more productive SHF2, there is currently no formal system to govern the activities of the aggregators, including the large-scale ones. One of the effects of this situation is that storage facilities and practices are variable, thereby hampering the development of third-party storage services. Most of the substantial private investment in storage facilities, especially in the northern states, is mainly for holding proprietary stocks. This limits options for aggregators when it comes to accessing working capital finance, in particular through the use of stored commodities as collateral.

The terms under which the large-scale aggregators transact with the SHF2 are also variable and often lack sufficient transparency. There appears, therefore, to be some mistrust among smallholder farmers when it comes to participation in such schemes. Some of the aggregators belong to various association, an example is the Amana Farmers and Grain Suppliers Association, which has a Chapter in Kaduna. However, it appears that most of the members are small to medium-scale aggregators and the large-scale ones are not actively involved.

3.4.3 Farmers' representative organisations

A review which is reported in Section 5.2.5 (Social Analysis), notes that there are several farmers' representative organisations in Nigeria but they appear rather ineffective in addressing some key challenges facing, especially smallholder farmers. The notable ones include the following:

- The Maize Association of Nigeria (MAAN)[14] and the Maize Growers, Processors and Marketers Association of Nigeria (MAGPMAN) [15], which are specific to the maize VC. The membership of MAAN includes researchers, extension and mechanization services providers, seed companies, fertilizer and chemicals distribution companies, transporters, maize traders and farmers. Its membership extends to maize consumers, especially poultry and livestock farmers, millers manufacturers.

  By its mandate, MAGPAN promotes information-sharing and facilitating linkage of farmers to various agricultural finance programmes including CBN's Anchor Borrower Programme. It has a membership of 70,000 maize farmers but has not programmes to foster output marketing and/or bulk procurement of inputs for farmer groups.

- The two organisations are part of the All Farmers' Association of Nigeria (AFAN), which is a federal-level organisations. AFAN's approach mainly involves delegating VC-specific issues to commodity-based organisations, including those at the state level.
- An example of a state-level organisation is the Amana Farmers and Grain Suppliers Association, which is based in Kaduna. It has over 1000 registered members, mostly maize producers but also includes traders. One of its key activities involves creating awareness about fertiliser use in collaboration with experts from IAR, Zaria. It is not involved in facilitating output marketing or dissemination of market information.
- Women Farmers Advancement Network (WOFAN) has membership consisting mainly of women and has about 1500 womens' groups each with 30 members. They operate mainly in the northern states and support rice and maize farmers. In the rice VC they

[14] https://maanng.org/about-us/
[15] https://magpaman.org/vision-mission-values

offtake and process paddy rice from the members. They also provide training for Village Savings and Loans Associations (VSLA) and guarantee loans taken by their members.

- The Maize Traders Association of Kano has over 350 registered members who own or share shops/warehouses in the Dawanau International Market. The market hosts 45-50 commodity associations each with about 500 trader members. The association does not promote offtake from organised farmers as procurement is mainly by individual traders.
- There are also specialised associations such as the Seed Entrepreneurs Association of Nigeria with seed companies and distributors as members. Only formal milling companies belong to the Flour Millers Association, which currently excludes the informal processors who account for a sizeable share of the maize flour market.

These organisations listed above represent only a fraction of the many which can be found in the agricultural value chains. Their main functions include sharing information, including information on the use of inputs (e.g. fertiliser and agro-chemicals) as well as other good agricultural practices. However, evidence from the survey conducted indicates that farmers rely more on their neighbours and official agricultural extension agents for such information than on these organisations. Dissemination of market information is also cited as one of the functions some of these organisations provide. Again evidence from farmers suggest that they rely more on traders and their neighbours for such information.

As noted in the discussions in Section 5.2.5, many of the associations are or attempt to engage with agencies at federal and state levels to secure resources for their members. For instance, in 2019, MAAN reported that it successfully linked over 8000 maize farmers through its Kano State Chapter to the Anchor Borrower programme. MAGPAMAN also reports that it played a role in linking 70,000 maize farmers in the FCT region to CBN's Anchor Borrower Programme. These positive outcomes appear, however, to be isolated since most of the smallholder farmers covered in the survey reported that they were unable to access inputs credit from any formal sources. This evidence is consistent with official reports by the NAERLS/FARMD (2020).

From the consultations with representatives of these organisations, it emerged that they have little or no capacity in advocacy regarding agricultural sector policies, especially as it relates to sub-regional trade in agricultural commodities. Though many of them cited the closure of Nigeria's borders as restricting their trade and impacting on prices, they did not have specific advocacy plans for required reforms. They also seemed to be more engaged in accessing government support programmes and did not have much to contribute in terms of design and implementation actions which meet the needs of their members. In particular, their limited involvement in the emerging structured inputs/output marketing systems (outgrower schemes) is a noted weakness which needs to be addressed if greater transparency is to be assured in order to enhance upscaling of such initiatives.

4. ECONOMIC ANALYSIS

4.1 Introduction:

The economic analysis reported in this chapter is intended to answer two key framing questions:

- What is the contribution of the maize value chain to economic growth in Nigeria; and
- Whether growth in the chain is inclusive.

In accordance with the standard methodology, answering these questions involved the following:

a. Undertaking financial analysis of the key actors
b. Assessing overall effects on the national economy
c. Analysing the sustainability and viability of the chain within the international economy
d. Assessing the inclusiveness of growth in the chain

Consistent with the adopted methodology, the bulk of the analysis is based on market prices. The key actors covered are stated in Section 3.2 of this report.

4.2 Financial analysis of operations of the key actors:

The financial analysis involves assessing how profitable the key actors are. The main tool of analysis is the operating account, which takes into account only flows involving market exchange and therefore applies actual market prices. The methodology used in the financial analysis centres around computation of operating accounts of key actors in the value chain as shown in Box 4.1 below.

Box 4.1: Computation of operating accounts of key actors

Value chain agents' operating accounts have been calculated based on the following outline:

Revenues

Production / output

- Sales
- Self-consumption
- Stocks variation

Direct subsidies

Expenses

(Cost of Production)

- Intermediate Goods and Services
- Value Addition (direct VA)
  - Value of rented land
  - Value of hired labour
  - Financial charges
  - Taxes / duties
  - Depreciation
  - Net profit

Source: Based on VCA4D Methodological Framework.

The analysis based on this computation makes it possible to answer the core question of how profitable and sustainable the activities in the maize value chain are for the actors involved. The analysis generates information on the overall net income for each category of actors, making it possible to compare income per individual entity or household with benchmarks such as national minimum wage or national living wage. Profitability is also assessed in terms of returns per applicable benchmarks. Due to difficulties in obtaining details on actual capital investments by the key actors, the main benchmarks used in assessing overall financial performance of the actors is return on turnover (net profit/marketed output). In this computation, household consumption is included, and the producer price obtained at the respective level is applied. Such a rate may be relatively more important for larger-scale operators, for whom it represents an indication of the efficiency of their operation. For the smaller-scale actors in the chain, the extent to which income generated from the chain contributes to overall household income and wellbeing may be the more relevant issue.

To ensure consistency with the environmental analysis in Chapter 6, the unit of analysis in this chapter is one (1) tonne of dry maize grain or the dry weight equivalent for fresh corn-on-cob. When this analysis has been done then flow data reported in Figure 20 and Table 4 is used to carry out financial analysis of the operations of the key actors. The focus is on actors at the following stages in the value chain:

- Upstream: mainly in the maize producers – mainstream smallholder farmers who receive no form of support in acquiring inputs (SHF1); the smallholder farmers who, as a result of participation in outgrower or other schemes are supported with some form of inputs credit (SHF2); as well as medium-scale farmers (MSF) and large-scale farmers (LSF).
- Midstream actors: mainly aggregators of different sizes, grain wholesalers and retailers;
- Downstream actors: feedmillers, large-scale food processing companies (millers) in the formal sector and micro/small-scale grain millers.

An important caveat is that analysis of the downstream actors and the large-scale actors at the midstream level is based on best-case industry projections as commercial confidentiality made it difficult to obtain detailed data from those consulted. Analysis of exports was limited mainly to the contribution of the maize value chain to foreign exchange generation. Indepth financial analysis of the export trade was considered to be beyond the scope of this study.

TABLE 5: OPERATING ACCOUNTS OF PRODUCERS OF MARKETABLE VOLUMES OF MAIZE IN NIGERIA (IN NAIRA IN 2019)

ITEM/PRODUCER TYPE	SHF1	SHF2	MSF	LSF	Sub-total (farmers)
Total revenues (value of production)	**485,480,250,000**	**227,670,207,500**	**265,620,640,000**	**207,693,225,000**	**1,186,464,322,500**
Sales (fresh corn-on-cob)	127,490,000,000	14,165,800,000	0	0	141,655,800,000
Sales (dry maize grain)	245,966,200,000	141,883,350,000	200,865,000,000	170,116,250,000	758,830,800,000
Self-consumption	112,024,050,000	32,602,500,000	19,960,500,000	8,161,550,000	172,748,600,000
Subsidies (direct)	-	39,018,557,500	44,795,140,000	29,415,425,000	113,229,122,500
Intermediate goods and services (total)	**174,625,725,000**	**89,732,332,500**	**103,611,040,000**	**68,427,925,000**	**436,397,022,500**
Seed		9,314,775,000	10,693,800,000	7,022,250,000	27,030,825,000
Fertiliser		16,249,107,500	18,654,740,000	12,249,925,000	47,153,772,500
Pesticides	42,832,725,000	13,454,675,000	15,446,600,000	10,143,250,000	81,877,250,000
Transport	36,243,075,000	11,384,725,000	13,070,200,000	8,582,750,000	69,280,750,000
Bagging materials		7,244,825,000	8,317,400,000	5,461,750,000	21,023,975,000
Utilities			594,100,000	780,250,000	1,374,350,000
Ploughing	95,549,925,000	32,084,225,000	36,834,200,000	24,187,750,000	188,656,100,000
Value added (direct)	**310,854,525,000**	**137,937,875,000**	**162,009,600,000**	**139,265,300,000**	**750,067,300,000**
Value of rented land	42,832,725,000	13,454,675,000	15,446,600,000	10,143,250,000	81,877,250,000
Value of hired labour	42,832,725,000	25,874,375,000	29,705,000,000	19,506,250,000	117,918,350,000
Financial charges	-	8,197,002,000	9,410,544,000	6,179,580,000	23,787,126,000
Local council levies	3,294,825,000	1,034,975,000	1,188,200,000	780,250,000	6,298,250,000
Taxes/duties	-	-	-	-	-
Depreciation	56,012,025,000	17,594,575,000	24,952,200,000	24,187,750,000	122,746,550,000
Net profit	165,882,225,000	71,782,273,000	81,307,056,000	78,468,220,000	397,439,774,000
Maize income per actor (N)	68,400	252,000	1,120,000	22,400,000	
Maize income per actor ($)	190.00	700.00	3,110.00	62,220.00	
Return on turnover (%)	34.2	31.5	30.6	37.8	33.5

4.2.1 Producer margins and earnings in the maize value chain

Table 5 above shows that maize production by all categories of farmers is very profitable. The overall average return on turnover (ROT) for farmers is 33.5% and the group of farmers obtaining the highest returns are the large-scale farmers, who post a ROT of 37.8%. It is apparent that they benefit from economies of scale but, notably, the SHF1 are not far behind them, with ROT of 34.2%. The SHF2 and MSF obtain ROT of 31.5% and 30.6% respectively. It is evident that the Government's inputs subsidy programme is impacting on profitability in the value chain, but mainly on the better-endowed farmers who are able to procure the available inputs. For instance, the ROT for SHF2 and MSF falls sharply to 14.5% and 16.8% respectively when the inputs subsidy they receive is taken out of the equation. Even for the LSF, there is a decline from 37.8% to 27.9%.

The analysis also shows that operations of the SHF2 is less profitable than that of the SHF1 producers. This is because uptake of inputs results in increased utilisation of non-family labour and other resources compared to the SHF1. However, it is also very evident that participation by the SHF2 in the outgrower schemes produces very positive impacts on their household income. The additional resources made available makes it possible for them to more than double their farm size but spreading inputs to "unsupported" maize plots and other crops implies that the productivity growth they experience is rather marginal, only about 15% increase in the average yield they obtain. They also obtain comparatively higher producer prices, close to 25% higher than the farmgate prices offered to SHF1 producers. This is partly because they market quality grains and also enjoy premium from selling in bulk. The marketing chain they participate in is also shorter, as shown in Figure 16.

The combined effects of these benefits from participation in the outgrower schemes is a substantial increase in maize-based household earnings by the SHF2 producers. The SHF1 households earn average annual maize-based income of about ₦ 68,400 (US$190), which has to be complemented by income from production of other crops in order to get over the poverty line (estimated at ₦ 137,000 or US$380 per annum). In contrast, SHF2 households obtain estimated annual maize-based income of ₦ 252,000 (i.e. US$700), which is far above the poverty line but lower than the official minimum wage per annum (i.e. US$1,000). Average annual earnings per household for MSF is about N1,120,000 ($3110.00) and for the estimate for the LSF is just over N22.4 million ($62,220) per annum.

Another notable evidence is the contribution of sale of fresh corn-on-cob to the revenues generated by the smallholder farmers (both SHF1 and SHF2). The price premium for the fresh corn, in terms of the dry weight equivalent, is well above 50%. Selling maize at that point also minimizes postharvest losses. However, the marketing window is rather short, except for farmers producing in the Fadama areas.

TABLE 6: OPERATING ACCOUNTS OF TRADERS OF MARKETABLE VOLUMES OF MAIZE IN NIGERIA (IN NAIRA IN 2019)

ITEM/TRADER TYPE	Rural collectors	SME aggregators	Large-scale aggregators	Wholesalers	Retailers	Sub-total (traders)
Total revenue (value of production	**488,260,800,000**	**542,512,000,000**	**431,841,250,000**	**467,374,375,000**	**125,437,000,000**	**2,055,425,425,000**
Sales	488,260,800,000	542,512,000,000	431,841,250,000	467,374,375,000	125,437,000,000	2,055,425,425,000
Commissions/subsidies	-	-	-	-	-	-
Intermediate goods and services (total)	**461,135,200,000**	**500,467,320,000**	**375,442,782,750**	**438,925,500,000**	**119,840,580,000**	**1,895,811,382,750**
Maize grain	461,135,200,000	488,260,800,000	362,746,650,000	406,412,500,000	110,963,500,000	1,829,518,650,000
Transport		9,765,216,000	7,254,933,000	16,256,500,000	4,438,540,000	37,715,189,000
Utilities			3,627,466,500	8,128,250,000	2,219,270,000	13,974,986,500
Other costs	-	2,441,304,000	1,813,733,250	8,128,250,000	2,219,270,000	14,602,557,250
Value added (direct)	27,125,600,000	42,044,680,000	56,048,267,250	28,298,875,000	5,596,420,000	159,113,842,250
Value of rented land			36,274,665	35,000,000		71,274,665
Value of hired labour		48,826,080	72,549,330	45,000,000		166,375,410
Financial charges			181,373,325	81,282,500		262,655,825
Local council levies	27,126	27,126	1,813,733	20,320,625	11,096,350	33,284,959
Taxes/duties			18,137,333	203,206,250		221,343,583
Depreciation			350,200,000	150,000,000		500,200,000
Net profit	27,125,572,874	41,995,826,794	55,387,918,864	27,764,065,625	5,585,323,650	157,858,707,808
Maize income per actor (N)	175,000	775,000	738,500,000	18,500,000	66,500	
Maize income per actor ($)	485.00	2,150.00	2,051,000.00	51,400.00	185.00	
Return on turnover (%)	5.6	7.7	12.8	5.9	4.5	7.8

4.2.2 Margins at the level of distributors (aggregators and traders)

The analysis reported in Table 6 above shows that the midstream distribution segment of the maize value chain is also profitable but the margins are much tighter than at the level of production. The average ROT for this segment is about 7.8% compared to over 33% at the producer level. The relatively tighter margins reflect the level of competition in the trade. It is also a reflection of the fact that traders focus mainly on spatial transformation functions and only engage marginally in intra-seasonal storage, leaving this as an additional function for smallholder farmer who are constrained by lack of the physical facilities and liquidity.

FIGURE 22: MAIZE AGGREGATION IN KADUNA STATE: SMALL AND MICRO-SCALE

Source: Authors

Rural collectors, who are community-based micro-aggregators, constitute the first line of aggregation in the maize grain trade. They are severely under-capitalized and trade in very small volumes as shown on the right in Figure 22 (a trader transporting two bags of maize, i.e. about 230 kg to an urban market. It is estimated that they may handle between 30-80 tonnes of maize grain during a marketing season.

Their margins are tight as the ROT the obtain is about 5.6%. However, household income generated through this activity is significant, estimated at about N175,000 (i.e. about US $485) per annum. This income is over 2.5 times higher than the average farm income earned by the SHF1 producers but just under half of the annual minimum wage. It must be noted, however, that they usually combine trading with farming at a scale similar to that of the SHF2 producers.

The small-scale aggregators are the main link between micro-rural aggregators or collectors and urban grain wholesalers. Sometimes they also trade with large-scale aggregators and LSFs who are contracted to supply to major offtakers. Due to working capital constraints they

usually deliver a truckload (using small pick-up trucks as shown on the left in Figure 22). Though they have to pay cash upon delivery system by farmers, they are required to extend trade credit lasting between 14-21 days to their buyers. This is one of the factors which limit upscaling by these grain traders. The average ROT they obtain is about 7.7% and their annual maize trade-based income is estimated at about N775,000 (i.e. US$2,150). This is more than double the annual minimum wage in Nigeria.

Large-scale aggregators, as shown in Table 6, post the highest ROT in this segment of the value chain. This is partly because of they offer other services including cleaning, drying and storing grains in order to ensure regular supply of grain of consistent quality to their offtakers. On the average they can earn net income of just over N738 million (US$2.05 million) per annum, but there is likely to be wide variance around this average depending on the size of their operations.

Wholesalers in urban markets also vary widely in scale. There are those who operate small-capacity warehouses and mainly target micro/small-scale processors, grain retailers and institutional buyers including public sector agencies. The larger operators are often involved in supplying directly to feedmillers and poultry farmers as well as in exporting grains into markets in the West African subregion. They tend to specialize in specific crops, even though there are many cases where they trade multiple crops. Average annual earnings from trading in maize obtained by wholesalers is conservatively estimated at about N18,500,000 (i.e. about $51,400). Maize grain retailers earn an estimated annual income of N125,000 (about $345) per annum from selling this crop. However, it has to be noted that they usually sell a range of grains in addition to maize.

4.2.3 Margins at grain transformation (processing)

Table 7 below reports results of analysis of the operations of the key maize grain transformers. It shows that investment in maize grain processing generates attractive returns, with ROT estimated at 16.3% for feedmillers and 23% for food millers and processors. The ROT for micro/small-scale millers is close to 20%, almost double the average interest rate on fixed deposits in the banking sector in the country in 2019 – which ranged from 8% to maximum 14%.

There are several of these operators in the country. Using a conservative estimate of over 100,000 such operations, it is projected that the operators can be earning about N540,000 (i.e. US$1,500) per annum.

TABLE 7: OPERATING ACCOUNTS OF MAIZE GRAIN TRANSFORMERS IN NIGERIA (IN NAIRA IN 2019)

Item/producer	Feedmillers	Food processors	M/S millers	Sub-total
Total revenues (value of production)	**736,629,900,000**	**242,302,400,000**	**278,208,220,000**	**1,257,140,520,000**
Sales (main product)	627,946,800,000	209,427,200,000	238,004,720,000	1,075,378,720,000
Sales (by-product)	108,683,100,000	32,875,200,000	40,203,500,000	181,761,800,000
Subsidies	-	-	-	
Intermediate goods and services (total)	**576,121,062,500**	**174,269,000,000**	**221,119,250,000**	**971,509,312,500**
Maize grain	503,162,500,000	152,200,000,000	201,017,500,000	856,380,000,000
Other ingredients etc.	2,515,812,500	761,000,000	1,005,087,500	4,281,900,000
Transport	5,031,625,000	1,522,000,000	2,010,175,000	8,563,800,000
Utilities (water/electricity)	40,253,000,000	12,176,000,000	16,081,400,000	68,510,400,000
Packaging and other costs	25,158,125,000	7,610,000,000	1,005,087,500	33,773,212,500
Value added (direct)	**160,508,837,500**	**68,033,400,000**	**57,088,970,000**	**285,631,207,500**
Value of rented land	10,063,250	3,044,000	4,020,350	17,127,600
Value of hired labour	25,158,125	7,610,000	10,050,875	42,819,000
Financial charges	50,316,250	15,220,000	20,101,750	85,638,000
Local council levies	25,158,125	7,610,000	10,050,875	42,819,000
Taxes/duties	37,737,187,500	11,415,000,000	1,005,087,500	50,157,275,000
Depreciation	2,515,812,500	761,000,000	1,608,140,000	4,884,952,500
Net profit	120,145,141,750	55,823,916,000	54,431,518,650	230,400,576,400
Return on turnover (%)	16.3	23.0	19.6	

TABLE 8: CONSOLIDATED OPERATING ACCOUNTS OF MAIN ACTORS IN MAIZE VALUE CHAIN IN NIGERIA, INCLUDING DIRECT VALUE ADDED (IN NAIRA IN 2019)

Item/value chain actor	Maize producers	Maize traders	Maize transformers	SUB-TOTAL
Total revenues (value of production)	**1,186,464,322,500**	**225,906,775,000**	**400,760,520,000**	**1,813,131,617,500**
Sales (fresh corn-on-cob)	141,655,800,000			141,655,800,000
Sales (dry maize grain or processed product	758,830,800,000	225,906,775,000	400,760,520,000	1,385,498,095,000
Self-consumption	172,748,600,000			172,748,600,000
By-products				-
Subsidies (direct)	113,229,122,500			113,229,122,500
Intermediate goods and services outside VC*	**436,397,022,500**	**66,792,932,750**	**115,129,312,500**	**618,319,267,750**
Seed, fertiliser and pesticides	156,061,847,500	0	0	156,061,847,500
Transport	69,280,750,000	37,965,289,000	8,563,800,000	115,809,839,000
Utilities	1,374,350,000	13,974,986,500	68,510,400,000	83,859,736,500
Ploughing	188,656,100,000	0	0	188,656,100,000
Other ingredients	0	0	4,281,900,000	4,281,900,000
Packaging and other costs	21,023,975,000	14,852,657,250	33,773,212,500	69,649,844,750
Value addition (direct VA)	**750,067,300,000**	**159,113,842,250**	**285,631,207,500**	**1,194,812,349,750**
Value of rented land/storage etc.	81,877,250,000	71,274,665	17,127,600	81,965,652,265
Value of hired labour	117,918,350,000	166,375,410	42,819,000	118,127,544,410
Financial charges	23,787,126,000	262,655,825	85,638,000	24,135,419,825
Local council levies	6,298,250,000	33,284,959	42,819,000	6,374,353,959
Taxes/duties	-	221,343,583	50,157,275,000	50,378,618,583
Depreciation	122,746,550,000	500,200,000	4,884,952,500	128,131,702,500
Net profit after tax	397,439,774,000	157,858,707,808	230,400,576,400	785,699,058,208

Source: Authors *Excluding value of maize grain supplied to distributors and transformers by domestic producers.

TABLE 9: SUMMARY OF VALUE ADDED BY ACTORS IN MAIZE VALUE CHAIN IN NIGERIA (IN NAIRA IN 2019)

Item/value chain actor	Direct value added by main actors				Indirect VA contributed by providers of goods & services	Total
	Maize producers	Maize traders & distributors	Maize processors & transformers	Sub-total		
Value of rented land/storage etc.	81,877,250,000	71,274,665	17,127,600	**81,965,652,265**	14,843,057,688	96,808,709,953
Value of hired labour	117,918,350,000	166,375,410	42,819,000	**118,127,544,410**	99,652,320,918	217,779,865,328
Financial charges	23,787,126,000	262,655,825	85,638,000	**24,135,419,825**	81,720,800,648	105,856,220,473
Local council levies	6,298,250,000	33,284,959	42,819,000	**6,374,353,959**	0	6,374,353,959
Taxes/duties	-	221,343,583	50,157,275,000	**50,378,618,583**	50,839,388,735	101,218,007,318
Depreciation	122,746,550,000	500,200,000	4,884,952,500	**128,131,702,500**	12,193,932,770	140,325,635,270
Net profit after tax	397,439,774,000	157,858,707,808	230,400,576,400	**785,699,058,208**	48,736,294,005	834,435,352,213
Sub-totals	**750,067,300,000**	**159,113,842,250**	**285,631,207,500**	**1,194,812,349,750**	**307,985,794,764**	**1,502,798,144,514**

4.3 Assessment of maize VC contributions

In this section the analysis focuses on assessing the contribution of the maize value chain to the economy of Nigeria in terms of the nominal value of the contribution and as a share of the overall gross domestic product (GDP) as well as of agriculture sector GDP. Also assessed are the chain's contribution to public finances, balance of trade and the extent to which it is integrated into the national economy.

The basis for computing value added in the maize value chain is data generated in the operating accounts, disaggregated into value of total production in the chain, intermediate goods and services (IGS) used and value added at different levels in the chain. Table 8 summarizes the accounts for the key actors, providing details of the direct value added generated. In Table 9 is summary of total (direct and indirect) value added in the chain.

4.3.1 Value added in the maize value chain in Nigeria

In 2019, Nigeria produced about 12.6 million tonnes of maize grain. Utilisation of the grain included household consumption, direct sale to consumers in both rural and urban areas for food as well as uptake by transformers. **Total value added** from production through distribution to transformation is estimated at close to **N1,502 billion** which is equivalent to just over **US$ 4.12 billion**. Out of this, the **direct value added** by the main actors in the value chain accounts for about 79.5% of the total value added whilst the remaining 20.5% represents the contribution from suppliers of goods and services from outside of the value chain.

The total value added in the maize value chain represents a contribution of about 0.92% of the national GDP, which in 2019 was estimated at about US$448.1 billion, making Nigeria the biggest economy in Africa, ahead of South Africa and Egypt. This contribution from the maize value chain also constitutes 3.8% of the contribution from agriculture, forestry and fisheries.

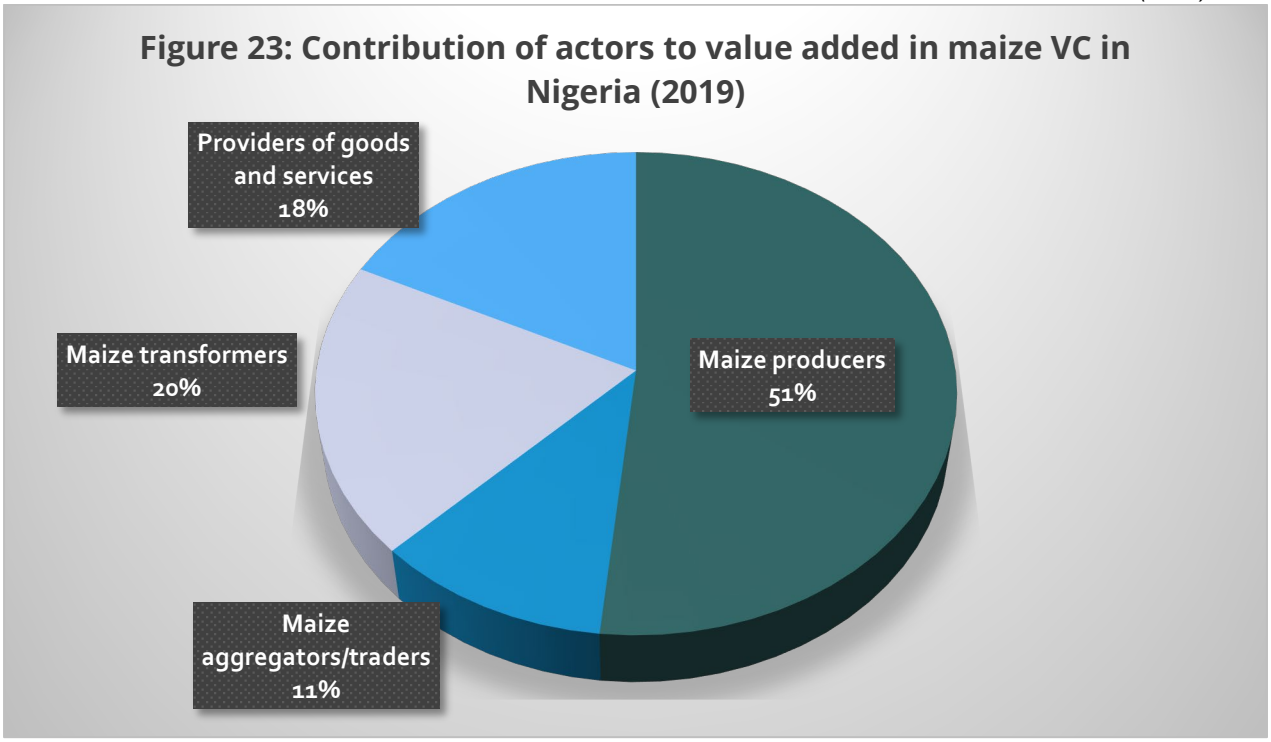
4.3.2 Actors contribution to value added

Figure 23 shows the contributions of various groups of actors to value added in the maize value chain. The share contributed to total VA by maize producers, which is estimated at 51%, dwarfs the share of all other actors in the chain. It should be noted that the producers' share takes into account household consumption of maize as was made evident in the operating accounts. Maize transformers account for about 20% of total value added in the chain. This rather low level of value added by transformers tends to typify many food crop value chains in Africa. For example, in 2018, transformers contributed less than 30% of total value added in the groundnuts value chain in Ghana despite the existence of considerable opportunities to expand processing activities[16]. This

[16] Source: VCA4D Report (2019) on Groundnuts Value Chain in Ghana.

is an indication of the potential scope for increased investment in upstream processing activities. Providers of goods and services (outside of the value chain) contribute about 18% of the total value added in the chain, while the share of value added generated by aggregators and traders is about 11%.

