VCA4D
VALUE CHAIN ANALYSIS FOR DEVELOPMENT

agrinatura for European Commission

Groundnuts value chain analysis in Ghana

Ulrich Kleih
Simona Bosco
Ravinder Kumar
Joseph Apeeliga
Baqir Lalani
Seth Yawlui

June 2020

UNIVERSITY of GREENWICH
NRI | Natural Resources Institute
Sant'Anna School of Advanced Studies – Pisa

Value Chain Analysis for Development (VCA4D) is a tool funded by the European Commission / DEVCO and is implemented in partnership with Agrinatura.

Agrinatura (http://agrinatura-eu.eu) is the European Alliance of Universities and Research Centers involved in agricultural research and capacity building for development.

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-

Team Composition
Economist and Team Leader: Ulrich Kleih and Baqir Lalani (Natural Resources Institute, University of Greenwich)
Social expert: Ravinder Kumar (Natural Resources Institute, University of Greenwich)
Environmental expert: Simona Bosco (Sant'Anna School of Advanced Studies, Pisa, Italy) National experts: Joseph Apeeliga and Seth Yawlui (Independent consultants)

The report was produced through the financial support of the European Union. Its content is the sole responsibility of its authors and does not necessarily reflect the views of the European Union. The report has been realized within a project financed by the European Union (VCA4D CTR 2016/375-804).

Citation of this report: Kleih, U., Bosco, S., Kumar, R., Apeeliga, J., Lalani, B., Yawlui, S., 2020, Groundnuts Value Chain Analysis in Ghana. Report for the European Union, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375-804), 150p + annexes

VCA4D Project Management Unit Support
Heval Yildirim | Methodology and economic analysis software (AFA)
Giorgia Mei, Sara Baumgart, Olimpia Orlandoni| Project management and graphic design

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ACDEP	Association of Church-Based Development NGOs
AFA	AgriFood chain Analysis; software for economic analysis of value chains
ASH	Aggregator linked smallholder farmers
CSIR	Council for Scientific and Industrial Research
CF	Commercial farms
DEVCO	European Commission's Directorate-General for International Cooperation and Development
DFID	Department for International Development
DRC	Domestic Resource Cost ratio
EC	European Commission
ECOWAS	Economic Community of West African States
EDF	European Development Fund
EPC	Effective Protection Coefficient
EUD	European Union Delegation
FBO	Farmer based organisation
FDA	Food and Drugs Authority
FRI	CSIR Food Research Institute
FTE	Full Time Equivalent
GAP	Good Agricultural Practice
GEPA	Ghana Export Promotion Authority
GhAIP	Ghana Agricultural Investment Plan
GHS	Ghana Cedis
GIZ	Deutsche Gesellschaft fuer Internationale Zusammenarbeit (German Agency for International Cooperation)
GLSS	Ghana Living Standards Survey
GN	Groundnuts
GoG	Government of Ghana
GSA	Ghana Standards Authority
GSS	Ghana Statistical Service
GWP	Global Warming Potential
Ha	Hectare
IC	Intermediate consumption
ICT	Information and Communication Technology
IFPRI	International Food Policy Research Institute
IGS	Intermediate Goods and Services
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organization
Km	Kilometre
KNUST	Kwame Nkrumah University of Science and Technology, Kumasi
LCA	Life Cycle Assessment
LG	Local Government
LUSPA	Land Use and Spatial Planning Authority (previously TCPD)
MADE	Market Development Programme for Northern Ghana
MOAP	Market Oriented Agriculture Programme
MoFA	Ministry of Food and Agriculture
Mt	Metric tonne
NASH	Non-aggregator linked smallholder farmers
NDA	Northern Development Authority

NGO	Non-Governmental Organisation
NIP	National Indicative Plan
NOP	Net Operating Profit
NPC	National Protection Coefficient
NR	Northern Region
NRI	Natural Resources Institute, University of Greenwich
NSEZ	Northern Savannah Ecological Zone
PFJ	Planting for Food and Jobs Programme
SADA	Savannah Accelerated Development Authority
SARI	Savannah Agricultural Research Institute
SME	Small- and Medium-scale Enterprise
SRID	Statistics, Research and Information Directorate, MoFA
T	Metric tonne
UDS	University of Development Studies, Tamale
UER	Upper East Region
UK	United Kingdom
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
US$	United States Dollar
UWR	Upper West Region
VA	Value Addition
VAT	Value Added Tax
VC	Value Chain
VCA4D	Value Chain Analysis for Development
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security
VSLA	Village Savings and Lending Association

Exchange rates (October 2019)

Euro (EUR) 1 = Ghana Cedis (GHS) 6

US Dollar (US$) 1 = Ghana Cedis (GHS) 5.4

ACKNOWLEDGMENTS

The authors would like to thank the stakeholders of the Ghanaian groundnuts value chain for their support and information provided during the course of this study. In particular, thanks are due to the many farmers, processors, traders, government officials, NGOs, and national and international organisations who have freely given of their time and provided information. The support and encouragement by colleagues and the PMU are gratefully acknowledged. We are grateful to the EC Directorate-General for International Cooperation and Development (DEVCO) and the EU Delegation to the Republic of Ghana for funding and supporting the study. The views expressed in this report are those of the authors and do not necessarily represent the views of EC DEVCO or the EU Delegation in Accra.

Executive summary

The relevance of focusing on value chain analysis is that it can make information and knowledge available and usable to support policy dialogue, decision-making, the role of the private sector, interventions' scale up and accountability, etc. Value Chains Analysis is a powerful tool for assessing a value chain potential in terms of growth, inclusiveness and sustainability. As requested, the analysis is guided by four questions: (1) what is the contribution of the VC to economic growth? (2) Is this economic growth inclusive? (3) Is the VC socially sustainable? (4) Is the VC environmentally sustainable? To answer these four questions, the analysis of the value chain is structured and subdivided into four sub-analyses: a functional analysis (Chapter II), an economic analysis (Chapter III), a social analysis (Chapter IV) and an environmental analysis (Chapter V).

In Ghana, groundnuts (*Arachis hypogaea* L) form an important part of the diet and are almost exclusively produced for domestic consumption in the form of products such as groundnut (GN) paste, snacks/roasted GN, oil, flour, and *kulikuli* (fried GN cake). In 2017, the annual groundnut production (with shell) was of the order 420,000 tonnes, produced on 338,000 hectares. Non-aggregator linked smallholder farmers (NASH) account for an estimated 88% of production, have an average groundnut (GN) farm size of 0.76 ha, and a yield of 1.3 t/ha of unshelled groundnuts. Aggregator linked smallholders (ASH) account for 10% of production, have average GN farms of 0.96 ha, and a yield of 1.6 t/ha. Commercial farmers (CF) account for 2% of GN production, have average farm sizes of 3.12 ha, and a yield of 2.2 t/ha. In addition, a sensitivity analysis has been undertaken for NASH farmers with a yield of 800kg/ha.

The bulk of groundnut production in Ghana takes place in northern parts of the country. There are about 201,000 tonnes of shelled groundnuts available in Ghana (shelling ratios of 0.47 at non-aggregator linked smallholder farmers level, and 0.55 at aggregator-linked and commercial farmers levels). The areas under groundnut production have gone down by 9 percent, over last 10 years, the country is increasingly relying on groundnut imports to meet its domestic demand. Approximately 34,000 tonnes of groundnuts are imported from neighbouring ECOWAS countries such as Nigeria, Burkina Faso, and Niger.

It is estimated that 20%, 10% and 5% of groundnuts are kept by NASH, ASH, CF farmers respectively, for on-farm consumption including seeds. The remaining groundnuts are sold by farmers in either shelled or unshelled form to aggregator and wholesale traders. According to trader interviews about 40% of sold groundnuts are consumed within the North of the country and about 60% in the South. It is assumed the proportions are the same for imported groundnuts. If groundnuts have not been shelled by farmers then traders will hire shelling services, which are mostly mechanised.

Processors of groundnuts prepare a range of products, including paste, snacks/roasted groundnuts, *kulikuli* (with oil as by-product), and groundnut flour (also with groundnut oil as by-product). Other, less important, groundnut products include *nkatie* cake. The bulk of the production takes place in the informal sector, mostly consisting of micro or small-scale enterprises. The resulting products, which form an important part of the Ghanaian diet, are sold through retailers, street vendors, restaurants, or institutions.

Physical post-harvest losses (grain losses) are 1.5% at production stage in the value chain according to a survey carried out by the team in Northern Ghana in August/September 2019. Given their relatively small size, they have been included in the shelling ratios which are raised to 47% for NASH farmers and 55% for ASH and CF farmers. Loss figures further downstream in the value

chain have been taken into account through the conversion ratios for processors and vary from 9% - 16% depending on the groundnut product and whether production is artisanal or semi-industrial. Aflatoxins are important, in particular for some processed products such as groundnut paste and *kulikuli*.

In addition to the informal sector, there is a formal sector preparing mostly groundnut paste or snacks, which are either sold in supermarkets or marts, or exported (e.g. to Nigeria or North America). The quantities produced by the formal sector are estimated at about 5,800 tonnes of paste and 5,700 tonnes of snacks. The majority of enterprises in the formal sector are SME factories, although a larger factory prepares snacks for the domestic market and exports.

Economic analysis

The economic analysis consists of a financial analysis, analysis of the effects within the national economy, an assessment of the viability within the global economy and an analysis of growth inclusiveness. A summary of the results of the economic analysis is presented below.

Overall, the groundnuts value chain is important for the Ghanaian economy in that the value of production in the chain is significant (i.e. about GHS 2.73 billion/€ 455 million), and in terms of employment generated (e.g. it is estimated that in total about 293,000 to 439,000 entrepreneurs plus 358,000 workers are employed in the groundnuts value chain). The majority of the entrepreneurs consist of smallholder farmers; however processors and retailers also have important numbers of enterprises as shown in the main text of the report. The groundnuts production sector is important as an employer in that farmers, in addition to their own labour, often hire workers on a daily basis for certain cropping tasks.

As for the sub-chains in the groundnuts value chain it is to note that the formal sub-chain uses 7.5% of the volume of groundnuts but generates 11% of the direct VA. This shows how the formal sub-chain leads to increased VA, for example through better quality of groundnuts used and products produced (e.g. through improved processing technology, better packaging) for consumers who are able to buy them at a better price.

At the same time, one needs to consider the importance of the informal sector in the groundnuts value chain. For example, the informal sector accounts for 88% of total groundnuts at the processing stage. In particular, paste is important in that it contributes an estimated 58% to the total production of processed products. 10% of paste is estimated to be produced by the formal sector. Snacks including roasted groundnuts contribute about 33% to processed products, and 17% of total snack output is produced by the formal sector. As for *kulikuli*, GN flour, and oil, these contribute 3%, 4%, and 2% to the production of processed products, and are entirely processed by the informal sector.

Net operating profits represent the main type of income from the groundnuts value chain. However, one must bear in mind that these also include the labour of entrepreneurs spent in their enterprises (e.g. owners of farms, or processing and trading enterprises). The total amount of net operating profits in the value chain is estimated at GHS 1.6 billion (€ 267 million). This amount of operating profits includes a significant amount of family labour on smallholder farms. As for the direct and indirect effects of the groundnuts value chain in Ghana, the driving effect ratio (indirect VA/direct VA) in the groundnut value chain is 0.26 meaning that there is also involvement of local businesses (e.g. transport providers, input dealers), contributing to growth in the value chain. The total (direct+indirect) wage labour are GHS 466 million (€ 78 million) and total value added is

around of GHS 2.38 billion (€ 397 million). The total value added would be of the same order of magnitude in the case with a yield of 800 kg/ha for NASH farmer.

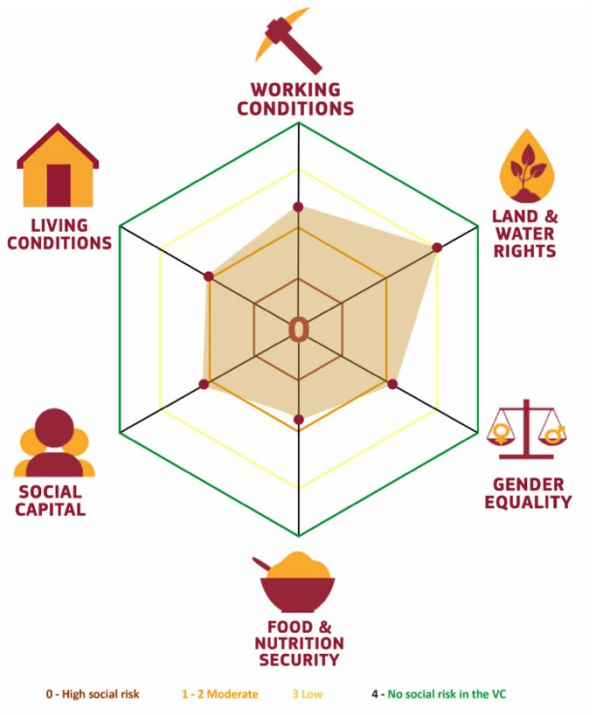
As for the distribution of value added (VA) by agent in the groundnut value chain, NASH farmers who are the majority of groundnut producers create the highest VA in the value chain (i.e. 39%), whilst ASH and CF producers have comparatively small value added (4% and 1%, respectively). Aggregator traders and wholesale traders contribute a relatively small VA (i.e. 1% and 4%, respectively). Informal processors of paste and snacks/roasted groundnuts have a more important VA, namely 14% and 9% respectively, whilst the VA of *kulikuli* and flour production (plus oil in both cases) is relatively modest (i.e. 1% each).

Informal retailers (i.e. 20%) contribute an important component of VA to the groundnut value chain, in particular through net operating profits which form their income. Formal sector aggregators (2%) and formal SME type processors of paste and snacks contribute 3% and 2% respectively.

In addition to the main agents in the value chain, providers of intermediate goods and services account for substantial amounts of value addition through the breakdown of these goods and services into the components of the VA (wages, taxes, financial charges, property income, net operating profits). The bulk of imports (i.e. GHS 190 million/€ 32 million, out of GHS 283 million/€ 47 million) are for the importation of shelled groundnuts from neighboring countries. Providers of intermediate goods and services include transporters, owners of tractor hire companies, agricultural input dealers, fuel suppliers, owners of buildings who lease them to traders or processors, etc. The fact that more taxes are generated through indirect effects is due to service providers being more part of the formal economy (e.g. fuel suppliers).

Social analysis

The following graph provide a picture of the main social consequences of the VC activities in 6 strategic domains.



The main findings from the social analysis of the groundnut value chain are presented below.

Working conditions:
The workers in the groundnut value chain are found at production, processing and trading levels. Overall, we estimate that about 90 percent of all actors and workers in the value chain are women.

There are three main risks related to 'working conditions' of workers in the value chain. Firstly, key occupational health and safety risks in the value chain are observed at the processing segment. As women are the main workers at processing sites, they could be potential target for occupational harm due to excessive heat and smoke in the spaces where they work. Roasting technologies /equipment demand urgent review and up-gradation. Secondly, groundnut producers and workers throughout the value chain are only able to earn about 15 to 20 percent of the living wage benchmark[1] from their groundnut production. There is a significant potential to increase returns of producers and workers if right conditions are developed. Thirdly, most workers in the VC have no full-time /permanent employment. Most are working on temporary work, which is paid on a daily or weekly basis. Most workers have no benefits except the daily wages.

Land and Water Rights:
The examples of large-scale land leases in other agricultural commodities in the country suggest history of violations and non-compliances with the principles of VGGT. This is not the case in groundnut value chain. This presents a clean slate to begin groundnut VC development – learning from experiences in other crops (e.g. Jatropha, Mango in Ghana) and from other countries in Africa. The VC needs to capitalise on promising business models such as the Aggregator-based businesses being supported by MADE (DFID funded) and MOAP (GiZ and EU co-funded) projects which could potentially provide an alternative to large-scale land acquisition by 'non-natives'.

Gender Equality:

[1] Source: www.wageindicator.org – Living wage in Ghana for a family of 6 (2 parent, 4 children) is in the range of 1070 to 1680 GHS per month

In Ghana, as in the rest of West Africa, groundnut is termed as the woman's crop due to the major role women play in its production, processing and trading. Groundnuts provide self-esteem, and financial independence to women involved either as producers, processors or traders. While women are economically very active in groundnut value chain, their access to resources and services is not commensurate. Land is inherited by men and women do not have any formal rights of their land. Women tend to get marginal or non-premium lands for their groundnut cultivation. This indicates a gender-disparity in access to land and non-land assets as well as assistance and services from government /NGOs.

Barriers to a greater decision-making role of women in the VC are related to prevailing economic risks such as access to lands and other resources, social risks due to the position of women in the families, lack of opportunities for education for women and policy risks such as groundnut not being part of priority crops for various programs of the Government of Ghana.

Food and Nutrition Security:
90 percent of groundnut farmers believe that their food expenditure as a proportion of total household expenditure has increased over the last five years. This is indicative of reduced per capita local production of food and downward trend in food supplies in local markets.

The priorities of the Government of Ghana to support maize, rice, soya bean and other crops have paid off in terms of increased production and better self-reliance. However, the area under production of highly nutritious food crops such as groundnut, millets and sorghum have gone down over the years.

Several discussions with a range of key informants and consumers have confirmed that groundnut is a major ingredient for Northern diet, as in most households' soup is taken almost daily. North Ghanaian diets include cereals, roots and tubers with this pattern of diet. Ghana is confronted with the triple burden of malnutrition (i.e. Protein Energy Malnutrition, Macronutrient Malnutrition and Overweight & Obesity). Protein Energy Malnutrition and Macronutrient Malnutrition are still prevalent in rural areas, especially in the Northern, Upper East and Upper West regions. The study team observed many instances of aflatoxin contaminated groundnut being used in the making of paste and contaminated groundnut being used in making of kulikuli. Aflatoxin has been implicated in the occurrence of stunting and underweight among children (WFP report).

Overall, a strong need has emerged for measuring aflatoxin levels across the value chain as this can guide design of appropriate responses – both at regulatory (including policy enforcements) level and at market level. At the same time, nutritional outcomes need to be assessed more rigorously to provide more evidence of impact of aflatoxin contaminated food items, and all development programmes and initiatives in Ghana would need to measure and improve their nutrition sensitiveness.

Social Capital:
Even though the Farmer based organisations providing support to groundnut farmers are currently limited in number, an alternative aggregator linked smallholder support mechanism has been developed well by MOAP and MADE projects. This approach is working very well to support farmers to access inputs and output markets. Their coverage though is only about 5 percent of total groundnut farmers in the country. The rest of the farmers are facing serious challenges in getting certified seed, fertiliser (due to a policy constraint), and support for improved agricultural advisory services and marketing of their produce.

Women membership in FBOs is around 42 percent of total membership. Structures such as Village Savings and Lending Association (VSLAs) are largely women centric. Many producer and processing groups being promoted have women as their main members. Aggregator based out-grower model also include mainly women.
The agricultural system providing support to producers in Ghana is project based. Groundnut have seen specific project investments (such as MOAP, MADE) recently which are emphasizing community involvement and participation in value chain development. The impact of these initiatives is already visible. Groundnut value chain is showing signs of exemplary pro-poor, pro-women and pro-youth development. However, project-based interventions from MADE and MOAP may remain small scale unless carefully scaled up. If the Government of Ghana policy and programme places more priority on the groundnut value chain, there is higher likelihood of addressing current constraints and improving community involvement and livelihoods.

Living Conditions:
Basic health infrastructure in rural areas especially in North Ghana is limited. Community Health Intervention Planning and Services (CHIPS) is the basic unit of health delivery in Ghana for preventive care managed by a community health officer. As per a key informant, there are challenges and a lot of factors that make health systems work improperly. The cost of local treatment for the main diseases is around 10 to 100 cedis ($1.8 to $18), depending on the disease. The health services are rudimentary and increasingly less affordable.

In Ghana, majority of groundnut producers and processors live in compound houses. The three former northern regions (now administratively considered as 5 regions), Northern (23.2%), Upper East (17.6%) and Upper West (23.3%), recorded low proportions of households living in dwellings whose outer wall is constructed with cement. Access to safe water and improved sanitation is poor in Ghana. A Water.org report says that 5 million (~18 percent) in Ghana lack access to safe water and 23 million (~82 percent) people lack access to improved sanitation.

Most groundnut producers are illiterate, and most groundnut processors are literate only up to Junior Secondary (JHS). The situation is changing now with children of groundnut farmers and processors. Several focus group discussions with groundnut farmers and processors revealed that most of their children are now going to school. School enrolment data suggest dropout rate is high for children transitioning from primary to secondary schools.

Environmental analysis

To answer the three questions asked by DEVCO regarding the environmental impacts of groundnut value chains in Ghana on the three areas of protection, Human Health, Ecosystem Quality and Resources Depletion, an attributional LCA study was carried out. Three main objectives are formulated for the LCA study to be undertaken:

- To quantify the potential environmental impacts of the current groundnut value chains in Ghana, based on available knowledge,
- To calculate the contribution of the main stages of the life cycle for the main products and to highlight the environmental hotspots;
- To provide elements for discussion on the sustainability of current groundnut value chains in Ghana.