FIGURE 23: CONTRIBUTION OF ACTORS TO VALUE ADDED IN MAIZE VC IN NIGERIA (2019)



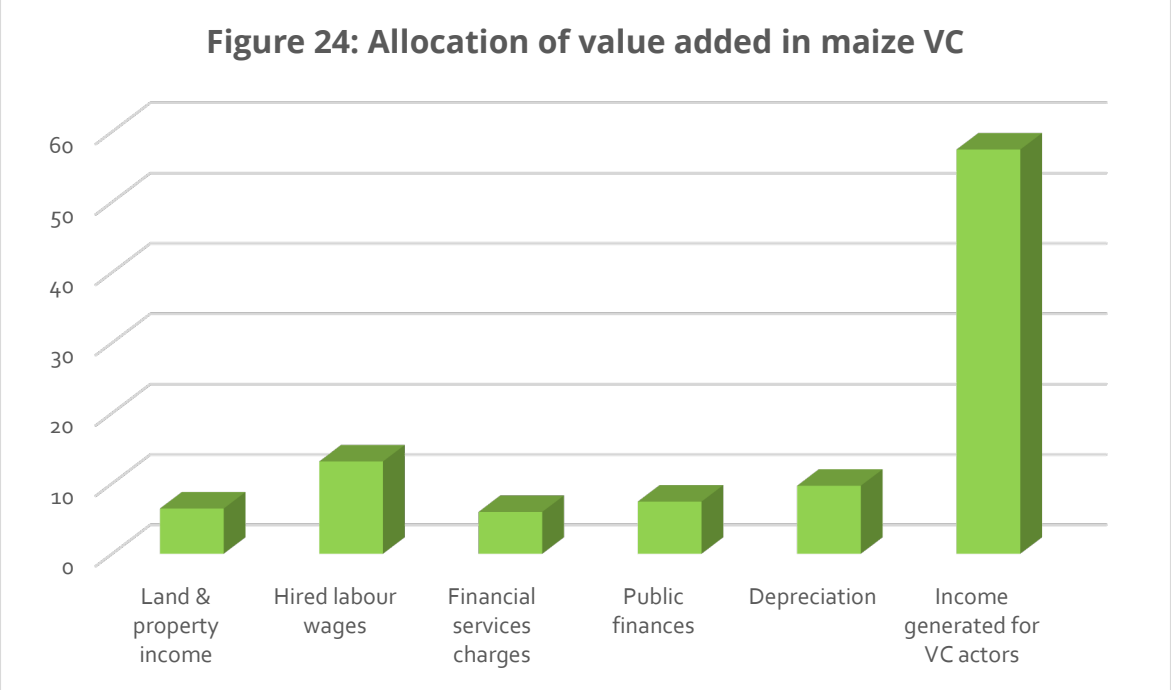
Among the maize producers, the SHF1, who are the least capitalized, are the leading contributors to value added in the chain. This is principally because of the large number of these smallholders. They contribute about 41.4% of the total value added at the level of maize grain production. The MSFs are the next largest contributors, their share of value added amounting to 21.6%.

Figure 24 shows the breakdown of allocation of total value added in the maize value chain. Income generated for actors in the value chain (i.e. their operating net profits), is by far the largest proportion of the total value added, estimated at about 57%. This is followed by the share allocated to hired labour wages, which accounts for about 13% of the value added. This is an indication of the labour-intensity of operations at production and in downstream transformation. The contribution to public finances in the form of taxes, import duties and local council levies represents about 7% of the value added.

Income accruing to providers of financial services is one of the lowest, at about 5.9%, confirming that most actors in the chain have very limited access to finance. Even then, the bulk of the charges of financial services are generated by the activities of the large-scale farmers, aggregators, grain wholesalers, and service providers such as inputs distributors, transporters and tractor services providers. The allocation for depreciation is a significant 9.7%. Allocation to land is higher only than that of income to financiers. This is despite the fact that land is critical in production and distribution segments of the

chain. Low levels of commercialization of the land market may explain this and is important in ensuring inclusiveness for smallholder farmers in maize production in Nigeria in the medium term.

FIGURE 24: ALLOCATION OF VALUE ADDED IN MAIZE VC



4.3.3 Contribution of maize value chain to public finances and balance of trade

The Government's inputs subsidy programme means the maize value chain takes more out of public finances than it contributes. The value chain contributes about N107.6 billion (about US$ 300 million) in the form of taxes and local council/government levies but receives about N113 billion (US$ 315 million) through inputs subsidies. It has been noted that the SHF1 producers do not benefit much from the inputs subsidy programme though they predominate production in terms of their share of total output and also their share of the contribution of producers to value added in the chain.

Foreign exchange earnings from maize grain exports into the regional markets is estimated at about US$ 230.4 million in 2019. During that same period, the total value of imported intermediate goods and services used in the value chain was about US$ 362.7 million. However, the value chain has great potential to increase foreign exchange earnings from maize exports, especially because of the long history of exporting into landlocked Sahelian countries. Achieving this potential would, however, require some policy actions.

Nigeria's maize value chain is well-integrated into the local economy. This assertion is based on the rate on integration of the value chain, which is calculated as the ratio of the

total value added in the chain to the total value of production. The estimated rate of integration is about 83%.

4.3.4 Contribution of value chain to employment generation

The maize value chain sustains employment for over 23 million people, the majority being in self-employment for smallholder farmers and temporary farm labourers who are engaged especially during the planting and harvesting seasons. The emergence of the formal Sub-chain 2, is creating new job opportunities in grain handling and storage. This is in addition to the over 300,000 self-employed micro/small-scale grain aggregators and a sizeable number of young people employed in the informal micro/small-scale milling industry.

4.3.5 Assessment of sustainability of maize value chain

One means of assessing the viability of the maize value chain within the global economy is by computing the domestic resource cost (DRC) ratio. The DRC is calculated by dividing the sum of labour and capital costs valued at market prices excluding transfers, by the difference between production and tradeable inputs at international prices (FOB prices). So DRC = (A+B)/(C-D) if:

- A: labour costs at market prices
- B: capital costs at market prices
- C: production value at international prices
- D: tradeable inputs (intermediate goods and services) at international prices

The DRC for the maize value chain in Nigeria is estimated at 0.19, which is well below unity (i.e. <1). The implication is that the value chain has a comparative advantage and is viable within the global economy. DRC also measures the overall economic gain or loss for the national economy and at the low end, as is the case in Nigeria's maize, it indicates high social benefits to the national economy.

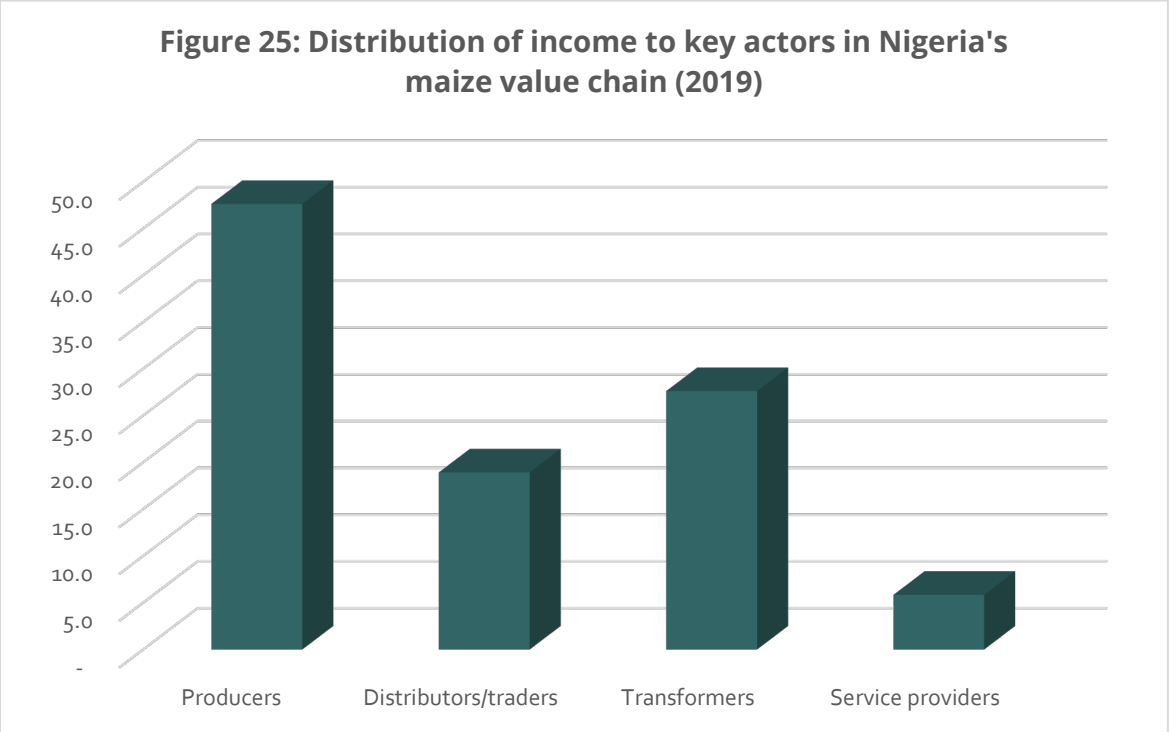
There is evidence, however, that local maize producers enjoy a level of protection as the nominal protection coefficient (NPC) for the chain is estimated at 1.09 meaning that the domestic value is higher than the international market price. The NPC is computed by dividing value of production at market gate by production at international prices, using import parity prices. This evidence highlights the need to increase the productivity of local maize producers if they are to be price competitive.

4.3.6 Assessment of inclusiveness in the maize value chain

The maize value chain is evidently inclusive. As shown in Figure 24, about 57% of the value added in the chain is income obtained by the key actors. Figure 25 depicts how this income accrues to different categories of actors. Producers earn close to 48% of the total income generated in the chain, whilst distributors/traders obtain about 19%, and 27% accrues to grain transformers. The share of income generated for service providers is estimated at 6%.

At the grain production level smallholder producers together account for almost 60% of the income generated at that segment whilst large-scale farmers account for just under 20%. At the distribution level, micro/small-scale actors receive about 47% of the total income. It is only at the level of transformation where large-scale actors dominate significantly. This is partly due to the dominance of the poultry feed milling industry, which accounts for 56% of the income generated by transformers. The remaining income obtained by maize transformers is shared almost equally between micro/small-scale millers (49%) and formal industrial millers and breweries (51%).

FIGURE 25: DISTRIBUTION OF INCOME TO KEY ACTORS IN NIGERIA'S MAIZE VALUE CHAIN (2019)



Wage income generated in the value chain is concentrated at the level of production (54%) and the labour-intensive provision of services, including inputs supplies and grain handling. Smallholder farmers (both SHF1 and SHF2) are the main source of wage labour income in the chain.

TABLE 10: SUMMARY OF EVIDENCE FROM ECONOMIC ANALYSIS OF MAIZE VALUE CHAIN IN NIGERIA

Question1			
CQ1.1	How profitable and sustainable are the VC activities for the entities involved?	**Profitability measure (return on turnover)**	**Farmers:** • **SHF1** – 34.2%; **SHF2** – 31.5%; **MSF** – 30.6%; and **LSF** – 37.8%.
		Benchmarks of farmers' net income per annum with minimum wage and/or job opportunities:	- National Poverty line = N137,000 ($380) per annum - National minimum wage = N30,000 per month of N360,000 ($640 or €565)
		Net income by type of actor	**SHF1:** N68,000 ($190) per annum. **SHF2:** N252,000 ($700) per annum. **MSF:** N1,120,000 ($3,110) per annum. **LSF:** N22,400,000 ($62,220) **Micro aggregators (rural collectors):** N175,000 ($485) **Small-scale aggregators:** N775,000 ($2,150) per annum. **Large-scale aggregators:** N738,000,000 ($2,051,000) p.a. **Wholesalers:** N18,500,000 ($51,400) per annum. **Grain retailers:** N66,500 ($185) per annum. **Micro/small-scale millers:** N540,000 ($1,500) per annum.
Framing Question 1: What is the contribution of the VC to economic growth?		**INDICATORS**	**RESULTS**
CQ1.2	What is the contribution of the VC to the GDP?	**Total VA and components**	**Total VA = N1,502 billion ($4.12 billion)** **Components:** Land/property income = 6.4%; Wages = 13.1%; Financial charges = 5.9%; Public finance = 7.4%; Depreciation = 9.7%; and Actors' net income = 57.5%
		VA share of the GDP	**Total VA share of GDP = 0.9%**
		Rate of integration into the Economy (total VA/VC production)	**Total VC production = N1,813 billion** **Rate of integration = 0.83**
CQ1.3	What is the contribution of the VC to the agriculture sector GDP?	**VA share of agriculture sector GDP**	**Share of agriculture GDP = 3.8%**

CQ1.4	What is the contribution of the VC to the public finances?	**Public Funds Balance**	**Contribution** to taxes/duties & local council levies = N107.6 billion; **Less Inputs subsidy** = N113 billion; **Net contribution** = - N5.4 billion (negative)
CQ1.5	What is the contribution of the VC to the balance of trade?	VC Balance of trade	VC imports = $362. Million and Grain exports = $230 million
		Total imports / VC production	7.0%
Framing Question 1: What is the contribution of the VC to economic growth?		**INDICATORS**	**RESULTS**
CQ1.6	Is the VC viable in the international economy?	**Nominal Protection Coefficient (NPC)**	**1.09** (indication of a level of protection)
		Domestic Resource Cost Ratio (DRC)	**0.19** (indicating VC has comparative advantage)
Framing Question 2: Is this economic growth inclusive?		**INDICATORS**	**RESULTS**
CQ2.1	How is income distributed across actors of the VC?	**Total farm income**	**N 750 billion ($2.08 billion)**
		% final price at farm gate	**In Sub-chains 1 = 68%; and Sub-chain 2 = 84%.**
		Total wages and salaries	**N 217.8 billion**
CQ2.2	What is the impact of the governance systems on income distribution?	**Income distribution**	**Sub-chain 2:** involves hierarchical control by large-scale aggregators who have to comply with minimum quality and volume standards set by major offtakers (e.g. feedmillers, breweries and food processing companies). Distribution chain is relatively shorter, leading to increased share of final grain price accruing to the SHF2 as well as MSFs and LSFs. **Sub-chains 1:** predominantly informal, lacks enforced standards for quality and measures, making trade rather opaque; farmers' share in final price is also lower due to distribution chain being long as a result of participation by a large number of rural collectors and small-scale aggregators.
CQ2.3	How is employment distributed across the VC?	**Number of jobs and self-employment**	Self-employment and rural temporary farm labour have dominant share of the over 23 million jobs sustained by activities in the value chain.

5. SOCIAL ANALYSIS

5.1 Introduction

The social profile covers six broad domains of enquiry– 1) working conditions, 2) right and access to land and water, 3) gender equality, 4) food and nutrition security, 5) social capital, and 6) living conditions. The VCA4D methodology further breaks down these six themes into 22 subsets and 63 questions for scoring and analysis. The social profile is based on a spreadsheet and formula in an excel table which includes recommendations on each risk identified as well as the spider diagram that presents the aggregate outcome of the scores on the six themes/dimensions.

The social analysis in this chapter intends to answer two main framing questions:

- Is the economic growth inclusive?
- Is the maize value chain socially sustainable?

For data collection, the team used a mixed methods design including literature review, key informant interviews with key stakeholders, survey data and discussions with farmers groups to carry out the social analysis of the maize value chain. Details about the methodology are provided in Section 1.2 of this report. The social analysis presented in this section consists of: Findings and analysis related to each theme (5.2), a summary and visual representation of the social profile of the actors in the value chain (5.3) including the main issues and challenges facing the maize value chain actors. Section 5.4 contains conclusions and recommendations.

5.2 Main findings of the six domains of social enquiry

5.2.1 Working conditions

Labour conventions ratified by Nigeria

Nigeria has been a member of ILO since 1960 and since has ratified 40 labour conventions. Of these conventions in force relevant to the maize value chain are those related to the right to organise, right of association for agricultural workers, collective bargaining, minimum age for admission to industrial employment (15 years), protection against accidents, wage protection and occupational safety and health among others. Nigerian labour laws mirror the provisions of most of these labour Conventions to a considerable extent[17]. At the moment most of the legislations concerned with wage labour, employment conditions and compensation, etc. are more relevant to the population in wage-labour employment which is around 20% percent of the economically active population in Nigeria[18]. The remaining 80% percent is part of the agriculture-dominated economy, of which in 2020, 34.6% are employed in agriculture (ILO estimate) and the remaining are part of the informal sector[19].

[17] Influence of ILO Conventions of Nigerian legislation - https://www.ilo.org/public/libdoc/ilo/P/09602/09602(1960-82-1)26-43.pdf (accessed on 07.07.2021)

[18] ILO STAT Database retrieved 29 January 2021 https://data.worldbank.org/indicator/SL.EMP.WORK.ZS?locations=NG

[19] https://tradingeconomics.com/nigeria/employment-in-agriculture-percent-of-total-employment-wb-data.html

Furthermore, Nigeria has ratified many regional and international human rights treaties including the International Covenant on Economic, Social and Cultural Rights (ICESCR) and the International Covenant on Civil and Political Rights (ICCPR) in 1993. The mandate of these treaties is to protect citizens from violence, torture, abduction and other ill-treatment. Under the agreements, Nigeria is obligated to adopt effective measures for the prevention, investigation, prosecution, and punishment of serious human rights abuses, and must ensure its citizens the right to education and the highest attainable standard of health, and provide redress and reparations to victims of serious human rights abuses. However, insurgency in the North-East has been systematically undermining the local population including smallholder maize producers non-discriminatory access to education and healthcare, and to protect women and girls from violence.

Labour rights and laws are more applicable to the workers in industrial processing of maize. Around 60% of the total production of maize is processed industrial sector for production of flour, beer, malt drink, corn flakes, starch, syrup, dextrose and animal feeds. Registered largescale operations with organized structures follow essential aspects of the laws when carefully monitored. Majority of small scale operators do not follow these labour laws.
Maize flour is made from ground endosperm (the white piece of the corn kernel). It is on record that more than 60% of Nigeria's production of maize is consumed by the industrial sector.

As per ILO modelled estimate, employment in agriculture in Nigeria has gone down from 48.13% in 2001 to 41.36% in 2010 to 34.6 % of the total employment in 2020.[20] In 2019, female % employment in agriculture was 45.57% of the total – the highest percentage so far. The lowest value was 42.29% in 1991[21]. In 2010, children employment in agriculture constituted 85.2% of the total % of children in economically active ages 7-14 years. This included around 77% of the total percentage of economically active girl children in the same age group.

According to available documentation[22], the share of Nigerian women in crop production is around 40%, substantially less than the much cited 1972 quote[23] that holds the estimate that "women are responsible for 60–80 [percent] of the agricultural labour supplied on the continent of Africa." For northern Nigeria it is further reduced to 32% whereas in southern

[20] https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=NG
[21] https://www.indexmundi.com/facts/nigeria/labor-force
[22] Palacious-Lopez, A. et.al. (2017) How much of the labor in African agriculture is provided by women? In Food Policy, 67, pp.52-63. (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5384444/#fn3)
[23] United Nations Economic Commission for Africa Human Resources Development Division. "Women: the neglected human resource for African Development" Can. J. African Stud. 1972;6(2):359–370. [Google Scholar] [Ref list] -"Few persons would argue against the estimate that women are responsible for 60–80 [percent] of the agricultural Labor supplied on the continent of Africa." A decade later, the Food and Agriculture Organization of the United Nations (FAO) posited that women constitute between 70 and 90% of the agricultural labor force in many Sub-Saharan African countries (FAO, 1984). A later incarnation of the statement surfaced in a 1995 FAO Report: "In Sub-Saharan Africa, agriculture accounts for approximately 21% of the continent's GDP and women contribute 60–80 [percent] of the Labor used to produce food both for household consumption and for sale."

Nigeria, the share is similar to eastern and southern Africa (51%). In the maize value chain, women are predominantly involved in processing maize whereas men are more involved in handling and storage both considered as important activities in the value chain.

Child labour in the maize value chain

Out of the 40 ratified ILO conventions, five specifically relate to child labour[24]. Sub-Saharan Africa has the largest proportion of children considered to be engaged in child labour (29 per cent of children aged 5 to 17 years). This is in stark comparison to the Middle East and North Africa, where 5 per cent of children in this age group are performing potentially harmful work. The use of child labour for agricultural purposes is a common practice in Nigeria especially for on farm activities. Family labour, mostly in the cases of small scale and medium scale farmers often includes children beyond 10 years. Age is always a serious consideration when assigning responsibility on the farm. In artisanal processing units, children are only involved in unskilled aspects to help the women whereas they are seen accompanying their mothers in small and medium scale production, processing and marketing operations.

In 2010, of the total % of children in economically active ages 7-14 years, children employment in agriculture constituted 85.2%, including 76.7% of total % of economically active girl children aged 7-14 years. Although maize is produced predominantly by smallholders there is little discussion and investigation on the prevalence of child labour in relation to maize as compared to the cocoa value chain. This could be attributed to the difference in the way cocoa and maize are produced. In cocoa, child labour is required at particular times in the farming calendar to complete time-sensitive tasks when cocoa farmers typically face labour shortages and/or cannot afford to hire external labour. Another reason could be the value accorded to maize as a staple crop or at best a cash crop in domestic or regional markets whereas cocoa is considered a luxury crop of relatively high-value crop with demand in international markets. According to a study (2018, Maikudi, Y.I. for the production of maize with respect to varying tasks, land preparation (about six man-days per hectare) and weeding (over eight man-days per hectare) are the tasks which utilize the highest amount of family labour. With regard to regulations for children working in agriculture, horticulture and domestic services, the Labour Act permits the employment of children under the age of 12 years.[25]

Job safety in the context of the maize

National Policy on Occupational Safety 2020 established by the Federal Government of Nigeria now seeks to ensure that all workers are safe at their workplaces across the country, deriving from provisions of the Nigerian constitution and the International Labour Organisation's (ILO) convention.

[24] These are- Convention 15 on Minimum Age (Trimmer and Strokers, 1921); Convention 16 on Medical Examination of Young Persons (Sea, 1921); Convention 58 on Minimum Age of Admission of Children Employment at Sea (1936); Convention 59 on Minimum Age (industry, revised 1937) and Convention 123 on Minimum Age for Admission to Employment Underground in Mines (1967).

[25] CLP_Compendium_of_HCL_List_Nigeria.pdf

In most industrial operations, the trade/labour union is often tasked with the responsibility of its members' welfare. Therefore, primary thing for any worker to do in order to access the privileges of the workers union is to become a member. The Federal Ministry of Labour and Productivity focuses on regulating and ensuring favorable working conditions for all Nigerian workers across the sectors. All citizens registered as employed are eligible to enjoy of the services from the Ministry.

With regard to maize processing, flour dust exposure can be hazardous and might give rise to respiratory, nasal and eye problems. There is no data available to evidence the specific risk to flour mill workers directly involved in production functions in maize flour milling[26]. It is likely that several socio-demographic (age, sex, education and income), behavioral (smoking, chewing tobacco) and work-related factors such as work experience, working hours per day, methods used for cleaning, mixing, packaging and loading (manual versus automated), use of protective gear/ clothing would have a bearing on the prevalence of chronic respiratory problems.

The team did not get a chance to assess if Nigerian mill owners are taking specific actions to reduce and/or control workers' dust exposure.

Job attractiveness – based on remuneration received

On average, the monthly cost of living for an individual in Nigeria amounted to 43,200 Nigerian Naira (approximately 111 USD), and around 137,000 Naira for a household (=380 USD). In 2020, the minimum wage in Nigeria reached 30,000 Naira. The average smallholder household consists of more than 6 household members. Only 13 percent of the smallholder farm households are female headed. On average, 55 percent of a Nigerian farmer's annual gross income comes from agricultural activities, among which crop production accounts for 49 percent plus around 6 percent from livestock keeping[27]. Maize is one of the five major crops grown – the others being cassava, yams, beans and millet.

Comparing maize-based incomes to benchmarks such as the national poverty line can be informative with regards to how inclusive the value chain is and its economic potential. For instance, as reported in Section 4.2.1, average annual income earned by SHF1 producers is about N68,000 ($190), indicating that the income these maize farmers obtain is only about 50 percent of the national poverty line. This may suggest that these farmers are very poor if account is not taken of the fact that they cultivate a wide range of crops as mentioned above. Downstream VC actors namely owners of medium and industrial processing enterprises and also aggregators /wholesalers and retailers are better-placed in terms of average earnings.

[26] Came across only one study for wheat flour mill workers: Ijadunola, K.T. et.al. (2004) Prevalence of respiratory symptoms among wheat flour mill workers in Ibadan, Nigeria. American Journal of Industrial medicine. 45:251-259.

[27] Source: FAO. 2018. Smallholders data portrait (available at www.fao.org/family-farming/data-sources/dataportrait/farm-size/en).

The conditions in the maize milling and trading are potentially attractive to youth (boys and girls) as higher-income earning opportunities.

Striking differences in daily wages for male and female labourers across states

The national minimum monthly wage for federal workers increased from 18,000 Naira (43.7 USD) in 2018 to 30,000 Naira (83 USD) in 2019, and has remained the same in 2020 and 2021. The national minimum wage is not applicable to workers in seasonal employment such as agriculture hence there is no compliance regulation by the Labour inspectorate. The households that participate in agriculture wage labour (43.6%) in upstream production activities such as planting/rearing, weeding/nurturing and harvesting are generally non-paid family labour or paid labour.

Wage rates are determined by the labourer and employer and there is not pre-set criteria to determine the minimum wage. Working conditions vary between actors. Workers who are involved in small-scale operations generally have sub-par working conditions. Facilities and equipment used are often below the requirements for standard working environments. Wages are also relatively low for most small and medium scale actors. The wage varies by the activity undertaken. In the North, 500-1300 naira per day and 1500-3000 naira per man-day in the South. While large scale processors earn the best incomes from the maize VC, the producers and retailers get the lowest returns. Processors and aggregators are likely to earn reasonable incomes from the maize VC. Women are largely involved in artisanal maize processing which contributes to almost 80% of their income source.

Working conditions per category

There are no uniform working conditions across the states. Farm/plant workers from different farms/plants experience varying working conditions. Wages for skilled labour are generally higher including other benefits. This indicates better working conditions compared to the unskilled labour, irrespective of gender.

Working conditions vary depending on the status of the company and of the worker. Generally, processors tend to enjoy better working conditions in manufacturing than other value chain actors because of the skilled nature of work required for the machinery operation and maintenance. It is worthy to note for small scale and about 50% of medium scale operations, working conditions across the categories are unfavorable.

Category	Wages	Work hours per day
SHF1	1000-2000	10
SHF2	1000-2000	10
MHF	1200-2500	8
LCF	1500-3500	8

TABLE 11: DAILY WAGES PER FARMER CATEGORY

Respect for labour rights in the maize value chain

Labour rights for all actors in the maize value chain are similar to those in other sub-sectors. Workers in large scale processing factories are registered with labour unions. Small scale value chain actors have organised associations that operate as umbrella bodies to present their collective interest.

Respect for labour rights						
VC actor	**Number of owners/ workers(*)**	**Respect of conventions**	**Freedom of association**	**Enforceable contracts**	**# forced labour**	**Risk of discrimination**
Farmers						
SHF	1-3	Unlikely	Free	Unlikely	Nil	Yes
MHF	4-10	Likely	Free	Likely	Nil	Not really
LCF	>10	Yes	Free	Likely	Nil	Sometimes
Processors						
SCP	1-3	Unlikely	Free	Unlikely	Nil	Yes
MCP	4-7	Likely	Free	Likely	Nil	Not really
LSP	8-20	Yes	Free	Likely	Nil	Sometimes
Aggregators	1-3					
	4-10	Unlikely	Free	Unlikely	Nil	Yes
	>10	Likely	Free	Likely	Nil	Not really
		Yes	Free	Likely	Nil	Sometimes

TABLE 12: RESPECT FOR LABOUR RIGHTS PER VC ACTOR

5.2.2 Land and water rights

Socially acceptability and sustainability of land and water rights are analysed in terms of responsible governance according to the UN Land Regimes. Are land and water rights socially acceptable and sustainable? This is the key guiding question of this section. The theme is divided into three sub-themes, namely: (i) Accession to the Voluntary Guidelines for the Responsible Governance of the UN Land Regimes (2012)29, (ii) Transparency, participation and consultation, and (iii) Equity, compensation and justice.

All urban land within a state is vested in the State Governor whereas all non-urban land is vested in the Local Government Authorities (LGA) in which they are located.

Multiple laws govern land administration in Nigeria, and vary from state to state. Traditional land holding and tenure systems in Nigeria are governed by two main legislations, namely the Land Tenure Law of Northern Nigeria 1962 and the Land Use Act 1978. The State Governors and LGAs are empowered by the Land Use Act 1978 to grant "statutory rights of occupancy". Statutory rights of occupancy are typically granted for 99 years, the maximum period stipulated by the Act, and may be renewed. *In rural areas, occupancy rights are granted for 50 years which may be renewed for another 50 years.* Land use and allocation committees

are responsible for land registration and administration, and advise the decision-makers on land allocation or revocation.

Land in the main maize growing areas in northern Nigeria were earlier governed under the Land Tenure Law of Northern Nigeria 1962 that stipulated that the (State) minister was responsible for land matters and allocation of land to natives of Northern Nigeria. This provided the natives the right to own land for a limited number of years. They could sell, mortgage, transfer the land subject to the minister's approval. Eventually the Land Tenure Law 1962 was repealed, and the Land Use Act 1978 was constituted. The latter vested exclusive powers over ownership of land in the territory of any given State in the hands of the Governors of the State, and LGAs within the state. At present the land system is characterised by several actors including government, community leaders, families/ clans, lawyers, brokers and estate agents among others.

Land tenure is governed by customary law, and transactions in the land market are largely informal. Land tenure systems are primarily governed by inheritance and with temporary arrangements made through rentals**. Land tenure system in Nigeria does not promote smallholder farmer's welfare as no farmer had formal title to their lands. This makes it difficult to have sufficient access to credit facilities. (**Tijani *et al*., 2014). High degree of land fragmentation has a negative effect on farm productivity. It increases both travelling time and cost of traveling between plots, hence lower labour productivity and raises the transport cost for inputs and outputs. These reduce overall productivity of the farm. This therefore depicts the need for urgent land reform policies and programmes that would give farmers access to more contiguous land holdings for increased agricultural production. In particular, there is the need for review of the land use decree to grant genuine farmers access to contiguous land holdings. (Iheke and Amaechi, 2015).

According to a study conducted in 2019, renters paid rents between 12 000 N per hectare per year (Oluwatayo, I.B.et.al.,2019). This arrangement varies by relationship, duration of usage and customary conditions.

Land title registration procedures are lengthy and cumbersome, and it takes several days. Hence. most agreements are verbal, binding and honored by both parties. Conflict usually results in landlords taking over the land. The Land Use act of 1978 implies that households with land do not have legal rights to the land in their custody. As communal land allocation is seldom documented, boundaries defining farm plots are uncertain and lead to conflicts. Availability of land has a direct bearing on food and livelihood security –due to inadequate access to land, farming remains at subsistence level. As titles to most lands are not clear, farmers are unable to present lands as collateral and access loans from formal financial institutions.

Customary land is allocated by the village chiefs (chieftaincy/emirate) who also demarcate communal lands for fishing, grazing etc. Usage of such land is free for all, with differential

access to certain plots or resources including harvesting rights, access for grazing, time of use based on special requests to the customary authority. Outsiders such as migrant labourers or pastoralists do not share the same rights. Such groups are eligible to rent land allocated by the village chief on payment of agreed tribute.

Adherence to the Voluntary Guidelines for Responsible Governance of Tenure (VGGT)

Voluntary Guidelines on the Responsible Governance of Tenure (VGGT) is to provide guidance to improve the governance of tenure of land, fisheries and forests with "the overarching goal of achieving food security for all and to support the progressive realization of the right to adequate food in the context of national food security". Adherence to VGGT is analysed in terms of position of smallholders and land acquisition. Nigeria endorsed the VGGT in 2012 (Tagliarino et.al., 2018[28]). In collaboration with the Africa Land Policy Initiative, the Federal Ministry of Works, Power and Housing (that houses the National VGGT Secretariat), and several state ministries for land agriculture, rural development, environment, and natural resources, as part of a project (2015-2016) FAO supported three states – Katsina, Kebbi and Anambra –to implement the VGGT guidelines. FAO provided IT equipment and developed an open-source cadastre and software to map grazing areas and forest reserves and support the registration process. The project established a multi-stakeholder platform with particular emphasis on harmonizing legislation with the management of pastoral lands. *No identified VGGT violations were found in available documentation.*

Transparency, participation and consultation

In the context of food and livelihood security, there are gender, location and income-group considerations in the allocation of land, where customary land rights do not confer women the right to use, control or transfer land (Kenneth, 2010). In almost all states in northern Nigeria, men own more land compared to women, and inherit it from their families. In all states women have user rights, and in the majority of cases they have customary rights to their land. For those few of the land owners who have title deeds, the land is in the name of the man. In some cases, both husband and wife are given a piece of land in their marriage, and each is responsible for his/her own plot. The wife and the husband have both customary rights and user rights to the land; in addition, the land assigned to the husband has a title deed in his name, and the land assigned to the wife has a title deed in her name. With regard to who makes decisions about how much land was allocated to growing maize, women reported that men the decisions on how much land should be allocated, but the men reported that decisions were made jointly.

Inheritance laws and population increase have resulted in fragmentation and reduction in size of farms. This has rendered mechanization impractical and affected their commercial viability. Farmers are not permitted to sell portions of land acquired through communal ownership therefore majority of farmers cannot acquire land and expand their farms to improve their production, either.

[28]https://landportal.org/library/resources/compensation-expropriated-community-farmland-nigeria

Equity, compensation and Justice

The system of compensation for land leases in based on informal agreements between the leaser and lease. Cash payments are preferred and agreed as a means to validate lease contracts. Down payments are often challenging for smallholder farmers, hence, maize produce is used as compensation for the leased land. The hold-up problems in the tenure arrangements makes the adoption and practice of integrated soil management difficult. This has serious environmental implications. Also, delayed payments of compensation for compulsory acquired lands by the state have been cited as a major cause of land litigation and inadequate security of tenure in the country. The team did not come across such cases related to the Maize VC. The main issues related to land in the Maize VC in Nigeria are with regard to: a) the traditional system of land ownership and b) exclusion of women.

5.2.3 Gender equality

Gender equality is analysed in terms of acknowledgement, acceptance and enhancement of the position of women in the Maize value chain. Is gender equality throughout the VC acknowledged, accepted and enhanced? This is the key guiding question of this section. The theme is divided into five sub-themes: economic activities, access to resources and services, decision making, leadership and strengthening the status of women, and heaviness of work and distribution of work.

Indicators of gender equality stated in Nigeria's gender policy document

In the year 2000, Nigeria adopted and passed the National Policy on Women that inter alia sought to 'integrate women fully into national development in order to remove gender inequalities that evolved through structures and processes created by patriarchy, colonialism and capitalism." The focus of the policy was the pursuance of legal equality for women and men and the removal of all obstacles to the social, economic and political empowerment of women. Subsequently under the leadership of the Federal Ministry of Women Affairs and Social Development, the government developed a Strategic Results Framework to enable the successful implementation of the core principles of the National Gender Policy.

In the maize farmers survey conducted by the team, 47 out of 211 farmers were women farmers of which 8 are large scale farmers with land holdings >10ha , and 10 medium scale farmers (5-10 hectares); 43 out of 47 women farmers own their lands and/or also rent land via certificates or customary allocation.

Participation of women in the maize value chain

Maize value chains involves several actors in different roles from pre-production (input suppliers, agro dealers) to production to post harvest handling, storage, buying and selling dry grains to traders or directly in markets or taking to local processors to grind into flour for home consumption and/or for sale at local and distant markets, and also direct sale to consumers for fresh consumption locally. In northern Nigeria, most agro dealers and their employees were men as they needed strength to lift bags and/or move stuff. Women on the

other hand were assigned light activities such as managing cash and handling product registration – activities that need more attention. Women participating in the value chain as entrepreneurs often face the difficulties in trying to grow maize businesses. This is partly related to a lack of business acumen and experience, but a primary reason is limited personal mobility. Similar to men traders, women maize traders also bought maize directly from farmers including their husbands in the villages, local markets and from other buyers and traders. However, majority of the buyers and traders bringing produce to the market is still men. Women repeatedly stated that it was hard to earn significant money from sale of the processed maize products they made in local markets, it was also very difficult for them to enter large markets selling unprocessed, improved maize. In Kaduna, women lamented that though the local market is not large enough to accommodate their maize processing and other agri-business ventures, they are not permitted travel to distant markets where 'there are always people ready to buy'. Sometimes family responsibilities also come in the way of women travelling to distant markets to procure maize available at lower prices. Limited mobility also hinders scouting (cheaper) maize suppliers beyond their village boundaries; there is more competition in town markets and they might not get enough quantities. Therefore, women have difficulties expanding their businesses.

Hardship and physical labour

Both men and women traders face financial challenges related to managing working capital for their businesses. They also have constraints related to adequate and suitable storage facilities and store their products in their houses. Very few maize farmers own their own vehicle, and have to rely on private transportation to carry their produce from one market to another, and are charged per bag. Labour is needed mostly for activities such as lifting, loading and unloading bags of maize that require physical strength. Sometimes trading might also require overnight stays in other locations. Cultural norms make the latter difficult for women. Women traders face several obstacles – cannot buy large quantities of maize at a time and/or hire labour due to limited working capital. and also have to hire men (labour) for packing, loading, unloading the bags- many men traders do not incur these costs as they handle these tasks themselves.

Medium and large scale buyers and processors involved in milling, packaging and marketing flour and other products are also maize buyers. They buy maize either directly from farmers, farmer-traders and/ or through commission agents mostly around harvest time. Processing companies hire both men and women as agents, and train them to set up buying points. They prefer to hire more men due to the (physical) nature of the work. Also it is easy for the men agents to stay in villages until they procure sufficient quantities of maize, and also travel on the company's trucks to transport the maize to the processing plants – social norms do not allow women to do this. Moreover, most of the activities in the processing plants are done by machines and workers need necessary skills to measure and pack the products, repair and maintain the machines, move produce from the store, clean, lift, load-unload maize or flour bags. All these activities are physically demanding and require strength hence are difficult for women to perform.

Small-scale processors – local millers who stand in local markets with small milling machines and cater to local households who grind maize for home consumptions – consist mostly of young men (and in some rare cases, women). These processors also face challenges related to power supply, price of fuel to operate generators, competition with other millers and/or readymade flours, taxes and license fees to rent space in local markets. These are mostly family-run businesses with young men providing the necessary labour. Owing to the physical nature of the tasks involved, and the timings (7am to 6pm depending on the quantum of work) men are preferred to run such businesses.

Division of labour

Seed storage dominated by women, although men also took part in this activity especially pertaining to improved seed. **Land preparation and planning** is done by the family i.e. both men and women together, and task division is almost equal (45:31). **Disease control and pest management** is mainly men's activity – women are excluded because chemicals are considered dangerous, and if women were involved it could affect their reproductive health. In some villages, however, spraying is carried out by (adult) women. **Weeding, harvesting and threshing activities are** mostly done by all members in the household irrespective of gender, and/or with hired labour. **Maize storage at household level** is the responsibility of women, men are involved in building or renting storage facilities whereas women assist in managing and controlling the stored produce. Children are also involved in storage. However, hired labour is categorically not involved. **Transportation** is handled by both men and women, whereas **marketing** is done independently by either or together. Hired labour is not involved at all. Maize is mostly sold at farm gate, local markets, the nearest sale point for agents of big processors and traders from distant markets. Main buyers are intermediaries (agents), local and outside traders, consumers and some medium and large-scale processors who buy directly from farmers. In most cases it is the man who negotiates prices at the point of sale, because "they have the skills (to negotiate) and knowledge to understand the economics as compared to women." When it comes to distant markets, it is mostly men or (boy) children who tend to participate as cultural norms restrict women's mobility. Some women however have been trading with large volumes and take their maize to more profitable markets beyond local markets. Literacy can also come in the way of women dealing with markets as larger markets use weighing scales and they might not be able to read them. Additionally, men can carry bigger loads on their motorcycles or carts compared to women who can only carry headloads. Women involved in trading hire private transportation. **Cooking/ food preparation** is traditionally in the women's domain as they have been trained from childhood to carry out those activities.

Access to resources and services

Both men and women use their own recycled seed saved from the previous season. In many cases maize seed is obtained from other farmers in exchange for labour; other sources include gift and purchased (improved) seed from agro-dealers, retailers, seed companies or seed-producer farmers. In many cases, women were the ones who went to buy maize seed

because men might spend the money on other things. If seed was not available in local markets, farmers were forced to travel to town which also involved transportation costs – in such cases, both men and moreso women did not have the disposable cash to pay for transport.
With regard to choice of specific varieties, women preferred easily-pounded and early-maturing varieties suitable for consumption, while men preferred maize with big cobs and sufficient grain that would fetch a good price when sold in distant markets. Seed breeders also reported that women preferred varieties with higher yields with limited inputs and suited to their own farm conditions, and also those with good keeping quality.

Financial Inclusion
Men and women producers access finance through banks (commercial banks & non-interest banks), other formal sources (insurance companies, capital markets, microfinance banks, pension schemes or shares, remittance through other formal channels), and informal sources (microfinance institutions, ajo/money lenders, esusu, savings). The reach of banking and other formal (non-bank) financial services in the rural areas is limited. Rates of financial exclusion are high among women, youth, people residing in rural areas, and farmers. Although women are significantly more excluded than men, many are economically active, with reports showing that their primary source of income is their own business.

As regulators, but also as a coordinating and liaison office for all financial inclusion stakeholders in Nigeria, CBN, through its Financial Inclusion Secretariat (FIS), is always on the lookout for stakeholders that can further accelerate the inclusion of women. The Central Bank, in turn, enacts policies and partners with stakeholders to develop products and continuously facilitates an environment for recommendations from stakeholders. In the drive towards ensuring that more women are financially included in Nigeria, CBN has championed major activities and products tailored to accelerate women's financial inclusion. Standout examples include the establishment of the MSME Development Fund (MSMEDF) and the inauguration of the National Financial Inclusion Special Interventions Working Group (NFISIWG). The MSMEDF is a N 220 billion (approximately USD 717 million) intervention fund set up by CBN that takes into consideration the unique challenges faced by women in accessing credit and has earmarked 60 percent of funds (N 132 billion, or roughly USD 430 million) for women. Funds are distributed directly to beneficiaries via participating financial institutions.

Collateral security increases chances of obtaining loans from financial institutions, especially banks. This does not discriminate gender but rather focuses on credit worthiness and collateral to back up ability of the applicant. These requirements often relegate smallholder farmers from the process. For non-institutional/informal sources of acquiring funds, such as moneylenders, traders and commission agents, relatives and landlords etc., culture then plays a significant role that can affect female farmers accessing finances. Generally, in the south, the ability to payback and status in society earns you access to acquiring the finances

needed irrespective of gender. There are actually women groups that empower themselves through savings systems and lend to each other.

Decision-making

Typically, in the maize producing areas in northern Nigeria, ethnicity and religion play major roles in determining women's decision-making authority. Other predominant factors that determine women's intra-household decision authority include; education, employment status and husband's educational attainment. Although many Nigerian women lack the economic power to fully participate in decision-making, as men's resources are increasingly becoming inadequate for household needs due to the recent economic decline, women's contribution has been increasing. This in turn has been found to significantly increase women's authority. Marital status also influences decision-making within households – while married women can easily make decisions pertaining to the home, their role in decisions related to selecting crops to cultivate, retaining or selling farm outputs, when to sell, how much to sell, use of income gained from sale of produce etc. is limited.

With regard to decisions on the quantity of maize to be sold or consumed, 62% of the respondents said that they were mostly made by men irrespective of the size of the farm whereas 26% reported 'jointly by both husband and wife' and 12% responded that the decisions were made by women/ wife.

Leadership and Empowerment

In the survey conducted by the team, almost one-third of the women farmers (43 out of 194) stated that they were members of some farmer organisation, but very few elaborated on the benefits of being member – only 10 women farmers mentioned benefits such as access to credit, input supply, training and extension support, and infrastructure support as benefits of being cooperative member in the current year. It was interesting to note that some women farmers stated that in order to become members they needed to be high status ladies and maize farmers, owning larger farm land, possess some form of document identifying them as a farmer (national ID card or passport), and have resources to pay the registration fees. None of the women farmers who participated in the survey were role-holders or held any leadership positions in any produce organisation.

Studies indicate that women typically have limited access to informal political space (Famworth, et.al. 2013). membership granting women full and equal participation in (running) producer groups and/or organisations contributes to gender equality. When women participate as role-holders as well as members, they can express their own needs and interests since the decisions they normally make better reflects their thoughts.

Experience elsewhere suggests that women aggregators/traders generally lack reliable value chain relationships that endure over the long term, with relation to both suppliers and buyers. This could be ascribed to their weak capital base – which in turn may be attributed to their lack of disposable cash in hand after spending their meagre incomes for household

needs. Women traders are trapped in a vicious circle, whereby they never build up sufficient working capital to buy maize in order to meet the needs of large buyers, nor are they able to build up investment capital. Due to the perceived financial weaknesses of women actors, both suppliers and buyers tend to prefer male aggregator/traders as value chain partners. Moreover, cultural norms like the 'purdah'[29] system prevalent in northern Nigeria disempower women further by not allowing them to take and sell their products themselves for the best price, and secure quality inputs in markets. And even if not restricted culturally, women are placed at a disadvantage as they are less likely to own for transportation and/or pay for loading/unloading – something that men can provide for themselves. Some women do overcome these constraints and become "market queens" (Clark, 2018) and also take on and groom younger ambitious women, but such women are the exception rather than the rule.

5.2.4 Food and nutrition security

Food and nutrition security is analysed in terms of availability, accessibility, utilisation and nutritional adequacy and stability. Are food and nutrition conditions acceptable and secure? This is the key guiding question of this section. The theme is divided into four sub-themes as defined by availability of food, accessibility to food, appropriate use of food, stability in time of availability, access and use of food.

FNS indicators and availability of food

Food security is a major issue in Nigeria. According to FAO Stat, out of Nigeria's 195.8 million citizens (2018) at least 29.4 million Nigerians were severely undernourished, and the number of severely food insecure people in 2018-2020 (3-year average) was 43 million i.e. around 21% of the total population. Percentage of population using safely managed drinking water is 21.3%, and safely managed sanitation services 29.9%, basic sanitation 41.8%. Per capita food supply variability 6 kcal/cap/day.

Children in the northern zones (North Central, North East, and North West) consume fewer foods rich in vitamin A and iron than those in the southern zones (South East, South South, and South West). Prevalence of stunting has remained the most severe form of malnutrition followed by under-five mortality rate and wasting. Most states in northern Nigeria, which are also the major maize producing states, are affected by stunting and wasting. According to the Nigeria DHS 2018, 37% of children under-five years are stunted, 7% wasted, and 22% underweight. The proportion of stunted children is the highest (57%) in the north western states -Sokoto, Zamfara, Kebbi, Kaduna, Katsina, Kano and Jigawa- and suffer from severe acute malnutrition (SAM) with Weight-for-height scores (WHZ) below minus 3, and are considered severely wasted. The most common foods given to children aged 6 to 23 months are foods made from grains some containing maize pap or maize porridge (pate). The most

[29] The purdah system is a viable institution of social exclusion among Muslim populations whereby a woman is allowed to see only her biological sons, brothers, uncle and husband, or any other relation in position of trust. She cannot even go to mosque to pray and must wear veil if she must go outside the house.

commonly used weaning foods in this zone are cereal-based (millets, maize, guinea corn) with very low protein and micro-nutrient content. Moreover the conditions in which these foods are prepared and stored also increase the risk of contamination. The prevalence of severe anaemia is highest in the North West and North East (4% each) and lowest in the South West (1%). By state, Zamfara has the highest prevalence (10%).

In general increasing farm output level increases food security status of arable farmers. While maize output has had a positive relationship with food security status of the maize farming households, the effect is very minimal. Therefore, increasing the maize output will not necessarily improve the food security status of maize farming households. Farm size has also had a positive influence on the food security status of maize-based farming households whereby the odds ratio and the marginal effect in favour of food security increased by the factor 0.834 and 0.028 units respectively when the area under cultivation was increased by one hectare. This is in consonance with the findings of Chepkirui et al., (2014) and Tefera and Tefera (2014) that farm size allocated to food crops had positive effect on food security among small-scale farmers in Kenya and Ethiopia respectively.

Availability of food

The low level of agricultural productivity often leads to less availability of food, which in turn results in less consumption of food with adverse consequences on malnutrition. Bridging productivity gaps combined with uptake is expected to have positive impact on food availability, dietary diversity, and micronutrient intake.

The average consumption per year reported in the survey, varies per state with higher volumes in the maize producing states. Kaduna farmers reported an average consumption of 13, 597 kilos per year followed by Katsina at 7259 kilos per year. Enugu average was 129 kilos per year. Almost 50% of the farmers (153 out of 211) in the survey stated that they do not (need to) purchase maize for consumption. Around 26% of the farmers surveyed reported an increase in the price of maize over the past five years. Nonetheless the survey also reported an average spending on buying maize ranging from 5500 naira in Delta state to 36,091 naira in Katsina state.

Contribution of maize to daily diets

Maize grain accounts for about 15 to 56% of the total daily calories in diets of people in about 25 developing countries, particularly in Africa (Prasanna et al., 2001). Grain colour is an important selection criterion. For human consumption, white is preferred whilst yellow maize

Dietary Diversity Scores (DDS) vary across the maize producing states. Using a 14 food-group model and a 24-hour recall, an assessment (Sanusi, R.A., 2010) indicated a mean DDS of 5.81, ranging from 6.61 in Akwa-Ibom state to 4.98 in Kaduna. Overall 83% of the participants had average/medium DDS (5-9) while 16.5% had low (1-4) DDS. These varied significantly among the states. Low DDS (1-4) was 25% and 33% in the states in the dry Savanna zone but 12.8% and 10% in the states in moist Savanna zone and 6.4 and 6.2 in humid forest.

is mainly used in the poultry industry. This has made promotion of biofortified vitamin A maize (VAM) rather difficult in Nigeria.

TABLE 13: LOCAL MAIZE PREPARATIONS CONSUMED

Whole grain foods	**Cooking, steaming, roasting**	• **Adalu - beans and corn recipe of the Igbos,** • **Egbo – cornmeal – Oyo state** • **Green maize** • **Popcorn –across the country**
Wet-ground maize foods	Wet grinding, steaming	• Sapala -Yoruba moimoi, • Abari moi - Delta state
Bread and snacks	Fermentation, baking, frying, roasted	• Masa – northern Nigeria (Hausa) • Donkwa/ Dodonkwa/ Tanfiri – cornmeal and peanuts – northern Nigeria
Sourdough and dumplings	Soaking, fermentation, steaming and cooking	• Ogi- local custard/ pap among Yoruba- breakfast dish • Dokunu- Ghanian food popular in Nigeria • Banku –fermented corn and cassava dough –similar to fufu (pounded yam)
Porridges	Non-fermented – milling, cooking	• Tuwo massara • Tombrown – • Pap –Akamu (Igbo)- breakfast food also used as weaning food
Beverages	Non-alcoholic- milling, soaking, cooking	• Kunun zaki – northern Nigeria • Obiolor (fermented millet)- Igala tribe Kogi state
	Alcoholic – germination, fermentation	• Pito – with sorghum - • Burukutu

Maize is consumed in numerous forms as industrial raw material in making livestock feed, starch, sweeteners, oil, beverages, glue, industrial alcohol, and fuel ethanol. Solely or together with other cereals, it is a primary component of local food preparations which contributes to caloric intake and total food demand among households in Nigeria (Muhammad-Lawal and Omotesho, 2008). In the rainforest and the savannah agro-ecological zones of Nigeria, maize is a majorly a cultivated cereal crop that provides diet for many people (Onasanya and Obayelu 2016).In most northern Nigerian households, maize is consumed in the form of Tuwo massara (Nigerian fufu)– cooked corn meal, eaten with soup or stew made out of vegetables (okra, baobab, melon) and/or goat meat. The southern equivalent of Tuwo massara is Tuwo agbado (corn flour swallow) in Yoruba. Boilded or roasted fresh corn is also a popular snack in the south. Local corn porridge – pap – is also a popular breakfast food. Tuwo massara is considered healthy as it is good for the eyes, cures constipation, reduces acidity., and boosts immunity among other benefits. It is considered a better substitute for cassava gari (Eba).

In the survey conducted by the team, flour and flour grits were reported as the most common form in which maize is consumed. This was followed by wholemeal, fresh corn on the cob, and popcorn.

Around 30% of total production in south (3 milllion tons) is consumed fresh, whereas in the north that could be as low as 7% of the total 9.3 million. Household consumption by farmers in around 14.99% of the total, either pounded in the house or in local grinding mills. When pounded in the house, less goes into the bran- in commercial milling 80% is retained as flour, and 20% is kept as bran and sold to poultry feed makers. High quality protein is likely to be lost in the bran. (Poor HH cannot afford chicken or eggs so it is not contributing to nutrition security – so it contributes to food security but not nutrition security; more than 90% cannot afford nutritious food).

Food-Non-food use of maize – 60% of the total maize grain produced goes to the feed sector based on grain; of the 2.9 million tons going to the food/ industrial grain market – 25% is utilised by breweries, 15% consumed locally in homes and remaining to flour mills; around 20% of the total is sold to poultry feed mills (bran)[30]. Breweries utilise only approximately 50,000 tons- and only 77 to 80% of the grain, rest is bran.

Food shortages

According to the farmer survey, the most common reasons for periodic food shortages are crop failure, unstable market prices – due to poor government policies, and large size of households. As coping with maize shortages, farmers mentioned "stocking up when the maize is cheaper" as the most common solution. Some others resort to consuming a low-quality substitute (low quality maize or another cereal). Other coping mechanisms mentioned in the survey include – borrowing money to buy stock up maize, relying on relatives and friends to fulfil requirement/ deficit, processing and storing as products with higher shelf life, reducing consumption, and borrowing grain/ food.

Nutritive value of maize

Maize is a cereal crop with high nutritional value. It is rich in carbohydrates – starch and dietary fibre, and valuable protein and micronutrients (Vitamins B and C, and beta-carotene; minerals-phosphorus, magnesium, zinc, copper, iron and selenium). The nutritional content varies per variety – sweet corn has more sugar whereas the darker yellow varieties have more carotenoids (pro-Vitamin A).

Accessibility of food

A recent study (Ogunniyi, et.al., 2021) on socio-economic drivers of food security among maize producing households in rural Nigeria (Ogun state) indicates that the quantity of maize output favours food security among the households. Food insecurity is higher among female-households than the male-headed counterparts. Larger households and maize farmers that operate on less than 5 hectares had a higher incidence of food insecurity. While access to information about improved maize variety favoured food security by reducing the probability of being food insecure by 12.9% points, the same had a higher impact on female headed

[30] https://babbangona.com/maize-farming-in-nigeria-exciting-facts-you-should-know/

households where the probability was reduced by 98.5% points. The study suggests that, among others, value of output sold, education, credit access and participation in government safety nets program significantly influenced food security among the maize farmers in the study area.

Contribution of aflatoxin contamination to food and nutrition insecurity

Increased consumption of processed foods with thrust on domestically produced processed foods has created economic opportunities for domestic producers and traders. However, food safety and nutrition is a concern. Maize is not only consumed fresh, boiled/roasted or in a low level processed form as flour or pap or Ogi but is also poses challenges as a key ingredient in animal feed (to serve rapidly growing livestock sub sectors) and those associated with increasing consumption of more commercially processed maize products such as cereals (cornflakes, golden morn etc).

In a study conducted in 2 Nigerian cities (Ibadan, South West Nigeria and Kaduna, North West Nigeria) Liverpool-Tasie et al. (2017b) found that domestically produced maize products dominate in retail volume terms across retail outlets in Nigeria. These retail outlets include independent supermarkets, grocery stores and non-services stores. In wet markets (where majority of shopping is conducted by the average Nigerian) the share of domestically produced maize based products is much higher accounting for over 80% of the volume of maize based products in both cities. Consequently, safety and quality of these products is an imperative.

Studies have reported high levels of aflatoxins in maize products available in domestic markets – namely in a locally processed and packaged maize meal (Ogi), a locally produced custard produced using imported corn starch, and a locally produced cereal product from a multinational food and beverage company. While the mycotoxins detected in the locally produced custard and the cereal from the international beverage company were below limit of detection (i.e. less than 2ppb), the locally produced Ogi had a high level of aflatoxin B1 of 15ppb – which could be attributed to the high levels of contamination of the maize grain and/or inefficient processing in terms of the fermentation process.

Regulation of aflatoxin levels is largely non-existent. Most maize based products get into the open market without being tested. In cases where 4 subsistence farming is practiced, farmers produce and consume maize without testing for aflatoxin. The regulation of the product is essentially non-existent. According to field research carried out by (Abt Associates Incorporates, 2013), farmers revealed that there was no evidence of testing for aflatoxin in maize before consumption or sales. Prevalent practice in some markets is that farmers voluntarily separate mouldy from clean grains while traders/sellers wash, sun dry and re-bag any maize grains that appear mouldy. In a country as food insecure and populous as Nigeria, crops are rarely discarded. When contaminated crops are rejected by one player, another poorer market base is ready to buy and use the crop at a lower cost.