Two main sub-chains have been identified: an informal/artisanal and a formal SME value chain (VC). The informal/artisanal value chain produces several products, among which the ones included in this study are: groundnut paste, groundnut snack, kulikuli, oil and flour. Groundnut

paste and snacks are produced also at formal SME level, but due to lack of data only paste was included in environmental analysis. We considered two different levels of production, one from small processors for the national market, and one from medium processors for both national market and export. Groundnut products were evaluated from cradle-to-retailer gate in the national market.

The results of the environmental analysis are expressed per 1 kg of each product, plus packaging, at retailer gate., The life cycle of the products consists of 5 main stages: 1) agricultural production (cradle-to-farm-gate); 2) shelling and sorting including transport from field to shelling; 3) processing, that include roasting, grinding and frying (the last one only for kulikuli); 4) packaging; 5) transport to an average retailer. The storing of GN at aggregator and wholesaler storehouses has no direct environmental impact, since no material or energetic input is used, while the transport from the farm and to processor is considered in other life cycle stages (namely, shelling and processing).

Overall, there were no important differences in terms of environmental impacts between the two chains and between all products. On average for all the products, main impacts are due to Ecosystem Quality (73% of total impact) and Human Health (26% of total impact), while Resource Depletion showed very low impact in all products (1% of total impact). The main impact categories contributing to Ecosystem Quality were land use (on average 73%) and freshwater eutrophication (on average 24%), while for Human Health the main impact categories were global warming (on average 58%) and particulate matter (on average 34%). Regarding Resources Depletion, fossil fuel scarcity covered 99.7% of the impact.

The contribution of the 5 life cycle stages revealed that cultivation had generally a major contribution, in all products, for the impact of land occupation, due to low crop yields, and freshwater eutrophication, due to phosphorus emissions from agricultural soil erosion. Shelling and sorting have low impact, even if these stages can affect the value chain, since in these two phases there are important losses of groundnuts. Roasting is responsible for most of the impact due to climate change, as a result of firewood use that includes land use changes due to deforestation for firewood extraction. For kulikuli, the impact due to firewood use is doubled, since also the frying stage uses firewood. Conversely, for formal paste produced in medium enterprise the roasting has a very low impact, since firewood is substituted by natural gas and electricity, that have a lower impact than firewood.

Few studies were available in literature to compare Ghanaian GN products with GN products in other countries; these studies were based only on one indicator, Global Warming Potential (GWP). The GWP in kg CO_2-eq/kg of paste (compared with peanut butter) and groundnut oil were in line or slightly lower than existing literature at market-gate, while GWP of raw groundnuts at field gate was much lower than the values reported in literature.

Framing question 1: What is the contribution of the VC to economic growth?

- The value chain (VC) activities are sustainable for the entities involved, in that all value chain enterprises are making a profit. If yields of 800 kg/ha are considered in NASH farms (i.e. sensitivity case), the profit would still be positive for NASH farmers.
- The value of production of the Ghanaian groundnuts value chain is about GHS 2.73 billion (€ 455 million), while, in 2018, the GDP of Ghana was US$ 65.56 billion (i.e. GHS 354 billion / € 59 billion). In view of this, the contribution of the groundnuts value chain (in terms of value added) to GDP is of the order of 0.7%.

- The contribution of value added of the groundnuts value chain to the agriculture sector GDP of Ghana is approximately 4.3%. In 2018, the GDP (at current market prices) of the agricultural sector was GHS 54.9 billion (€ 9.15 billion) (GLSS 6).
- The contribution of the groundnuts VC to public funds is GHS 110 million (€ 18 million) (taxes, no subsidies).
- The contribution to the balance of trade is GHS 283 million (€ 47 million) of imports (of which about GHS 190 million/€ 32 million for shelled groundnuts), and exports of the order of GHS 46 million/€ 7.7 million (i.e. exports of groundnut paste and snacks). As a result, the net contribution to the balance of trade is negative at GHS 237 million (€40 million).
- Viability of the value chain within the global economy is measured by indicators such as Nominal Protection Coefficient (NPC), and Domestic Resource Cost ratio (DRC). A DRC of 0.28 indicates that the value chain is viable within the global economy. An NPC of 1.1 indicates that the agents in the value chain are slightly protected and don't have comparative advantage.
- Risks of growth sustainability at each level of the VC include, at production level, not enough support for smallholder organisations, climate change (e.g. water shortages, increase of pests and diseases), declining soil fertility, and at processing/export level, food safety and other regulations, actors neglecting workers' rights, insufficient capacity building of aggregator traders playing an intermediary role between processors and farmers.

Framing question 2: Is this economic growth inclusive?

- The value of wages (GHS 466 million in total/€ 78 million) represents 23% of value addition, compared to profits of GHS 1.6 billion (€ 267 million). As stated, it should be noted that the latter also include family labour in the case of agricultural production and small-scale self-employed entrepreneurs as far as trading and processing are concerned.
- It is estimated that about 651,000 to 797,000 persons work in the groundnuts value chain. This includes about 293,000 to 439,000 entrepreneurs plus 310,000 waged workers (assuming that each labourer works 100 days per year in the groundnut value chain and is paid GHS 15/day, including the value of food provided). The number of producers is higher if a yield of 800kg/ha is assumed in the case of NASH farmers (sensitivity case scenario), resulting in about 608,000 NASH farmers (rather than 374,000 NASH farmers in the standard case scenario).
- The farming sector creates 70% of wages, the processing sector 25%, and the trading sector 5%. This reflects the fact that farmers employ hired labour for certain time-consuming tasks during groundnut production. The vast majority of farmers are smallholders (representing an estimated 98% of production). Women play an important role in groundnut production (about 90 percent of all actors and workers in the value chain).

The marketing and governance arrangements in the Ghanaian groundnut value chain resemble a combination of horizontal and vertical governance system with large-scale traders and processors in the driver's seat. Smallholder farmers are underrepresented at all levels, although they constitute the majority of producers. The farmgate price in the case of shelled groundnuts is 34% of the retail sales price (example of roasted groundnuts).

Overall, the Groundnut value chain is showing signs of exemplary pro-women, pro-poor and pro-youth value chain development. However, as highlighted above, many constraints need to be addressed for inclusive and sustainable expansion of the groundnut sector in Ghana, for which a very large potential exists as is evident from experiences of other countries (Senegal, The Gambia and Nigeria) in West Africa.

Framing Question 3: Is the VC socially sustainable?

We estimate that about 90 percent of all actors and workers in the value chain are women. This suggests that any initiative for value chain upgradation has significant likelihood of benefitting

women and consequently health, education and food and nutrition security of a large number of families in Ghana. The social analysis conducted in 2019 shows that the groundnut value chain, at the present juncture, carries moderate to low social risks and offers vast opportunities for pro-poor and inclusive economic development in the country.

Framing Question 4: Is the VC environmentally sustainable?

The summary response to the framing questions is reported below:

Is the value chain environmentally sustainable?	
What is the potential impact of the VC on human health?	Impact on human health is responsible for 21% of total impact in artisanal products and for 37% in formal SME products. The impact on human health is related to the effects of global warming and particulate matter emissions. Global warming impact is mainly due to groundnut roasting stage, and also to frying stage for kulikuli, since groundnut roasting and frying are carried out using firewood that is associated to deforestation and land use change in transitional zone and woody savannah. Particulate matter is produced during groundnut transport along the value chain, from the field to retailer, and is particularly important in the formal SME sub-chain.
What is the potential impact of the VC on ecosystem quality?	The potential impact on ecosystems is the most important area of protection, being responsible of 78% of impact in artisanal products and 60% in formal SME products. Land use is the impact category with the higher potential impact both on ecosystem quality and on total impacts, followed by freshwater eutrophication. Land use impact is completely related to groundnut cultivation. High land use is due to relatively low crop yields, which lead to high levels of land occupation, decreasing from NASH to ASH and CF farms. However, it is important to highlight that high land use is also due to significant groundnut losses during the value chain, which in turn are due to storage conditions, sheller type, mould infection and overall quality of grain. The impact of freshwater eutrophication is due to high phosphorus emissions due to soil erosion in groundnut cultivation, that is naturally high in Ghana, so soil cover during rainy season could be important to reduce this impact.
What is the potential impact of the VC on Resources Depletion?	Groundnut VC has a low impact on resource depletion, since very few materials or energy inputs are required in the studied products. Slightly higher impacts were observed in formal SME products, even if on average resource depletion is responsible for the 1% of total impact both in artisanal and in formal SME products.

Recommendations

The groundnuts value chain represents an important creator of employment for Ghana and different groundnut products are also a key ingredient in local dishes consumed by all social

classes. In view of this, the following recommendations are made to further develop the groundnut value chain, taking into account associated aspects such as social and environmental considerations. The recommendations are equally important.

- Groundnut value chain development
  - ***Place priority on groundnut value chain development:*** The economic and social analyses suggest that any initiative for groundnut value chain upgradation has significant likelihood of benefitting women and consequently health, education and food and nutrition security of large number of families in Ghana. Many areas of value chain development can transform the inclusivity and economic impact of the value chain. These could be - business incentives, favourable financing arrangements, seed market development, addressing quality constraints related to aflatoxin etc. Under right conditions, a segment of youth looking to start their agribusinesses would find the groundnut value chain attractive for their new ventures. This suggests that priority placed on groundnut value chain development by the Government of Ghana (GoG) is likely to be a highly relevant and inclusive socio-economic development strategy. While the GoG policies and programmes for promoting cereal crop production locally have been somewhat successful, it might have had the unintended effect of downscaling the production of nutritious crops. The GoG would need to review its priorities in the light of importance of groundnut for food and nutrition security of the population, especially in the North of Ghana. Policy constraints can be removed to unleash groundnut value chain development. The extension system should get capacity building to support groundnut farmers and processors.
  - ***Integration of the groundnut value chain between SME/larger-scale operators such as formal processors, retailers, or exporters, with operators on the ground (e.g. farmers and aggregators):*** This is to convey extension information (e.g. about good agricultural practices) as well as information about price, quantity, and quality requirements on groundnuts. Also, actors such aggregators should make available inputs required by farmers (or guide them to where they can obtain them) and encourage producers to supply raw material meeting buyers' requirements. As part of the aforementioned initiative, it is suggested to train aggregators and other traders on fair trading practices (e.g. approximate value of produce at each stage in the value chain), and that better-quality produce should attract higher buying prices. The initiative should encourage buyers to pay better prices to farmers recognising the efforts in producing good quality output (i.e. better-quality output should fetch higher prices). Further modernisation of the value chain, would, for example, entails shelling and roasting of groundnuts using more mechanised equipment producing a good quality output. Further training of equipment manufacturers and engineers in Ghana is recommended in this context.
  - ***Conduct a comprehensive review to refine the aggregator linked smallholder model***: The study has highlighted potential of the ASH model and documented some impact stories. More work is needed to further develop this model especially regarding its potential to provide financial access to smallholders through a revolving fund as is established by MOAP. A comprehensive review in this regard could be timely for designing the upscale model. Better design and improved and expanded implementation of MOAP pilot on financial inclusion through aggregators is the need of the hour.
  - ***Develop a multi-stakeholder partnership platform on land policy and its implementation:*** Multi-actor partnerships and experimentation with alternative business models need continued support. At the same time, new land policy bill would

need to address private sector, smallholder relationships. Also, the new land bill needs to be effectively implemented. The regulatory framework for land governance - though improving over the years - needs an implementation framework, capacities and mechanisms to ensure fairness, transparency, participation and consultations in land deals and in guiding alternative business models as is seen in the groundnut value chain. The model framework of implementation of the new land bill needs to go through democratic process of consultation, awareness and capacity building throughout the country.

- Adherence to good agricultural practices
  - ***Good agricultural practices (GAP)*** should be adhered to as far as pre- and post-harvest value chain activities are concerned. Aggregators and extension staff have an important role to play in this context. Aggregators are expected to supply (or identify someone who can supply), inputs such as seed, fertilisers, packaging material, and groundnuts production and processing equipment to farmers or their groups. In collaboration with MoFA extension staff they will also provide extension on good agricultural practices (GAP).
  - The production and use of certified groundnut seed are to be encouraged.
  - Institutions responsible for development and production of foundation seeds should be supported to produce and supply sufficient foundation seeds of groundnut.
  - The availability for farmers and aggregators of fertilisers suitable for legume crops, and the application of more agroecological practices can help in increasing groundnut yield.

- Farmer based organisations – increase inclusion and participation of women as members and leaders of FBOs
  - ***Increase efforts for greater inclusion and participation of women as members and leaders of FBOs***: While gender policy framework could provide minimum (and mandatory) representation of women in different groupings, the action could be more at grassroot level in terms of promoting and supporting women's participation and capacities in groups, as this will enhance their access to services and resources. The Ministry of Gender, Children and Social Protection in Ghana can review the need to establish social protection funds for women and their families who slide into further 'impoverishment' due to extraneous circumstances.

- Social development – reduce health and safety risks and improve working conditions
  - ***Reduce health and safety risks across the value chain and introduce modern roasting technologies***: Roasting technologies can be improved, new roasting equipment can be introduced, working with Alliance for Improved Cookstoves /other platforms in the country. Modern post-harvest technologies (harvester, shelling machine, roaster, storage solutions etc.) in groundnut should be promoted on a large-scale by MOAP, MoFA and other projects /agencies in the country. These will not only improve production /processing efficiency but also ameliorate hardships of women in terms of health and safety risks being faced currently. Further it is suggested that a detailed health, environment and safety audit of the value chain is carried out, the results of which should be used in informing strategies for addressing occupation health and safety risks in the groundnut value chain. Accompanying this, an awareness campaign should be conducted, engaging owners and workers at processing segment of the value chain so that they understand the risks of current operations and are willing to

change behaviours and take up safe technologies for their processing operations. Collaboration with Rural Enterprise Programme (REP) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in groundnut value chain.

- ***Improve working conditions, wages and promoting entrepreneurship in the value chain:*** It is an economic challenge to alter the current situation on working conditions and wages with supply of labour being higher than the demand. Nonetheless certain parts of the value chain could be targeted by incentivising 'collectivisation /formalisation' which can then lead to better wages for the workers. Youth engagement in the value chain development should be promoted through incubation funds providing them initial risk capital. This will create a 'pull' factor and some incentives to unleash innovation and entrepreneurship in the sector.

- Environmental sustainability
  - ***Impact on Land Use:*** High land use in groundnut-based products is due to relatively low crop yields, which lead to high levels of land occupation per unit of GN-based product. Therefore, it is important to highlight that any improvement in crop yields would lead to a potential reduction in land use. In this regard, improved agricultural practices such as use of improved seeds, use of adequate sowing density and fertilization can have a positive impact on yields. Moreover, it is important to support the adoption of agricultural practices that can improve soil quality and nutrient availability and at the same time reduce external input requirements, following the principles of agroecology, for example using crop residues (i.e. groundnut shell) as compost for soil. Overall, a wider adoption of Good Agricultural Practices for groundnut cultivation among farmers can help both in increasing groundnut yield and in reducing the risk of aflatoxin contamination. However, it is important to highlight that high land use is also due to the significant groundnut losses during the value chain, due to storage conditions, sheller type, mould infection and overall quality of grain. Thus, it is fundamental to work on reducing the groundnut losses to effectively reduce the land occupation.
  - ***Impact on Global Warming:*** Global warming impact was mainly due to groundnut roasting stage, and also to frying stage for kulikuli. Indeed, groundnut roasting and frying are carried out using firewood that is associated to deforestation and land use change in Transitional Zone and Woody Savannah. The substitution of open fire roasting drums fed by firewood, used in all products with exception of ME paste, with improved oven or, even better, with roasting machines fed by electricity and natural gas can have a very positive consequence on ecosystem quality, contributing to the reduction of firewood consumption and directly to forest degradation and deforestation, as well as better working conditions.

- Infrastructure development
  - Given that a lot of trading and processing happens in facilities and markets which lack infrastructure, it is recommended to consider **further infrastructure investment** to fulfil these tasks (e.g. to improve equipment used for groundnut paste and minimize the risk of cross contamination due to milling of other products (e.g. maize milling), to ensure water supply (for cleaning the equipment) and energy supply, to encourage further investments in market facilities where processors and traders can undertake their business in hygienic conditions allowing them to respect standards and

regulations). Investments can go hand-in-hand with training and awareness raising at processor and trader levels as far as quality and food standards are concerned. Investment initiatives involving development partners should be carried out in collaboration with the Government of Ghana, and take lessons learned in other sectors into account (e.g. road sector).

- Aflatoxin reduction
  - ***Measure, control and reduce aflatoxins across groundnut value chain***: A strong need has emerged for measuring aflatoxin levels across the value chain as this can guide design of appropriate responses – both regulatory (including policy enforcements) and at market level. At the same time, nutritional outcomes need to be assessed more rigorously to provide more evidence of impact of aflatoxin contaminated food items. All development programmes and initiatives in Ghana would need to measure and improve their nutrition sensitiveness.
  - Because much aflatoxin contamination occurs in particular during **post-harvest operations**, harvesting the crop at the right time, rapid drying on platforms to avoid contact with soil, restricting humidity during storage, sorting at various stages (including removing damaged, shrivelled, and immature pods) and using new or clean storage bags could potentially reduce fungal growth and toxin production. Also, appropriate infrastructure and equipment for food trading and processing needs to be encouraged. The promotion of Aflasafe (a natural product developed by IITA and partner organisations) use on groundnut fields can reduce the source of aflatoxin contamination.

1. Introduction and context

1.1 About the Study

This Groundnut Value Chain Analysis in Ghana has been conducted in the VCA4D project which is part of the European Union 'Inclusive and Sustainable Value Chains and Food Fortification Programme'. The study was achieved by using the tools and methods presented in the DEVCO/C1 "Methodological Brief – Frame and Tools. Key features of the experts' work (20p)". The objective of the study was the description and analysis of the Groundnuts Value Chain, using the tools and methods included by DEVCO/C1 in the "Methodological support for analysis and development of inclusive and sustainable value chains".

To support the groundnut value chain in Ghana, it is necessary to understand it and to target where the leverage effects lie in the chain to intervene and make it inclusive and sustainable. It is the objective of the VCA final report. The objective of the study was to produce knowledge about the growth, inclusiveness and sustainability of the Groundnuts Value Chain (VC) in Ghana. In this context, the expert team orientated their analysis along the following four leading questions: 1) what is the contribution of the VC to economic growth? 2) Is this economic growth inclusive? 3) Is this VC socially sustainable? 4) Is the VC environmentally sustainable?

The methodological framework (VCA4D) developed by the EC included an evidence-based, largely quantitative, analysis toolkit. It consisted of a robust diagnosis system to describe the state of affairs for the functioning of the chain (VC system, technical diagnosis and governance) and the three dimensions of sustainability (economic, environmental, and social).

The study team consisted of the following team members:

- Ulrich Kleih, team leader and economist, Natural Resources Institute (NRI), University of Greenwich, UK; from 16 July 2019 associate of NRI, University of Greenwich, UK.
- Simona Bosco, environmental/lifecycle analysis expert, Sant'Anna School of Advanced Studies, Pisa, Italy.
- Ravinder Kumar, social development expert, Natural Resources Institute, University of Greenwich.
- Messrs Joseph Apeeliga and Seth Q. Yawlui, national experts, Tamale, Ghana.
- Dr Baqir Lalani, economist, NRI, University of Greenwich.

The study consisted of the following phases:

- Brussels: Briefing at VCA4D PMU and DG-DEVCO, 23 & 24 April 2019.
- 1-day training of Ulrich Kleih and Dr Gideon Onumah by skype on AFA methodology in May 2019. The trainer was Dr Frederic Lançon, CIRAD (France), and U Kleih and Dr G Onumah were at NRI, in Chatham, United Kingdom.
- 1st round of fieldwork: May/June 2019, Accra, Tamale, Wa, including briefing and debriefing meetings at the EU Delegation in Accra.
- 2nd round of fieldwork: August 2019, field survey with 45 smallholder farmers, 20 processors,
- 3rd round of fieldwork: October 2019, visits to producers, processors, traders, public services, and non-governmental organisations in Accra, Kumasi, Techiman, Tamale, Bolgatanga, including debriefing meeting at the EU Delegation in Accra.

- Analysis and report writing September – November 2019.
- Debriefing at VCA4D PMU and DG-DEVCO, Brussels: 30 January 2020.
- Finalisation of report: First half of 2020.