Potential of maize to stabilise food shortages and/or household income

Maize is produced mainly by smallholder farmers. Maize farmers in the northern region, that produces the largest volumes, who practice inter-cropping with yam and cowpea, or cassava and cowpea, or with sweet potato or sorghum. The crops are mostly rainfed, and the main season is May to October in the north, followed by a second season from August to January. Seasonality has its bearing on consumption patterns and food security. Maize is an important component of poultry feeds however in recent times, the ban on importation of maize has created severe shortages in supply of maize to the poultry industry. The ban has not only affected the livelihoods of poultry farmers but also maize farmers who suffer from low productivity, loss of crop due to disease and/or are unable to get an assured market and price for their produce.

5.2.5 Social capital

Do formal and informal farmer organisations/cooperatives participate in the value chain? How inclusive is group/cooperative membership? Do groups have representative and accountable leadership? And are farmer groups, cooperatives and associations able to negotiate input or output markets? Is social capital enhanced and equitably distributed throughout the VC. These are the key guiding questions of this section. The theme is divided into three sub-themes: performance of producer organizations, access to information and trust between agents of the chain, and social commitment of the populations.

Myriad farmer organisations, professional associations and groups
There are several farmers' organisations, ranging from commodity-specific cooperatives to organisations with a general scope on agricultural sector issues. There are networks that operate locally and umbrella organisations, large federations with provincial and national chapters, as well as those which are women-specific in terms of membership. At the local level, producer organisations (FPOs) help to access to input and output markets, and information, but not much collaboration was seen in produce marketing.

Most associations are dominated by men, reflecting prevailing social and business norms. Revenue comes primarily from membership fees. None of the associations met with had annual dues or received any direct assistance from donors (except WOFAN that operates like a development NGO). Several of the associations the team met with are members of national level umbrella organizations.

Market level commodity associations are mostly led by "market queens" or "sarkin kaswa" - chosen for customary/personal leadership qualities and also for financial resources, as they need to devote time to carrying out their duties. They can influence supply by limiting market access to members, apparently with the collusion of the market authorities.

Services offered to the members – benefits to maize farmers
Based on the farmer survey conducted by the team, out of 211 farmers, 156 (34 female) reported being members of farmer organisations consisting of state level organisations – Ebonyi State,

Enechi cooperative, Kari association, Ofobi Union, Ubulu-uku, Yabanya), regional (Northern Agricultural Farmers' Association), national level producer associations (AFAN, MAGPAN), multi-purpose cooperative associations (Market Garden, Nagarta Funtua, Goodwill, God's Grace, Unguwar, and maize farmers associations like MAAN. Membership fees range from 100 naira to 5000 naira per year. Some farmers reported that they did not have to pay any registration fees. With regard to benefits of the membership, 32.7% of the farmers including female farmers reported 'source of information' as an important benefit. Other benefits of being member included opportunity to interact with other farmers and/or participate in development programmes, buying inputs in bulk, better market access and access to credit. Furthermore of the 211 farmers interviewed, around 31 farmers mentioned that they were not members of any association and/or did not receive any benefits from their membership.

Inclusiveness of the associations

Most small and medium processors operate individually and rely on personal relationships of trust developed with customers over long periods. Women small scale traders and processors have limited capital and negotiating power in relation to the large scale (male) traders; there might be few informal groups, especially of women traders and processors, formed by NGOs to promote collective production and marketing. Not clear if/how associations like WOFAN and WIN address this.

Discussions with association role-holders indicated that membership of most organisations/ associations appeared to be based on self-selection by those who have the necessary resources to participate (e.g. large farms/ high production) or to develop the resources (e.g. own warehouses or trucks). Thus, it is likely that membership in practice excludes the smallest farmers.

Information and confidence

Most smallholder maize farmers in Nigeria grow maize for food, feed and income mostly in rainfed conditions. With climate change, they are exposed to significant risks of production and income failure.

The farmers survey revealed that most female smallholder farmers rely on their neighbouring farmers for information about different inputs such as seeds/ varieties, fertilizers/ their usage, and land preparation and management techniques – the proportion of male farmers depending on their neighbouring farmers was almost equal for all types of farmers. Table 14 *below presents other main sources of information.*

Sources of information	Total respondents	female	male
Extension agents	106	19	87
Neighboring farmers	151	36	115
Agrodealers	66	16	50
Internet	20	4	16

Mass media-radio, TV etc.	71	5	66

TABLE 14 : MAIN SOURCES OF INFORMATION ACCESSED BY FARMERS
(Source: farmers survey conducted by team)

In addition to the above, farmers also included family and relatives, and the cooperative as other sources of information about inputs.

Smallholders rely on the large-scale farmers for price information, and as aggregators is also responsible for setting the price with off-takers/ commission agents from the south. Based on meetings during the field mission it was evident that the trust between value chain actors is not high, especially while dealing with market players. Side selling takes place irrespective of verbal agreements. All transactions are done in cash and on-the-spot. The large flour mills buy maize from agents/ aggregators, therefore the smallholders cannot negotiate price and quality with them directly. This creates distrust among farmers.

With respect to the seed supply system for maize, most smallholders grow local varieties and use seed from previously saved harvests and/or seed obtained from extensionists or their neighbours. In some locations farmers lack access to new and improved varieties due to poor access to finances as well as poor linkages with seed companies/suppliers. New varieties are slow to reach the market.

In the farmer survey, a large number of farmers mentioned using hybrid or improved seed (SAM777, premier, Oba Super, Prozer, treated) whereas some preferred local varieties (Zafa, Zappa, Panar/ pana, Asandu, Abukpo, Oka ocha, Oka red, Fanner etc.). ***Grain size was stated as the main reasons for varietal preference*** *(78%) followed by taste (69%) and colour (53%).* ***Among the reasons stated by the female farmers, taste was given the most importance.*** *Other reasons included early maturity, drought tolerance, fast growth, high yields, resistance to disease and spoilage, size/weight of cob, and ease of marketing. Lack of information about improved varieties and tradition were also cited as reasons for choosing local varieties.*

There are issues related to land governance especially with regard to boundaries, records. Most land records and tenure agreements are ambiguous about title and ownership, and available data on land registration is unreliable. Policies are in place but implementation is weak. There is need to streamline land and financial transactions – provide provenance, improve efficiency and transparency, and reduce corruption.

Social involvement - Government programmes contributing to improve access to quality inputs, credit, markets etc.

One of the main initiatives to support farmers to improve their productivity and link them to large-scale processing companies (off-takers) is government of **Nigeria's Anchor Borrowers Programme**[31] implemented in collaboration with the Central Bank of Nigeria (CBN). To-date

[31]Central Bank of Nigeria (2016) Anchor Borrowers' Programme Guidelines https://www.cbn.gov.ng/out/2017/dfd/anchor%20borrowers%20programme%20guidelines%20-dec%20%202016.pdf

around 70,000 maize farmers have benefitted from this programme[32]. The programme organises smallholder subsistence farmers into producer groups, and provides them with loans through approved financial institutions to help scale up their production and graduate to (semi)commercial farmers. Large scale processors sign agreements with the farmer groups to off-take the harvested produce at agreed prices. The farmer groups a) undergo training in business skills, improved agricultural practices and group dynamics, b) obtain quality inputs through pre-approved suppliers, c) have access to extension services to complement the training and to ensure adherence to the recommended agricultural practices.

Other government development programmes and initiatives supporting agriculture development and contributing to the livelihood of farmers in Nigeria including maize farmers are:

- International Fund for Agricultural Development (IFAD) – Partnership with FGN in financing 12 agricultural programs to impact farming households
- Agricultural Promotion Plan (APP) – Government strategic framework to make agriculture a business rather than just developmental perspective
- Directorate of Food, Road and Rural Infrastructure (DFRRI)
- Operation Feed the nation (OFN)
- Seed Support Initiative to reduce COVID-19 impact in collaboration with ICRISAT, CDA and Syngenta Foundation
- Green Revolution Programme (GR)
- National Accelerated Food Production Program (NAFPP)
- National Agricultural Land Development Authority (NALDA)

Multilateral organizations collaborate with governments to create enabling environments where agricultural innovations can be effectively integrated into the systems to maximize their impact on beneficiaries. Additionally bi-lateral and multi-lateral programmes contribute towards increasing food supply and income, reducing poverty and malnutrition as well as improving small farmers' and rural dwellers' livelihoods.

Available documentation indicates that maize farmers have benefitted from participating in these programmes with regard to adoption of improved agricultural practices, increased productivity, improved income, better access to financial support as well as access to quality inputs namely improved seed, agro-chemicals and fertilisers.

5.2.6 Living conditions

Living conditions, the 6th sub-domain, are analysed in terms of access to health services, housing, education and training. The guiding questions per subdomain are:

[32] Source: MAGPAMAN website (http://magpaman.org/category/cbn-anchor-borrowers)

- Health services: Do households have access to health facilities?; Do households have access to health services?; Are health services affordable for households?
- Housing: Do households have access to good quality accommodations?; Do households have access to good quality water and sanitation facilities?
- Education: Is primary education accessible to households; Are secondary and/or vocational education accessible to households?; Existence and quality of in-service vocational training provided by the investors in the value chain?

In the Human Development Index (HDI) 2019, with HDI value 0.539 and life expectancy at birth 54.7 years, Nigeria was ranked 161 out of 190 countries[33]. By dropping three spots from 158 in 2018, Nigeria is now in the low human development category. At the sub-national level, among the major maize cash crop producing states[34]Adamawa and Niger have the lowest HDI value. With regard to health security and capabilities, globally Nigeria (Index score 37.8) ranks 96th/ 190 and 11th /54 in the Africa region, on the 2019 GHS Index with lower than average global scores for prevention including immunization, healthcare capacity, and public health vulnerabilities. The country score of 2.8 compared to global average 24.4 on health capacity in clinics, hospitals and community care centers is very low, with no score on infection control and communication with health workers during a public health emergency[35]. The estimate of infant mortality rate in the country is 19 deaths per 1000 births with mortality among children under 5 at 128 per 1000[36]. Furthermore, the average life expectancy of Nigerians is estimated by the World Health Organization to be 54.4 with women having a life expectancy of 55.4 and men of 53.7.[37]

Health services

Nigeria has a three-tiered health system; primary, secondary, and tertiary based on the three tiers of government – local, state, and federal. Approximately 62% of Nigerians live below the poverty line [10], with northern geopolitical zones having the highest poverty rates in the country. There are more health services providers in the south as compared to the northern states of Nigeria. Given its poor performance in health indicators, healthcare infrastructure and preparedness of healthcare delivery is very critical for Nigeria. The organisation of healthcare delivery (primary healthcare) varies across regions and their socio-economic status, and between healthcare services provided by private and public service providers. For instance, the public PHC system –health posts and dispensaries- the basic units of healthcare delivery have been eliminated by many states whereas in the northern states, they still represent an important share of PHC facilities. However, the general condition of

[33] http://hdr.undp.org/en/countries/profiles/NGA

[34] Central states: Kaduna (0.516), Taraba (0.506), Adamawa (0.488), Plateau (0.569) and Niger (0.488), and Ogun (0.675) Osun (0.619) and Oyo (0.637) in the south.

[35] https://www.ghsindex.org/wp-content/uploads/2019/08/Nigeria.pdf

[36] UNICEF. 2019. (https://www.unicef.org/nigeria/ situation-women-and-children-nigeria; accessed July 30, 2021)

[37] WHO. 2019. (https:// www.who.int/countries/nga/en/; accessed July 30, 2021)

these facilities is poor[38]. Most health facilities offer child health services, however, maternal services and particularly family planning services are less likely to be offered. In the major maize-producing states Kaduna, Niger, Taraba – a large share of PHC facilities have limited (functioning) medical equipment, medical supplies including drugs and vaccines needed to offer basic health services.

Access to healthcare services

Household size, distance and cost of treatment are the main reasons for unequal access to healthcare facilities in rural areas. These factors seriously affect women and children's access to basic healthcare, as a direct consequence of the patriarchal system that operates in Nigeria – more pronounced in the maize producing north-eastern and north-central regions. Restricted ability to make decisions about spending income, prioritising their healthcare and that of their children, mobility issues compounded by distance and lack of cash to afford transport create further hindrances for women and children to access health services. Additionally, delays caused due to lack of resources and under-staffing in the PHCs[39],

Health issues faced by maize processors

There are studies indicating the prevalence of respiratory symptoms and lung function of flour mill workers in north central Nigeria (Tosho, et.al., 2015) as a result of exposure to airborne grain-dust particulates. Milling, engineering, cleaning, packing and other warehouse personnel experiencing regular daily exposure, show respiratory symptoms such as cough, sputum production, shortness of breath, wheeze and chest discomfort. The studies in flour mills also report high concentration of total suspended particulate (TSP) which had a direct bearing on the respiratory health status of the flour mill workers.

Housing

More than 80% of farmers in Nigeria are considered smallholders (own <5 ha land) and they produce 99% of Nigeria's agricultural outputs. 73% of smallholder households live in poverty with one quarter of those in extreme poverty (< USD1.25a day) [40] In northern Nigeria, smallholders (Hausa farmers) typically live in clusters or groupings within calling distance of one another. The houses are mostly surrounded with compound walls made of mud with maize stalks, where farmers sleep and/or keep their animals or store their grain in traditional storehouses (rumbuna). The building material used can be a proxy indicator of the economic situation of the farmer – when thatched or mud roofs are replaced by galvanized sheets and/or cement is added to build the walls. While settled Fulani farmers also have housing similar to the Hausa farmers, the nomadic Fulani households continue to migrate between the villages and the 'bush'. Conflicts between nomadic Fulanis and settled crop farmers force the nomadic herders to move farther in search of forages.

[38] Indicators of poor infrastructure include leaky roofs, broken windows/ doors and no waste disposal system, no electricity, no cold storage (fridge/ ice box), no running water or toilets.

[39] Two health workers available for every 1000 people (https://theconversation.com/why-nigerias-weak-health-system-affects-women-and-girls-the-most-163904)

[40] https://www.cgap.org/research/slide-deck/insights-household-survey-nigeria

Low access to safe drinking water and high prevalence of open defecation

In 2018, Nigeria's Water, Sanitation and Hygiene (WASH) sector was declared to be in a state of emergency by the Government.[41] According to UNICEF's 2018 WASH NORM I survey[42] around 68% of the population (2 million people) did not have access to basic water supply and sanitation services. Open defecationn 2019, a combination of inadequate infrastructure, a lack of required human capital, poor investment, and a deficient enabling regulatory environment – amongst other challenges – meant that approximately 60 million Nigerians were living without access to basic drinking water. 80 million people had no access to improved sanitation facilities, while 167 million couldn't access basic handwashing facilities.

Only 2% of the population living in the North Eastern region, which consists of the major maize-producing states and smallholders, have access to safely managed drinking water. People living in the North Central – another major maize producing area - recorded the highest proportion of open defecators at 51%, while the lowest was recorded by people in the North West at 9%. People living in the rural areas (10%) are three times more likely to practice open defecation than those in the urban areas (29%). With regard to hygiene services – handwashing facilities within households, only 6% of the households in North Central had access to and were able to demonstrate proper handwashing techniques with soap under running water. Water, sanitation and hygiene services are inadequate in schools with only 26% of schools in the country providing access to basic sanitation services, and 14% schools with basic gender-sensitive water supply and sanitation services.

Education and training

Only about 65% of girls compared with 71% of boys have a primary education. And only 39% of girls complete junior secondary school while 29% complete senior secondary school[43]. These indicators vary widely across the country and disproportionately affect those in the rural areas, particularly in northern Nigeria.

Primary school completion is lowest in the North-West geopolitical zone and is below 60 per cent in Bauchi, Kaduna, Katsina, Kebbi, Ogun and Yobe States. Children from the three southern geopolitical zones are twice as likely to make the transition from primary to secondary school than those from the North-Central zone. In some States – Benue, Niger, Kebbi and Sokoto – the transition rate to secondary school is less than 30 per cent. However, in the maize growing states/areas, significant school enrolment with more than 40% female enrolment is observed from kindergarten to university level.

[41] https://www.worldbank.org/en/news/feature/2021/05/26/nigeria-ensuring-water-sanitation-and-hygiene-for-all
[42] https://www.unicef.org/nigeria/media/3576/file/WASH%20NORM%20Report%202019.pdf
[43] https://education.gov.ng/nigeria-digest-of-education-statistics/

Among maize farmers surveyed more than 50% of the farmers – male and female – had some level of education, majority had secondary school level. Of the women farmers surveyed almost 50% had primary school level education (see Table 15*).*

	LSF		MSF		SH1		SH2	
Education	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*
None	*1*	*3*	*0*	*4*	*5*	*3*	*0*	*3*
Primary	*4*	*9*	*6*	*14*	*6*	*11*	*4*	*13*
Secondary	*2*	*17*	*2*	*14*	*3*	*17*	*6*	*15*
Tertiary	*1*	*8*	*2*	*15*	*2*	*7*	*3*	*11*
	8	***37***	***10***	***47***	***16***	***38***	***13***	***42***

TABLE 15 ***: EDUCATION LEVEL OF FARMERS***
(Source: farmer survey conducted by team)

5.3 Social analysis summary

In addition to the outcomes of the social analysis alongside the six research domains, it is important to take into account the challenges experienced and listed by all the actors if the Maize VC is to be strengthened.

Figure 26 below gives a visual representation of the social analysis with a spiderweb covering the aggregated scores of the six research domains. Table 16 gives a summary of the main issues per area studied.

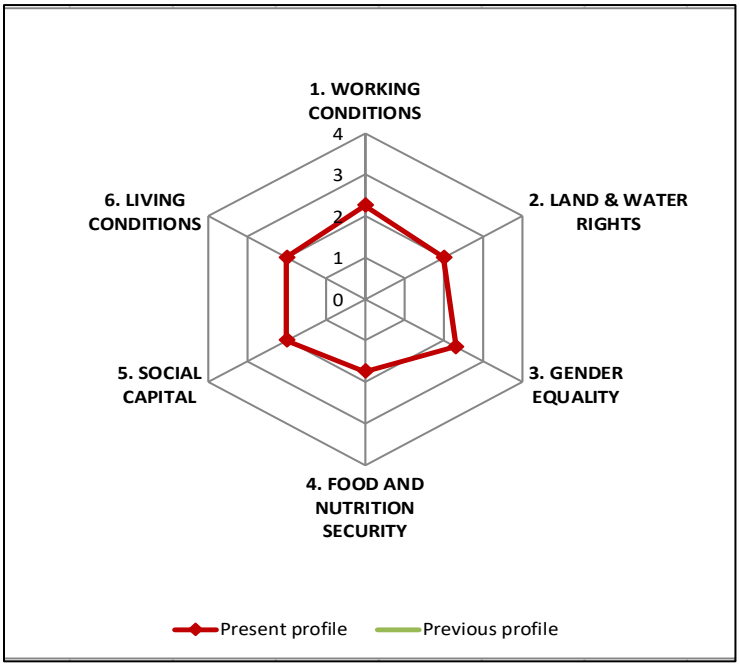


FIGURE 26: SOCIAL PROFILE OF THE MAIZE VC IN NIGERIA

The spider-web shows that all dimensions have moderate to low scores (some information pertaining to Land and Water Rights is not available). However, there is clearly need for intervention and improvement in the maize VC in almost all components. Specific current risk areas are:

- *Working conditions* – in relation to fair and enforceable contracts, and measures to avert discrimination based on age, gender and education in employment;
- *Land and water rights* – adherence to VGGT, access to alternative livelihood strategies;
- *Gender inequality* with regard to land rights and ownership including assets other than land, access to inputs and services, low influence in service provision and policy decision-making, and physical drudgery.
- *Social capital* – inclusiveness in membership of existing producer organisations, accountable and representative leadership and advocacy to influence and negotiate in input and output markets.

Maize has potential to increase activity and income, create employment and improve livelihoods for all VC actors, at all stages. This can be achieved only if solutions are encountered for all the challenges identified and if risk mitigation strategies are in place.

Inclusiveness

Considering the entire maize value chain with its labour supply/demand, output supply, input purchase, exports and impact in the livestock industry, it is difficult to estimate how many people's livelihood depend on maize. The length of the value chain suggests that multiple millions including non-producers such as skilled and unskilled labour involved in various VC operations, processors, market actors at various levels, transporters etc. around the country

gain direct and indirect employment in the maize value chain Maize is consumed in all the states in Nigeria. More than 40 percent of these are women and as in other value chains, observable changes show increase women and youth involving across the entire value chain. Aflatoxin contamination and Fall Army Worm outbreaks, climate change, inadequate, finance, high cost of quality inputs continue to reduce productivity, and pose risks to the maize value chain.

TABLE 16: SUMMARY OF KEY ISSUES IDENTIFIED IN THE MAIZE VALUE CHAIN

Working conditions	• Labour laws reflect international conventions, but enforcement is not strong. • Working conditions in industrial processing units (big mills) seem favourable and attractive. • Working conditions for small and medium scale processors in local markets not very favourable.
Land & water rights	• There are issues related to land governance especially with regard to boundaries, and title records. • Most land records and tenure agreements are ambiguous about title and ownership, and available data on land registration is unreliable. • Policies are in place but implementation is weak, particularly with regard to regulation of financial transactions
Gender equality	• Strong traditional role and task division between men and women operate with limited capital and negotiating power • Women traders and processors (artisanal and small-scale) unable to expand their businesses due to limited business skills and limited personal mobility to source cheaper supplies and access distant markets; • Women have very limited access to land and land title - and therefore limited collateral to access formal credit; • Women dominate seed recycling and grain storage but have low to no decision-making power in production and expenditure of income related decisions
Food and Nutrition security	• VC actors in most states experience food shortages for approximately three months in a year -it varies per state, for example in Anambra is food insecure in December-January, and June-July ; North-eastern states of Kaduna and Katsina experience food shortage in November-January, Delta state mostly April to June, Enugu in June-August. • Reasons for shortage include crop failure, unstable market prices (leading to hoarding) and large number of household members; • Diets in maize-producing area –as well as in rest of the country – are cereals-based; fruits and vegetables not very available in the three northern regions. • Deficit of 20 million MT of maize production needed for consumption needs; import ban and high industrial demand for the feed sector (60%) further competes with consumption needs; • Maize bran can provide high quality protein to poor households but the bran is usually lost in milling; • High levels of aflatoxin reported in maize products available in local markets; testing is not mandatory
Social Capital	• Associations dominated by male farmers reflecting prevailing social norms • Women traders and processors (artisanal and small-scale) often excluded from professional associations – they largely operate as informal groups facilitated by NGOs and/or development programmes; • Membership of most associations is based on self-selection by those who have necessary resources to participate – thus likely to exclude the smallest farmers; • Small and medium scale (informal) processors covering 70% of the processors, operate individually -not included in professional associations; • - Smallholders lack access to new and improved varieties due to poor access to finances as well as poor linkages with seed companies/suppliers.

Living Conditions	• Access to and affordability of health care is a huge challenge in the rural areas • Small and medium scale milling units with poor ventilation, work-place hygiene and limited supply of protective respiratory equipment/ gear pose flour dust exposure related health risks to workers in those units; poor regulation to ensure worker safety; • Low access to safe drinking water and high prevalence of open defecation • Aflatoxin contamination in maize and maize products and lack of awareness across the value chain represent a serious food safety and health risk

5.4 Conclusions from social analysis

Maize is an important crop in the Nigerian food system –with a significant role in the wider economy as well as in household food and nutrition security. Policies that discouraged local production and encouraged cheap imports to address food shortages have fuelled inflation and adversely affected livelihoods of all actors in maize value chains. Land acquisition systems pose limitations for maize production by smallholder farmers. With access only to family land they have to depend on informal lease and/or renting arrangements with no security of tenure. Lack of capital further compromises their access to quality inputs, with fluctuating market prices adding to the disincentives. On the other hand, the larger farmers are willing and able to invest in productivity enhancement measures to meet the demands of the feed industry. Membership of producer organisations facilitates their access to inputs – seed and fertiliser -and advisory services available through distribution channels set up by private agricultural companies.

As a cash crop, the maize value chain – production and sale – is dominated by men. Although women recognise the potential of maize as a nutritious food crop, they are unable to assert themselves as producers due to limitations such as non-ownership of land, lack of access to credit, information and resources, and social norms that withhold them from access to markets.

TABLE 17: MITIGATION MEASURES PER DIMENSION

1. WORKING CONDITIONS	
1.1 Respect of labour rights	Requires strong efforts from the government on monitoring and enforcements of labour laws and regulations. Labour associations and worker representation could improve transparency.
1.2 Child Labour	Children are a high risk group, and as maize is perceived as a cash crop there is risk that children esp. school dropouts in rural areas will be involved in value chain activities as cheap labour. More stringent law enforcement, periodic monitoring and checks by legal inspectors, raising awareness about the social and health hazards of child labour and using agricultural practices requiring less labour could be some ways to reduce child labour in maize value chains.
1.3 Job safety	Stronger awareness raising among farm labourers and preventive measurements (e.g. always first aid kit in the field, transportation means available in case of emergency). Similar measures in milling units to reduce health hazards due to flour dust inhalation.
1.4 Attractiveness	Ensuring minimum wages for upstream actors in the value chain, and skills training and facilitating access to credit to improve infrastructure and reduce losses for downstream VC actor.s
2. LAND AND WATER RIGHTS	
2.1 Adherence to VGGT	Ensuring sustained functioning of the vigilance mechanisms set up to support land registration and harmonising of pastoral lands. Raise awareness among smallholders to prevent them from being exploited in price negotiations while selling their land.
2.2 Transparency, participation, consultation	Encourage smallholders particularly women farmers to take on roles within farmer organisations; build leadership skills
2.3 Equity, compensation, justice	Government agencies to prioritise and support improving women's access to resources commensurate to their role in the value chain –particularly land and credit. Special efforts and partnerships with civil society organisations and development partners to promote and sustain increased women's participation and leadership roles in various collectives throughout the value chain.
3. GENDER EQUALITY	
3.1 Economic activities	Higher participation of women in the VC may be promoted, but would require cultural shift especially in the North Central and North East states; Facilitate access to credit and training for women.
3.2 Access to resources & services	Overall improvement in realising property and land rights, and titles to be streamlined, esp. for women
3.3 Decision-making	Promoting participation of women in technical capacity building. But also gain more insight into the desire of women to participate in the production process aside from domestic work, care for family and other income generating activities.
3.4 Leadership & Environment	Higher participation of women in the VC may be promoted, not only through reserved positions but also concerted efforts to sustain gender transformational changes.
3.5 Hardship & Division of labour	

4. FOOD AND NUTRITION SECURITY

4.1 Availability of food	Reduce deficit in maize production by supporting smallholder farmers to enhance productivity through better extension services, timely and quality input supply (improved seed, fertiliser)
4.2 Accessibility of food	Create price incentives for farmers to sell produce in local markets as food rather than for industrial use and/or in distant markets.
4.3 Utilisation and nutritional adequacy	Nutrition education and behavioral change to encourage consumption of more diverse food -probably, outside the scope of the VC. Increase and facilitate availability of more diverse and nutritious food items in the northern regions (vegetables and fruit). Facilitate promotion of fortified/ blended flour.
4.4 Stability	Proper measures to manage climate change and diversify income portfolio and facilitate smallholders to maintain balance between acreage used for food and cash crops.
5. SOCIAL CAPITAL	
5.1 Strength of producer organisations	Ensure that maize smallholders – men and women – benefit equally from membership of the various producer organisations. Support and ensure use of producer organisations not only as a platform for farmer-to-farmer extension but also as a space to interact with other VC actors. Capacity building to find local solutions to local problems should be a priority of the POs.
5.2 Information and confidence	Create adequate representation and opportunities for all types of farmers to be involved including role-holding. Government extension workers to monitor domination of large famers and processors.
5.3 Social involvement	Ensure that beneficiary selection mechanisms for government and other development initiatives are fair and equitable, and focusing on sub-sector development.
6. LIVING CONDITIONS	
6.1 Health services	Improved healthcare delivery with an emphasis on preventive healthcare to reduce morbidity, that indirectly affects productivity for smallholders and/or farm wage laborers. Improving health insurance system., and regular monitoring of health posts and services recommended. Regulate working conditions in flour mills to prevent respiratory health issues among workers.
6.2 Housing	Through improved income, but also public efforts.
6.3 Education and Training	Efforts to reduce number of school dropouts especially girl children. Better organization of the sector and stronger involvement of the public sector may help

6. IS THE VALUE CHAIN ENVIRONMENTALLY SUSTAINABLE?

6.1 Introduction

The objectives of the environmental analysis of this VCA4D study is to assess the environmental sustainability of the Nigerian maize value chain. In the initial stage of the study, the main environmental concerns were identified, based on interviews with various actors and literature review. These concerns can be summarised as follows:

1. **Flooding**: regularly causing maize yields losses and erosion along the river banks.
2. **Changing rainfall patterns**: prolonged dry spells and increased risk of pests and weeds.
3. **Low soil fertility**: low yields due to inadequate soil management, soil erosion, and run-off.
4. **Food loss**: part of the maize grains are lost for human consumption throughout the value chain.
5. **Deforestation**: due to increasing pressure on land for maize cultivation and other agricultural activities, causing loss of biodiversity and ecosystem services and greenhouse gas emissions.
6. **Fossil energy use/emissions**: combustion of diesel and natural gas for maize cultivation, post-harvest handling, processing and transport, and fertiliser production and use cause greenhouse gas and air polluting emissions, affecting human health and ecosystems through climate change and other environmental effects.

To be able to analyse the impact of these topics on the sustainability of the Nigerian maize value chain, we first analyse each topic qualitatively using the information from interviews with actors and literature review. To support this descriptive analysis, the following quantitative assessments are done:

- **Yield gap analysis**: this analysis quantifies the effects of crop management and environmental conditions on the yield. In a yield gap analysis, the potential yield is calculated with a crop growth model based on the local weather conditions with perfect water and nutrient availability. This is then compared with the yields measured in practice. The difference is called the yield gap. Each factor explaining the yield gap, such as water shortage, nutrient shortage, Striga, fall armyworm, flooding, is then quantified.
- **Food loss analysis**: with this analysis the biomass flows through the value chain are quantified. Post-harvest losses can be visualised in a Sankey diagram, where the thickness of the arrows in the diagram represents the quantity of food production and food losses.
- **Life cycle assessment** (LCA): LCA is a technique that quantifies environmental impacts due to emissions, land use and resource extraction throughout the value chain. This includes production of fuels and agro-chemicals, cultivation, processing, transport and market/retail. The environmental impacts are aggregated using specific indicators per unit of product (for example ton CO_2eq per ton of maize product as an indicator for climate change).

The first four of the main environmental topics, flooding, changing rainfall patterns, low soil fertility are difficult to address with LCA. These are not directly caused by maize production but mainly affect the maize yield and food loss in the post-harvest activities. Quantification of these issues can be done

by yield gap analysis. Because in LCA, the food loss is not much visible in the results, visualisation of food loss is done additionally in a Sankey diagram.

The following part of this chapter is structured as follows:

- Section 6.2: Life cycle assessment
- Section 6.3: Yield gap analysis
- Section 6.4: Further analysis of the main environmental topics
- Section 6.5: Synthesis of the environmental aspects

6.2 Life cycle assessment

A life cycle assessment (LCA) of the Nigerian maize value chain was done to calculate environmental impacts due to emissions, land use and resource extraction throughout the value chain per unit of product (1 ton maize grains harvested or 1 ton of maize product). LCA is done by following four steps:

1. Goal & scope definition: methodology description
2. Life cycle inventory: description of the data used in the assessment
3. Life cycle impact assessment: results of the calculations
4. Interpretation: discussion and conclusions

The following subsections follow these steps.

6.2.1 Goal & scope definition

6.2.1.1 Goal

There are three main goals for the LCA study on the Nigerian maize value chain:

1. Assess the environmental impact of Nigerian maize value chain on human health, ecosystems quality and resource scarcity
2. Understand the environmental hotspots in the life cycle of Nigerian maize flour
    a. Which are the most relevant impact categories
    b. Which are the most relevant life cycle stages
    c. Which are the most relevant processes
    d. Which are the most relevant environmental interventions (emissions, land use, resource
3. Compare the environmental impact of maize cultivated in different regions of Nigeria and by small holder, medium scale and large scale farmers.

6.2.1.2 Audience

The audience is policy makers of the European Commissions and the Nigerian Ministries, but also consultants and researchers. For this reason, this report contains a high level description of the methodology and results, where technical details are reported separately.

6.2.1.3 Specific guidance followed

The ISO 14040/44:2006 standards for life cycle assessment are followed as much as possible, but not all requirements are met, because these are more applicable to company specific studies.

6.2.1.4 Review

The study is reviewed by Thierry Tran from CIAT/CIRAD, who is an LCA expert within the Agrinatura network to assure it meets an agreed degree of compliancy with the ISO standards.

6.2.1.5 Functional unit

A functional unit is the quantified performance of a product system for use as a reference unit. The functional unit for the life cycle impact assessment and environmental hotspot analysis is 1 year or 1 ton of (packed) Nigerian maize product with reference year 2019, because depending on context either 1 year or 1 ton is more relevant. The yearly production in 2019 was measured as 12.6 million tons of packed maize product. The packed maize product is a composite of the various maize-based products in Nigeria, and was defined as follows: 1 ton of dry corn equivalent (90% dry matter[44]) at the market with a share of 44% corn feed, 23% industrial corn flour, 15% small scale corn flour, 9% corn on the cob, 6% bran/germ from industrial milling and 4% bran/germ from small scale milling (based on the data provided in Figure 20 and Table 4 in the functional analysis). The functional unit for comparing the environmental impact of maize cultivated in different regions of Nigeria and by small holder, medium scale and large scale farmers is **1 ton of maize grains harvested**, at the farm.

6.2.1.6 System boundaries

The system boundary in LCA is a set of criteria specifying which unit processes are part of a product system, where a unit process is the smallest element considered in the life cycle inventory analysis for which input and output data are quantified. The following life cycle stages are included;

1. maize cultivation
2. post-harvest handling
3. transport of maize grains
4. flour milling
5. packaging
6. distribution

The supply chains of all relevant inputs of these stages, such as fertilizers, packaging material, chemicals and energy are also included. The production of capital goods is included. The consumption stage is not included as this is not part of the value chain. This also means that any animal husbandry is excluded as well. Retail, cooking/roasting of fresh corn on the cob, and waste treatment are also not included as these are considered negligible. Figure 27 shows the most important product flows and processes in the analysis of the Nigerian maize product.

[44] The yields and production statistics are given in all data sources in ton of dry corn equivalents

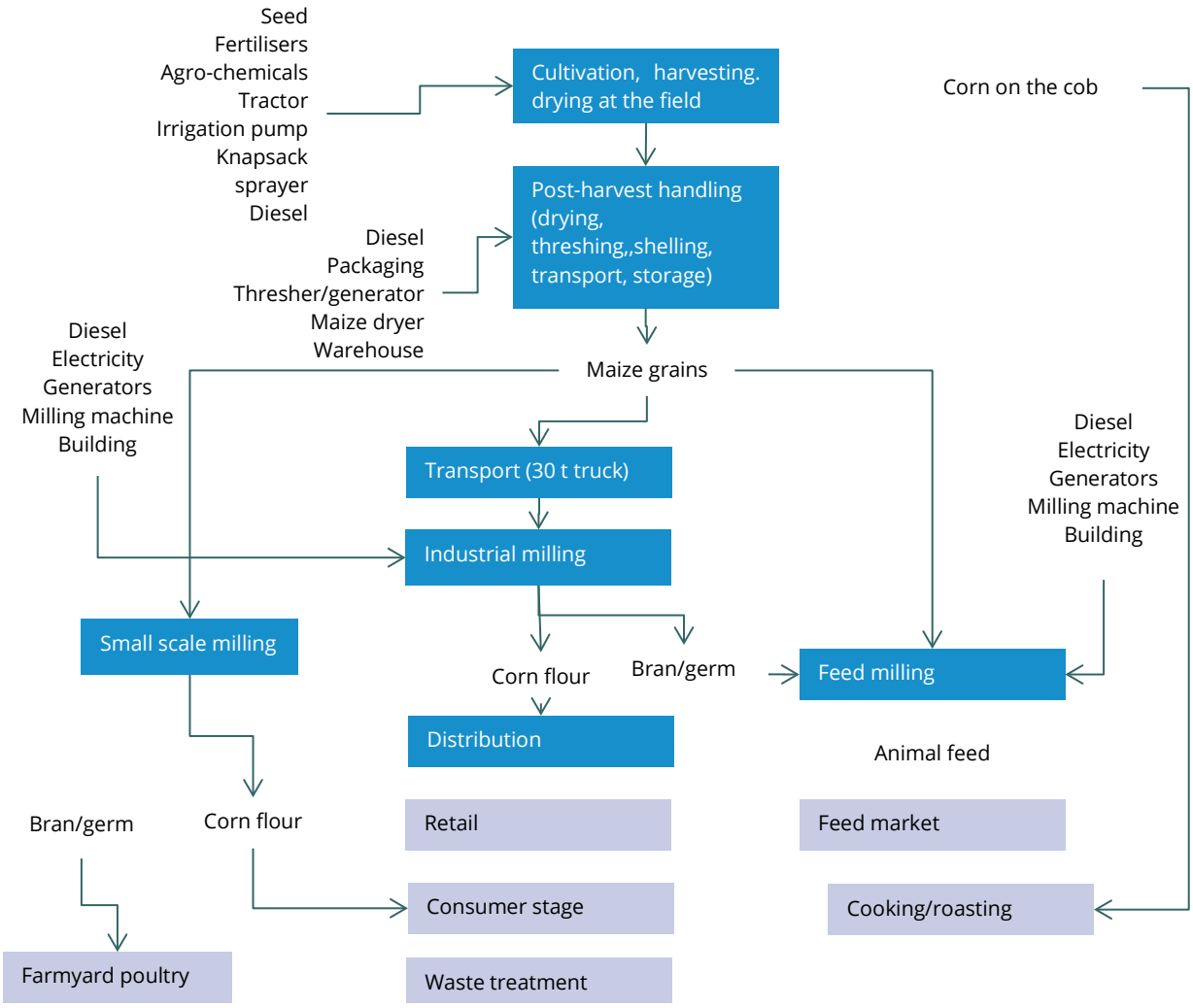


FIGURE 27: INPUTS AND PROCESSES IN THE VALUE CHAIN OF NIGERIAN MAIZE PRODUCTS RELEVANT FOR THE LIFE CYCLE ASSESSMENT

6.2.1.7 Geographical scope

The maize cultivation in the North and the South of Nigeria are modelled separately. All production of maize products in Nigeria is considered to be included in the analysis.

6.2.1.8 Background data selection

For the environmental impact of the supply chains of needed inputs, such as fertilizers, packaging material, chemicals and energy, the Agri-footprint 5.1 (economic allocation version) and Ecoinvent 3.6 (cut-off by classification version) databases are used as available in the latest version of the LCA software SimaPro (9.1). These are internationally renowned LCI databases for agricultural products (Agri-footprint) and general inputs (ecoinvent).

6.2.1.9 Multifunctionality

For the cultivation stage, all impacts from cultivation were allocated to the maize grains, so the stover and residues from the cob were not considered as co-products.
For the post-harvest stage, the impacts from cultivation, post-harvest handling, transport and processing were allocated to maize flour and by-products from milling (bran/germ or middling used as feed), based on the relative mass of the co-products. In many cases of food processing with by-products used as feed, economic allocation is applied, where the main, higher valued product has a higher share of the impact. This allows fairer comparisons with alternative products. However, the purpose of this study is to calculate the environmental impact of the Nigerian maize value chain as a whole, which includes both main products and by-products: maize flour, maize meal, and maize grains and milling by-products for feed. So, any allocation methods lead to the same results. For simplification, mass allocation was applied.

In the background processes that the foreground processes link to (ecoinvent cut-off and Agri-footprint economic), also economic allocation is applied and for waste treatment the cut-off approach is applied. The latter means that environmental impact of collection and processing of waste material that is recycled/used in another product life cycle is attributed to the latter (not to the product system that results in this waste).

6.2.1.10 Emission modelling

For calculating the emissions from fertiliser, pesticide use and land use change, the PEF Guide (Zampori and Pant, 2019) is largely followed. The parameters and equations are described in detail in Figure 28 and Table 18, respectively.

The land use change factor is calculated by dividing the slope of the linear trend of maize area in Nigeria over a period of 20 years by the current area. The latest available data are from 1998 and 2017 (Figure 29; FAOSTAT, 2021). The slope is 196 thousand ha and the area in 2017 was 6540 thousand ha. So, the land use change factor is 0.03 ha/ha.

Of all the crops in Nigeria with an increasing area trend over the 20 year period, the total slope is 1082 kha/year, while of all the crops with a negative slope, the total slope is -382 kha/year (based on the FAOSTAT data). The net increase is therefore 700 kha/year. The deforestation rate in Nigeria is estimated at 100 kha/year (roughly based on the deforestation rates in Nigeria in the past 5-7 years according to Global Forest Watch, 2021; Figure 29). So, the increased area for crops is for 14% at the cost of forests, 55% at the cost of other crops and the remaining 31% (based on the 20-year trend analysis of the FAOSTAT data) is assumed to be at the cost of grasslands.

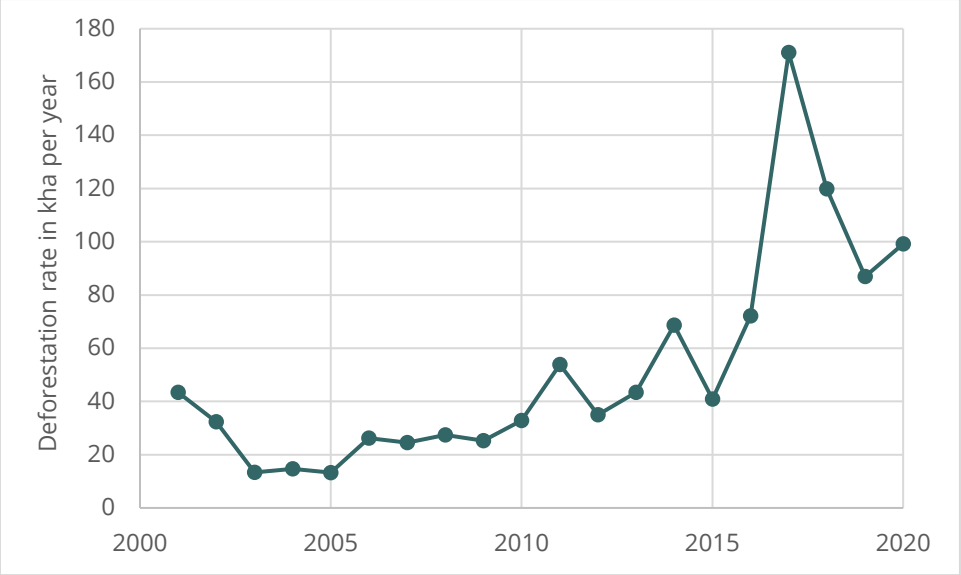


FIGURE 28: TREE COVER LOSS IN NIGERIA FROM 2001 TO 2020 (SOURCE: GLOBAL FOREST WATCH, 2021)

This approach follows the modelling guidelines of PAS 2050:2011 (BSI, 2012) and the supplementary document PAS2050-1:2012 (BSI 2012) for horticultural products as recommended by the PEF Guide (Zampori & Pant, 2019).

TABLE 18: INPUT PARAMETERS FOR CALCULATING CULTIVATION EMISSIONS AND LAND USE

Parameter	Description	Unit	Amount	Source (need to add footnotes)
N_graze	Nitrogen from grazed residue	kg N/kg	0.01	estimate
N_burn	Nitrogen from burned residue	kg N/kg	0.02	estimate
N_atsow	Nitrogen in soil at sowing	kg/ha	20	estimate
N_UREA	Urea N content	kg N/kg	0.466	Fertiliser bags
N_AN	Ammonium nitrate N content	kg N/kg	0.265	Fertiliser bags
N_DAP	Ammonium phosphate N content	kg N/kg	0.22	Fertiliser bags
N_NPK15	NPK 15-15-15 N content	kg N/kg	0.15	Fertiliser bags
N_NPK20	NPK 20-10-10 N content	kg N/kg	0.2	Fertiliser bags
N_manure	Manure N content	kg N/kg	0.005	estimate
N_compost	Compost	kg N/kg	0.02	Estimate
N_res	N in crop residues	kg/kg	0.006	IPCC (2006)
N_grain	Grain N content	kg N/kg	0.016	IPCC (2006)
N_cobs	N in cobs (measured in kg N per kg dry grains)	kg/kg	0.016	Assumed same as grains
Frac_leach	Nitrate leaching fraction	kg N/kg N	0.3	IPCC (2006)
Rbg_bio	Ratio of below-ground residues to above-ground biomass	kg/kg	0.22	idem

N_below	N in below ground biomass	kg/kg	0.007	idem
AB_slope	Slope aboveground residue dry matter	kg/kg	1.03	idem
AB_intercept	Intercept aboveground residue dry matter	kg/ha	0.61	idem
dm_product	Dry matter content dry grains	kg/kg	0.87	idem
FracGASFurea	Ammonia emission fraction urea	kg N/kgN	0.15	Zampori and Pant, 2019)
FracGASFAN	Ammonia emission fraction ammonium nitrate	kg N/kgN	0.1	idem
FracGASFother	Ammonia emission fraction other	kg N/kgN	0.02	idem
FracGASFmanure	Ammonia emission fraction manure	kg N/kgN	0.2	idem
N2factor	Atmospheric N emissions	kg N2/kg N	0.09	idem
N2Ofactor	Nitrous oxide emission factor	kg N2O/kg N	0.022	idem
P_leach	Phosphorus leaching	kg P/ha	0.07	idem
frac_leach_base	NO3- base loss (synthetic fertiliser and manure)	kg N/kgN	0.1	idem
LUC	Land use change factor	Ha/ha	0.03	See main text
From_forest	Fraction of land use change from forests	ha/ha	0.14	Idem
From_crops	Fraction of land use change from other crops	ha/ha	0.54	Idem
From_grass	Fraction of land use change from grassland	ha/ha	0.32	Idem
LUC_above	Biomass in aboveground biomass forests	ton/ha	120	Estimate based on literature (reference)
LUC_below	Biomass in belowground biomass forests and grassland	ton/ha	40	Estimate based on literature (reference)

TABLE 19: EQUATIONS FOR CALCULATING CULTIVATION EMISSIONS AND LAND USE

Parameter	Description	Unit	Equation
P_tot	Total P (based on P contents of the chemical fertilisers)	kg P/ha	0.15*npk15+0.57*dap+0.1*npk20
PO43_water	Phosphate	kg	(1+p_tot/0.3261*0.2/80)*0.175/0.3261
GASF	Ammonia N (Zampori and Pant, 2019)	kg NH3-N/ha	FracGASFother*(npk15*n_npk15+npk20*n_npk20+dap*n_dap)+FracGASFAN*an*n_an+FracGASFurea*urea*n_urea+manure*n_man*FracGASFmanure
Nfert_tot	N input with all fertilisers	kg n/ha	urea*N_urea+an*N_an+dap*N_dap+NPK15*N_npk15+npk20*n_npk20+manure*n_man +compost*n_compost
N_removal	N-removal with the harvest	kg N/ha	yield*N_cobs+(1-res_left)*bm_above*n_res
bm_above	Aboveground biomass (IPCC, 2006)	kg/ha	AB_intercept+AB_slope*product*dm_product/1000
NO3_loss	Nitrate base loss	kg N/ha	frac_leach*nfert_tot*62/14
N_balance	N balance	kg	Nfert_tot-N_removal
N_loss	N loss	kg	GASF+Nfert_tot*(frac_leach+N2Ofactor+N2factor)
NH3_air	Ammonia emissions to air	kg	GASF*17/14
N2_air	Nitrogen, atmospheric emissions to air	kg	N2factor*nfert_tot*28/14
N2O_air	Dinitrogen monoxide emissions to air	kg	N2Ofactor*nfert_tot*44/28
CO2lime	Carbon dioxide, fossil emissions to air from lime	kg	0.12*44/12*lime
CO2urea	Carbon dioxide, fossil emissions to air from urea	kg	0.2*44/12*urea
occup	Occupation, annual crop (assuming 3 crops per year)	m2a	10000/3
from_fortest	Transformation, from forest, secondary (non-use), NG	ha	From_forest*LUC
from_crop	Transformation, from annual crop, NG	ha	From_crops*LUC
from_grass	Transformation, from grassland, natural (non-use), NG	ha	From_grass*LUC
to_crop	Transformation, to annual crop, NG	ha	1*LUC
luc_above	Carbon dioxide, land transformation emissions from land use change aboveground biomass	ton	LUC_above*0.5*44/12*from_forest*LUC
luc_below	Carbon dioxide, land transformation emissions from land use change belowground biomass	ton	LUC_below*0.5*44/12*(from_forest+from_grass)*LUC

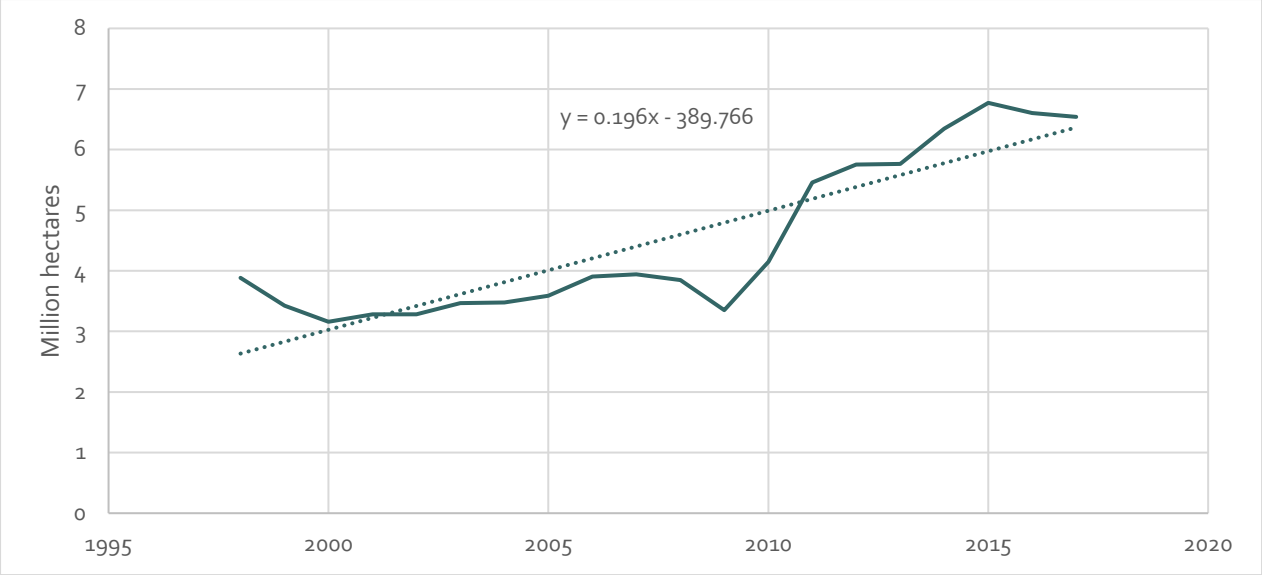


FIGURE 29: MAIZE AREA IN NIGERIA BETWEEN 1998 AND 2017 (SOURCE: FAOSTAT)

6.2.1.11 Impact assessment methods

The ReCiPe 2016 Midpoint and Endpoint H methods are used (Huijbregts et al., 2016). The endpoint method converts emissions, land use and resource extraction in three areas of protection resource scarcity, ecosystems quality and human health. The contribution of more specific environmental impact categories, such as climate change, fine particulate matter formation, land use, and fossil resource scarcity to the three endpoint indicators can also be analysed with this method. However, due to the high uncertainty of the endpoint indicators, midpoint indicators were also defined in the ReCiPe 2016 methods. The midpoint indicators are expressed in units that represent the impact at some point between the environmental intervention and the area of protection. For example, climate change is expressed in kg CO_2 equivalents, representing the global warming potential.

6.2.1.12 Software

SimaPro 9.1 is used.

6.2.1.13 Sensitivity analyses

No sensitivity analysis is applied.

6.2.1.14 Data quality

The data quality of the foreground unit processes were rated on four different quality aspects:

- Technical representativity
- Geographic representativity
- Time representativity
- Precision

A score of 1 to 5 is given, where 1 is the highest rate and 5 the lowest (for more detail see Zampori and Pant, 2019). The average ratings for cultivation, packaging and market are all 1.75, despite a poor

quality rating for the precision factor (Table 20). Land use change as a separate life cycle stage has a similar rating, but has an even lower precision due to very high uncertainty of the data. The other processes received an average of 2.25-2.75, which means that the data quality is not good for these processes. So, the overall data quality is considered low. However, it was not possible within the scope of the project to collect more reliable data. The results must therefore be interpreted with care. However, given the goal of the project, we consider the data quality to be acceptable in this study.

TABLE 20: DATA QUALITY RATINGS FOR THE FOREGROUND UNIT PROCESSES BASED ON THE QUALITY RATING METHODOLOGY DESCRIBED IN ZAMPORI AND PANT (2019)

	Technical representativity	Geographic representativity	Time representativity	Precision	Average
Land use change	1	1	1	5	2.00
Cultivation	1	1	1	4	1.75
Industrial flour milling	1	3	3	2	2.25
Packaging	1	1	1	4	1.75
Small scale flour milling	3	3	3	2	2.75
Feed milling	3	3	3	2	2.75
Transport	2	3	2	2	2.25
Market	2	1	1	3	1.75
Waste treatment	1	3	2	3	2.25

6.2.2 Life cycle inventory data

The tables below describe the data and sources for inputs and outputs of the different life cycle stages. For cultivation and post-harvest handling, farm survey data are partly used for diesel, petrol and pesticides use, and for crop residue handling. However, the survey data on yields and total amounts of fertiliser used are unreliable. The yields and production shares of each farm type were estimated for the different farm types as described in Section 3.3.

- no differences in yield between the North and the South,

The amounts of nitrogen in fertilisers used are based on rough assumptions due to lack of reliable sources. They are calculated assuming

- a nitrogen requirement by the harvested maize grains
- 50% of the nitrogen in chemical fertilisers is lost
- 65% of the nitrogen in organic fertilisers is lost
- The amounts of the different types of fertilisers are based on the percentages of nitrogen from the different types of fertilisers as found in AfricaFertilizer.org (2021) and the nitrogen contents of the fertilisers. According to AfricaFertilizer.org (2021), fertiliser apparent consumption in 2018 in Nigeria was
    - 57.3% urea,
    - 13.5% NPK 15-15-15,
    - 13.5% NPK 20-10-10, and
    - 15.7% Ammonium phosphate.
- no chemical fertilisers are used by SHF1,
- 70% of the nitrogen in fertilisers used by SFH2 is from chemical fertilisers,
- 90% of the nitrogen in fertilisers used by MSF and LSF is from chemical fertilisers.
- The ratio of different types of organic fertiliser is assumed to be

    - 40% pig manure,
    - 40% poultry manure, and
    - 20% compost.
- The nitrogen content in the grains is assumed to be 1.6% (assuming an average protein content of 10%; FAO, 1992),
- the nitrogen content of animal manure 0.5% and
- the nitrogen content of compost 2%.

For processing, also no distinction is made for the North and South, because the data from the survey are not reliable enough and the contribution of this stage to the environmental impact of the maize product was found to be small. So, the same processing data are applied to both regions. The processing data are largely based on the ecoinvent dataset for flour milling in South Africa combined with own estimates, and estimates based on the survey. Packaging, transport and market are largely based on own estimates. Food losses throughout the supply chain are based on APHLIS (2021).

Table 21: Data and sources for inputs and outputs of the different life cycle stage (SHF1=common small holder farmer, SHF2=supported small holder farmer, MSF=medium scale farmer, LSF=large scaler farmer)

Inputs/outputs	Unit	SHF1	SHF2	MSF	LSF	Comment
Cultivations						
Production share	% (dry grains)	52.3	16.4	18.9	12.4	See Section 3.3)
Yield (dry grains)	kg/ha	1800	2100	3500	4500	
Urea	kg/ha	0	60	129	92	Calculated as explained in the main text
NPK 15-15-15	kg/ha	0	14	30	22	
NPK 20-10-10	kg/ha	0	14	30	22	
Ammonium nitrate	kg/ha	0	0	0	0	
Ammonium phosphate	kg/ha	0	16	35	25	
Pig manure	kg/ha	2880	1000	560	400	
Poultry manure	kg/ha	2280	1000	560	400	
Compost	kg/ha	1440	500	280	200	
Muriate of potash	kg/ha	0	9	18	12	Based on statistics and N fertiliser estimations
Single super phosphate	kg/ha	0	5	10	7.5	
seed use	kg/ha	32	32	32	32	farm survey and secondary data/estimates
diesel use	kg/ha	25	25	25	25	
petrol for spraying	kg/ha	20	20	20	20	
pesticides use	kg/ha	4	4	4	4	
Crop residues as material	kg/kg	0.05	0.05	0.05	0.05	Farm survey
Crop residues as fuel	kg/kg	0.10	0.10	0.10	0.10	
Crop residues for animals	kg/kg	0.35	0.35	0.35	0.35	
Crop residues left in field	kg/kg	0.50	0.50	0.50	0.50	
Post-harvest handling						
Dry maize cob fuel	kg/kg cob	0.50	0.50	0.50	0.50	Farm survey
Dry maize cob feed	kg/kg cob	0.35	0.35	0.35	0.35	
Dry maize cob compost	kg/kg cob	0.15	0.15	0.15	0.15	
Dry maize husk fuel	kg/kg husk	0.25	0.25	0.25	0.25	
Dry maize husk feed	kg/kg husk	0.50	0.50	0.50	0.50	
Dry maize husk compost	kg/kg husk	0.12	0.12	0.12	0.12	
Post-harvest grain losses	kg/kg grains	0.064	0.064	0.064	0.064	APHLIS (2021)
diesel use for threshing	kg/kg grains	0.005	0.005	0.005	0.005	Estimates
packaging material use	g/kg grains	1.4	1.4	1.4	1.4	
storage facility use	m2/kg grains	5E-8	5E-8	5E-8	5E-8	
pesticides use	kg/kg grains	4.4E-6	4.4E-6	4.4E-6	4.4E-6	

TABLE 22: DATA AND SOURCES FOR INPUTS AND OUTPUTS OF THE DIFFERENT LIFE CYCLE STAGES

Stage	Input/output	Unit	Amount	Source
Industrial flour milling	Maize flour production per kg grains	kg/kg grain	0.80	Own estimate
	By-product production per kg grains	kg/kg grain	0.20	
	Water use	dm3/kg grain	0.02	ecoinvent (maize dry milling, South Africa)
	Total electricity use	Wh/kg grain	56	
	Share of electricity from the grid	Wh/kg grain	45 (80%)	Estimated based on survey
	Share of electricity from diesel generator	Wh/kg grain	11 (20%)	
	Transport distance to processing (>32 ton truck)	km	200	
	Transport losses	kg/kg grains	0.024	APHLIS (2021)
Packaging	Amount of polyethylene per kg of flour	g/kg flour	5	Own estimates
	Amount of PET per kg flour	g/kg flour	4	
	Amount of carton box per kg meal	g/kg meal	10	
Small scale flour milling	Maize flour production per kg grains	kg/kg grain	0.80	Own estimate
	By-product production per kg grains	kg/kg grain	0.20	
	Water use	dm3/kg grain	0.02	ecoinvent (maize dry milling, South Africa)
	Electricity use from diesel generator	Wh/kg grain	56	
Feed milling	Corn feed	kg/kg grain	1	
	Water use	dm3/kg grain	0.02	
	Heat for drying (assuming from heavy fuel oil combustion)	MJ/kg grain	0.29	Assumed 0.05 l water/kg and 5.74 MJ/l (based on ecoinvent maize drying)
	Total electricity use	Wh/kg grain	56	
	Share of electricity from the grid	Wh/kg grain	45 (80%)	
	Share of electricity from diesel generator	Wh/kg grain	11 (20%)	
	Transport distance to processing (>32 ton truck)	km	200	
	Transport losses	kg/kg grains	0.024	APHLIS (2021)
Distribution	Transport distance to market (3.5-7.5 ton truck)	km	200	Assumed
Market	Electricity use	Wh/kg	10	Small amount assumed
Waste treatment	All packaging material is assumed to go to landfill.	g/kg flour or meal	19	Assumed

6.2.3 Life cycle impact assessment results

The life cycle impact assessment results are presented here in four steps:

- Total impact of the Nigerian maize value chain on the endpoint damage categories human health, ecosystems quality and resources per ton maize product.
- Contribution of the specific environmental impact categories and environmental interventions (emissions, land uses and resource extractions) on the three damage categories per ton of maize product.
- Contribution of the different life cycle stages to the impact indicators of the most relevant impact categories per ton of maize product.
- Comparing the impact of the different farm types and states on the most relevant impact categories per ton of maize grains.