1.2 Methods

The methodology employed for the study used the following tools:

Data collection:

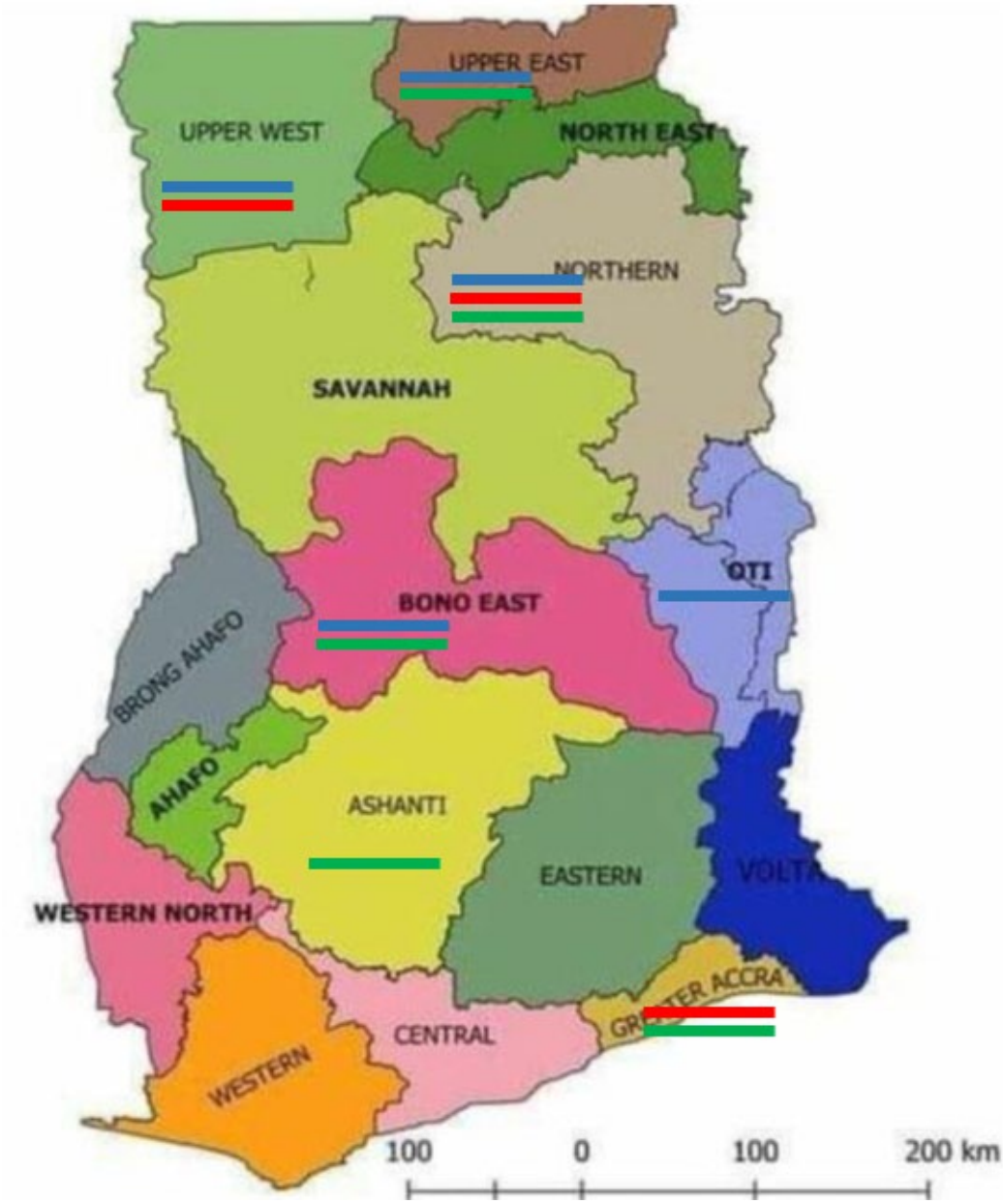
- Review of published and grey literature.
- Consultation of websites.
- Discussions with stakeholders belonging to the public and private sectors, using semi-structured checklists. At farmer level, a mix of rapid and participatory rural appraisal methods were employed.
- Questionnaire developed for tablet use by enumerators for data collection at producer, processer and trader level. The survey with 48 farmers (14 smallholder farmers not linked to aggregators, NASH, 16 smallholder farmers linked to aggregators, ASH, and 18 commercial farmers with more than 5 acres of groundnut production) in August 2019 (in 5 districts) served to provide a picture of "typical" production, processing, and trading systems in groundnut growing regions of Ghana. Given the small sample size, which was due to resource and time constraints, it was not possible to have a fully representative sample of groundnut farming, trading, and processing systems at national level. In addition, 20 traders, and 20 processors have been interviewed in the same five groundnut growing regions of Ghana (i.e. Northern Region, Upper East, Upper West, Oti, and Bono East).

Analysis:
Using the guidelines developed by the management unit of the project, the following were undertaken:

- Calculations for the functional and economic analysis of the value chain, using the AFA (AgriFood Chain Analysis) software.
- Analysis of key social development questions.
- Life Cycle Assessment (LCA) for environmental analysis.

The main objective of the study was to obtain and analyse information regarding the Ghanaian part of the groundnut value chain. In view of this, the groundnut import and export value chains were only analysed concerning the Ghanaian parts of the chain. It should be noted that not all stakeholders in the value chain have been equally forthcoming in providing information. Whilst some members of the value chain have been very open in sharing information, others were reluctant to meet the study team. In view of this some of the data had to be estimated.

Figure 1 shows the map where fieldwork took place for the groundnuts value chain analysis between late May and October 2019.



Source: https://www.ghananet.co.uk/regions-of-ghana.html

FIGURE 1: MAP OF GHANA AND LOCATIONS WHERE THE STUDY TOOK PLACE

1.3 Importance of the agricultural sector

According to the World Bank[2], in 2018, using the Atlas method for calculations, Ghana had a Gross National Income (GNI) of US$ 63.36 billion. If the calculation method is based on Purchasing Power Parity (PPP), the GNI is US$ 138.28 billion in 2018, or US$ 4,650 per capita. Gross Domestic Product (GDP) was US$ 65.56 billion in 2018 (at current $), and the GDP growth rate was 6.3% per annum in 2018. This compared to an annual inflation rate of 10.2% (GDP deflator). Exports of goods and services represented 35% of GDP in 2018, and imports 38%. Employment in agriculture (% of total employment) in Ghana was reported at 41% in 2017, according to the World Bank collection of development indicators (quoted by Trading Economics[3]). The GDP (at current market prices) for the agricultural sector was GHS 54.9 billion in 2018, and GHS 40.3 billion for the crops sector (GSS, 2019).

GLSS6[4] states that the estimated number of households in the country is 6.6 million with a mean household size of 4.0 compared to 4.4 obtained from the 2010 Population and Housing Census. In the North of the country average household sizes are higher than the national average (e.g. 5.5 for Upper West, 5.4 for Northern and 4.5 for Upper East). Household sizes are generally higher in rural areas (4.5) compared to urban (3.6) ones. Given that the population of Ghana is approximately 30 million means that about 7.5 million households reside in the country in 2019. The Republic of Ghana has a total land area of 238,842 sq.km, and the population was 28,956,587 in 2017 (MoFA, 2018). It is estimated that the rural population constitutes 49.1 percent of the country's total population (MoFA, 2018).5 Of the land area, 125,000 sq.km (52% of the total) were allocated for agriculture in the form of annual crops (5% of total), tree crops (7%), bushfallow and other uses (25%) and unimproved pasture (15%). The remaining land included forest reserves, savannah woodland, wildlife reserves and unreserved forest. In 2018, Agriculture, forestry and fishing contributed 20% of value added to GDP, which compares to 28% in 2010, and 35% in 2006. According to MoFA (2018), agriculture is predominantly on a smallholder basis in Ghana and the majority of farm holdings are less than 2 hectares in size, although there are some large farms and plantations, particularly for rubber, oil palm and coconut and to a lesser extent, rice, maize and pineapples. The main system of farming is traditional which involves the hoe and cutlass and whilst there is little mechanized farming, bullock farming and tractor ploughing is practiced in some places (e.g., in the North).

Ghana is a tropical country, with annual average temperatures ranging from 26.1^{0}C in places near the coast to 28.9^{0}C in the extreme north. There are two rainy seasons in the south from March to July and from September to October (bimodal rainfall system), and one rainy season in the north, from May to October (uni-modal rainfall system). There are five main agro-ecological zones in Ghana, which are Rain Forest, Deciduous Forest, Transitional Zone, Coastal Savannah and Northern Savannah (Guinea and Sudan Savannah). The rainfall distribution by agro-ecological zones is shown in Table 1.

The main crops grown include,
Industrial Crops: Cocoa, Oil Palm, Coconut, Coffee, Cotton, Kola, Rubber, Cashew, Shea, Soya bean.

[2] https://databank.worldbank.org/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=GHA (accessed, 6/11/2019)

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

[4] Ghana Living Standards Survey Round 6 (GLSS 6), Ghana Statistical Service, August 2014; Ghana Statistical Service, Accra, Ghana.

[5] Ministry of Food and Agriculture (MoFA, 2018) Agriculture in Ghana 2017: Facts & Figures; Ministry of Food and Agriculture, Statistics, Research, and Information Directorate (SRID).

[6] https://databank.worldbank.org

Starchy staples, Cereals and Legumes: Cassava, Cocoyam, Yam, Plantain, Maize, Rice, Millet, Sorghum, Cowpea and Groundnut.
Fruits and Vegetables: Pineapple, Citrus, Banana, Pawpaw, Mango, Tomato, Pepper, Okro, Egg Plant, Onion.

As for the area planted to major food crops in 2017, these include (in '000 hectares), maize (970), cassava (926), yam (493), plantain (363), groundnuts (320), rice (239), sorghum (224), and cocoyam (204) (MoFA, 2018).

TABLE 1: RAINFALL DISTRIBUTION BY AGRO-ECOLOGICAL ZONES IN GHANA

Agro-ecological Zone	Mean annual Rain (mm)	Growing Period (Days)	
		Major season	Minor season
Rain Forest	2,200	150 – 160	100
Deciduous Forest	1,500	150 - 160	90
Transitional	1,300	200 – 220	60
Coastal Savannah	800	100 – 110	50
Northern Savannah:			
Guinea Savannah	1,100	180 – 200	*
Sudan Savannah	1,000	150 – 160	*

Source: Ghana Meteorological Agency (GMet), Accra: in (MoFA, 2018)

1.4 Government agricultural sector policies

Groundnut is among the products that the Government supports in line with its national strategy of creation of new jobs in the agricultural sector. Value chains development is guided by the 2nd Phase of Medium-Term Agriculture Sector Investment Plan (METASIP II) (2014 – 2017), the successor of which is the Ghana Agricultural Investment Plan (GhAIP) – (2018-2021), currently being finalised. In the meantime, the development of the agriculture sector is supported by the Government through two main flagships, "Planting for Food and Jobs" (PFJ) and "One District One Factory" (1D1F supporting value addition) which are expected to attract youth to agriculture. These programmes both promote the commodity chains of key export crops, as well as address food security concerns. Groundnut is one of the crops supported by the PFJ flagship since 2018.

Additionally, the Government developed strategies for reducing the poverty gap between North and South and accelerating the development of the poorer, most vulnerable savannah regions. The Northern Development Authority (NDA, ex-SADA) targets the identification of growth poles with strong economic potential, with the aim of attracting investments in six agribusiness zones in the Northern Savannah Ecological Zone.

EU support for the agricultural sector and the groundnuts value chain

The EU cooperation policy is in line with these priorities, as reflected in the 11th EDF EU-Ghana National Indicative Plan (NIP) 2014-2020. The Focal Sector n°2: "*Productive Investment for Agriculture in Savannah Ecological Zones*" (EUR 147M) promotes inclusive rural economic growth through sustainable agribusiness development intended to improve smallholders' incomes and create sustainable opportunities for the most vulnerable. Through the implementation of three interconnected programmes, the EU contributes to generate sustainable agriculture wealth in

selected growth pole areas by improving access to water, storage, markets, energy, finance and by securing permanent jobs along the supported value chains.

In particular, the EU provides support in the 11 districts of the Upper West, 2 districts of the Savannah and 1 district of the North East Regions, in line with the priority zones of NDA (ex-SADA agribusiness zone 6) agreed between the government and the EU. The three interconnected programmes are:

(i) The Productive Investments Programme focuses on improving the access to market, to water for agricultural production, to roads and storage facilities and the generation of energy for different productive uses in the value chain.

(ii) The Resilient Agriculture against Climate Change (REACH) focuses on the protection of natural resources to enable a sustainable and inclusive improvement in the rural economy through enhanced implementation of climate change adaptation and mitigation practices.

(iii) The Market Oriented Agricultural Programme (MOAP) uses a value chain approach focusing on high-value crops. It supports integrated business models along selected value chains to stimulate community and private investments for production and service provision, and economic activities which positively impact youth and women. Since 2017, thanks to the EU intervention, this support has also been extended to Cashew, Groundnuts, Mango, Rice, Soybeans, Vegetables and Sorghum in the Northern Regions of the country, for a period of 6.5 years (2017-2023).

2. Functional analysis

The functional analysis of the groundnut crop in Ghana was conducted to obtain and start with a detailed 'big picture' of the value chain (internationally, regionally, nationally and locally). It is the first stage for understanding the functioning of a value chain from the production level to the final consumption one and to gather factual descriptive elements of technical processes and channels. It is also a way of identifying actors and stakeholders, as well as their power and role, in the value chain process.

2.1 Groundnut production

Groundnuts (*Arachis hypogaea* L.) are a leguminous, nitrogen-fixing crop that is well suited for cultivation in the relatively dry savannah zones of Africa (Masters et al, 2013). It is widely grown in northern Ghana for both home consumption and sale, with women actively involved in the production, processing and marketing of groundnuts (Masters et al, ibid). Groundnuts are an important cash crop and its seeds are a rich source of edible oil (43-55%) and protein (25-28%). Whilst the crop is grown in most parts of the country, it is estimated that over 70% of farmers in the North of Ghana cultivate groundnuts and together account for over 85% of the national output (Owusu-Adjei, 2017)[7], based on information from Technoserve (2009).[8]

Figure 2 and 3 show details of groundnut production in Ghana in form of area planted, output (tonnes of unshelled groundnuts) and yields. The figures are based on data of the Food and Agriculture Organization of the United Nations (FAO). The data of the Ministry of Food and Agriculture are similar (MoFA, 2018). Groundnut production in Ghana increased sharply around 2002 and was highest in 2010 when it was 531,000 tonnes of unshelled groundnuts. Between 2013 and 2017, production has ranged between 400,000 and 450,000 tonnes. The figures used in the economic calculations of the analysis are based on 420,000 tonnes of unshelled groundnuts, produced on 338,000 hectares. As for yields, these were highest in 2009 during the last ten years (1.54 t of unshelled groundnuts/hectare) and have ranged between 1.2 and 1.3 tonnes between 2013 and 2017 (Figure 3). For NASH farmers, a sensitivity analysis has been undertaken with a yield of 800kg/ha. In addition to domestic production, about 17% of groundnuts are imported into Ghana (i.e. representing 71,400 tonnes of unshelled groundnuts or 33,600 tonnes of shelled groundnuts, assuming a shelling ratio of 47% for the entire quantity).

Whilst the nuts are eaten in the form of paste, snacks, roasted groundnuts, flour, *kulikuli*, or oil, groundnut leaves, stems and roots are fed to animals as a source of fodder during the dry season. Rotated with maize, the crop forms an integral part of the mixed cropping-livestock system that is the bedrock of the livelihood strategies pursued by poor farmers in northern Ghana (MADE, 2014). It fixes nitrogen in the soil to provide the needs of the maize crop, however the contribution it could make would increase if there was a higher concentration of Rhizobia in the soils of northern Ghana.

[7] Owusu-Adjei E, Baah-Mintah, R, and Salifu B. (2017), Analysis of the Groundnut Value Chain in Ghana, *World Journal of Agricultural Research, 2017, Vol. 5, No. 3, 177-188* Available online at http://pubs.sciepub.com/wjar/5/3/8 ©Science and Education Publishing DOI:10.12691/wjar-5-3-8.

[8] Technoserve (2009). Feasibility study on farm to factory supply of in-shell groundnuts. Interim Report, Legume Team. Tamale: Technoserve.

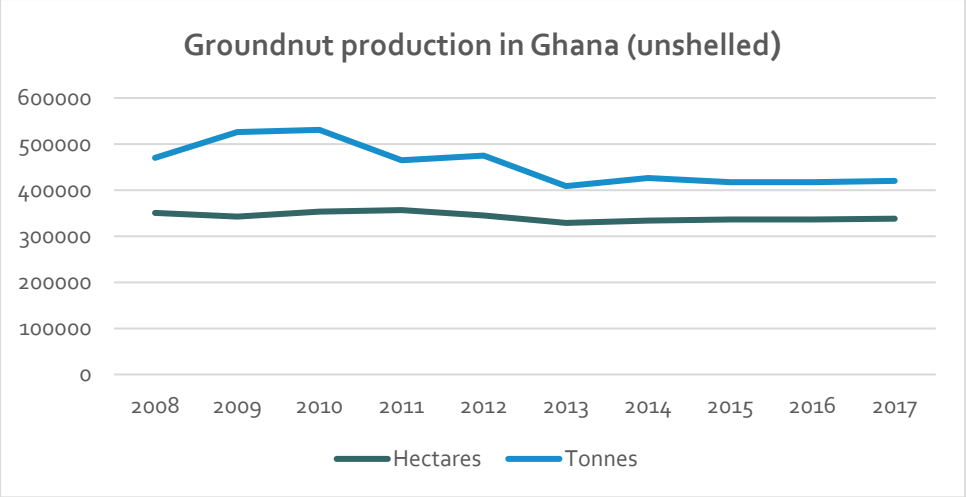


FIGURE 2 : GROUNDNUT PRODUCTION IN GHANA (UNSHELLED)
Source: FAO Stat (http://www.fao.org/faostat/en/#data/QC)

According to Owusu-Adjei et al (2017), based on a survey with 300 farmers, the activities for groundnut production include, land preparation, sowing, crop management (e.g. weed control, fertiliser application in a few cases, pest and disease management), harvesting, post-harvest management including farm gate processing. Groundnut farmers employ hired workers to undertake activities such as weeding and harvesting, however, in most cases family labour is employed in addition to hired labour to reduce labour cost. Only 13% and 25% of producers employ solely hired and family labour respectively, the remaining 62% of producers employ both forms of labour concurrently (Owusu-Adjei, 2017). According to the same source (Owusu-Adjei, ibid), groundnut is mainly produced under rain-fed conditions, has mainly one cropping season per year, and farm sizes are generally small with an average of 0.8 ha. Results from their research indicated that groundnuts are produced by smallholder farmers with farm sizes ranging from 1 - 2 acres (0.4 - 0.8 ha).

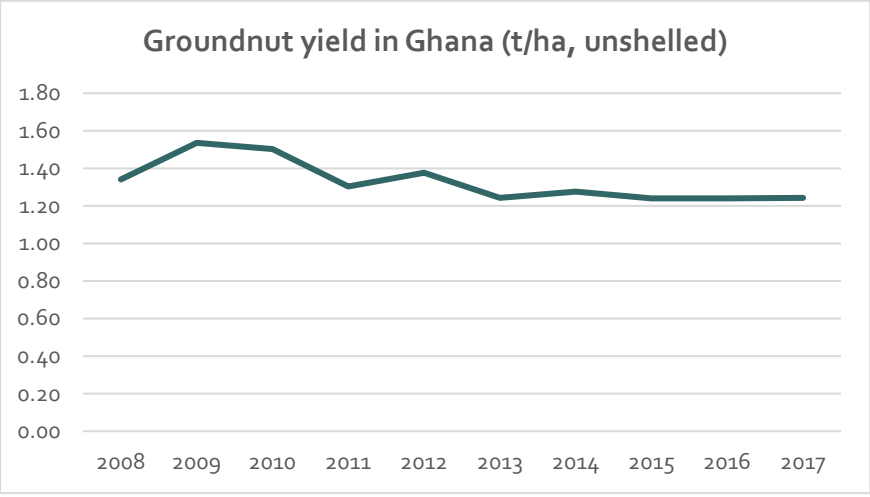


FIGURE 3: GROUNDNUT YIELD IN GHANA (T/HA, UNSHELLED)
Source: FAO Stat (http://www.fao.org/faostat/en/#data/QC)

At the same time, there are surveys which indicated that producers have larger areas. For example, Luehr (2018), based on a survey with 400 farmers for the Market Oriented Agricultural Programme (MOAP) in North West Ghana, calculated that the total average size of farms is 16.6 hectares, the land size under production (season 1) is 4.6 hectares, and the cultivation area for groundnut is 2.1

hectares. It was further calculated that the cultivation area for groundnut was 1.3 hectares in terms of median, 0.8 hectares in terms of 25% value, 2.4 hectares in terms of 75% value, and the standard deviation was 2.7 hectares. 332 farmers indicated groundnut production out of a total sample of 400 farmers.