6.2.3.1 Total impact on endpoint damage categories

The total impact of the Nigerian maize value chain on the endpoint damage categories human health, ecosystems quality and resources per ton maize product (44% corn feed, 23% industrial corn flour, 15% small scale corn flour, 9% corn on the cob, 6% bran/germ from industrial milling and 4% bran/germ from small scale milling) is shown in Table 23. The human health indicator is expressed in disability adjusted life year (DALY), which means that 1 DALY represents the loss of the equivalent of one year of full health due to disease, disability or mortality for one person. Per ton of maize product 2.26E-03 DALY are caused, which translates to about 28,500 DALY for a total of 12.6 million ton of maize production in 2019 (this is about 0.57% of the total environmental impact on human health during one year for the total population of Nigeria, based on the global per capita impact). The ecosystems quality indicator is expressed in species.yr. The score for this indicator per ton of maize product is 2.52E-5 species.yr or the disappearance of 318 species during one year due to the total production in 2019 (this is about 0.21% of the total environmental impact on ecosystems quality during one year for the total population of Nigeria). The resources indicator is expressed in USD2013 surplus cost. This means than 1 ton of maize product causes the cost of producing the fossil fuels used in the value chain of maize product increases marginally in the future by 38.9 USD valued in the year 2013 (so this needs to be corrected for inflation to convert to the current year). The total surplus cost in 2019 was 491 million USD (this is about 0.01% of the total environmental impact on resource scarcity during one year for the total population of Nigeria). Climate change has a contribution to the human health and ecosystems quality, but is also reported separately here. The total climate change impact is 1.6 ton CO_2eq per ton maize product or 19.3 10^6 ton CO_2eq per year (this is about 2.40% of the total greenhouse gas emissions during one year for the total population of Nigeria).

TABLE 23: TOTAL IMPACT OF THE NIGERIAN MAIZE VALUE CHAIN ON THE ENDPOINT DAMAGE CATEGORIES HUMAN HEALTH, ECOSYSTEMS QUALITY AND RESOURCES PER TON MAIZE PRODUCT (THE GLOBAL AVERAGE IMPACT PER YEAR IS BASED ON THE NORMALISATION DATA OF THE RECIPE METHOD FOR THE ENDPOINT INDICATORS AND WORLD BANK (2021) FOR CLIMATE CHANGE*

Damage category	Unit	Total per ton maize product	Total maize production per year	% of global average impact per year*
Human health	DALY	2.26E-03	28,500	0.57%
Ecosystems	species.yr	2.52E-05	318	0.21%
Resources	USD2013	38.9	491 10^6	0.01%
Climate change	ton CO_2eq	1.5	19.3 10^6	2.0%

6.2.3.2 Contribution of midpoint impact categories and interventions

The contribution of the specific environmental impact categories and environmental interventions (emissions, land uses and resource extractions) on the three damage categories per kg of maize product is shown in Figure 30. More than 80% of the human health impact is explained by global warming (climate change) and fine particulate matter formation. Global warming also contributes significantly to the ecosystems quality impact, which together with land use contributes more than 80% to this damage category. The fossil resource scarcity impact category contributes for almost 100% to the resource damage category. So, the most relevant impact categories are:

- Climate change (63% contribution to human health and 17% to ecosystems quality damage)
- Fine particulate matter formation (31% contribution to human health damage)
- Land use (77% contribution to ecosystems quality damage)
- Fossil resource use (99% contribution to resource scarcity impact)

The most relevant environmental interventions are shown in Figure 31. This shows that carbon dioxide emissions from land transformation have the largest contribution to climate change affecting human health and ecosystems quality. After that fossil carbon dioxide and nitrous oxide emissions (mainly from fertilisers) contribute significantly to the climate change impact. Ammonia and direct fine particulates are the most relevant emissions contributing to fine particulate matter formation impact on human health. The occupation of the land for maize cultivation is the dominating environmental intervention affecting ecosystems quality. As expected, crude oil extraction and to a lesser extent natural gas extraction are the most relevant interventions for the resources damage category.

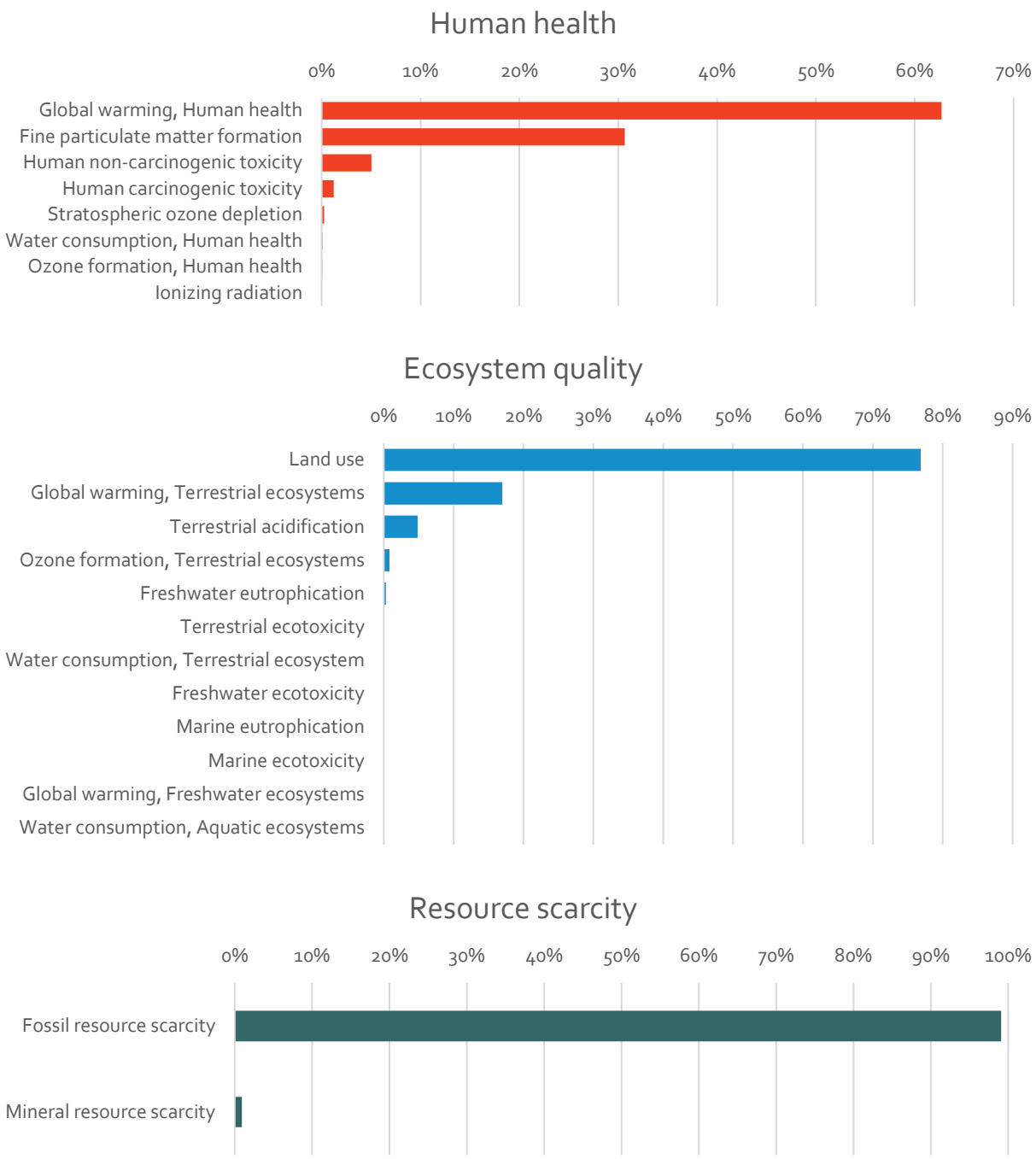


FIGURE 30: CONTRIBUTION OF THE SPECIFIC ENVIRONMENTAL IMPACT CATEGORIES ON THE THREE DAMAGE CATEGORIES PER TON OF MAIZE PRODUCT

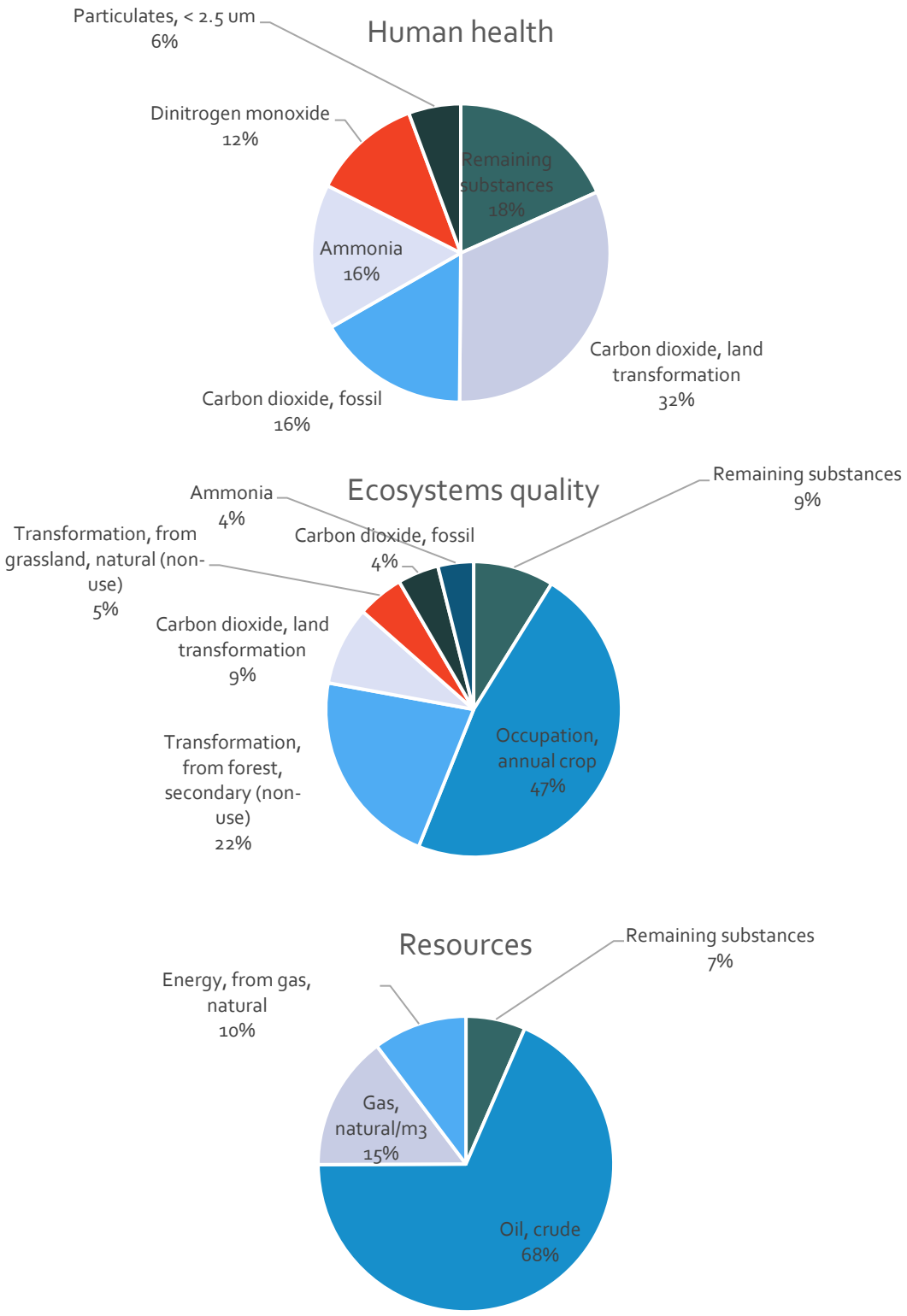


Figure 31: Contribution of the specific environmental interventions (emissions, land uses and resource extractions) on the three damage categories per ton of maize product

6.2.3.3 Life cycle stage contribution

The contribution of the different life cycle stages to the impact indicators of the most relevant impact categories per ton of maize product are presented in Figure 32. This shows that cultivation has the highest contribution in the most relevant impact categories, with the exception of climate change, where land use change has an even higher contribution. The other life cycle stages have a small contribution in the climate change impact category, but is higher in fine particulate matter formation, and more substantial in the fossil resource use impact category. This is because the contribution of emissions from combustion of fossil fuels is more pronounced in the latter two impact categories. Especially distribution has a relevant impact on fossil resource use. So, the most relevant life cycle stages contributing to the environmental impact of Nigerian maize product are cultivation, land use change, and to a lesser extent transport.

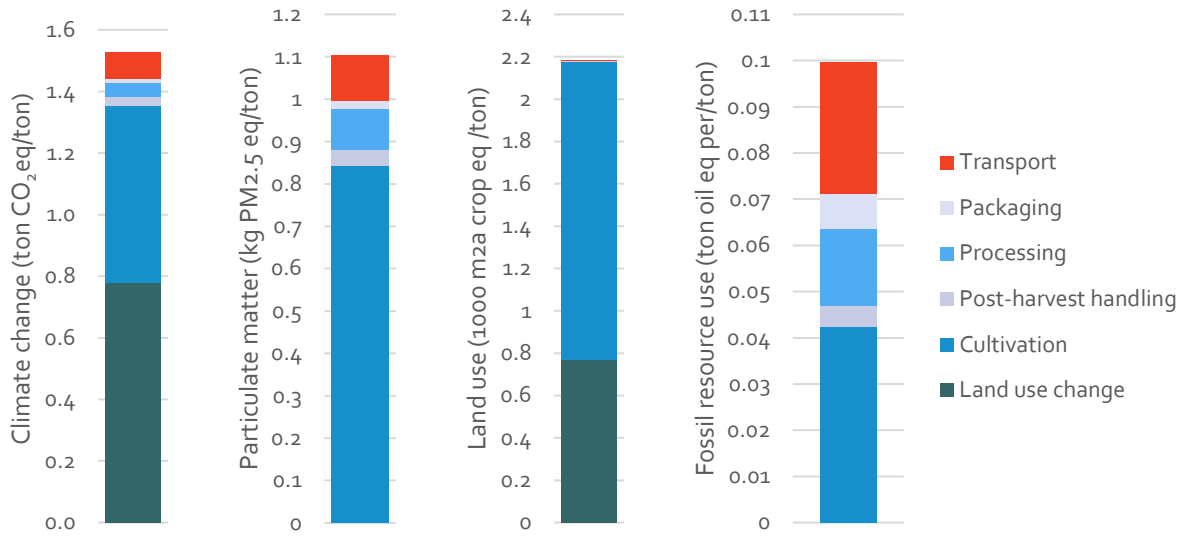


FIGURE 32: CONTRIBUTION OF THE LIFE CYCLE STAGES ON THE FOUR MOST RELEVANT IMPACT CATEGORIES PER TON OF MAIZE PRODUCT

6.2.3.4 Comparing the impact of the different farm types and regions

Comparing the impact of the different farm types – common small holder farmer (SHF1), supported small holder farmer (SHF2), medium scale farmer (MSF), large scaler farmer (LSF) on the most relevant impact categories per ton of maize grains shows that there are large differences in all four relevant impact categories (Figure 33). Differences due to yield variation are most pronounced for land use and climate change. Those are due to the large contribution of land use change, which is linearly related to the yield. The impacts of fossil resource use and particulate matter formation are related to the energy intensity of the cultivation and the inputs, where the mainstream smallholder farmer has a significantly lower impact and large scale farmer a significantly higher impact compared to the other two farm types.

Ammonia emissions causing fine particulate matter formation take place because of fertiliser application and fine particulates are emitted from fertiliser production. The amounts of fertiliser use in the different farm types are based on assumed nitrogen use efficiencies for chemical and organic fertilisers. Diesel use and petrol use per hectare and therefore also per ton of maize is estimated low,

so most of the impact on fossil resource use is from production of inputs, such as fertilisers and pesticides.

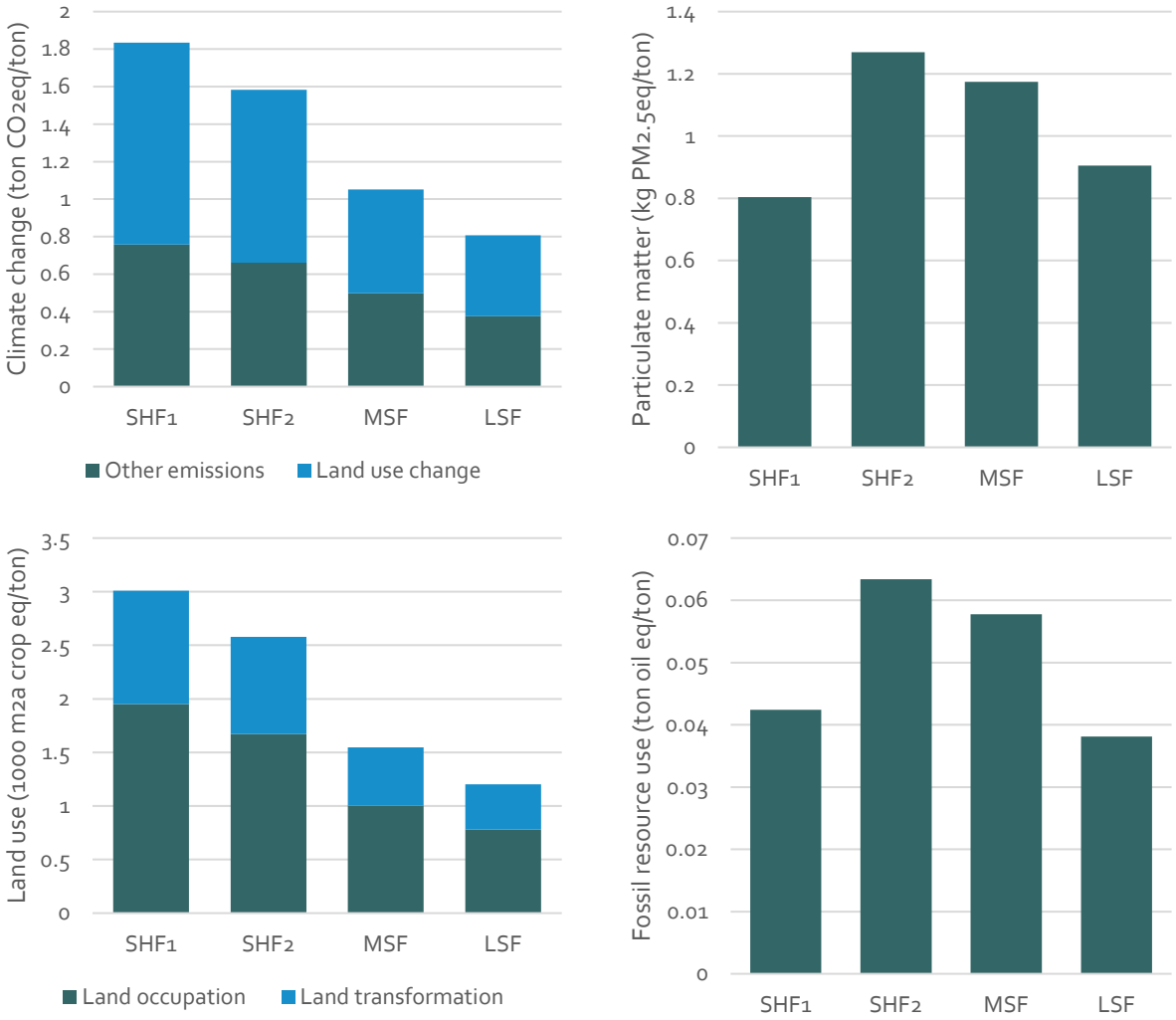


FIGURE 33: COMPARING THE IMPACTS OF 1 TON OF HARVESTED MAIZE GRAINS FROM THE DIFFERENT FARM TYPES FOR THE FOUR MOST RELEVANT IMPACT CATEGORIES

6.2.4 Discussion and conclusions

The following can be concluded from the life cycle assessment of Nigerian maize product:

- The total impact of the Nigerian maize value chain on the endpoint damage categories human health, ecosystems quality and resources per ton maize product (flour/feed/fresh corn on the cob) is:
    - 2.26E-03 DALY per ton of maize product, which means 28,500 life year of a person lost by disease, disability, or mortality due to the production of maize products in 2019.
    - 2.52E-5 species.yr per ton of maize product, which means that the production in 2019 caused the disappearance of 318 species during one year.
    - 38.9 USD of surplus cost valued in the year 2013 due to 1 ton of maize product (increased marginal cost of producing the fossil fuels used in the value chain of the Nigerian maize product) or 491 million USD due to the total production in 2019.
    - 1.5 ton CO_2eq of climate change impact due to 1 ton of maize product or 19.3 10^6 ton CO_2eq due to the total production in 2019.
- Contribution of the midpoint environmental impact categories and environmental interventions (emissions, land uses and resource extractions) on the three damage categories per kg of maize flour or meal:
    - Climate change contributes 63% to human health and 17% to ecosystems quality impact, mainly caused by carbon dioxide emissions from land use change and to a lesser extend from fossil fuel combustion, and nitrous oxide emissions from fertiliser production and use.
    - fine particulate matter formation contributes 31% to human health impact, due to ammonia emissions (almost all from cultivation) and direct fine particulates emissions mainly from cultivation, but also from processing, transport, post-harvest handling, and packaging (in that order).
    - Land use contributes 77% to ecosystem quality impact, which is mainly land occupation for maize cultivation.
    - Fossil resource use explains 99% of the resources impact, which is mainly crude oil and natural gas extraction for energy production throughout the value chain. Crude oil is mainly used for diesel use in cultivation and transport and natural gas is mainly used for electricity use in processing.
- The most relevant life cycle stages contributing to the environmental impact of Nigerian maize flour or meal are
    - cultivation,
    - land use change, and
    - (to a lesser extent) distribution.
- Comparing the impact of the different farm types on the most relevant impact categories per kg of maize grains:
    - The lower the yield, the higher the impact on climate change and land use. The mainstream smallholder farmer has the lowest yield and therefore the highest impact on these categories. On the other hand, this farm type has the lowest impact

on fine particulate matter formation and fossil resource use as it does not use chemical fertiliser and is much less dependent on fossil fuels.

6.3 Yield gap analysis

The water-limited potential yield of maize grains in Nigeria is from about 6 ton per ha in the northern states to up to 13 ton per ha in the southern states included in this study, according to Yieldgap.org (2021) (Figure 34). To be able to reach these yields, several agronomic practices need to be optimal:

- Basic practice (adequate ploughing, seeding, harvesting)
- Improved/hybrid seeds: use varieties that are adapted to the environmental circumstances and to the desired yield
- Weed control: manual or chemical removal of weeds
- Pest & disease management: preventive measures and control using pesticides
- Run-off/erosion control: implementation of ridges, etc.
- Improve soil quality: increase the organic matter content
- Flood control: this is flood management at the (inter)national level
- Adequate fertiliser application: balanced nutrients, regulating the acidity, adapted to the crop needs at different stages

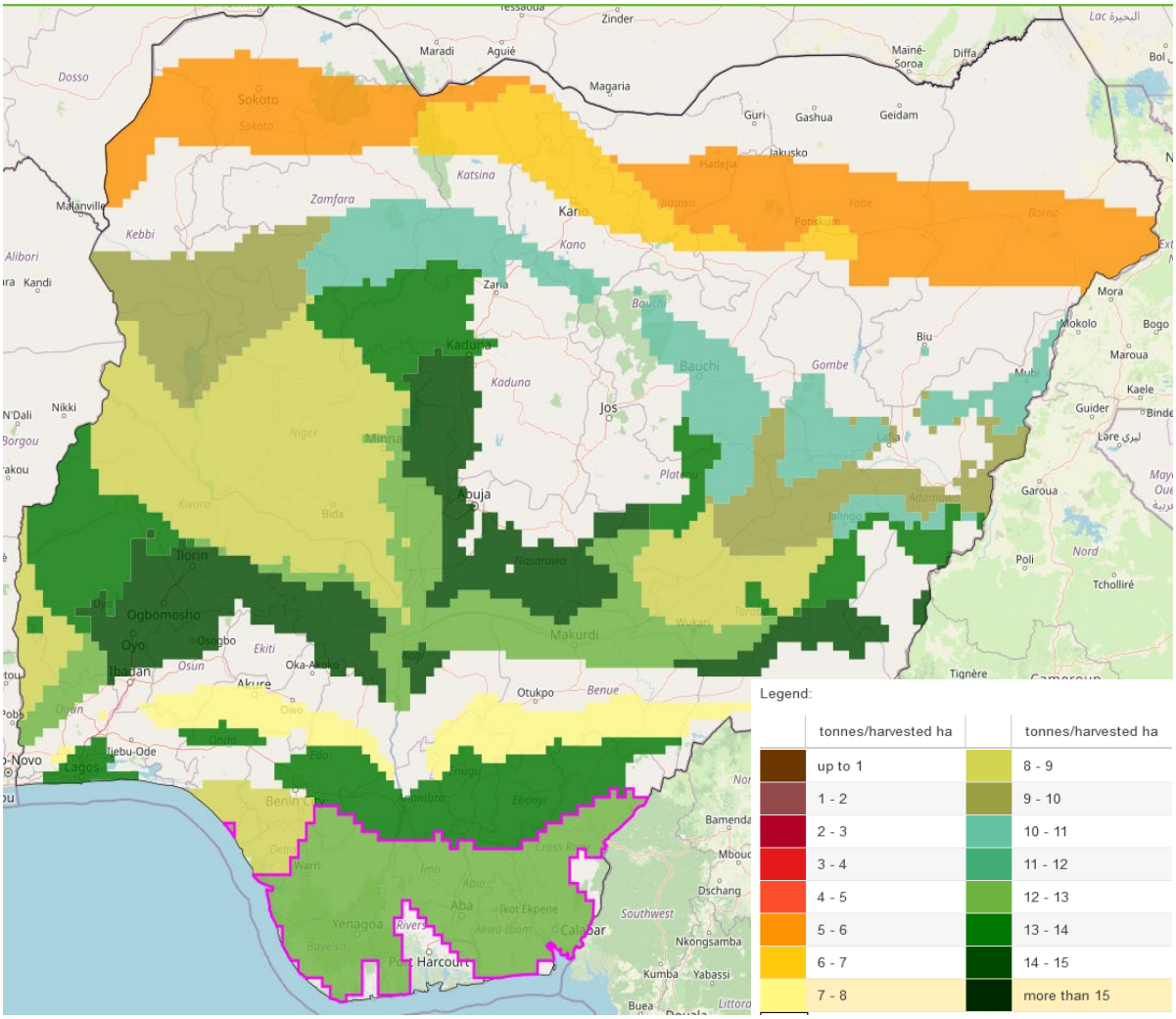


FIGURE 34: WATER-LIMITED YIELD POTENTIAL (SOURCE: YIELDGAP.ORG, 2021)

Figure 35 and Figure 36 show the maize grain yield gap analysis of three different attainable levels of possible agronomic practices in the southern and northern states of Nigeria included in this study and the theoretical practices to reach the potential yield. The graphs are based on expert judgement estimations, but the purpose is for visualising possible contributions of the management practices described above to the actual, attainable and potential yields in the north and south regions. It is expected that the fertiliser management is the main factor affecting the yield, especially in the southern states, where water is less limiting and much higher yields can be attained when adequate fertiliser management is applied. After that the genetics of the seeds has a large contribution to the possibility to attain much higher yields than with current practice.

However, higher yielding varieties are also known to be more dependent on adequate fertiliser and pest & disease management. So, note that this interaction is not visualised in the graphs. Other important factors are pest & disease management and weed control, as pests like fall army worm and weeds such as striga can damage a large share of the yield if not managed properly. Run-off/erosion control and improved soil quality have some effect on the yield, but these effects are more difficult to estimate.

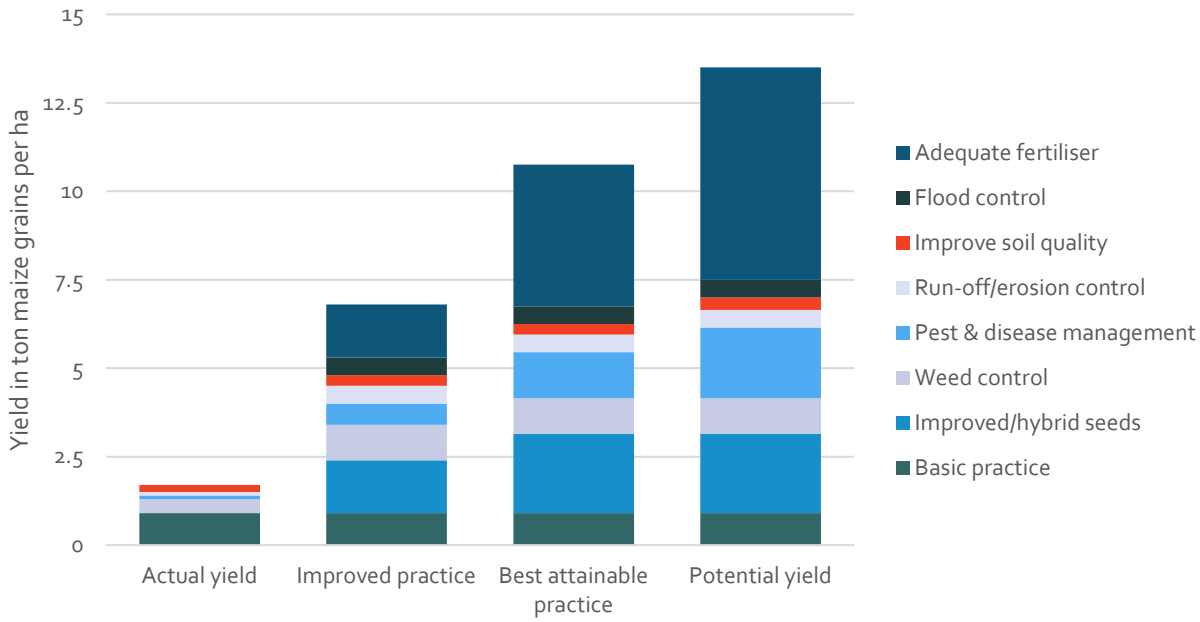


FIGURE 35: MAIZE GRAIN YIELD GAP ANALYSIS OF THREE DIFFERENT ATTAINABLE LEVELS OF POSSIBLE AGRONOMIC PRACTICES IN THE SOUTHERN STATES OF NIGERIA INCLUDED IN THIS STUDY AND THE THEORETICAL PRACTICES TO REACH THE POTENTIAL YIELD (BASED ON EXPERT JUDGEMENT ESTIMATIONS)

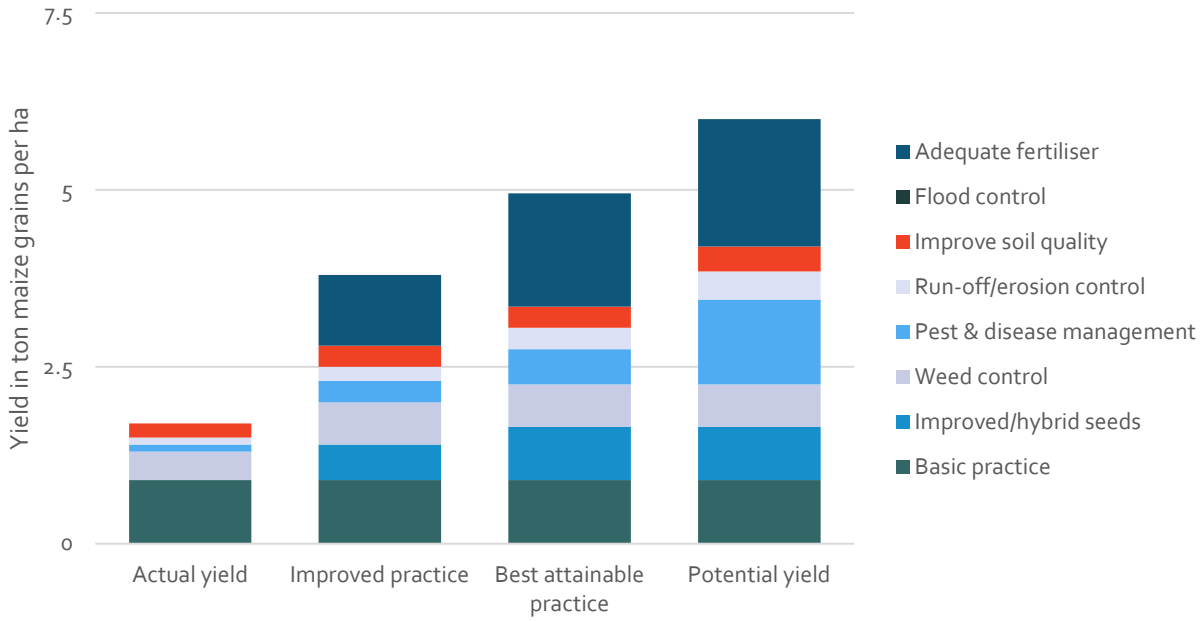


FIGURE 36: MAIZE GRAIN YIELD GAP ANALYSIS OF THREE DIFFERENT ATTAINABLE LEVELS OF POSSIBLE AGRONOMIC PRACTICES IN THE NORTHERN STATES OF NIGERIA INCLUDED IN THIS STUDY AND THE THEORETICAL PRACTICES TO REACH THE POTENTIAL YIELD (BASED ON EXPERT JUDGEMENT ESTIMATIONS)

6.4 Further analysis of the main environmental topics

The following subsections describe the main environmental topics in the order as listed above.

6.4.1 Flooding

Serious flooding events have occurred in the past decades in Nigeria, mainly along the river banks[45]. This has affected many people who had to be displaced and regular cases of deaths. The floods also causes extensive damage to farmlands, including large maize and other crop yield losses, erosion, and landslides. Actors of the value chain think that the flooding has become more severe partly due to climate change, i.e. increasing rainfall in Nigeria and upstream countries. This is confirmed by Dike et al. (2020), who found that heavy rainfall days increased significantly over the Guinea coast and sub-Sahel regions from 1975-2013, resulting from the increasing intensity and frequency of rainfall extremes. The Nigerian Sahel region is characterized by a decreasing wet-day frequency, which demonstrates that a large proportion of the increasing total precipitation in the region is more associated with intense rainfall than its frequency. These characteristic increasing trends of rainfall extremes may explain the frequent flood events over Nigeria (Dike et al., 2020). Heavy flooding events are also thought to be strengthened by the presence of river dams for hydro-electric power generation and water supply for irrigation, industry, and households (Figure 37), as the area directly below the dams bis more vulnerable (Table 24).

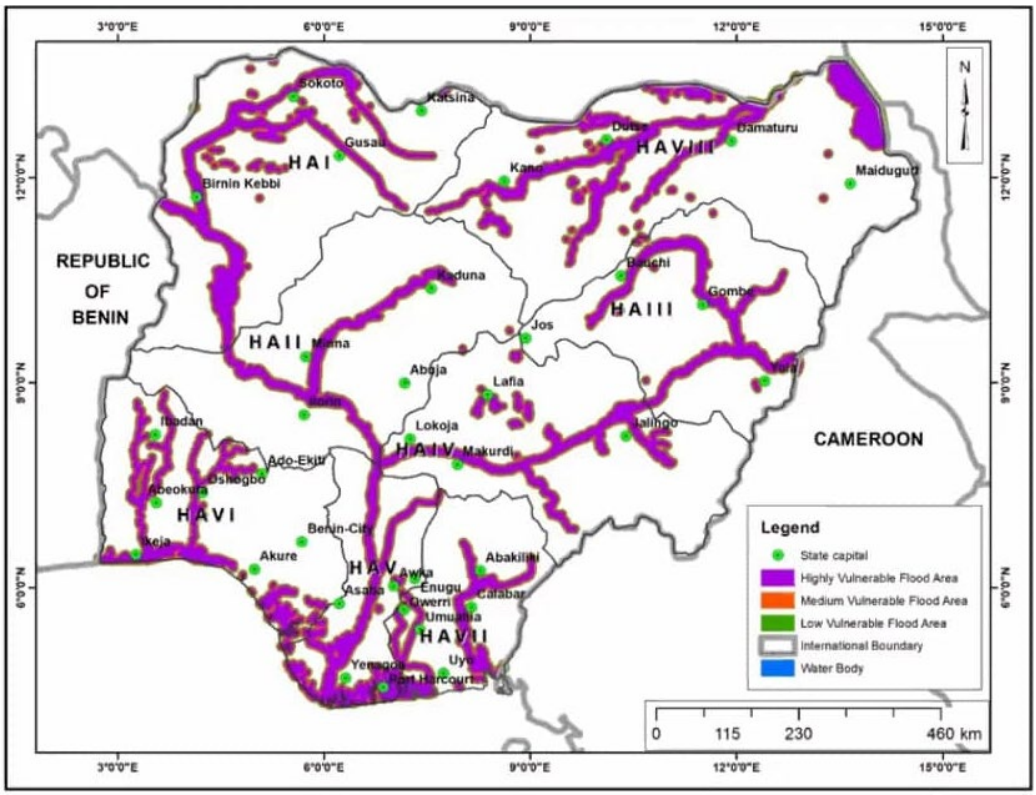


FIGURE 37: FLOOD ZONE VULNERABILITY MAP (SOURCE: 2021 ANNUAL FOOD OUTLOOK)

[45] https://floodlist.com/tag/nigeria

TABLE 24: LIST OF A NUMBER OF LARGE DAMS IN NIGERIA (SOURCE: WIKIPEDIA, 2021)

State	Dam	Capacity (millions of m3)	Surface area (hectares)	Primary usage
Osun State	Ede-Erinle Reservoir	5,300,000	188,558	Water supply
Oyo State	Asejire Reservoir	82,000	2,369	Water supply
Niger State	Kainji Dam	15,000	130,000	Hydro-electric
Niger State	Jebba Dam	3,600	35,000	Hydro-electric power
Gombe State	Dadin Kowa Dam	2,800	29,000	Water supply
Bauchi State	Kafin Zaki Dam	2,700	22,000	Planned - irrigation
Kano State	Tiga Dam	1,874	17,800	Irrigation, water supply
Sokoto State	Goronyo Dam	942	20,000	Irrigation
Kano State	Challawa Gorge Dam	930	10,117	Water supply
Oyo State	Ikere Gorge Dam	690	4,700	Hydro-electric, water supply
Adamawa State	Kiri Dam	615	11,500	Irrigation, plans for hydro-electric
Niger State	Shiroro Dam	600	31,200	Hydro-electric power
Sokoto State	Bakolori Dam	450	8,000	Irrigation
Ogun State	Oyan River Dam	270	4,000	Water supply, irrigation,hydro-electric
Katsina State	Zobe Dam	177	5,000	Water supply
Katsina State	Jibiya Dam	142	4,000	Water supply, irrigation
Kebbi State	Zauro polder project			Irrigation

The flooding is usually most severe in the south-western states, but also near the dams in the northern states. The worst flooding event in Nigeria was in 2012 when most states were affected, but every year there are many people and agricultural land affected. The Nigerian National Emergency Management Agency (NEMA) is responsible for the prevention and management of disasters, including flooding. This governmental organization may provide information on the magnitude of the problem and solutions on how to reduce flooding risks for maize farmers. There are many methods for flood management, such as diversion canals, barriers, and planting vegetation to retain excess water. More effort seems to be needed to align policies on national and local levels in the attempt to manage flooding events better in the future.

6.4.2 Changing rainfall patterns

A number of actors have expressed their concerns about the changing rainfall patterns that have been observed in the past decades in Nigeria (Dike et al., 2020). The changing rainfall patterns include the occurrence of more prolonged dry spells with a higher risk of reduced crop growth, pests, in particular fall armyworm (*Spodoptera frugiperda)* since its arrival in Nigeria in 2016 and the African maize stem/stalk borer (*Busseola fusca*), and weeds, in particular Striga. Many actors mentioned in the outbreak of fall armyworm in 2017, when the pest caused severe damage in many maize fields. Since then, the severity is diminishing, but actors stress the need for farmers to learn and apply integrated pest management techniques to reduce the pest further and prevent outbreaks such as in 2017. An important aspect is that maize farmers have access to irrigation water in the case of prolonged dry spells.

The implementation of Integrated Striga Control/Management (Purdue University, 2021) includes the use of Striga resistant varieties and provides a solution in affected areas, though there are still farmers in Nigeria exposed to ISM practices, who do not adopt the practice due to land endowment constraints (Baiyegunhi et al., 2019). Moreover, Striga resistance genes are still under study in the International Institute for Tropical Agriculture (IITA) maize breeding programme (Yacoubou et al., 2021).

Integrated Pest Management includes the use of pesticides, agronomic practices and botanicals from neem plants; however, the IPM program adopted by Nigerian farmers has not yet achieved appreciable success in eradicating this pest (Odeyemi & Ugwu, 2021). The development of varieties resistant to pests like fall armyworm is also still under development (Rwomushana et al., 2018; FAO, 2018; CGIAR, 2019). Another way to control the pest is the development of the mobile app called "Fall Armyworm Monitoring and Early Warning System (FAMEWS)" by FAO (2020). This provides users of the app current information of when and where the pest is spreading. Control of maize stem borer can be done by biological control using parasitic natural enemies (Calatayud et al., 2020). Also, stimulating insectivorous birds could be a natural method of insect pest control (Tela et al., 2021). The use of the traditional neem extracts is also mentioned as a non-chemical way of pest control (Akhigbe, 2021).

Another effect of the changing rainfall patterns is a reducing length of the rainy season, especially in the northern agro-ecological zones of Nigeria. The shortened rainy season hampers maturing of the grains and reduced grain yields. A solution for this can be the introduction of early or extra early maturing varieties, though the yield potential of these varieties is lower (Tofa et al., 2021).

A third effect of changing rainfall patterns is that in some regions of the country, rainfall may continue after harvest time. When the maize is not adequately handled for drying, the extended rainfall showers can cause moulding and accumulation of aflatoxins in the maize grains. Actors have indicated that the moulded grains are used for feed production. However, the fungal secondary metabolites impose serious health risks on both humans and household animals (Sipos et al., 2021). If moulding cannot be prevented, there are also interventions with chemical agents such as acids, enzymes, gases, and absorbents in animal husbandry that have been demonstrated as effective in reducing mycotoxins in feed and food (Sipos et al., 2021). This may affect poultry health and the quality of meat (Wen et al., 2021) and eggs (Zhao et al., 2021). The Northern Nigerian Flour Mills are installing a laboratory to test the maize grains on aflatoxin as they acknowledge this as a serious health risk.

6.4.3 Low soil fertility

Many actors say that the leading cause of the low average national maize yield compared to South Africa and other African countries is due to low soil fertility in Nigeria. They think that this is partly due to inadequate soil management, soil erosion, and run-off, but largely due to insufficient application of mineral fertilisers (Aliyu et al., 2020). The lack of sufficient mineral fertilisers is mainly a social-economic issue, but from an environmental perspective, there is a need to understand better factors such as soil type, weather conditions, the slope of the land, flooding events, crop rotation, and use of organic fertiliser (Dawi et al., 2017). These factors can give insight into site-specific requirements of the macronutrients nitrogen, phosphorus and potassium, and micronutrients, such as calcium, magnesium, sulphur, zinc, and boron. Several initiatives in the country have started investigating this to formulate regional specific requirements and stimulate the blending of fertilisers (The Guardian Nigeria, 2021). The response of applying fertilisers to the maize crop also depends on the variety and seed quality. So, there is also a need to better understand how much of which varieties are used in

each agro-ecological zone, and which varieties are most suitable for which circumstances (Rurinda et al., 2020). Based on the current state-of-the-art knowledge, digital tools have been developed, also available in a mobile app to calculate the optimal site-specific nutrient requirements (CGIAR, 2021).

6.4.4 Food loss analysis

To be able to make a complete view of the biomass flows throughout the Nigerian maize value chain, different sources were used as shown in Table 25 to Table 29. The values are all approximations but give a global picture of where the total produced biomass during maize cultivation ends up further on in the value chain (Figure 38). This shows that only a small part is used for producing food, while the largest part is used as feed, of which a considerable share is from stalks, husk and cobs, but also maize grains. The residues and maize grains for feed will be converted in a complex of mainly meat, eggs, and manure. Part of the crop residues are going directly or through composting back to the field or is used as fuel. There is some biomass wasted due to pest damage. Postharvest losses in the value chain are in total considerable, mainly due to losses during field drying.

Because of the large contribution of cultivation and land use change found in the life cycle assessment, we can conclude from the food loss analysis and life cycle assessment combined that an important share of this impact is caused by the losses throughout the supply chain. Some ways to reduce the losses and therefore the environmental impact are improving storage facilities and using aflatoxin resistant varieties.

Table 25: Biomass percentages of maize plant parts (Halford, N. G., & Karp, A. (Eds.). (2011). Energy crops (No. 3). Royal Society of Chemistry.)

Plant part	Biomass
Grains	46%
Stalks	28%
Leafs	11%
Cobs	8%
Husk	7%

Table 26: Biomass percentages of maize flour milling (based on own estimates)

Co-products	Biomass
Flour	80%
Germ/bran	20%

TABLE 27: BIOMASS LOSSES

Grain damage	Amount	Unit	Source
Pest damage on the field	0.2	kg dm/kg total biomass	Abrahams et al. (2017)
Harvesting/field drying	0.064	kg/kg dry grains	APHLIS (2021)
Further drying	0.040	kg/kg dry grains	idem
Grains lost during threshing and shelling	0.013	kg/kg dry grains	
Transport from field	0.024	kg/kg dry grains	
Household level storage	0.047	kg/kg dry grains	
Transport to market	0		
Market storage	0		

TABLE 28: RESIDUE MANAGEMENT (BASED ON OWN SURVEY)

Management	Stalks (kg/kg)	Leaves (kg/kg)	Husk (kg/kg)	Cob (kg/kg)
Fed to animals	0.38	0	0.48	0.35
Used as fuel	0.08	0	0.25	0.52
Left on the field/composted	0.5	1	0.18	0.13
Used as material	0.04	0	0	0

TABLE 29: SHARE OF MAIZE GRAINS USED IN FEED PROCESSING, FLOUR PRODUCTION AND CONSUMED AS FRESH ON THE COB

Destination of the maize grains/fresh maize	Maize grains equivalents (%)
Fresh/green maize	6.9
Postharvest losses	15.1
Household consumption by farmers	15.0
Feed grain market (mainly feed mills for poultry/livestock)	35.1
Food/industrial grain market (including for breweries)	23.0
Exports (mainly into regional markets)	4.9

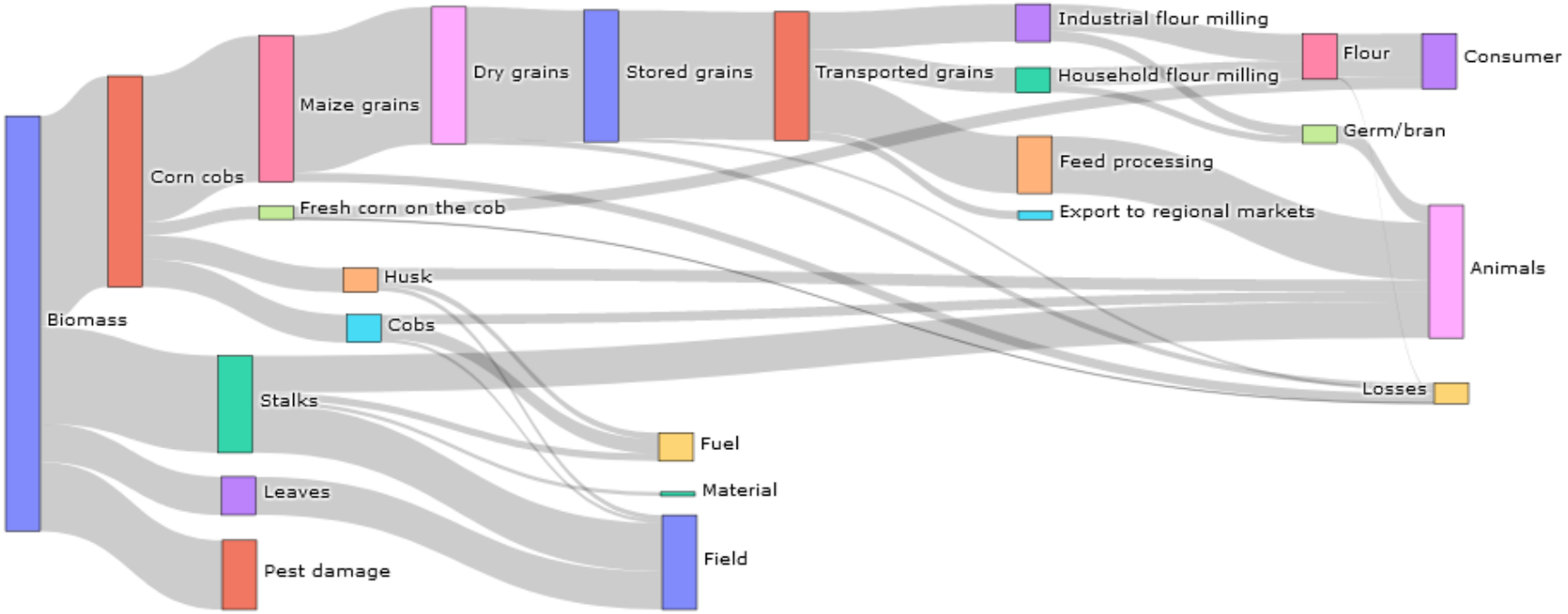


FIGURE 38: SANKEY DIAGRAM TO VISUALISE BIOMASS FLOWS THROUGHOUT THE VALUE CHAIN

6.4.5 Deforestation

Forests provide several valuable functions, as they may reduce the climate change enhanced impacts of extreme events and disturbance, such as wildfires, floods, and droughts (Leal Filho et al., 2021; Orimoloye et al., 2021), but also as forests serve as carbon storage and for preserving biodiversity. Biodiversity provides diverse ecosystem services (provisioning, support, regulating and cultural), provision of food and medicine, raw materials, and aesthetic values (Lohbeck et al. 2016). Awareness among Nigerians of the forests value however seems to be limited (Akindele et al., 2021). Deforestation and agricultural land expansion, among which the increased area under maize cultivation, has caused a considerable loss of forest area in Nigeria in the past decades as observed by USGS (2021;Figure 39). Initially, the trees are cut for timber and particularly for fuelwood because natural gas for cooking is inaccessible for most people in rural areas (Adedayo, 2021). Subsequently, the fields are not reforested due to crop cultivation and cattle grazing. This includes maize cultivation, but directly or indirectly, increasing area under maize cultivation in Nigeria contributes to the pressure on land and therefore contributes to a drive for deforestation activities.

Deforestation is the clearing of trees on land covered with forest, but according to the FAO definition forest is land with at least 10% of tree canopy cover and there is a large difference in impact between the deforestation of dense tropical rainforest in the south of Nigeria and savanna woodland in the central agro-ecological zones of the country. So, it is difficult to assess the actual environmental impact of deforestation in Nigeria, but it is obviously a major environmental issue with long term, partly irreversible effects.

According to the Digital Observatory for Protected Areas (DOPA) Explorer (JRC, 2021), the forest cover in Nigeria is only 5.5%, and Nigeria has an overall low protection rate of 11.6% or 13.9% terrestrial protection (Figure 40). The area of natural ecosystems is according to this source on the other hand, high at 56.6%, even though the agricultural area is 77.7% and the land degradation rate is 31.9%. According to Natural History Museum (2021), the biodiversity intactness has decreased from 58% in 2000 to 53% in 2014 and has likely decreased steadily at a lower rate to 52% in 2020, where the decrease is mainly concentrated in the south (De Palma et al., 2021). On the other hand, there are only few key biodiversity areas identified in Nigeria (Figure 41), which means that most areas in Nigeria are not key to the protection of biodiversity. Given that the biodiversity intactness was already as low as 58% in 2000, most of the key biodiversity damage had likely already occurred before that time. Thus, even though deforestation in the past 20 years in Nigeria may have had less serious effect on biodiversity than would be expected, it likely has had a major impact on land degradation and has certainly contributed to large amounts of greenhouse gas emissions, with subsequent environmental impacts.

One way to reduce the pressure on forest land is to increase crop yields. Especially for Nigerian maize cultivation, there is a vast potential for increasing the yields, as described under the topic of low soil fertility. Increasing crop yields alone, however, does not solve the problem. Alternatives for fuel wood need to be available (Adedayo, 2021). Cultivated land has to be converted back to forests, taking into account the socio-economic (negative and positive) consequences for the farmers. There are some initiatives of planting and nursing tree seedlings, such as organised by Oxfam Nigeria (Oxfam Novib, 2021), but the scale is still small compared to the loss of forests in the past decades. To assure the

growth and protection of the seedlings, local people need to be involved in managing the reforestation activities, and support from local authorities is crucial. To stop further deforestation and stimulate afforestation, serious efforts are required from the national and local governments to align and take action. Currently, there seem to be too many conflicts in policies to address the issues related to deforestation.