According to the survey carried out by the VCA4D study team in August 2019, the farm sizes are, (a) 3.0 acres for non-aggregator-based smallholder farmers (NASH), (b) 3.3 acres for aggregator-based smallholder farmers (ASH), and 7.8 acres for commercial farmers (CF). The survey was based on 48 farm households in 5 groundnut producing regions in Northern Ghana (i.e. 14, 16 & 18 farmers belonging to NASH, ASH, and CF, respectively). Discussions with farmer groups by the mission team near Wa in Upper West Region in June 2019 found that farm sizes under groundnut crop were of the range of 1.9 acres (mixed group, NASH) to 2.4 acres (women's group, ASH).

Harvested groundnuts are sun-dried for 5 - 7 days depending on the intensity of the sun, and the dried nuts are either sold in shelled or unshelled form. 48% percent of the respondents in the survey carried out by Owusu-Adjei et al (2017) sell groundnuts mostly in unshelled form while 52% sell them in shelled form. Luehr et al (2018), based on a survey carried out for the Market Oriented Agriculture Programme (MOAP) in North-West Ghana, found that nearly all of the interviewed farmers sell their products unprocessed.

According to MoFA (2018), agriculture is predominantly on a smallholder basis in Ghana and the majority of farm holdings are less than 2 hectares in size, although there are some large farms and plantations. This also applies to the North of Ghana, although there the size of farms may be slightly larger due to more land available.

(Akwasi Kanyam, 2016)[9], based on a survey with 1005 farm households in 40 communities of northern Ghana, state that the average farmer cultivated 1.88 acres of land for groundnut production and 4.68 acres for other crops, besides groundnuts (maize, soya, rice and millet being the dominant crops grown in the region). This implies total farm sizes of 6.6 acres (i.e. 2.6 ha). In addition, farmers tend to have land which is fallow or used as cattle pasture.

According to Akwasi Kanyam (2016), the average groundnut production was approximately six bags, each bag weighing about 100 kilograms. 24% percent of households delayed harvest for a day or more, while 60% delayed threshing by two or more days. This was considered staggering, given the importance of timely harvest and threshing to aflatoxin control.[10] 59% of farmers dry their groundnuts on some form of dirt, a practice exposing the groundnuts to fungal spores and moisture in the dirt, making them susceptible to fungi contamination and invasion by *Aspergillus flavus* and *Aspergillus parasiticus*. About 46% reported non-sorting of their groundnut which was considered unfortunate because sorting out physically damaged and infected grains was deemed to result in a 40% to 80% percent reduction of aflatoxin levels (Park, 2002, quoted in Akwasi Kanyam, 2016). The same source considered that the average drying period for groundnuts were approximately six days (Akwasi Kanyam, ibid).

According to the same source, in a typical farming community in the North of Ghana, more than 90% of farm families will cultivate groundnuts, and of their crops, groundnuts are the crop most likely to be marketed commercially (Tsigbey, 2003; Masters et al., 2013; quoted in Akwasi-Kanyam,

[9] Two Essays on Peanut Aflatoxin Risk in Ghana, by Daniel Akwasi Kanyam, A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy, Athens, Georgia, US, 2016.

[10] The research conducted by Akwasi-Kanyam was in relation to aflatoxin risk and control in the groundnuts sector.

2016). At the same time, it is recognised that the constraints imposed on groundnut production in the North of Ghana are substantial and productivity has been declining over the years due to poor crop management practices and lack of institutional support (Bucheyeki et al., 2008, quoted in Akwasi-Kanyam, 2016). MADE (2014)[11] indicates that due to the absence of machinery, groundnut is a very labour-intensive crop, taking up plenty of labour during production and post-harvest management. The same source implies that the time taken to sow, weed, harvest and dry in the production process prevents farmers from expanding harvested areas.

In Northern Ghana, like many other African countries, it is observed that labour shortages often occur at peak harvest periods, even in areas that normally have surplus labour supply. According to Akwasi Kanyam (2016), about 25% of the respondents in their survey reported that the timing of harvest and stripping was affected by labour availability, meaning that handling of larger volumes of groundnuts depends on the availability of family labour and the number of workers that can be hired in the local labour market. The same source (Akwasi Kanyam, ibid) states that income constraints affect the ability of farmers and households to adopt good farming practices.

Given that the North of Ghana is more impoverished and poorer than other parts of the country and given that the majority of farmers operate with low incomes from their holdings it was expected that income constraints affect the ability of farmers to adopt good post-harvest practices (Akwasi Kanyam, ibid).

For the groundnuts value chain analysis, the following figures regarding farm sizes and yields were taken into account, as shown in Table 2.

TABLE 2: FARM SIZES AND GROUNDNUT YIELDS APPLIED IN THE ECONOMIC CALCULATIONS OF VCA

	Groundnut farm size (ha)	Yields (t of unshelled GN/ha)	Percentage of total production
Non-aggregator linked smallholders (NASH)	0.76	1.3[12]	88%
Aggregator linked smallholders (ASH)	0.96	1.6	10%
Commercial farmers (CF)	3.12	2.2	2%

Source: Interviews and literature; Nb. 1 hectare was rounded to 2.5 acres

As for groundnut varieties, the majority of farmers produce the *"Chinese" (Shitaochi)* variety, which has been introduced to Ghana in the 1960s (Masters et al, 2013). Figure 4 shows the results from the survey carried out by the groundnuts value chain study team in 5 northern regions of Ghana

[11] Market Development in Northern Ghana Programme (2014) Groundnut Market Diagnostics, Report submitted to Department for International Development (DFID), by DAI in association with Nathan Associates London Ltd.
[12] In addition, a sensitivity analysis was carried out based on a yield of 800kg/ha produced by NASH farmers, showing how the lower yield would impact on indicators such as farmers' operating profit.

in August 2019. The overwhelming variety produced was *Chinese*, and others included "Nigeria", Manipinta, Samnot 23, Fmix, Agric, or were unknown.

GEPA have produced a groundnut training manual[13] as part of the EC supported Trade Related Assistance and Quality Enabling Programme (TRAQUE), in particular to build capacity of export oriented companies by providing information and training to groundnut and cereals producers, processors and exporters, so that they will be able to meet Food Safety Standards Requirements in the EU markets.

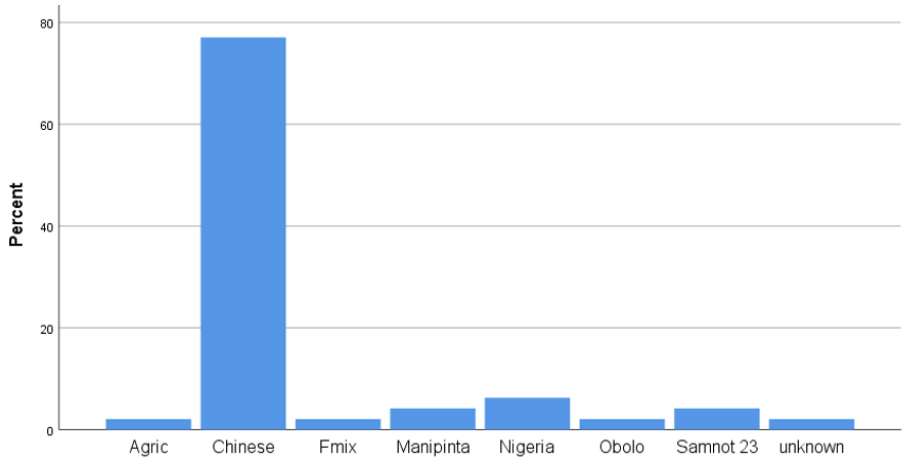


FIGURE 4: GROUNDNUT VARIETIES PRODUCED IN NORTHERN GHANA
Source: Survey carried out by groundnuts value chain analysis team in August 2019

The manual lists the characteristics of groundnut varieties released in Ghana. The varieties include, Chinese (Shitaochi), Edorpo-Munikpa, Jusie-Balin, Sinkarzie, Nkatiesari, Mani Pintar, Kpanielli, F-mix, Nkosuor, Azivivi, Adepa, and Jenkaa. The characteristics include growth habit, seed colour, maturity days (89 – 120 days), kernel yield (1.8 – 2.9 t/ha), maxi bags per acre (8-12), and uses (confectionary and oil), based on information of the Food Crops Development Project. The recommended quantity of seed required is of the order of 45 – 55 kg/ha. As for time of planting and harvesting, amongst other things, the manual states that if the cultivar matures and is harvested during the rainy period, post-harvest drying becomes problematic and aflatoxin contamination of kernels would increase (GEPA, based on Food Crops Development Project). As for the selection of a good site for cultivating groundnuts, it is stated that the following requirements must be met:

- Temperature: requires 5 months of warm weather, 20^{O}C to 35^{O}C.
- Rainfall: should be in the range of 500 to 1000 mm that is evenly distributed throughout the growing period.
- Soils: should be, well drained, loose, friable; sandy to sandy loam; pH 5.5 to 7; moderate amounts of organic matter to improve ability of soil to hold water; well supplied with calcium and phosphorus.

Table 3 outlines the agricultural practices encountered for groundnut production during the VCA4D missions and survey in 2019.

TABLE 3: AGRICULTURAL GROUNDNUT PRODUCTION PRACTICES IN NORTHERN GHANA

[13] GEPA (no date) Groundnut Training Manual; as part of Trade Related Assistance and Quality Enabling Programme; Ghana Export Promotion Authority, Ministry of Trade and Industry.

Production step	Agricultural practice
Land clearing	In many cases land clearing includes cutting grass and bushes with cutlasses when the land has been used before. During the survey in August 2019, 1 out of 14 (1/14) NASH farmers, 7 out of 15 (7/15) ASH farmers, and 8 out of 18 (8/18) CF farmers stated hiring labour for land clearing. Costs ranged from GHS 40 – 240 per acre, e.g. in the case of ASH. In the case of CF land clearing costs were of the order of GHS 100 per acre, and GHS 300 for clearing two acres of land in the one case of NASH where labour was hired.
Ploughing	Almost all farmers spend money on ploughing which is mostly done by tractors, but also with hoes or by ox-ploughs if tractors are not available. The survey results were as follows: NASH – 13/14; ASH – 14/16, and CF 16/18 farmers spent money on ploughing costing approximately GHS 100 per acre.
Harrowing	Harrowing is rarely done or only attracts costs in few cases. E.g. according to the survey in Aug 2019, 2/14 in the case of NASH; 0/16 in the case of ASH, and 3/18 farmers in the case of CF farmers. Costs tend to be smaller in the case of harrowing if it is applied, e.g. GHS 20 – 30 per care, although costs can be as high as GHS 110/acre in one case of commercial farmer.
Planting/sowing	Most farmers hire workers for planting, costing GHS 100 – 230 per acre. The survey results show that 9/18 NASH farmers; 13/16 ASH; and 16/18 CF farmers hired labour for planting. Some farmers, for example those who are not linked to aggregators, broadcast seed, whilst others sow in line.
Weeding (1st and 2nd)	First weeding is done by most farmers and hiring of labour for manual weeding was done as follows, according to the survey: 6/14 in the case of NASH; 11/16 in the case of ASH; and 15/18 in the case of CF farmers. The costs of labour were of the order of GHS 650 in the case of NASH farmers hiring labour, GHS 500 in the case of ASH farmers, and about GHS 1000 in the case of CF farmers. Although herbicides have been seen in input stores, few farmers seem to apply them for weed control (e.g. Condem/glyphosate based). 2nd weeding is done by fewer farmers, and the survey results are as follows: 3/14 NASH farmers, 8/16 ASH farmers, and 7/18 CF farmers.
Fertiliser application	Little fertiliser is applied by farmers in groundnut production. The survey shows that only 2 commercial farmers hired labour for fertiliser application. If fertiliser is applied (e.g. by ASH or CF farmers) then it is often 1 bag (50 kg) of TSP (triple super phosphate) fertiliser given that subsidised maize fertiliser is either not available or not ideal to be used.
Harvesting	Harvesting takes place by hand, requiring hired labour. At the same time, according to the survey only 6 NASH farmers (out of 14) employed labourers for harvesting (those who hired labour spent per groundnut farm GHS 730 on average). 7/16 farmers stated spending on hired labour (GHS 637 on average). 11 out of 18 CF farmers stated that they hired labour (those who hired spent a total of GHS 1222 on average).
Transport to farm	Only part of the farmers spend money for transporting groundnuts from the field to the farm; 7/14 in the case of NASH (GHS 23, those who hire transport); 7/16 in the case of ASH farmers (GHS 25 on average, those who hire); and 12/18 in the case of CF farmers (GHS 44 on average, those who

Production step	Agricultural practice
	spent). Hired transport can involve hiring a Motorking, or labourers who carry the groundnut harvest to the farm.
Plucking	Part of the farmers hire labour for plucking groundnuts. According to the survey 7/14 NASH farmers (each farmer spending a total of GHS 718 on average on hired labour); 10/16 in the case of ASH farmers (spending GHS 769 on average); 11/18 CF farmers (spending 1532 on average in total).
Storing	Storing of groundnuts often takes place in shelled form in the house of the farmer, using jute or polythene bags. The quality of storage can be a problem in that the storage room may be poorly ventilated or bags may have been used before.
Shelling	Most farmers manually shell groundnuts shortly before using them for home consumption and some before selling them. Other farmers sell unshelled groundnuts to traders who then take care of shelling (e.g. by hiring mechanised shellers).

Source: VCA4D survey in August 2019, and observations during missions.

2.2 Groundnut processing

Following storage (often on-farm), groundnuts are shelled either by farmers (manually) or by traders who may hire mechanical shellers from service providers. In particular, for groundnut snacks or roasted groundnuts buyers often prefer to buy groundnuts which have been shelled manually in that their quality is considered better (e.g. less damaged kernels).

Groundnuts are widely used by households to make soups (by including groundnut paste in the soup), snacks (e.g. roasted groundnuts), *kulikuli* (processed groundnut cake cooked as fried balls or strings), groundnut flour (often used as a condiment for grilled meat; and, as in in the case of *kulikuli*, also yields oil as by-product). In the majority of cases, groundnuts are sorted and roasted before they are processed into products such as paste, which involves grinding (e.g. often in a mill which is also used for milling other products such as maize).

Anim-Somuah et al (2013), in the context of a study to strengthen agri-food value chains for nutrition, state that groundnuts are consumed widely by poor and middle-class consumers in Ghana, providing an important source of energy, protein and monounsaturated fats. They have identified 7 food products derived from groundnut: whole, roasted groundnuts; recipes using groundnut paste; canned groundnut soup; traditional groundnut snacks; packaged groundnut snacks; groundnut-chocolate spread; and groundnut lipid drink. According to them (Anim-Somuah et al, ibid), food processors source groundnuts from traders who aggregate supplies from numerous small-scale farmers. Due to this supply chain structure, it is difficult to trace supplies to their origin or achieve consistent quality supplies. Given that the aflatoxin contamination of groundnuts is a serious food safety concern which inhibits the potential of groundnuts as nutrient-dense food in Ghana, the lack of a traceable supply chain makes it difficult to obtain groundnuts with low aflatoxin levels, especially for processed foods.

The formal sector is characterised by a range of factories, the majority of which are small to medium-scale enterprises (SME). The information in the economic and environmental section is based on a factory producing 20 tonnes of groundnut paste per month, using 26 tonnes of raw material (i.e. shelled groundnuts). However, it is understood that there are quite a few smaller enterprises and there is one larger factory producing groundnut snacks for the domestic and

export markets within the region (e.g. Nigeria). Environmental analysis does not consider snack production in formal sector due to lack of data.

Aflatoxin in groundnut products

Aflatoxins are carcinogenic metabolites produced by species of Aspergillus fungi, namely Aspergillus flavus and Aspergillus parasiticus (N'Dede et al., 2013, quoted in Akwasi Kanyam, 2016) and found in diverse foods and feeds. Although they have been found to pose a threat to food safety and human health, they are invisible, odourless and tasteless. "Consumption of moderate to high amounts of aflatoxins has been linked with increased risk of liver cancer, kidney inflammation, spleen enlargement, reduced sperm count, infertility, birth defects, low birth weight, and growth inhibition in young children (Turmer et al., 2007; Agnes & Akbarsha, 2003; Uriah, Ibeh, & Oluwafemi, 2001; Jackson & Groopman, 1999; quoted in Akwasi Kanyam, 2016)".

Figure 5, based on a survey by Florkowski et al (2013), shows the average total aflatoxin content in groundnut products that have been processed by small-scale, cottage industries. In particular, *Kulikuli*, which is a fried product made of groundnut cake, shows high aflatoxin levels (i.e. 76.91 parts per billion, ppb). Groundnut paste (42.49 ppb) is also well above the limit set for processed groundnut products, set by the European Union at 4ppb. Other products which are above this threshold include pounded raw peanut, *dakwa*, and *nkati* cake. Roasted groundnuts were below the threshold only showing 1.02 ppb. Dawadawa, which is also included in the figure below (Figure 5), is normally the boiled or fermented seed of the locust bean tree – Parkia biglobosa. A dawadawa type of product is made from fermented Bambarra groundnut. It is not thought that dawadawa is processed from groundnut (*Arachis hypogaea*) which is quite different from Bambarra groundnut (*Vigna subterranea*).

Although the fungus resides in the soil and infects crops in the field (e.g. groundnuts and other crops), it is then passed on into the value chain, often through inappropriate post-harvest and processing practices. For example, unsafe storage practices (use of poorly ventilated rooms, or already used bags for storage), the use of water to moisten already dried groundnuts to ease shelling, high temperatures and unsafe processing practices (e.g. lack of facilities to clean mills), add to the build-up of aflatoxin.

There is a significant association of high aflatoxin levels with delayed harvest and drying on bare dirt, while sorting by quality results in a reduction in aflatoxin levels (Akwasi Kanyam, 2016). In an assessment of the effect of post-harvest measures (e.g. improved methods of groundnuts drying and storage) on aflatoxin contamination levels in groundnuts for subsistence farmers in the Northern and Upper East Regions of Ghana, it is shown that sun drying on a tarpaulin reduces aflatoxin levels in groundnuts by approximately 40 percent compared to status quo methods of drying (Akwasi Kanyam, 2016). Furthermore, according to Park (2002, quoted in Akwasi Kanyam, 2016) sorting out physically damaged and infected grains can result in a 40 to 80 percent reduction in aflatoxin levels.

The main findings of the study by Akwasi Kanyam (2016) are that aflatoxin levels increase 5-fold when groundnuts harvest is delayed by a day or more, drying nuts on dirt increase aflatoxin levels by 34%, whilst sorting out physically damaged and infested groundnuts (based on mould content, empty pods and reduced size), reduces aflatoxin levels by 83%.

According to a project flyer[14], IITA and partner organisations have developed a natural product (i.e. *Aflasafe*) which significantly reduces aflatoxin levels in crops. *Aflasafe* contains native non-toxic strains of *Aspergillus flavus* that out-compete producing ones when applied in the field. When *Aflasafe* is correctly applied and all facilitative conditions are met, farmers in several countries consistently achieve 80% to 100% reduction in aflatoxin contamination in their maize and groundnut fields. It is understood that the *Aflasafe* distribution system in Ghana is in its early stages and only small quantities of the product are currently applied by farmers (also due to cost reasons). MOAP has, over the past 2 seasons, conducted trials which show promising results, especially in the 2019 season.

More information on aflatoxin in Ghanaian groundnuts is presented in Annex 8.2.

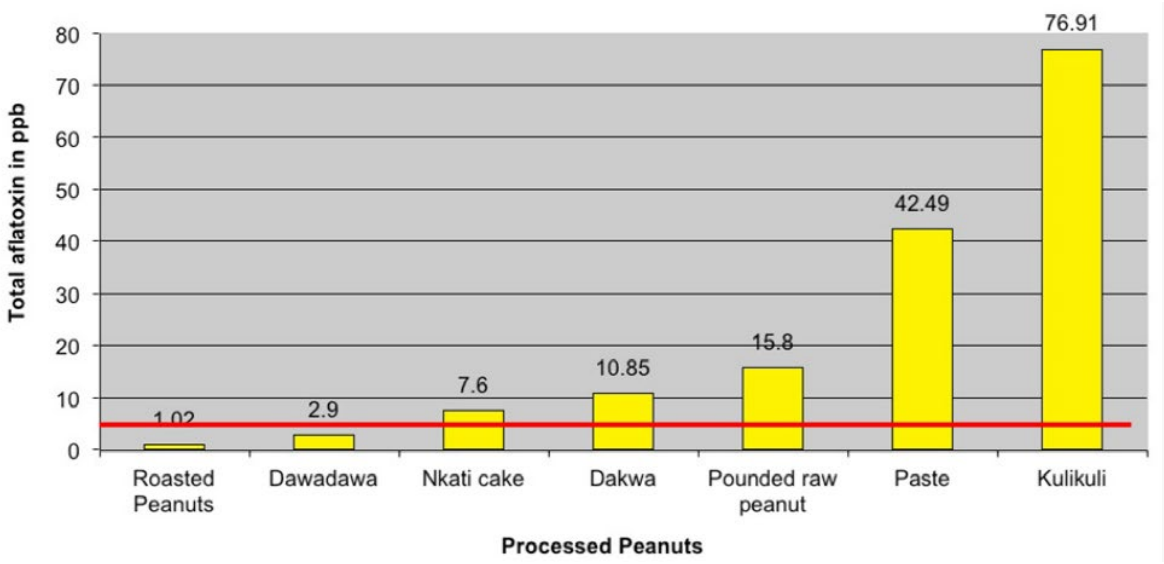


FIGURE 5: AVERAGE TOTAL AFLATOXIN CONTENT IN COTTAGE INDUSTRY PROCESSED GROUNDNUT PRODUCTS
Note: The EU limit in process food products, shown in red, is 4 ppb.
Source: Florkowski, J W, and Kolavalli, S (2013)

Opoku et al (2018) state that aflatoxin concentrations in cereal-legume blends sampled in supermarkets and mini-marts in Ghana ranged from 1 to 1094 ppb while those in cereal-only samples ranged from 1 to 11.7 ppb. The lowest aflatoxin concentrations were found in samples from the Upper East region with a mean of 1.5 ppb (1 to 3.8 ppb) while the highest were in samples from the Central region with a mean concentration of 457 ppb (6.6–1094 ppb). According to the authors (Opuku et al, ibid) aflatoxin concentrations in approximately a third of the infant formulations sampled exceeded the acceptable standard of 20 ppb, some by a factor of over 5 (100 ppb) and may contribute to the perennial malnutrition (stunting and iron deficiency) prevalent among children in Ghana.