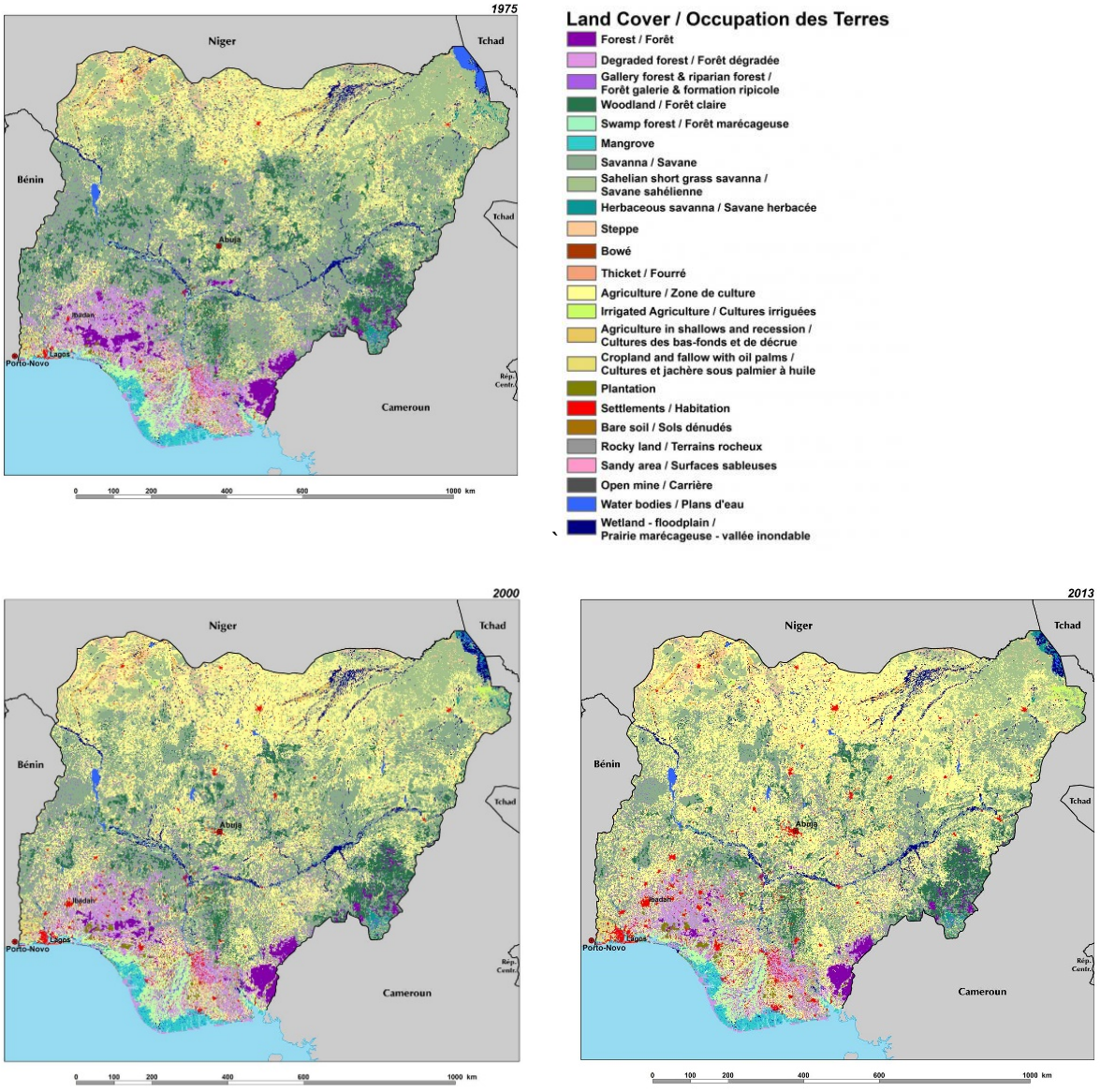


FIGURE 39: LAND USE MAPS OF NIGERIA (2000 AND 2013) (SOURCE: USGS, 2021)

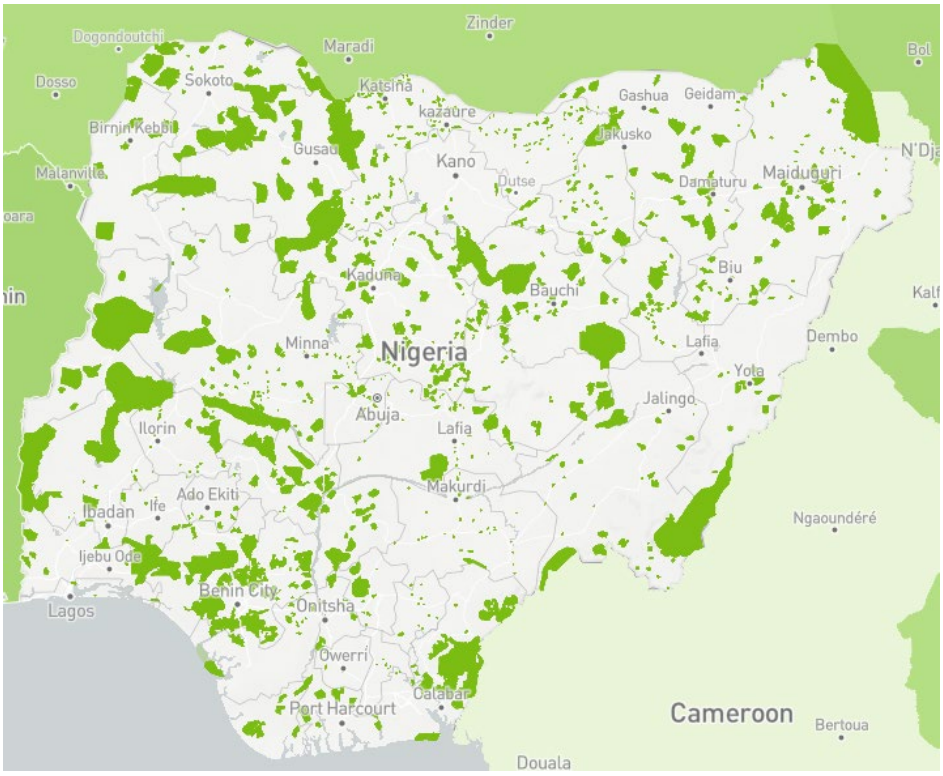


Figure 40: Protected areas of Nigeria (Source: JRC, 2021)

Figure 41: Key Biodiversity Areas (KBAs) in Nigeria (source: Key Biodiversity Areas, 2021)

6.4.6 Fossil energy use/emissions

The use of fossil energy sources cause the scarcity of fossil resources and therefore limits the access to affordable energy for the general population. The combustion of fossil resources results in emissions of nitrogen oxides, particulates, carbon monoxide, and carbon dioxide, which cause human health issues and climate change. Energy is mainly required in the maize value chain for corn flour and animal feed milling (including mechanical drying in the Southern states), and to a lesser extent for threshing, irrigation (though very few farmers apply irrigation to maize), and transport.

The national electricity grid is poorly accessible in rural areas and does not provide reliable and continuous current, so maize processing is mostly done by using diesel generators, which emit large quantities of the mentioned harmful gasses. The Northern Nigerian Flour Mills currently uses four inefficient diesel generators of 30-40 years old, which supplies between 10 and 20% of the electricity for milling. This exemplifies the seriousness of the problem. These generators need to be replaced soon. The question is, what would be the best solution. One possible environmentally friendlier solution than new diesel generators may be solar energy. At a small scale, an entrepreneur from Lagos is installing solar panels in northern Nigeria for small scale maize milling, apparently with success, but this is still at an early phase of implementation. For large-scale milling, however, it may be too challenging to install enough capacity to supply the energy required by the large machines and there may be other technical challenges at that scale.

Another issue with fossil energy is the bad state of the roads. The amount of diesel the trucks need to combust per km is likely much higher than in case the roads are in a good state. Moreover, the trucks are loaded with 30 tonnes of maize bags, which may be higher than the optimal load for the trucks that are used. This needs to be further looked into.

Besides the combustion of fossil resources, another source of greenhouse gasses in the value chain of maize is the use of nitrogen fertiliser. Even though only a few percent of the nitrogen in the fertiliser is emitted as nitrous oxide, the contribution of this gas to climate change is large, because nitrous oxide is about 300 times as potent as carbon dioxide per kg of gas. So, the inefficient use of nitrogen fertiliser has a significant effect on climate change.

6.5 Synthesis of the environmental concerns

6.5.1 Is the value chain environmentally sustainable?

The Nigerian maize value chain is causing environmental damage and could therefore be more sustainable. However, this can be said of almost every food value chain. So, it would be more informative to compare the environmental impact of the value chain with alternative and comparable value chains to determine which value chain has more impact and is therefore less sustainable. For example, the environmental impact could be compared to other carbohydrate rich food products, such as rice or cassava products. We could also compare with more sustainable techniques that could be applied in the value chain. Such comparisons can be complex and go beyond the scope of this study. Nevertheless, the quantitative analyses and literature review in this study give insight into the causes and effects for the environmental concerns related to the Nigerian maize value chain.

6.5.2 Causes and effects of the main environmental concerns

The following can be concluded on the six main environmental concerns identified:

a) **Flooding**: flooding not only regularly affects people's wellbeing in the river areas, especially in the south and near dams, but also affects the agricultural production in these areas, including the production of maize grains. It is caused by increasing rainfall in Nigeria and upstream countries, and the presence of dams likely increases the flooding intensity near the dams. Maize yields may be low due to flood damage, but also due to limited use of fertiliser and extensive agronomic practices, likely because there is high risk of crop damage in general and loss of the investment of buying fertilisers and good quality seeds.
b) **Changing rainfall patterns**: the prolonged dry spells and increased risk of pests and weeds hamper the growth of the maize plants and can limit the growth of the grains. Pests and weeds can damage the yields greatly, which makes the use of costly seeds and adequate amounts of fertilisers to reach higher yields a risky strategy, as irrigation is not feasible in many areas and the pests and weeds can be very persistent in Nigeria.
c) **Low soil fertility**: average maize yields are low in Nigeria partly due to inadequate soil management, soil erosion, and run-off, but improving soil quality is not easy. It depends on many factors, such as soil type, weather conditions, the slope of the land, flooding events, possibilities for crop rotations, and availability of organic fertiliser. Thus, an integrated and site specific approach is needed to understand how to improve the soil quality.
d) **Food loss**: The food loss visualisation shows that there are significant food losses throughout the maize value chain, but that most losses are caused during drying/storage of the maize grains. A large part of the harvested grains and the crop residues is used as feed for animals. The food losses occurring in the value chain of the animal products is however out of scope of this study. Nevertheless, a considerable share of the environmental impact from cultivation and land use change found in the life cycle assessment is caused by the maize lost for both feed and food applications.
e) **Deforestation**: deforestation has been severe in Nigeria in the past 50 years and has likely caused significant loss of biodiversity, contributed to land degradation and large amounts of greenhouse gas emissions. The driver of deforestation in the country is the exponential population increase leading to increasing pressure on land for maize cultivation and other agricultural activities. What part of the biodiversity loss and greenhouse gas emissions from land use change can be attributed to the maize cultivation in Nigeria is difficult to quantify, but the applied methodology at least gives some insight into the magnitude off the problem compared to other environmental issues related to the Nigerian maize value chain. The life cycle impact assessment also showed that the mere occupation of land also contributes significantly to the environmental burden of maize cultivation in Nigeria, especially when low yields lead to increasing land use and land use change.
f) **Fossil energy use/emissions**: combustion of diesel and natural gas for maize cultivation, post-harvest handling, processing and transport contribute significantly to the overall environmental impact of Nigerian maize product. This is mainly because fossil resource combustion leads to carbon dioxide and fine particulate matter emissions, and to increasing fossil resource scarcity. Fertiliser production and use also contribute significantly as this causes greenhouse gas and ammonia emissions (which enhanced fine particulate matter formation).

7. EMERGING CONCLUSIONS AND FORWARD ISSUES

7.1 Introduction

This report has shown, including in Chapter 2, that Nigeria has made giant strides in maize production (depicted in Figure 4). The VC, with a Domestic Resource Cost (DRC) ratio of 0.19, has evident comparative advantage, in particular in the production of non-GM white maize for which it is currently the leading producer of the crop in Africa. South Africa leads in total output of maize, but the bulk of it is GM-maize, which consumers in most African countries do not accept. The maize value chain makes very significant contribution to the country's economy. Total value added generated per annum in the VC is estimated at N1,502 billion (i.e. US$ 4.12 billion). This constitutes 0.9% of national GDP and 3.8% of the country's agricultural GDP.

Upstream public sector investments in promoting adoption of higher-yielding varieties, uptake by farmers of inorganic fertiliser and other inputs as well as market-driven pull by private feedmilling and food processing companies have contributed to this. A recent growth driver is the emergence of large-scale aggregators who are providing a strong link between producers and offtakers. Their entry has enabled some smallholder farmers to overcome some resource constraints as well as opened up opportunities to optimize earnings by trading into a shortened, potentially more remunerative formal market segment.

The Federal Government has the ambition of increasing annual output to 20 million tonnes, that is by about 60%. Considering existing agro-climatic conditions, this is technically feasible. Furthermore, the substantial capacity of the feedmilling industry as well as subregional grain export markets to absorb increased output implies that the growth targeted can be sustainable. There is also great potential for this growth to be inclusive, especially as demonstrated by the performance of the SHF2 producers.

However, achieving this target requires interventions to address a number of identified risks and challenges which are summarised in Table 30. The strengths, weaknesses, opportunities and threats which are prevalent in the value chain have been discussed in some depth in the preceding chapters. In this chapter some actions which can enable actors to address identified weaknesses and constraints and/or better exploit existing/emerging opportunities are discussed. It covers three different levels:

a) Upstream – focusing on producers, including in particular the smallholder farmers who dominate maize production;
b) Midstream – focusing on aggregators and traders; and
c) Downstream transformers including formal processing industries as well as micro/small-scale millers.

TABLE 30: SUMMARY OF STRENGTHS, WEAKNESSES (CONSTRAINTS), OPPORTUNITIES AND THREATS IN NIGERIA'S MAIZE VC

Strengths	Weaknesses/constraints
• Nigeria is the leading maize producer in Africa • Maize flour and (to a lesser extent) fresh corn-on-the-cob (and popcorn) are important sources of carbohydrate • Maize grains, bran, and crop residues are important to feed ingredients for poultry, aquaculture, and livestock • Maize grows in all parts of the country across all agro-ecological zones • There is commendable growth in the agro-processing industries and more chances for increased investments. • With the largest market in Africa, Nigeria has the ready demand for surplus maize supply. Increase interventions from government, CSOs, CBOs, NGOs and private/public sector investors, helps advance chances of increased production and processing to satisfy the local market. • Available skilled and unskilled labour for maize production, processing and marketing. • Nigeria has the available land and favourable climate to increase maize production. • Rise in private sector involvement and evolution of entrepreneurship, women and youth participation has improved the entire value chain, including improving access to capital and other factors of production. • Availability and affordability of improved maize varieties. • Imposition of bans on maize imports to protect local producers.	• Low yields compared to other large maize producing countries • No steady production/supply over the years • Limited access to public extension services • Lack of finance • Postharvest challenges/food waste • The effect of Aflatoxin • Low soil fertility/soil erosion • Deforestation due to expansion of the arable land area for maize and other crops • Yield losses due to fall armyworm, stem borer, Striga, and other pests • Flooding causes yield losses and land degradation • The use of diesel for milling and transport causes greenhouse gas and air-emissions • Policy obstacles • Erratic rainfalls and other climate change effects that cause regular unplanned shifts. • Existence of several representative organisations but lacking capacity to address key challenges facing VC actors

Opportunities	RISKS/Threat

• Vitamin A maize varieties
• Aflatoxin resistant maize varieties
• Major regional exporter of non-Genetically modified (non-GMO) maize varieties
• Better access to fertiliser blends according to the site-specific crop needs
• Farmers associations can improve their organisation to improve yields and reduce postharvest losses through…
• Improve access to extension services
• Improve access to finance
• Mobile apps for warnings and advice on pests, flooding, rainfall, varieties, fertilisers
• Index-based insurance piloting and promotion nationwide, due to occurrence of drought and flooding.
• Increased investment opportunities across the maize value chain through the Nigerian Investment Promotion Commission
	• **Natural risks** originate from the crop production environment.
	  ○ Weather risks e.g. drought, floods, erratic rainfall, and hailstorms.
	  ○ Biological risks: crop and livestock diseases and pests.
	• **Market risks** arise from imperfections in inputs and output markets, including:
	  ○ Uncertain access to inputs.
	  ○ variability in inputs quality, and volatility in prices.
	  ○ Uncertain access to remunerative markets; volatility in output prices (affect both producers and consumers).
	• **Human health risks** affect the availability of family/non-family labour. Including endemic diseases (e.g., malaria), epidemics (e.g. Ebola) and pandemics (e.g. COVID-19).
	• **Policy and regulatory risks** can cause volatility in prices and/or uncertainty in transacting. Includes macroeconomic policies which drive up inflation, and affect interest rates and exchange rates.
	• **Unpredictable agricultural trade policies** which affect trade in maize and other agricultural commodities within the sub-regional market (e.g. into Sahelian countries and Cameroon).
	• **Security risks** may be localised or national. Civil strife and/or breakdown in law and order affecting the security of farmers and traders.
	• **Production risks** may cause domestic shortages resulting in imports which can threaten value chain actors.

7.2 Upstream challenges and potential solutions

Maize is an integral food item in cereal-based diets in all states of Nigeria. It also has prominence as a cash crop, offering income generating opportunities for smallholder farmers, women and youth-led businesses (artisanal processing, trading/ aggregating for large mills and distant markets) and industrial uses in the poultry and animal feed industries. SHF1 producers who lack the means to acquire and utilize yield-enhancing inputs. Women carry out most of the production-related tasks and are also involved in traditional processing and small-scale trading in local markets. Most SHF1 farmers lack access to finance and extension advisory services, though land does not seem to be a binding constraint. Their low-inputs, low-yield farming system is technically profitable as the return on turnover is an appreciable 34.2%. However, annual maize-based income per household, which is estimated at about N68,000 ($190) is well below the national poverty line (estimated at N137,000 or $380). This implies that SHF1 households cannot subsist on income from maize cultivation alone.

Not surprisingly, the youth appear not to be interested in producing maize at this scale, especially as formal sector earnings are substantially higher (the national minimum wage is about N360,000 or $640 per annum). Wage rates tend to be unequal for male and female labourers engaged in upstream activities such as planting, weeding and harvesting. Most SHF1 producers rely on unpaid family labour do not apply and there are no formal contracts.

The case of SHF2 producers, discussed in Chapter 3, shows that interventions which boost output and productivity among smallholders can lead to significant positive impacts. The interlocked ties which these smallholders have with private grain aggregators/service providers enables them to access inputs (mainly inorganic fertiliser, improved seeds, pesticides and herbicides for weed control). As a result, they become more productive (with their yields rising by over 16%). They are also able to expand area under maize cultivation and, crucially, sell their output into an assured but also shorter marketing chain which leads to an increase in the margins they obtain. They also obtain extension advisory services as part of the package of support provided by the aggregators.

Direct economic, social and environmental impacts are associated with these interventions which enable smallholder farmers to transition from SHF1 to SHF2. It fosters financial inclusion for smallholders, making inputs credit available to them, even if indirectly. Maize-based household income also rises significantly, to about N252,000 ($700) per annum, which is far above the poverty line, implying that the transition to SHF2 can be an effective means for smallholders to escape poverty.

This income is also higher than the annual national minimum wage by 9.4%. It is therefore not surprising that the team found a number of youth engaged in outgrower schemes involving grain aggregators. Most of these young farmers, mainly men, usually travel from the north into southern communities to engage in informal employment or trading but

return “home” to invest in maize production. The indication is that programmes which catalyse transition from SHF1 to SHF2 can help in stemming rural to urban migration, especially by the youth.

In terms of household food and nutrition security, it emerged from consultations with most smallholders that increased output usually resulted in increase in household food availability because the food systems tend to be based predominantly on available cereal grains. The rise in household income also implies that SHF2 producers are able not only to meet daily calorific needs but also be better-placed to buy other nutrient-rich food sources. In this context, it is important to note that the poultry industry is one of the most important offtakers of maize grain in Nigeria. Growth in the egg value chain, which is dependent on maize output (as maize accounts for over 60% of the cost of egg production) affects access to affordable animal protein sources.

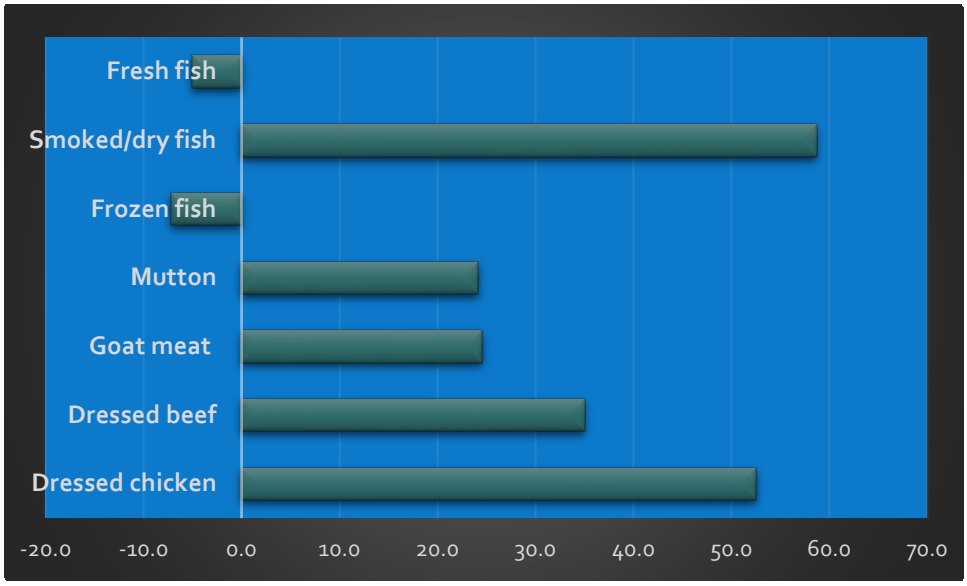
Official data published by the NAERLS (2019) indicates that the average cost per kilogram of eggs in Nigeria in 2019 was about N970 ($2.70)[46] across the country. Average egg prices are lower in the north, estimated at about N900 ($2.50) per kilogram. The average cost in the south is about N1,045 ($2.90) per kilogram. Figure 42 below shows how the cost of eggs compares with other animal protein sources.

Apart from some fish products, all other animal protein sources are more expensive than eggs. For instance, a kilogram of beef is about 35% more costly than eggs. Even though beef production is mainly concentrated in the north and the poultry industry is centred in the south, dressed beef cost about 32% more per kilogram than the equivalent in eggs in the north. Mutton and goat meat are over 20% more expensive than eggs. Quite interesting is the comparative cost of dressed chicken to eggs – about 50% higher – an indication that the poultry industry is more into egg production than the production of broiler meat.

Fresh fish and frozen fish are marginally cheaper than eggs, between an average of 5% to 7%. It has to be noted that fresh fish, especially from the sea, is generally seasonal and there is a general preference for fresh or dried/smoked fish, which incidentally is almost 60% more expensive than eggs.

FIGURE 42: COMPARATIVE COST OF ANIMAL PROTEIN SOURCES IN NIGERIA (2019)

[46] This estimate is based on the conversion of the market price from per dozen or crate of eggs into kilos using an average weight of between 55-60 grams per egg. This is to allow for ease of comparison with other animal protein sources.



Source: Based on data from NAERLS, 2019.

As far as the environmental impact of the transition to SHF2 is concerned, the most important effect is from increasing yields as it leads to more efficient conversion of cultivated land back into natural ecosystems, allowing more biodiversity and carbon storage in vegetation and soils (carbon storage helps reduce carbon dioxide in the atmosphere and therefore mitigates climate change). This evidence is consistent with the conclusions by Burney et al. (2010), who demonstrate that increase in crop productivity from 1961 to 2005 helped to avoid up to 161 Gt of carbon emissions and were a relatively cost effective for mitigation, despite use of inputs that increased emissions. Similarly, Vlek et al. (2004) found that increase in yield resulting from a 20% rise in the utilisation of fertilizer in the production of rice, wheat, and maize can take almost 23 million hectares out of cultivation without changing the level of production.

However, it is important to stress that yield increase should not be limited to the application of chemical fertilisers and pesticides as this may have a negative impact on soil quality, i.e. fertility and water holding capacity, and surrounding ecosystems. Soil conservation practices therefore need to be an integral part of supporting farmers to increase yields. This includes application of compost, mulch and/or animal manure, crop rotations including leguminous crops, applying conservation/ridge tillage for run-off and erosion control, and planting trees where possible for soil conservation, biodiversity stimulation and carbon storage. It is important that these practices are promoted as part of the package offered by the public extension system as well as by the private aggregators as part of their outgrower schemes.

7.3 Midstream actions

Until recently, the midstream section of the maize value chain was entirely dominated by micro, small and medium-scale aggregators who focused mainly on carrying out the spatial marketing function of buying from producers and supplying to end-users. Being capital constrained meant that they could not offer much by way of storage and they also did not provide pre-financing of inputs for farmers. This has changed with the entry of the large-scale aggregators (see Box 2.2), and the benefits in terms on impact on SHF2 farmers has been discussed in the preceding section.

Their capacity to leverage finance from local sources (e.g. as anchor borrowers) is what enables them to support smallholders whilst meeting the requirements of formal grain users such as feedmillers and food manufactures. Though it primarily involves direct procurement from smallholder farmers, it allows for other smaller-scale aggregators to participate by supplying to them and or other wholesalers.

One drawback of this emerging system is the perception that it is not sufficiently transparent. Farmers appear to have a "weak voice" because they are not represented in bargaining between the more powerful aggregators and individual smallholders. Several farmers organisations exist (and many were consulted by the team). However, their focus seems to be more on lobbying for involvement in subsidized inputs (e.g. fertiliser) than in effectively representing farmers in such negotiations. None of the farmers' organisations consulted played a significant role in output marketing. This capacity constraint needs to be addressed as part of the process of strengthening the midstream segment of the value chain. In particular, by ensuring more fair bargaining the sustainability of the emerging distribution chains dominated by large-scale aggregators can be assured and upscaling achieved. Further to this, the policy obstacles which create price volatility needs to be addressed, especially the ad hoc trade interventions which have been shown in discussions in Chapter 4 to impact negatively on the predictability of producer prices.

7.4 Downstream actions to boost value added in the maize chain

The predominantly white maize-based production system in Nigeria is one of the factors contributing to the high incidence of Vitamin A deficiency, especially in the north. Cultivation of Vitamin A maize (VAM) is seen as having the potential to address this challenge as producers will also have access to home-grown nutrient-rich maize. Lack of mainstream market for VAM is however hampering uptake of cultivation by most producers, including medium and large-scale farmers. So far it is unclear whether the major feedmillers and food manufacturers offer sufficient market incentives to turn this situation around. This is partly due to the fact that they are uncertain about consistent supplies – hence the need to work out an integrated plan that builds supply and offtake capacity simultaneously.

Whilst streamlining the midstream section of the maize value chain (as in Section 7.3) will encourage investment by formal sector players involved in grain transformation it is

important to also pay attention to the specific needs of the micro/small-scale milling industry. Investing in transforming the operations of these actors can produce significant social impacts, including creating employment opportunities for the youth.

It is also anticipated that such a drive can be crucial in reducing emissions at that level, considering that most of them are using antiquated machinery which contribute to high levels of pollution. Indeed, an important way to reduce the environmental impact in the value chain is the use of more sustainable energy sources, including at the level of the transformers. Currently there are very few alternatives though. Solar panels may provide a solution, but besides technical challenges, there is a considerable investment and risk that the solar panels get stolen. For transport, there are currently no noteworthy alternatives to fossil fuels. Transportation could be made more efficient though to reduce the emissions, in particular by improving the roads.

In targeting improvements at the level of micro/small-scale transformers, the major health safety problems identified at the milling operations visited need the attention of policymakers in addition to the food safety issues noted in Chapter 4.

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Annex 1:

TABLE 31: SELECTED BACKGROUND DATASETS FOR INPUTS AND OUTPUTS OF THE DIFFERENT LIFE CYCLE STAGES (DB=DATABASE; EI=ECOINVENT; AFP=AGRI-FOOTPINT)

Input/output	Background dataset selected	DB
Seeds	Maize seed, organic, for sowing {GLO}| market for | Cut-off, S	EI
Diesel for tractor	Tillage, ploughing {GLO}| market for | Cut-off, S	EI
Petrol for spraying equipment	Application of plant protection product, by field sprayer {GLO}| market for | Cut-off, S	EI
Urea	Urea, as 100% CO(NH2)2 (NPK 46.6-0-0), at regional storehouse/RER Economic	AFP
NPK 15-15-15	NPK compound (NPK 15-15-15), at regional storehouse/RER Economic	AFP
NPK 20-10-10	NPK compound (NPK 15-15-15), at regional storehouse/RER Economic	AFP
Ammonium nitrate	Calcium ammonium nitrate (CAN), (NPK 26.5-0-0), at regional storehouse/RER Economic	AFP
Ammonium phosphate	Di ammonium phosphate, as 100% (NH3)2HPO4 (NPK 22-57-0), at regional storehouse/RER Economic	AFP
Pig manure	Manure, liquid, swine {GLO}| market for | Cut-off, S	EI
Poultry manure	Poultry manure, fresh {GLO}| market for | Cut-off, S	EI
Compost	Compost {GLO}| market for | Cut-off, S	EI
Carbofuran	Carbofuran, at plant/RER Economic	AFP
Atrazine	Atrazine, at plant/RER Economic	AFP
Paraquat	Paraquat, at plant/RER Economic	AFP
Glyphosate	Glyphosate, at plant/RER Economic	AFP
pesticides emissions	pesticides emissions | cultivation | VCA4D Nigeria	own
Agro-chemical packaging	Packaging, for fertilisers or pesticides {GLO}| market for packaging, for fertilisers or pesticides | Cut-off, S	EI
Crop residues harvested fraction	Biowaste {GLO}| treatment of biowaste, municipal incineration | Cut-off, S	EI
Crop residues burned on field fraction	Biowaste {GLO}| treatment of biowaste, municipal incineration | Cut-off, S	EI
Crop residues fed to animals fraction	Biowaste {RoW}| treatment of biowaste, industrial composting | Cut-off, S	EI
Packaging to landfill	Waste plastic, mixture {RoW}| treatment of waste plastic, mixture, sanitary landfill | Cut-off, S	EI
Packaging recycled	Mixed plastics (waste treatment) {GLO}| recycling of mixed plastics | Cut-off, S	EI
Packaging burned	Waste plastic, mixture {RoW}| treatment of waste plastic, mixture, municipal incineration | Cut-off, S	EI
Dry maize cob yield for fuel	Biowaste {GLO}| treatment of biowaste, municipal incineration | Cut-off, S	EI
Dry maize cob yield for feed	Biowaste {CH}| treatment of biowaste by anaerobic digestion | Cut-off, S	EI
Dry maize cob yield for compost	Compost {RoW}| treatment of garden biowaste, home composting in heaps | Cut-off, S	EI
Dry maize husk yield for fuel	Biowaste {GLO}| treatment of biowaste, municipal incineration | Cut-off, S	EI
Dry maize husk yield for feed	Biowaste {CH}| treatment of biowaste by anaerobic digestion | Cut-off, S	EI
Dry maize husk yield for compost	Compost {RoW}| treatment of garden biowaste, home composting in heaps | Cut-off, S	EI
Diesel	Diesel, burned in agricultural machinery {GLO}| market for diesel, burned in agricultural machinery | Cut-off, S	EI
Wood	Heat, district or industrial, other than natural gas {RoW}| heat production, wood chips from industry, at furnace 300kW | Cut-off, S	EI
Diesel	Transport, freight, lorry 3.5-7.5 metric ton, euro4 {RoW}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Cut-off, S	EI
Polypropylene bags	Polypropylene, granulate {GLO}| market for | Cut-off, S	EI

From grid	Electricity, low voltage {NG}| market for electricity, low voltage | Cut-off, S	EI
Solar panels	Electricity, low voltage {ZA}| electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted | Cut-off, S	EI
warehouse	Building, hall, steel construction {RoW}| building construction, hall, steel construction | Cut-off, S	EI
pesticides	pesticides emissions | storage | VCA4D Nigeria	own
Pesticides	Pesticide, unspecified {GLO}| market for | Cut-off, S	EI