2.3 Groundnut trade

Trading of groundnuts and groundnut products takes place at two levels, namely (a) between farm and processing operations, and (b) between the latter and final consumption or exports. As such the main trader categories include aggregators, wholesalers, and retailers. Aggregators and wholesalers can operate one after another (e.g. aggregators assemble groundnuts, and wholesalers then buy and transport them to centres in Southern Ghana such as Accra, Kumasi,

[14] https://aflasafe.com/wp-content/uploads/pdf/Aflasafe-Q&A-En.pdf

Cape Coast, or Takoradi). They can also operate in parallel whereby traders would assemble produce and sell it to processors in Northern Ghana (e.g. in Tamale, Bolgatanga, or Wa). At the same time, wholesalers can buy produce on rural markets (e.g. from farmers or small assembly traders), transport it to Southern Ghana and sell it to processors.

As far as on-farm consumption, and groundnuts sold by farmers and consumed in northern and southern Ghana are concerned the following estimates were made (Table 4).

TABLE 4: REPARTITION OF GROUNDNUTS IN GHANA

Groundnuts produced and consumed	Quantities (tonnes)*	Notes
Groundnuts produced in Ghana (unshelled);	420,000	Ghana production of GN
Groundnuts, Ghana production (shelled)	201,400	Ghana production shelled
Groundnuts imported (shelled) from within ECOWAS	33,600	17% of Ghana production
Total quantity of groundnuts available in Ghana	235,000	100% of groundnuts (shelled)
Groundnuts consumed on-farm and seeds (shelled)	37,300	On-farm consumption in Ghana
Groundnuts sold (shelled), produced in Ghana	162,600	Ghana groundnuts sold
Total quantity of groundnuts sold, including imports	196,600	Total quantity sold, shelled
Groundnuts sold and consumed in the North	78,640	Quantity sold in North, 40%
Groundnuts sold and consumed in the South	117,960	Quantity sold in South, 60%

Source: Trade interviews; team estimates; numbers are rounded.
*including losses

As indicated, an amount of about 33,600 tonnes of shelled groundnuts are procured in neighbouring countries and sold in Ghana. It is assumed that this quantity is also sold in a proportion of 40% in the North and 60% in the South of Ghana. Importers of groundnut products can be relatively large-scale traders based in Southern Ghana (e.g. Accra or Kumasi), who import groundnuts from countries within the region (e.g. Nigeria, Niger, Burkina Faso). Smaller importers may be based in Northern Ghana (e.g. Upper East Region) and travel across the border to buy groundnuts, which they then sell to processors in Northern Ghana (and in some cases they may be processors themselves) or to other traders (e.g. wholesale traders from Southern Ghana). It is estimated that the quantity of groundnuts imported represents 17% of domestic supplies (i.e. assumed to be about 33,6000 tonnes of shelled groundnuts).

Retailers are traders who mainly buy products from processors and sell processed groundnut products including, groundnut paste, snacks/roasted groundnuts, *kulikuli*, flour, or groundnut oil to consumers. As for the latter three products there was not enough information on retail costs and profits for the VCA4D study, as a result of which during the economic analysis it was assumed that processors directly sell these products to consumers.

Retailing of groundnut products (e.g. snacks, oil, and paste) is solely undertaken by women. Retailers may trade a combination of paste, oil, roasted groundnuts or several other commodities. They go to processors or markets for their supplies and sell to consumers (Owusu-Adjei, 2017). The latter may be customers encountered in markets or on the side of the road (e.g. if retailers are street vendors). Also, restaurants offering dishes including groundnut products represent a retail outlet.

In addition to informal outlets such as markets, there are formal retail outlets such as supermarkets or mini marts. Supermarkets or mini marts are more likely to be frequented by middle-class consumers and sell groundnut products at higher prices compared to informal markets. For example, a jar of groundnut paste of 600 grams would be sold for GHS 16.50 in October 2019 (e.g. GHS 27.50/kg).

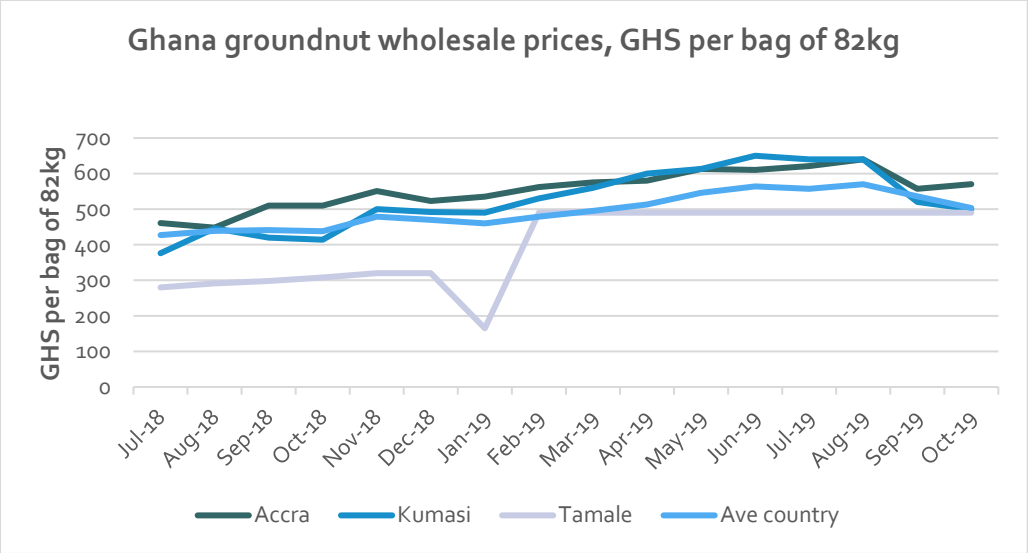


FIGURE 6: GROUNDNUT WHOLESALE PRICES IN GHANA
Source: https://esoko.com/food-prices-in-ghana-october-2019/
https://esoko.com/tag/commodity-prices/

As far as market information services (MIS) are concerned, Esoko is a well-known organisation in Ghana. It is an ICT company which, as part of their services, collects market price data from 46 markets across the country and publishes agricultural commodity wholesale prices on a monthly basis. The prices are validated before they become public good. Figure 6 provides an example of groundnut prices in selected markets between July 2018 and October 2019.

Losses

Losses in the groundnut value chain do exist, however it is difficult to quantity them in that they are often included in conversion ratios for shelling, roasting, or processing into paste or other groundnut products.

Conversion rates, groundnut outflows, losses and wastes of the main groundnut products have been estimated, starting from shelled groundnuts to the final product at retailer. Values considered in this study are reported in Table 5. Details on losses types are reported in appendix 8.5.

TABLE 5: CONVERSION RATES, GROUNDNUT OUTFLOWS, LOSSES AND WASTES OF THE GROUNDNUT PRODUCTS INCLUDED IN THIS STUDY (%).

Product	Roasted GN (snack)	Artisanal paste	Kulikuli	Oil	Flour	SME paste (SE)	SME paste (ME)
Conversion rate (from shelled GN to final product) (%)	83.9	79.7	60.6	19.1	57.6	78.7	78.7
Oil/cake extraction (%)			19.1	60.6	19.1		
Losses (%) (sorting, transport, grinding)	8.8	13.0	13.0	13.0	16.0	14.1	14.1
Wastes	7.3	7.3	7.3	7.3	7.3	7.2	7.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Some of the losses could be reduced by improving the efficiency of the conversion ratios. A study by the Natural Resources Institute[15] states that the average annual post-harvest loss has been estimated at 10% in the case of oilseeds (e.g. groundnuts), recognising that this estimate does not take into account potential quality-related economic losses.

The study by Kutsanedzie et al (2012), states that most of the traders sampled (77) in different markets of Ashanti, Brong Ahafo, and Greater Accra Regions do not want to incur extra cost to control pest and mould infestation, and as result they handle a smaller number of bags of produce in order to sell them fast to avoid damages which will decrease their profit margins. The study focused on storage and handling practices of maize and groundnut traders in Ghana. The study

[15] Natural Resources Institute (2016) Reducing Postharvest Losses in the OIC Member Countries; study commissioned by the Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC).

also included measuring the moisture content of stored produce and it was found that the majority of traders store their produce above the moisture content of 14%, which makes the produce vulnerable to pest and mould attack (Kutsanedzie et al (ibid).

2.4 Groundnut consumption

As already indicated, groundnuts represent a major food for the majority of Ghanaians (MADE, 2014; Owusu-Adjei, 2017, Florkowski and Kolavalli, 2013; Akwasi Kanyam, 2016, Masters et al, 2013).

Different figures for per capita consumption were obtained. Assuming that total supply of shelled groundnuts is 235,000 tonnes (domestic supply plus imports) this would result in a per capita consumption of 7.83 kg of shelled groundnuts (assuming that Ghana's population is 30 million).

For example, during the VCA4D survey processors and traders stated that most households would attempt to buy a small pack of groundnut paste per day to include in soup or use as spread. It was estimated that a small pack of groundnut paste sold by retailers in markets weighs about 50 grams (based on three to four soup spoons full of paste, each having a net weight of about 15 grams). Based on this quantity consumed, the annual consumption of groundnut paste per household would be 18.25 kilograms. Assuming that 4.5 million households consume 50 grams per day would result in 82,125 tonnes of groundnut paste consumed per annum. During the study it has been calculated that about 83,800 tonnes of groundnut paste are sold in Ghana by the informal sector, and about 5,840 tonnes of paste by the formal sector (including exports of 1150 tonnes).

It can be assumed that most farm households will not buy groundnuts for paste processing, and some households may not buy groundnut paste every day, and instead consume other groundnut products. At the same time, it ought to be indicated that these figures are only based on the statements of a few traders. A survey based on a larger sample of traders or consumers would be required to estimate more precisely the household consumption of groundnut paste and other products in Ghana.

Groundnut products are sold in numerous locations, including, in markets, supermarkets, mini-marts, restaurants, and by street vendors. In addition, institutions such as schools or military would serve groundnut-based products to their residents. Also, groundnut is used for weaning foods, and as such makes an important contribution to the diet of infants, for example in the northern part of the country which suffers from the highest rates of child malnutrition and stunting in Ghana (MADE, 2014).

According to Meng et al (2017) and the Monitoring African Food and Agricultural Policies Project, (2013) (quoted in Meng et al, 2017), groundnut plays an important role in the Ghanaian diet as a major source of plant protein and energy. The study by Meng et al (ibid) examines the presence of common groundnut products in the diets of urban households in Ghana, as well as the important attributes of products as viewed by consumers, and also identifies the consumer characteristics for each main groundnut product applying the survey data collected in urban Ghana in 2011. Groundnut products studied include, paste, roasted groundnuts, *nkati* cake, *dzowe*, *kulikuli* (also mentioning *kulikulisim*, which is crushed *kulikuli* and used as a condiment to flavour roasted meats), sugar-coated nuts, and groundnuts in chocolate. The study results indicate that roasted groundnuts, boiled groundnuts and groundnut paste are the 3 groundnut products consumed by the largest share of urban respondents in Ghana. Only 0.56% of the households reported that they do not eat roasted groundnuts, 0.84% do not eat boiled groundnuts and 1.22%

do not eat groundnut paste (Meng et al, 2017). The same study further states that "large households prefer paste, whereas the less educated and those from households with children prefer roasted groundnuts".

2.5 Stakeholders in the groundnut value chain

Table 6 outlines the stakeholders in the groundnut value chain and their respective roles. Whilst public sector stakeholders such as MoFA and other Ministries, as well as Local Government develop and implement policies, it is private stakeholders such as farmers, traders, and processors which ensure the functioning of the value chain.
As for groundnut producers, three categories of farmers have been identified for further analysis, namely:

(a) Smallholder farmers (SHF) not affiliated with an aggregator (NASH);
(b) Smallholder farmers (SHF) affiliated with an aggregator, who, in addition to purchasing farmers' produce, can also provide services such as input supply and extension (ASH);
(c) Commercial farmers, who tend to operate on a larger scale than SHF (e.g. 5 acres of groundnut production and above; in the case of the Ghana groundnuts value chain analysis it is estimated that commercial farmers produce groundnuts on an average of 7.8 acres of land which is based on information from the farmers' survey carried out by the team in August 2019).

As for traders and processors, these fall into two categories, namely:

(a) Actors belonging to the informal, artisanal, sector,
(b) Actors belonging to the formal, SME sector.

TABLE 6: STAKEHOLDERS AND THEIR ROLES IN THE VALUE CHAIN

Stakeholders	Role in the Value Chain
Ministry of Food and Agriculture (MoFA)	Policy development (e.g. PPMED, WIAD), provision of research and development (through CSIR research institutes, such as SARI and CRI), statistics and information (e.g. SRID).
Other ministries, e.g. Ministry of Finance and Economic Planning; Ministry of Trade and Industry.	Planning of economy, taking into account: government policy, fiscal and monetary priorities, and data (GSS). Ministry of Trade and Industry and its authorities (e.g. GEPA) are to promote trade relationships with other countries.
Public sector services: - Ghana Statistical Services; - Ghana Standards Authority; - Ghana Export Promotion Authority; - Food and Drugs Authority; - Ghana Revenue Authority.	Services with specific tasks, such as collecting, processing, and making available statistical data; promoting trade relationships with other countries; collecting tax revenue; policy development and enforcement (e.g. food safety related).
Local Government (LG)	Direction, research and extension through LG MoFA offices; market managers and inspectors (e.g. of food safety and environmental aspects)

Stakeholders	Role in the Value Chain
Inputs suppliers	Private or public sector providers of seeds, chemicals (e.g. fertilisers), implements, etc, organised in GAIDA
Universities	University of Ghana, KNUST, UDS, Nkoranza, etc; carrying out teaching and research projects.
Service providers	Private sector providers of services (e.g. tractor ploughing, shelling machines, manufacturers of groundnut paste)
Farmers	Groundnut farmers belonging to 3 categories (a) Smallholder farmers (SHF), not affiliated to aggregators (NASH) (b) Smallholder farmers (SHF), affiliated to aggregators (ASH) (c) Commercial farmers (CF)
Processors	Groundnut processors belonging to 2 categories (a) Informal / artisanal sector (b) Formal SME sector
Traders	Groundnut traders belonging to 2 categories (a) Informal / artisanal sector (b) Formal SME sector
Workers (not family labour)	Workers carrying out various tasks in the value chain, such as weeding, harvesting, sorting, handling, and processing of groundnuts
Transporters	Owners of vehicles (e.g. lorries, Motorkings), as well as drivers and assistants.
Development partners (multi-lateral, and bi-lateral)	EU Delegation in Accra; FAO, GIZ, DFID, USAID, World Bank, etc Development of investment priorities in collaboration with GoG; monitoring of economy, social and environmental situation in conjunction with government; formulation of development projects in conjunction with GoG.
NGOs	E.g. Women for Change; META; ACDEP. Development and execution of projects, awareness raising activities, etc
International organisations	IITA, IFPRI, ICRISAT, SNV, WFP, international foundations. Carrying out of agricultural research as prioritised by the CGIAR centres and other partners; development and execution of analyses and projects; support of population groups in need; support of Ghanaian organisations and projects (e.g. through their CSR activities).

2.6 Groundnuts value chain map and issues in the chain

Figure 7 shows a map of the groundnut value chain in Ghana in 2019 as outlined in the above sections. In, particular, it shows the production level distinguishing between non-aggregator linked smallholder farmers (NASH, the vast majority), aggregator smallholder farmers (ASH), and commercial farmers (CF), who are a small minority.

Traders include aggregators, wholesalers, and importers, representing the link between production and processing, as well as retailers of various groundnut products (e.g. paste, snacks, flour, kulikuli, groundnut oil), who form the link between processors and consumers. It should be mentioned, that for this value chain analysis there was not enough information on costs and profits in retailing of kulikuli, flour, and groundnut oil, as a result of which it was assumed that processors directly sell in these cases to consumers. Also, groundnut flour is frequently used as condiment by preparers of grilled meat (e.g. restaurants or street vendors).

In addition to the large number of informal, artisanal processors, there is a formal sector of processors, mostly comprising small and medium-scale (SME) companies but also a large factory producing groundnut snacks. Institutional buyers of groundnut products such as schools or military also belong to the formal sector. Some formal processors also export to overseas (e.g. North America) or regional markets (e.g. Nigeria).

The map of the value chain (Figure 7) is followed by a figure (Figure 8) outlining major issues encountered by actors in the value chain. As far as inputs are concerned, this includes the fact that the amount of certified groundnut seed is limited, groundnut fertilisers are often not available as a result of which farmers opting for TSP which is not subsidised (in comparison to maize fertiliser). Also, there are labour shortages during part of the crop cycle (e.g. during harvest time), and the financial support is often not appropriate for farmers (e.g. reimbursements may be required every month and not when the harvest is available).

Issues affecting groundnut production include the fact that tractor ploughing is not always available, in particular for farmers in distant communities. Apart from ploughing there is little other mechanization in the production part of the groundnut value chain including harvesting and shelling. In addition to manual shelling, the latter is also done by machines, however these need to be improved to yield better quality produce (e.g. kernels which are less damaged). Good agricultural practices (GAP) are not always followed due to lack of extension or means on the part of the farmers to follow them. At the same time, groundnuts are largely a women's crop and thereby contribute to diet and income of smallholder families.

Aggregator and processor issues are related to facts that the majority of business takes place in the informal sector, and that despite a considerable consumption of groundnut products in Northern Ghana, large quantities are transported to consumption centres in the South. Imports of groundnuts from neighbouring countries within the region take place at least during part of the year. Groundnut is recognised as a profitable crop and has recently attracted more government support. In future, closer links within the value chain need to be established, in particular involving formal sector processors and farmers, with aggregators playing an intermediate function if required.

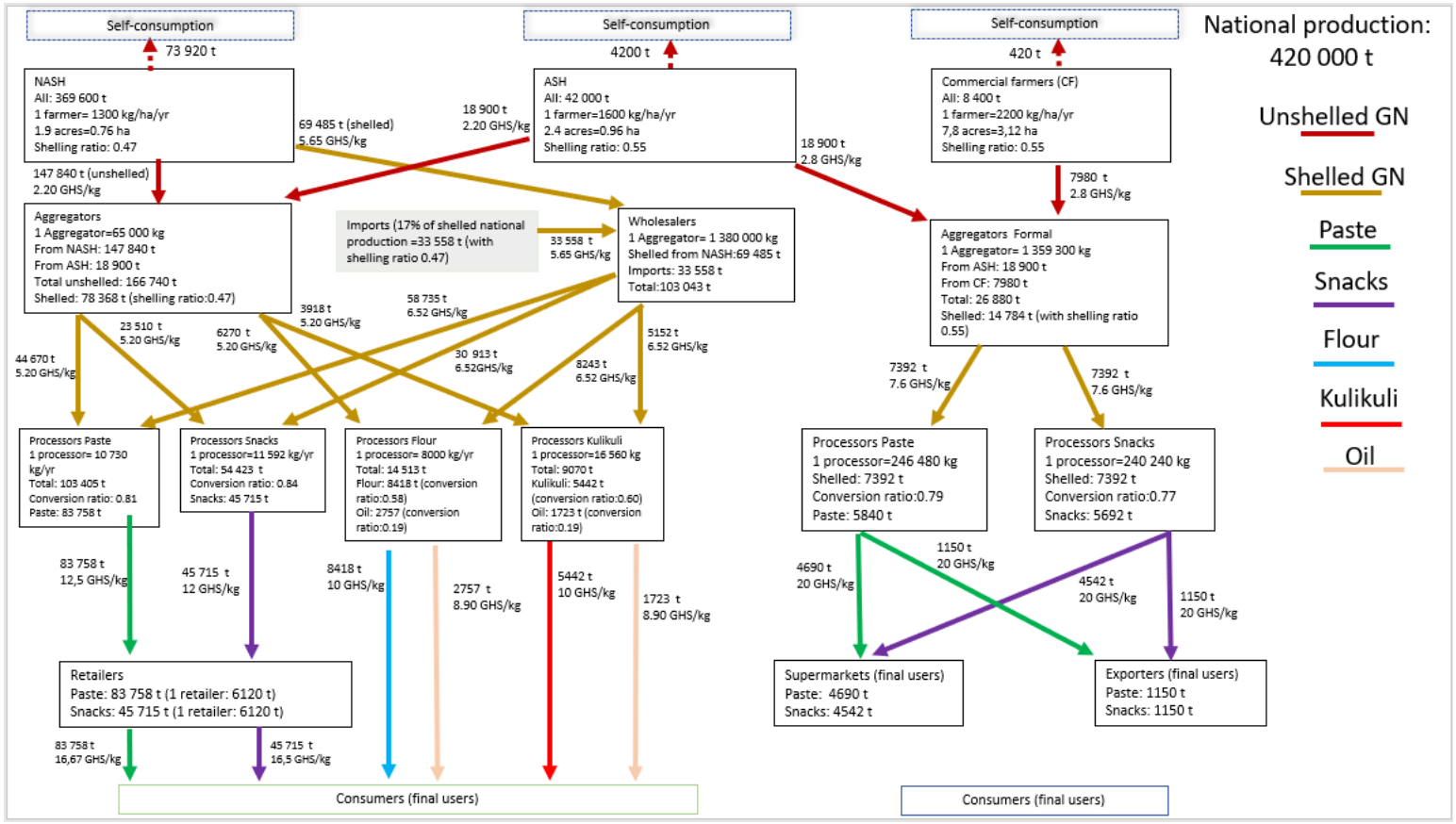


FIGURE 7: GROUNDNUTS VALUE CHAIN MAP IN GHANA

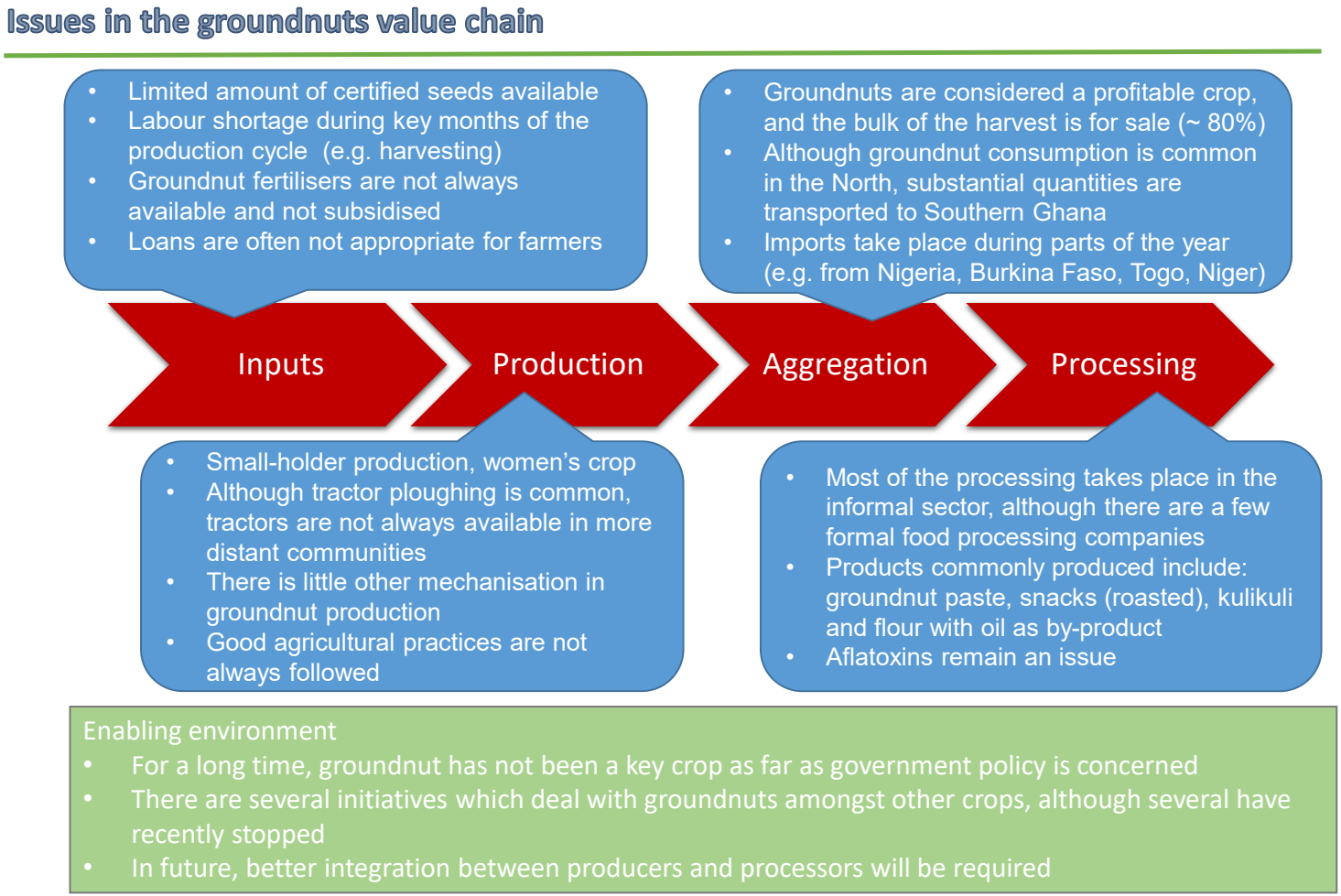


FIGURE 8: ISSUES IN THE GROUNDNUTS VALUE CHAIN

2.7 Governance in the groundnut value chain

Traders such as aggregators and wholesalers (in particular large-scale ones) play an important role in the market in that they represent the hub of the value chain. They are the best informed connecting the production areas of the country with centres of consumption.

Owusu-Adjei (2017) concluded that distributors are the dominant governors in the groundnut value chain. Factors that underline this assessment include, (a) the degree of organization by distributors which is higher compared to that of producers and processors, (b) they hold and distribute market information (in particular price information), and they are also better able to protect themselves from competition from other potential traders (e.g. through trade permits from market queens or other members of groundnut traders' associations).

At the same time, one has to recognise that the groundnut value chain is largely atomistic in its nature in that there are many, mostly smallholder producers, and plenty of processors, retailers and consumers. This atomistic nature of the value chain is likely to stifle innovation.

Ministries (e.g. MoFA), international development partners, and NGOs largely play a facilitating role, in that they provide information, extension services and support to the agricultural sector and rural households. Agro-input dealers will become more important in future as the use of agricultural inputs will increase (e.g. fertilisers, chemicals, certified seeds, hired services of mechanised agricultural equipment).

In future, it can be expected that larger-scale actors will develop in the formal sector (in addition to the one large-scale factory that currently exists) who will take the value chain forward. This entails a better integration between formal processors, aggregators, and farmers. Whilst in some cases there will be direct link between large-scale enterprises (who may be processors, retailers, and exporters at the same time), in other cases it will be aggregators who will play the role of intermediary between processor and processor.

As part of this model, farmers will be better informed of quality and other requirements by buyers, and at the same time receive extension services and inputs (or information about where they can obtain them). Buyers, on the other hand, have to buy better-quality produce at higher prices than standard quality.

3. Economic analysis

The objective of the Economic analysis of the groundnut value chain in Ghana consists in collecting relevant information to answer the two following framing questions:

- What is the contribution of the value chain to economic growth?
- Is the economic growth inclusive?

The economic analysis follows the functional analysis of the value chain because substantial amounts of information and data collected can be used in both analyses. It is, for example, the case for the main actors of the VC identified, the main impacts of the VC on the global economy and on the overall economic growth of the country. Results of the economic analysis of the VC should bring clear and detailed indications on its contribution to economic growth (including financial or actors' individual impact) and on the inclusiveness of the growth and impacts.

3.1 Background

The economic calculations will cover the following aspects:

- Financial analysis of actors in the value chain.
- Economic analysis based on the effects-method (i.e. breaking down the Intermediate Goods and Services into their value addition components).
- Viability of the VC in the international economy (e.g. calculation of indicators such as Domestic Resource Cost ratio).

As indicated in the functional analysis section of the report, the annual Ghanaian production of unshelled groundnuts is 420,000 tonnes on 338,000 hectares (based on FAO estimates for 2017). In addition, there are imports from neighbouring countries estimated at 17% of the national production (i.e. 33,558 tonnes of shelled groundnuts, assuming a shelling ratio of 47%).

The farms considered are non-aggregator linked smallholder farmers (NASH), aggregator linked smallholders (ASH), and commercial farmers (CF). Groundnut farm sizes, yields, and percentage of total production are shown in Table 7.

TABLE 7: FARM SIZES AND GROUNDNUT YIELDS APPLIED IN THE ECONOMIC CALCULATIONS OF VCA

	Groundnut farm size (ha)	Yields (tonnes/ha)	Percentage of total production
Non-aggregator linked smallholders (NASH)	0.76	1.3	88%
Aggregator linked smallholders (ASH)	0.96	1.6	10%
Commercial farmers (CF)	3.12	2.2	2%

NB. a) In addition, a sensitivity analysis has been carried out for a yield of 800 kg/ha produced by NASH farmers.
b) The yields are for unshelled groundnuts.

Traders fall into the following categories:

- Aggregators (buy unshelled GN from farmers mainly at farmgate, transport them to town, shell them using mechanized service providers, and then sell to larger wholesale traders or directly to processors.
- Wholesale traders buy from aggregators or directly from farmers who bring their produce in shelled form to local community or town markets. For simplification reasons, in the flow-chart it has been assumed that wholesalers obtain their groundnuts from farmers or importers.
- Importers buy shelled groundnuts in neighbouring countries such as Niger, Burkina Faso, Nigeria or Togo, and transport them to Ghana. Different importers have been encountered, including large-scale wholesale traders who buy substantial quantities (e.g. in Niger) of shelled groundnuts which they import to urban centres in Southern Ghana.
- Retailers of final groundnut products include both informal and formal retailers selling processed groundnut products. Whilst some retailers sell groundnut products together with other products, others sell just groundnut products (e.g. groundnut paste or roasted groundnuts). Formal outlets include supermarkets and shops or marts.

As indicated, processors fall into two main categories, i.e.

- Informal, artisanal, small-scale processors, who constitute by far the majority and manufacture the bulk of groundnut products;
- Formal, mostly SME processors, who process an estimated 7% of the total amount of groundnuts entering the value chain.

TABLE 8: GROUNDNUT PRODUCTS ANALYSED DURING VCA

Product	Sector	Tonnes
GN production by NASH smallholder farmers, unshelled	NASH	369,600
GN production by ASH smallholder farmers	ASH	42,000
GN production by commercial farmers (CF)	CF	8,400
Home-consumption (food and seed), unshelled	On-farm	78,540
Imports from within ECOWAS region, shelled GN	Importers	33,558
Aggregator traders, informal, shelled GN	Informal	78,368
Aggregator traders, formal, shelled GN	Formal	14,784
Wholesale traders, informal, shelled GN (including imports)	Informal	103,043
Groundnut paste	Informal, artisanal	83,758
Snacks / roasted groundnuts	Informal, artisanal	45,715
Kulikuli. Sold directly to consumers	Informal, artisanal	5,442
Groundnut flour, sold directly to end-users	Informal, artisanal	8,418
Groundnut oil, sold directly to end-users	Informal, artisanal	4,480
Groundnut paste, sold to supermarkets	Formal, SME factory	4,690
Snacks / roasted groundnuts, sold to supermarkets	Formal, SME factory	4,542
Groundnut paste, exported	Formal exports	1,150

Product	Sector	Tonnes
Snack / roasted groundnuts, exported	Formal exports	1,150

The products produced by groundnut processors, include:

- Groundnut paste (most consumed groundnut product);
- Snacks and roasted groundnuts;
- *Kulikuli* together with groundnut oil;
- Groundnut flour (often used as condiment by meat grillers) with groundnut oil as by-product;
- Other products such as *dakwa*, *nkatie* cake, and pounded raw groundnuts (not included in analysis because not enough information has been available on these products).

The formal sector is characterised by a range of factories, the majority of which are small to medium-scale enterprises (SME). The information regarding this sector in the economic section is based on a factory producing 20 tonnes of groundnut paste per month, using 26 tonnes of raw material (i.e. shelled groundnuts). However, it is understood that there are quite a few smaller enterprises and there is one larger factory producing groundnut snacks for the domestic and export markets within the region (e.g. Nigeria).

The total supply of groundnuts in Ghana includes domestic production of 420,000 tonnes of unshelled groundnuts and imports of 33,558 tonnes of shelled groundnuts. In view of this the quantities of products produced and distributed in the value chain have been calculated as shown in Table 8.

3.2 Financial analysis

Tables 9 to 11 show the results of the financial analysis in terms of production (sales plus the value of home-consumption in the case of farmers), intermediate consumption (IC) of goods and services, value addition and its elements, gross profit, depreciation, and net operating profit. The analysis starts with farmers, followed by processors and retailers.

The analysis of groundnut production is based on NASH farmers (non-aggregator linked smallholder farmers), ASH farmers (aggregator linked smallholder farmers, and commercial farmers (CF). Details of the farmer categories are explained above. The financial calculations show that the net operating profit is highest in the case of commercial farmers (around GHS 14,000 per farm per season), followed by aggregator linked smallholders (around GHS 2,200 per farm per season), and non-aggregator linked smallholder farmers (around GHS 1,270 per farm per season). In particular, this is due to higher yields in the case of CF and ASH farmers as a result of good agricultural practices, and more input use (e.g. fertiliser or certified seeds), and the larger farm sizes. In addition, farmers who can sell better quality groundnuts receive a higher price for their produce. Commercial farmers may have a lower intermediate consumption of goods and services if they own some of the equipment required for production (e.g. tractors).

The financial analysis of processing is shown in Table 10 and based on informal, artisanal processing of groundnut paste, snacks / roasted groundnuts, kulikuli plus oil (by-product) and flour plus oil. The formal sector processing is based on SME companies producing groundnut paste and snacks/roasted groundnuts. The results show the range of net operating profit possible per annum for the different companies. The informal companies have a net operating profit of around GHS 7,800 to GHS 23,000 per annum. At the same time, this may be based on different company

models. For example, the artisanal groundnut paste processing company shown in the calculations is more based on family labour, and, as a result, has a higher net operating profit, while the snack processing company is based more on hired labour, leading to a lower net operating profit. Also, the fact whether a company uses more service providers (e.g. mills for grinding of paste) or uses their own equipment has an impact on the company results. A company that owns their own equipment and is able to make good use of it, is likely to have lower costs in the form of depreciation. At the same time, it also depends to what extent a company is able to finance the purchase of the equipment from their own funds (equity) or requires a loan which tends to attract high interest rates (i.e. commercial interest rates are about 30% p.a.).

The formal sector enterprises show SME companies producing groundnut paste and snacks/roasted groundnuts. Their annual quantities of shelled groundnuts are 312 tonnes, and the output they produce is of the order of 240 – 250 tonnes per annum. The net operating profits per company are of the order of GHS 1,001,540 (snacks) to GHS 1,339,818 (paste). The costs of producing snacks are considered higher, amongst other things due to the use of condiments for the production of snacks, but also higher transport costs and more use of containers or sachets if direct sales (e.g. on the side of the road) are made.

Box 1: Sensitivity analysis of groundnut yields

A sensitivity analysis has been carried out regarding yields obtained by NASH farmers (non-aggregator-based smallholder farmers). In addition to taking an average yield of 1.3 t/ha, a yield of 800 kg/ha has been taken into account as worst case scenario. This translates into an annual production per groundnuts farm (0.76 ha) of 608 kg, resulting in a value of production including sales and home consumption which is GHS 1,338 per annum. (compared to 2,174 in the standard case). In the sensitivity case scenario, the value of Intermediate Goods and Services (IGS) is GHS 395, and value of hired labour inputs is GHS 433 per groundnuts farm per annum leaving an annual gross profit of GHS 510 per farm. Given that no depreciation has been taken into account in the case of NASH farmers, this is also the annual net operating profit per farm. Compared to this, the net operating profit of NASH groundnut farmers in the standard case scenario is GHS 1,269 per annum (also see Table 8 below).

As for NASH farmers involved in the value chain, this would mean that about 608,000 NASH smallholder farmers would produce groundnuts (assuming the quantity produced by NASH farmers would be 369,600 tonnes per annum). This compares to 374,000 NASH farmers in the standard case scenario.

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TABLE 9: FARMER OPERATING ACCOUNTS (IN GHS/FARM)

Type of production	NASH	ASH	CF
GN farm size (hectares)	**0.76**	**0.96**	**3.12**
Value of production			
Yield (kilograms), main product	988	1,536	6,864
Sales price, main product (unshelled GN per kg)	2.2	2.5	2.8
Sales revenue + home consumption	**2,174**	**3,840**	**19,219**
Intermediate Goods and Services (IGS)			
Tools (hoe, cutlasses)	38.0	48.0	156.0
Transportation of inputs (e.g. seed, fertiliser)	28.5	36.0	
Tractor hire for ploughing (@ GHS100/acre)	190.0	240.0	
Seed, traditional	91.2		
Seed, certified		240.0	780.0
Chemicals (herbicides)		36.0	117.0
Fertilisers (TSP)		264.0	858.0
Transportation of GN to farm	38.0	60.0	
Fuel (diesel for tractors, trucks)			252.7
Electricity (Irrigation)			
Water (Irrigation)			
Transport of GN to market (long-distance)	19.0	36.0	156.0
Other Intermediate Goods and Services (IGS)			
Total IGS	**404.7**	**960.0**	**2319.7**
Value addition			
Value of land			
Value of labour inputs			
Land clearing (no chemicals, cutlass)	114.0	144.0	468.0
Burning of leaves	76.0	96.0	312.0
Land preparation 1 - ploughing			62.4
Land preparation 2 - ripping			
Land preparation 3 - harrowing			62.4
Transport of inputs from market	28.5	36.0	117.0
Planting, sowing	22.8	48.0	156.0
Fertiliser application		9.6	31.2
Weeding (manual)	91.2	115.2	374.4
Harvesting (pulling/uprooting)	76.0	115.2	468.0
Harvesting (plucking)	91.2	144.0	561.6
Total labour	499.7	708.0	2613.0
Financial charges			
Taxes / duties			
Subsidies			
Gross profit	**1,269**	**2,172**	**14,286**
Depreciation			
Tractor			70.2
Motorking			46.8
Sprayer (chemicals)			15.6
Total depreciation			**132.6**
Net operating profit (GHS per farm per season)	**1,269**	**2,172**	**14,154**

TABLE 10: PROCESSOR OPERATING ACCOUNTS (IN GHS P.A.)

Type of processing	GN paste	GN snacks	Kulikuli & oil	GN flour & oil	GN paste (formal)	GN snacks (formal)
Value of production						
Output of main product (kilograms p.a.)	10,731	11,592	16,560	8,004	246,480	240,240
Sales price (per kg of main product)	12.50	12.00	10.00	10.00	20.00	20.00
Output of by-product (kilograms p.a.)	-	-	5,244.00	2,622.00	-	-
Sales price (per kg of by-product)			8.90	8.90		
Sales/revenue	**134,136**	**139,104**	**212,272**	**103,376**	**4,929,600**	**4,804,800**
Intermediate Goods and Services						
Cost of groundnuts (shelled)	79,488	82,800	165,600	82,800	2,371,200	2,371,200
Quantity of raw material (kg p.a.)	13,248	13,800	27,600	13,800	312,000	312,000
Purchase ı Purchase price (GHS/kg)	6.00	6.00	6.00	6.00	7.60	7.60
Transport of product	11,520	1,440	-	-	24,000	60,000
Hire of roasting equipment	1,920	-	-	-	-	-
Use of grinder / mill	3,600	-	4,500	2,250	-	-
Electricity for grinder / mill	-	-	-	-	15,000	-
Fuel for generator	-	-	-	-	-	-
Plastic containers (e.g. tubs, small buckets)	9,216	17,892	-	-	240,000	360,000
Fuelwood / charcoal	1,920	2,400	6,000	3,000	-	-
Building (rented)	-	-	-	-	12,000	12,000
Condiments	-	-	600	-	-	240,000
Gas, LPG (for roasting, cylinder, 40kg)	-	-	-	-	13,500	13,500
Internet platform/communication	600	-	-	-	2,400	2,400
Water	-	-	-	-	455	455
Total IGS	**108,264**	**104,532**	**176,700**	**88,050**	**2,678,555**	**3,059,555**
Value addition	-	-	-	-	-	-
Land rental	-	-	-	-	-	-
Labour inputs	2,880	22,320	6,600	3,300	225,840	225,840
Financial charges	-	-	-	-	60,000	60,000
Taxes / duties	300	300	300	300	496,427	367,477
Subsidies	-	-	-	-	-	-
Gross operating profit	**22,692**	**11,952**	**28,672**	**11,726**	**1,468,778**	**1,091,928**
Depreciation	1,680	4,000	5,800	3,960	128,960	90,389
Net operating profit (NOP), GHS p.a.	**21,012**	**7,952**	**22,872**	**7,766**	**1,339,818**	**1,001,540**

As for traders, four categories have been analysed, namely groundnut aggregator traders, wholesalers, and retail traders for groundnut paste and snacks produced by the informal sector. The annual net operating profit is of the order of GHS 56,745 to GHS 757,500 in the case of aggregators and wholesalers, respectively. The annual net operating profit of informal retailers is estimated at GHS 13,760.

It is understood that there are retail outlets who sell more products however it proved difficult to obtain the information required for the financial calculations either due to time constraints or because traders were reluctant to provide the information required (e.g. supermarkets). Also, it is understood that groundnut flour is mainly used as condiment for grilling meat in restaurants or by street food vendors.

In the case of aggregator traders, it is assumed that they buy and sell 10 bags of unshelled groundnuts per day, which are then shelled using mechanized equipment hired near the production centres (e.g. in Wa in Upper West Region). It is assumed aggregator traders buy groundnuts in villages during 100 days in the year, and then shell the groundnuts and sell them to processors or other traders. Wholesalers would hire or use their own lorries to transport large quantities (e.g. 300 bags) of shelled groundnuts from Northern Ghana to consumption centres in the South (e.g. Kumasi, Accra, Cape Coast). This shows in the financial results of wholesale trading

enterprises, which may only trade once per week but relatively large quantities, resulting in substantial sales figures and profits generated.

The financial results of retailers in the individual sectors need to be compared to labour fee rates, which provide a comparison as far as their alternatives are concerned. Profit margins of GHS 46/day compare to a daily wage rate of about GHS 15/day. At the same time, one must bear in mind that the profit margins may include the labour of other family members.

TABLE 11: TRADER OPERATING ACCOUNTS (IN GHS P.A.)

Type of trading	Aggregator	Wholesaler	Retailer GN paste (informal)	Retailer GN snacks (informal)
Number of days traded p.a.	100	50	300	300
Value of production per enterprise (groundnuts only)				
Output/sales (kg p.a.)	65,000	1,380,000	6,117	6,117
Sales price (GHS/kg)	6.00	6.52	16.67	16.67
Sales/revenue (GHS p.a.)	**390,000**	**9,000,000**	**101,950**	**101,950**
Intermediate Goods and Services (IGS)				
Cost of groundnuts	304,255	7,800,000	75,000	75,000
Quantity bought (kg p.a.)	138,298	1,380,000	6,000	6,000
Purchase price (per kg)	2.20	5.65	20.00	20.00
Transport	10,000	210,000	1,500	1,500
Packaging	4,000	90,000	10,740	10,740
Storage costs (hiring of room)	4,000	15,000	-	-
Shelling (hired meachanised sheller)	8,000	-	-	-
Total IGS	330,255	8,115,000	87,240	87,240
Value addition				
Value of land	-	-	-	-
Value of labour				
Handling	2,000	45,000	600	600
Commission fee	-	75,000	-	-
Total labour	2,000	120,000	600	600
Financial charges	-	-	-	-
Taxes / duties	1,000	7,500	300	300
Subsidies	-	-	-	-
Gross profit	56,745	757,500	13,810	13,810
Depreciation	-	-	50	50
Net operating profit (NOP), GHS p.a.	56,745	757,500	13,760	13,760

3.3 Effects within the national economy

This section provides an analysis of the effects of the groundnuts value chain within the national economy. It shows the results of the analysis consolidated for the country. The calculations have been carried out using the AFA (AgriFood chain Analysis) software.

VC consolidation

Table 12 indicates that the **value of production by the groundnuts value chain in Ghana is about GHS 2.73 billion**. As for the final output produced by farmers (NASH, ASH, and CF), this

reflects self-consumption of food and seeds. The bulk of their production is sold to aggregators and wholesale traders, who then sell the shelled groundnuts to processors. The latter either sell through retailers, or directly to consumers.

As far as farmers are concerned, smallholders who are not linked to aggregators (NASH) play an important role in the value chain in that, for example, their wage bill is GHS 176 million, and their net operating profits are GHS 553 million. The former figure reflects their importance as an employment provider in the value chain, whilst the latter needs to take into account that profits include their time spent on groundnuts production (including family labour). Other important employers in terms of hired labour include ASH farmers, and informal processors of paste and snacks (also highlighted in Table 12).

The value chain is an important consumer of intermediate goods (GHS 571 million) and services (GHS 279 million). Goods can include seed (traditional or certified), fuelwood, fertilisers, and packaging in the form of bags and different types of tubs, buckets and sachets. Services are important for farmers in that the majority rely on hired tractor ploughing (GHS 78 million), whilst traders would often hire transport services, including the hire of vehicle (e.g. truck, motorking, or car), fuel, and driver (GHS 157 million in total).

Land rent costs are not an issue in groundnut producing parts of Ghana, as a result of which it has been valued at zero throughout. Also, subsidies have been valued at zero in the case of groundnut production, processing, and trading. The only subsidized items encountered where fertilizer for maize (which is usually not used for groundnuts) and subsidies on tractors and their equipment (40%) made available through MoFA.

Financial services are not used by many agents in the value chain, in that interest rates are considered too high or credit terms are difficult for agents, in particular those operating in the informal sector. This includes the majority of agents active in the groundnuts value chain. As for taxes and duties, most processors and traders have to pay a daily or monthly fee to the Local Government (LG). This can be GHS 1/day or GHS 0.5 per bag of GN traded. Only enterprises in the formal sector pay a corporate income tax on their profits (25% on profits).

TABLE 12: SYNTHETIC ACCOUNTS AGGREGATED BY AGENTS (IN GHS)

Actor	Output	IGS	VA	Wage	Tax	Financial Charge	Depreciation	Net Operating Profit	Number of Actors
Producer NASH	1.206.449.306	476.641.849	729.807.457	176.270.767	0	0	0	553.536.690	374.089
Producer ASH	103.739.998	26.243.787	77.496.211	18.370.651	0	0	0	59.125.560	27.337
Producer CF	23.519.999	2.838.818	20.681.181	3.054.545	0	0	162.273	17.464.363	1.224
Aggregator (Informal)	407.617.792	398.275.634	9.342.158	2.411.940	1.205.970	0	0	5.724.249	2.565
Wholesaler	672.693.165	606.649.218	66.043.947	9.035.146	564.697	0	0	56.444.104	75
Processor Paste informal	1.047.821.154	777.506.277	270.314.877	16.186.390	1.686.082	0	9.442.061	243.000.344	7.806
Processor Snack informal	549.049.620	385.815.330	163.234.291	63.392.064	852.044	0	10.190.445	88.799.738	3.738
Processor Kulikuli	69.820.427	56.642.684	13.177.743	1.562.081	71.004	0	1.368.951	10.175.708	508
Processor Flour	108.810.641	90.401.080	18.409.562	2.499.329	227.212	0	2.990.106	12.692.915	680
Retailer informal	2.152.317.498	1.764.522.159	387.795.339	8.218.205	4.109.103	0	698.547	374.769.484	21.156
Aggregator formal	110.673.063	78.681.462	31.991.602	1.285.566	80.348	0	0	30.625.688	20
Processor Paste formal	115.041.740	62.509.256	52.532.484	5.270.413	11.585.060	1.400.216	3.009.064	31.267.732	24
Processor Snack formal	112.129.285	71.400.623	40.728.662	5.270.412	8.575.785	1.400.216	1.875.636	23.606.612	24
VALUE CHAIN	**2.731.067.198**	**849.511.696**	**1.881.555.503**	**312.827.507**	**28.957.303**	**2.800.432**	**29.737.082**	**1.507.233.178**	**430.459**

The direct value added of the groundnuts value chain in Ghana is estimated at GHS 1.88 billion. As for the sub-chains in the groundnuts value chain there are interesting points to note. For example, the formal sub-chain uses 7.5% of the volume of groundnuts but generates 11% of the direct VA. This shows how the formal sub-chain leads to increased VA, for example through better quality of groundnuts used and products produced (e.g. through improved processing technology, better packaging).

At the same time, one needs to consider the importance of the informal sector in the groundnuts value chain. For example, total production (sales figures) show the importance of the informal sector as they account for 88% of total output at the processing stage. In particular, paste is important in that it contributes an estimated 58% to the total production of processed products (GHS 1.16 billion). 10% of paste is estimated to be produced by the formal sector. Snacks contribute about 33% to processed products (i.e. GHS 662 million, of which 17% is produced by the formal sector). As for kulikuli, GN flour, and oil, these contribute 3%, 4%, and 2% to the production of processed products, and are entirely processed by the informal sector).

Figures 9 and 10 show breakdowns of the production components within the value chain and return to cash by agent.

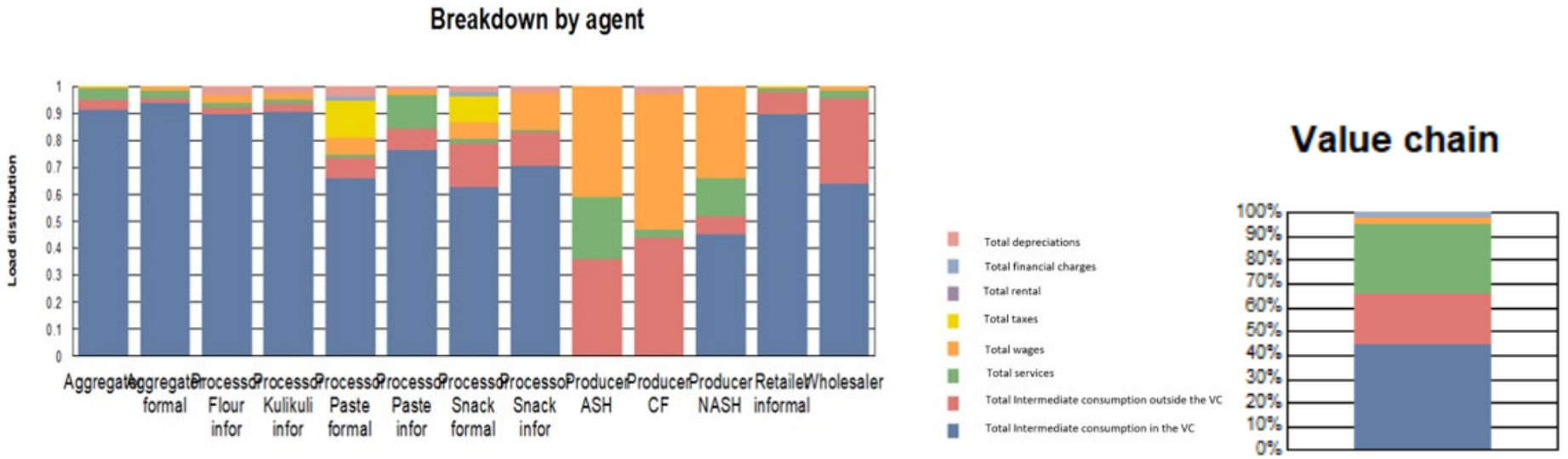


FIGURE 9: BREAKDOWN OF THE PRODUCTION COMPONENTS BY AGENT AND AT VC LEVEL

Figure 9 (left hand side) shows the breakdown of the production components at VC level and by agent, indicating the importance of total intermediate consumption in the value chain for processors and traders (i.e. groundnuts or their products in one form or another). NASH producers also have some intermediate consumption in the value chain in the form of traditional groundnut seed. Intermediate consumption outside the value chain includes intermediate consumption of goods and services (red and green parts of the chart, respectively) used in the form of agricultural inputs, fuel or packaging and services such as tractor hire for ploughing, transport, or roasting of groundnuts.

The orange part of Figure 9 shows the importance of waged labour in the production of groundnuts but also processing. Trading only provides a limited amount of wages (e.g. handling of produce). At the same time some of the labour inputs are included in the net operating profits (NOPs) in the form of labour by the entrepreneur or their family Figure 9 (right hand side) shows the main elements of how the value chain is broken down into its production components, e.g. total intermediate consumption in the value chain (i.e. approximately 45% of total production). This reflects to what extent the value chain relies on groundnuts and groundnut products for intermediate consumption by traders and processors (i.e. blue part of chart). Other main elements show intermediate consumption outside the value chain (e.g. agricultural inputs, packaging; red part) and (services (e.g. hire of transport, tractor ploughing services, shelling and grinding services; green part).

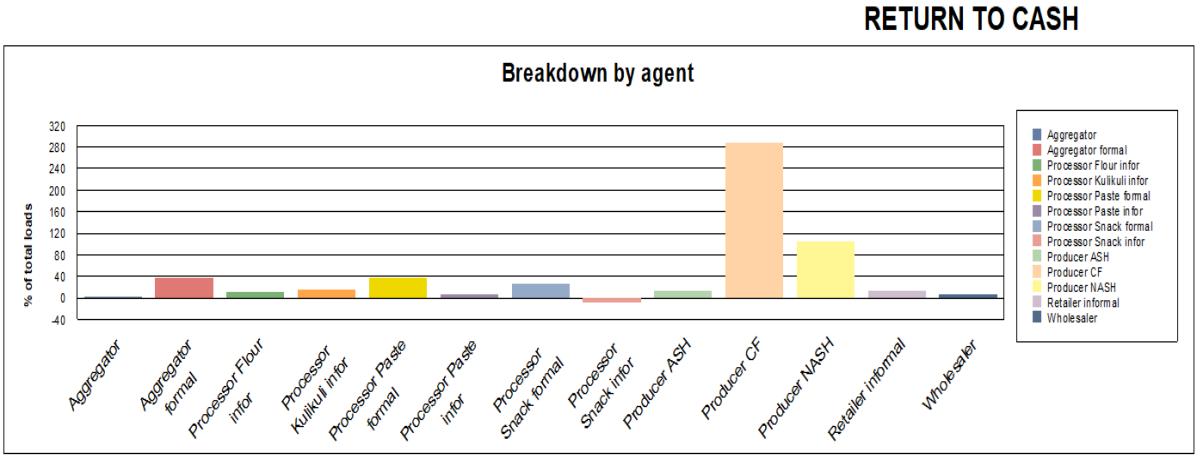


FIGURE 10: BREAKDOWN OF RETURN TO CASH BY AGENT

The breakdown of return to cash (Figure 10) shows that commercial farmers (CF) have the highest return to cash, followed by NASH producers, and formal aggregators and processors of paste and snacks. Informal traders and processors have a relatively low return to cash. The same is the case for ASH producers, reflecting their relatively high outlay for agricultural production inputs. Informal processors of groundnut snacks have a slightly negative return on cash.

Direct and indirect effects

Table 13 shows both direct and indirect effects of the groundnuts value chain. In particular, this includes a break-down of intermediate consumption (goods and services) into their value addition components, which results in the indirect effects. Imports include, amongst other things, shelled groundnuts, fuel (which is procured from other countries under old contracts until new supplies from domestic production will take place), machinery (e.g. tractors), and chemicals (e.g. herbicides).

There are elements of intermediate consumption (IC) which have not been disaggregated due to absence of details about their composition (e.g. around GHS 71 million in total). The wage component of value added is GHS 537 million if indirect effects from intermediate consumption are taken into account. Tax income shows GHS 110 million (e.g. based on fuel taxes from transport services, but also other taxes or duties which service providers have to pay). Financial charges are estimated at GHS 63 million if indirect effects are taken into account (e.g. tractor service providers or fuel companies are likely to take credit from banks).

Property income is a relatively small GHS 4.2 million (e.g. rent of buildings). Depreciation is GHS 29.7 million and includes depreciation of machinery and equipment. The net operating profit is GHS 1.6 billion taking indirect effects (GHS 166 million) into account.

The total value added (i.e. both direct and indirect) of the groundnuts value chain in Ghana is estimated at GHS 2.38 billion (Table 13; Figure 11). In addition, there are imports worth GHS 283 million.

The two largest components of effects of the value chain are net operating profits and wages. As already indicated net operating profits also include the labour of entrepreneurs spent in their enterprises (e.g. farms, processing enterprises, or trading companies). Taking this into account, GHS 1.6 billion for net operating profits appear reasonable, in particular given that this includes a significant amount of family labour on smallholder farms.
As for wages they are of the order of GHS 537 million, including both direct and indirect effects. The latter includes wages in the service sector (e.g. tractor and truck drivers, or operators of grinding mills). A more detailed calculation of the number of hired wage labourers and entrepreneurs depending on the groundnuts value chain is presented in section 3.5.

TABLE 13: DIRECT AND INDIRECT EFFECTS OF THE GROUNDNUTS VALUE CHAIN IN GHANA

	Direct effects (GHS)	Indirect effects (GHS)	Total effects (GHS)
Imports	282,932,923	0	282,932,923
IC not disaggregated		70,672,005	70,672,005
Value added			
Wages	312,827,507	153,171,916	465,999,423
Tax (+) Sub (-)	28,957,303	81,229,172	110,186,476
Financial charges	2,800,432	60,065,791	62,866,223
Property income	0	4,165,312	4,165,312
Depreciation	29,737,082	0	29,737,082
Net operating profit	1,507,233,178	165,623,226	1,672,856,404
VA not disaggregated		31,657,667	31,657,667
VA	1,881,555,513	495,913,084	2,377,468,597

NB. The total value added would be of the same order of magnitude in case of a yield of 800 kg/ha for NASH farmer. Only the number of NASH farmers would be affected.

The breakdown of total effects in the groundnut value chain is illustrated in Figure 11, which is based on Table 13.

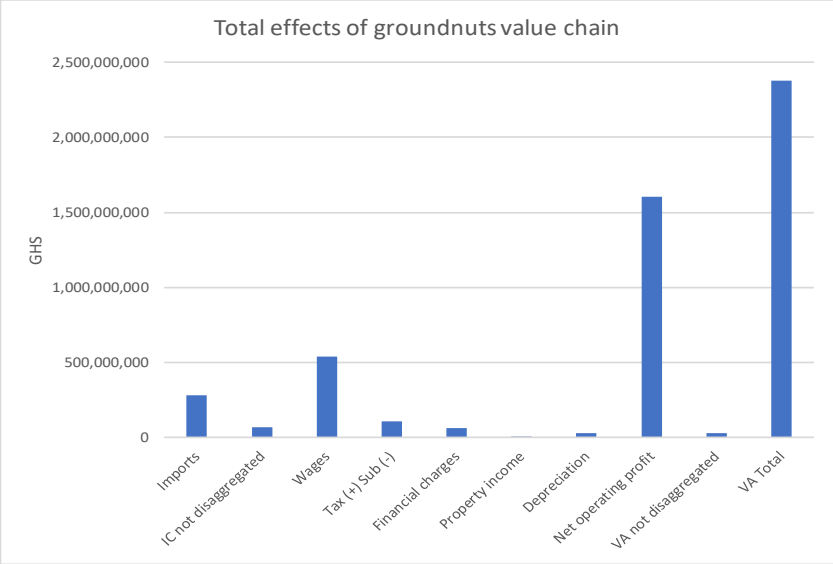


FIGURE 11: BREAKDOWN OF TOTAL EFFECTS IN THE GROUNDNUT VALUE CHAIN

Contribution of the VC to the GDP

The consolidated value of production of the Ghanaian groundnuts value chain is about GHS 2.73 billion, while, in 2018, the GDP of Ghana was US$ 65.56 billion (i.e. GHS 354 billion). The contribution of the value chain to GDP in terms of value addition (i.e. GHS 2.38 billion) is of the order of 0.7%.

The rate of integration into the economy (total VA/ value of production of the VC) is 87%.

Contribution of the VC to the agriculture sector GDP

The contribution of value added of the groundnuts value chain to the agriculture sector GDP of Ghana is approximately 4.3%. In 2018, the GDP (at current market prices) of the agricultural sector was GHS 54.9 billion (source: GLSS 6).

Contribution of the VC to the public finances

The contribution of the groundnuts VC to public funds is GHS 110 million (taxes, no subsidies).

Contribution of the VC to the balance of trade

The contribution to the balance of trade is GHS 283 million (€ 47 million) of imports (of which about GHS 190 million/€ 32 million for shelled groundnuts), and exports of the order of GHS 46 million/€ 7.7 million (i.e. exports of groundnut paste and snacks). As a result, the net contribution to the balance of trade is negative at GHS 237 million (€40 million).

3.4 Viability of the value chain in the global economy

Viability of the value chain within the global economy is measured by indicators such as Nominal Protection Coefficient (NPC), and Domestic Resource Cost Ratio (DRC). A DRC of 0.28 indicates that the value chain is viable within the global economy (Table 14). An NPC of the order of 1.1 indicates

that the agents in the value chain are slightly protected and don't have comparative advantage in terms of income.

TABLE 14: VIABILITY OF VALUE CHAIN IN THE GLOBAL ECONOMY

Indicators	**Values**
DRC	0.278
NPC	1.103

3.5 Growth Inclusiveness

There are an estimated 439,000 enterprises in the groundnuts value chain (Table 15). The vast majority of them are smallholder farmers including about 374,000 NASH and 27,000 ASH smallholder farmers. A sensitivity case study based on a lower yield of 800 kg/ha (compared to the standard case scenario of 1300 kg/ha) shows that about 608,000 NASH farmers will be active in the groundnuts value chain (assuming their annual production will still be 369,600 tonnes). Other important groups of agents include aggregators (2,500 enterprises), informal paste manufacturers (7,800 enterprises), informal snack processors (3,940), informal groundnut flour processors (680) and informal retailers of paste and snacks/roasted groundnuts (about 21,100).

Assuming larger farm sizes (e.g. 3 acres per NASH farmer) would result in 237,000 farms, and in the case of ASH farmers, 19,900 farms would be the result if a groundnut farm size of 3.3 acres per farmer is assumed. These farm sizes are based on the results of the farmer survey by the VCA4D team in August 2019. As for informal aggregators, their number would be reduced to 556 if an annual turnover of 300 tonnes per enterprise (rather than 65 tonnes) was assumed. Leaving the other numbers as they are would result in 293,000 enterprises in the value chain. In addition, there are about 256,000 hired workers directly employed in the groundnuts value chain (assuming a daily wage rate of GHS 15, and 100 days worked per annum in the value chain), and approximately another 102,000 as the result of indirect effects. In view of this, about 651,000 to 797,000 hired workers and mostly small-scale entrepreneurs depend on the groundnuts value chain.

TABLE 15: NUMBER OF ENTERPRISES IN THE GROUNDNUTS VALUE CHAIN

Agent	Number of enterprises in value chain
Producer NASH	374,089 Standard case scenario 607,895 Sensitivity case scenario
Producer ASH	27,344
Producer CF	1,224
Aggregator	2,565
Wholesaler	75
Processor Paste informal	7,806
Processor Snack informal	3,944
Processor Kulikuli informal	508
Processor Flour informal	680
Retailer informal	21,156
Aggregator formal	20
Processor Paste formal	24
Processor Snack formal	24
Value chain	**439,459** (or 673,265 in the case of a sensitivity analysis)

- Employment is created through direct effects and indirect effects in the value chain through the breakdown of the intermediate consumption of goods and services into indirect value added and indirect import. In particular, those agents who rely more on service providers are likely to generate substantial employment through this way. The total employment created in the value chain is of the order of GHS 466 million, corresponding to 31 million person-days of labour (at GHS 15/day), or 310,000 person-years (at 100 days p.a. worked in the GN value chain) (Table 16).

TABLE 16: DISTRIBUTION OF WAGES WITHIN THE GROUNDNUT VALUE CHAIN

Agent	Wages for hired labour (GHS)	Person-days (@ GHS 15/day)	Person-years (100 days worked per year)
Producer NASH	176,270,767	11,746,397	117,463
Producer ASH	18,370,651	1,224,710	12,247
Producer CF	3,054,545	203,636	2,036
Aggregator	2,411,940	160,796	1,608
Wholesaler	9,035,146	602,343	6,023
Processor Paste informal	16,186,390	1,079,093	10,791
Processor Snack informal	63,392,064	4,226,138	42,261
Processor Kulikuli informal	1,562,081	104,139	1,041
Processor Flour informal	2,499,329	166,622	1,666
Retailer informal	8,218,205	547,880	5,479
Aggregator formal	1,285,566	85,704	857
Processor Paste formal	5,270,413	351,361	3,514
Processor Snack formal	5,270,412	351,361	3,514
Value chain (direct effects)	**312,827,507**	**20,850,180**	**208,501**
Value chain (direct and indirect effects)	**465,999,423**	**31,066,628**	**310,666** (or 124,266 FTE workers, if FTE is assumed to be 250 days per year).

Figure12 shows the VA distribution by agent. NASH farmers who are the majority of groundnut producers have the highest VA in the value chain (i.e. 39%). ASH and CF producers have comparatively small value added (4% and 1%, respectively). Aggregator traders and wholesale traders also have a relatively small VA (i.e. 1% and 4%, respectively). Informal processors of paste and snacks/roasted groundnuts have relatively important value added, namely 14% and 9% respectively, whilst the VA of kulikuli and flour production (plus oil in both cases) is relatively modest (i.e. 1% each).

Informal retailers (i.e. 20%) contribute an important component of VA to the groundnut value chain, in particular through net operating profits which form their income. Formal sector aggregators (2%) and formal SME type processors of paste and snacks contribute 3% and 2% respectively.

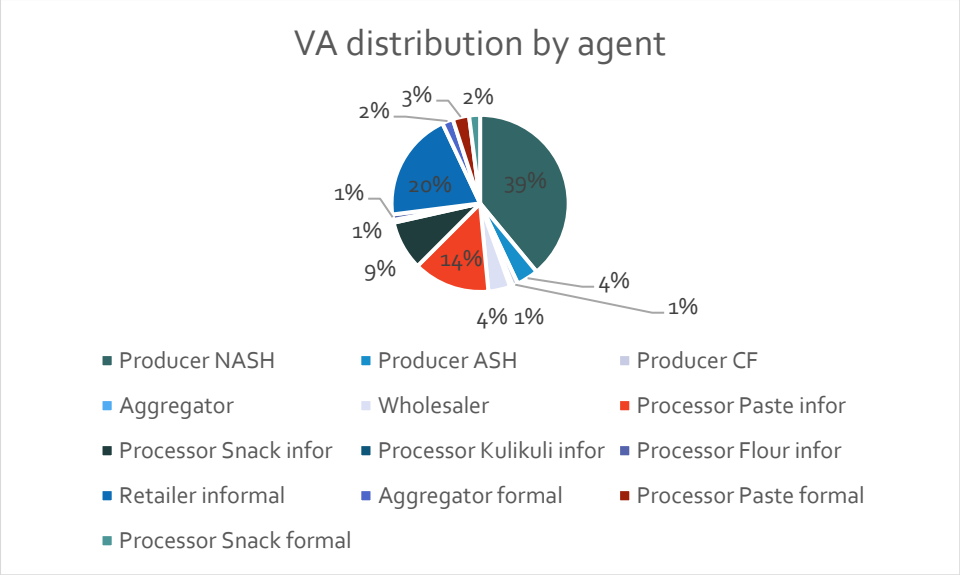


FIGURE12: VA DISTRIBUTION BY AGENT

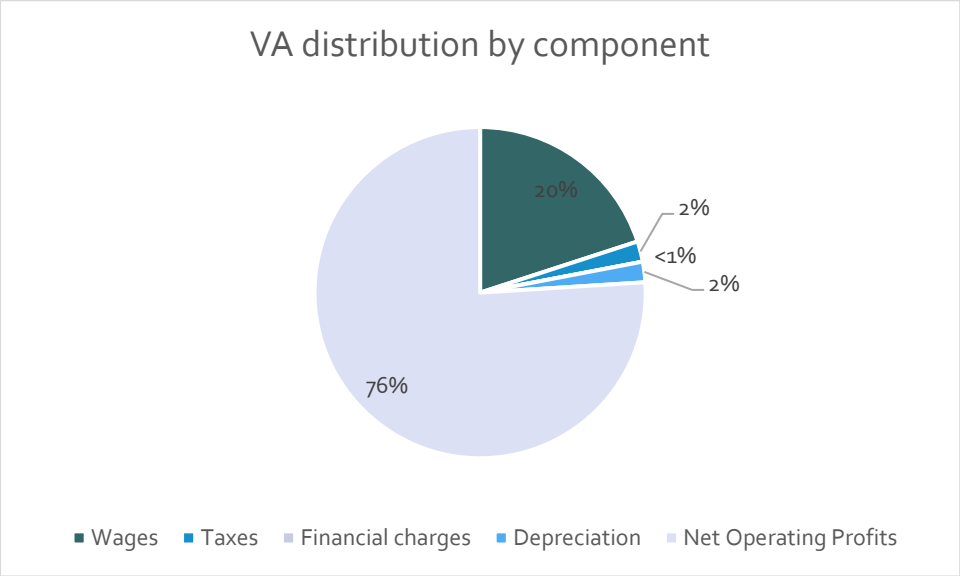


FIGURE13: VA DISTRIBUTION BY COMPONENT

Figure13 shows the VA distribution by component. It is shown that net operating profits (NOPs) constitute the main element of value addition (mainly reflecting the income of the large number of self-employed, small-scale entrepreneurs in the value chain), followed by wages for workers employed as part or full-time workers in production, processing, and trading of groundnuts and related products. In particular, NASH farmers constitute a large employer of hired labour for specific tasks such as harvesting of GN. Other important employers include the ASH production sector, and processors (in particular informal processors of paste and snacks). As for VA distribution by stage, the farming sector contributes 44% of VA, whilst trading (26%) and processing (30%) contribute the remainder (Figure 14).

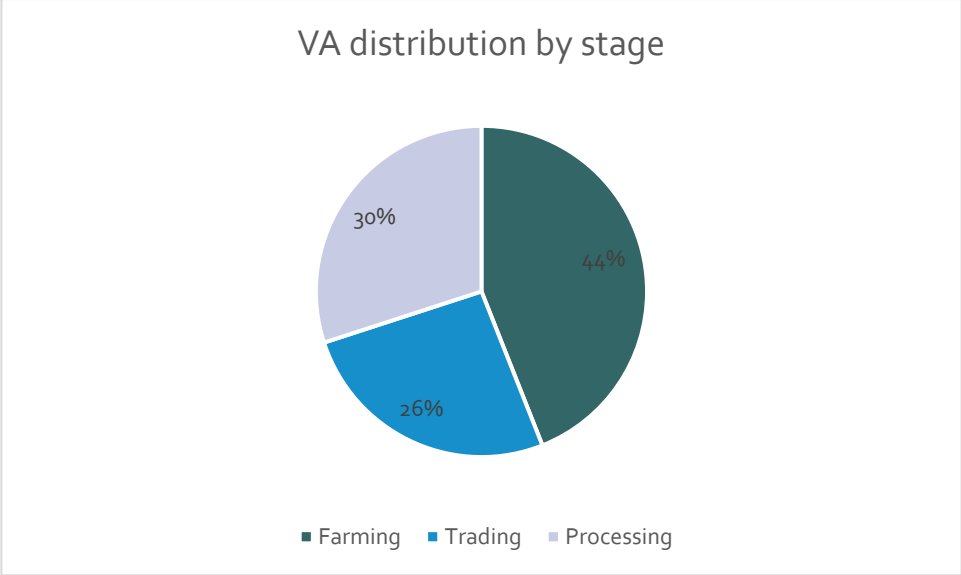


FIGURE 14: VA DISTRIBUTION BY STAGE

TABLE 17: SUMMARY TABLE OF ECONOMIC INDICATORS

Framing Question		Indicators	Results
CQ1.1	How profitable and sustainable are the VC activities for the entities involved?	Net income by type of actor	**Farmers (farm/season): NASH:**GHS 1,269 (GHS 510 in sensitivity analysis), ASH: GHS 2,172, CF: GHS14,154 **Traders:** Aggregators and wholesalers: GHS 56,745 – 757,500 p.a.; Informal retailers: GHS13,760 p.a.; **Processors:** Informal: GHS 7,766 – 22,872 p.a. Formal SME: GHS 1 million – 1.34 million p.a.
		Benchmark of farmers' net income with minimum wage and/or job opportunities	**Daily wage labour: GHS15/day (including the value of food provided)** **15-20% of living wage (the living wage in Ghana for a family of 6 is in the range of 1070 to 1680 GHS per month)**
CQ1.2	What is the contribution of the VC to the GDP?	Total VA and components	**GHS 2.377 billion; out of which GHS 1.6 billion NOP, and GHS 466 million wages**
		VA share of the GDP	**GDP was GHS 354 in 2018;** **VA share of GDP was 0.7%**
		Rate of integration into the Economy (total VA/VC production)	**VC production is GHS 2.73 billion; Rate of integration is 0.87**
CQ1.3	What is the contribution of the VC to the agriculture sector GDP?	VA share of the Agriculture sector GDP	**4.3%**
CQ1.4	What is the contribution of the VC to the public finances?	Public Funds Balance	**Taxes: GHS 110 million, no subsidies**
CQ1.5	What is the contribution of the VC to the balance of trade?	VC Balance of trade	**Negative at GHS 237 million net imports**
		Total imports / VC production	**10% (some elements of the IC have not been disaggregated)**
CQ1.6	Is the VC viable in the international economy?	Nominal Protection Coefficient (NPC)	**1.10**
		Domestic Resource Cost Ratio (DRC)	**0.28**
CQ2.1	How is income distributed across actors of the VC?	Total farm income	**GHS 630 million (NOP for NASH, ASH, and CF)**
		% final price at farm gate	**34% (based on case where farmers sell shelled groundnuts at GHS 5.65, and retailers sell snacks or roasted GN at GHS 16.50)**
		Total wages and salaries	**GHS 466 million (Total wages)**
CQ2.2	What is the impact of the governance systems on income distribution?	Income distribution	**Net Operating Profit (NOP) is important, although it also covers entrepreneur's time, and family labour**
CQ2.3	How is employment distributed across the VC?	Number of jobs and self-employment	**Hired workers: ~310,000, based on 100 days of work p.a. (or about 124,000 FTE workers if FTE consisting of 250 days p.a. is considered).** **Enterprises:** **293,000 – 439,000 (depending on the average size of farm used in the computation)** **This figure would go up by about 234,000 NASH farms if yields of 800 kg/ha are considered (i.e. sensitivity case).**

4. Social analysis

4.1 Introduction

The social analysis of groundnut value chain in Ghana broadly addresses the question of whether the value chain is socially sustainable (VCA4D framing question 3). The social analysis also shed light cross cutting its view with the economic analysis on the inclusivity of economic growth catalysed by the value chain (framing question 2). It investigates the social landscape of groundnut value chain, with a view to assessing both the existing social conditions and social relationships in the value chain. The value chain analysis finds out the positive and negative social impacts, potential risks and benefits of future value chain development under different groundnut production systems – Aggregator linked Smallholders' production (ASH), Non-Aggregator linked smallholders (NASH), and Commercial Farmers (CF). The purpose of the overall analysis is to inform decision makers on the social outcomes and impacts of different production models of the value chain coming into operations in the country. The analysis can function as a baseline for future monitoring of the value chains development. The approach is based on the generation of evidence on the status of the value chain, to inform decision making and lesson learning.

4.2 Methodology

The social analysis examines existing social conditions and social relationships in the value chains, considering the institutional and policy context for agriculture in general and groundnut value chain in particular. It assesses the potential risks and benefits of future development of the value chain for improving farmers' income, reduce poverty and improve nutrition. It complements the economic analysis in considering income and wage distribution in the value chain, the roles and employment of different social groups and gender.

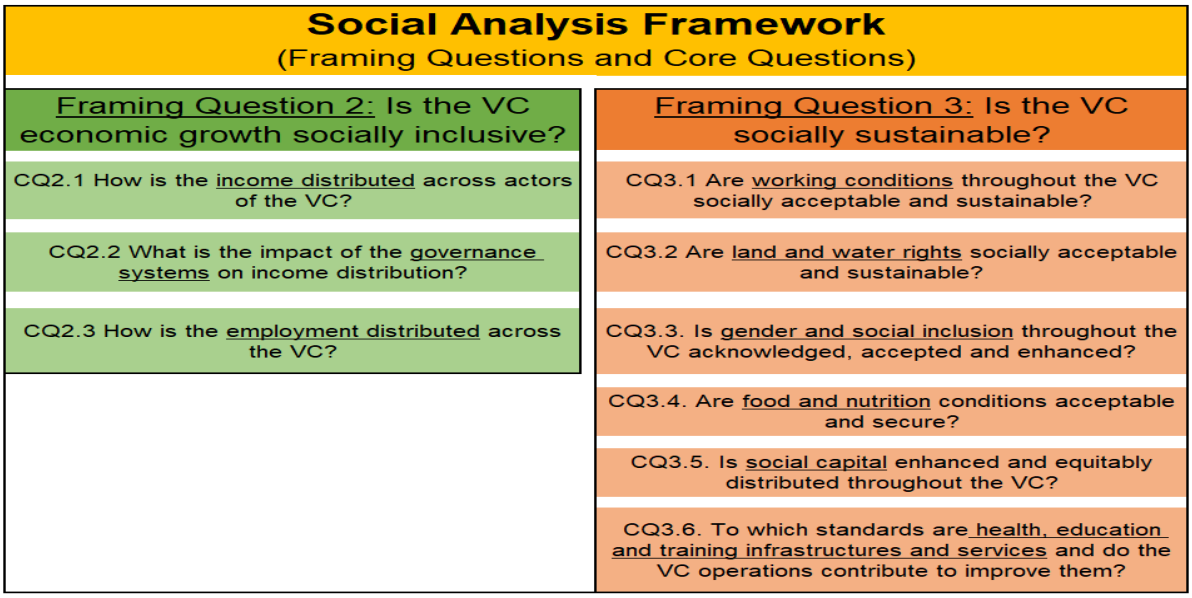


FIGURE15: SOCIAL ANALYSIS QUESTIONS

The social analysis draws on multiple sources of information. It requires a combination of data gathering from secondary data sources such as policy and strategy documents, national statistics, agriculture statistics, census data, research reports and studies, as well as field data collection from groundnut stakeholders e.g. producers at different scales, processors, traders, transporters,

loaders, input suppliers, wholesalers, retailers, exporters, service providers, government agencies, bi-lateral and multi-lateral agencies, private companies and NGOs.

The social analysis requires information which cross-cuts different sectors and government departments; for example, on working conditions, gender, nutrition, health, education, producers' organisations. Some issues needed sensitive handling, for example, gender relations, child labour, nutrition, working conditions, labour relations and hygiene practices. The methods of inquiry were largely qualitative, focusing on the main questions defined in the six domains, drawing on existing data, where available, but triangulating, validating and adding information from field visits and subsequent survey in different locations in Ghana. The main tools were *key informant interviews* (with stakeholders in the value chains) and *focus group discussions* with men and women producers and processors across different districts and chiefdoms. These exercises have used various participatory tools such as problem ranking, gender division of labour, seasonality analysis, food consumption analysis, household dietary diversity score etc. The social analysis has also collated quantitative data / evidence to provide justifications to the ratings on various social profile parameters. The quantitative data from survey - initiated after a mission in the country - have been utilised in analysing on different parameter of social analysis. Secondary data sources have also been used to this end. Wherever possible and needed, some quantification has also been attempted through using traffic lights and other rating scales.

TABLE 18: SUMMARY OF SOCIAL DOMAINS, QUESTION TOPICS AND TOOLS OF ENQUIRY

Social Domains	Sub Domains and Questions	Tools /methods used
1. **Working Conditions** Are working Conditions throughout the VC socially acceptable and sustainable?	1.1 **Respect of labour rights** (labour standards; freedom of association, employment conditions, discrimination) 1.2 **Child labour**; school attendance, exposure to harmful jobs 1.3 **Job safety**; accidents, damage to health? 1.4 **Job attractiveness**; wages, conditions attractive to youth?	• Review of Labour policies and laws • Key informant interviews with administrative leaders at different tiers (Central, district and chiefdom) Key informant interviews with NGOs /CSOs personnel, education officers, health workers, social workers. • Focus group discussions with men and women producers and processors • Interviews with owners and workers of groundnut production areas • Interviews with labourers in different parts of the value chains
2. **Land and water rights** Are land and water rights socially acceptable and sustainable?	2.1 **Adherence to voluntary guidelines;** land, responsible fisheries**.** 2.2 **Transparency and consultation**; in planning and decision making? 2.3 **Equity and compensation**; tenure rights, access to land and water, compensation, complaints procedures and arbitration?	• Review of VGGT in the context of country situation • Key informant interviews with administrative leaders at different tiers (Central, district and chiefdom) • Key informant interviews with NGOs /CSOs personnel, education officers, health workers, social workers. • Focus group discussions with men and women producers and processors • Review of Land Policy and other associated documents

Social Domains	Sub Domains and Questions	Tools /methods used
3. **Gender Equality** Is Gender and social inclusion throughout the VC acknowledged, accepted and enhanced?	3.1 **Economic activities and inclusion in VC**; women & vulnerable groups 3.2 **Access to resources and services**; women's ownership of assets, land rights, access to credit and services? 3.3**. Decision making**; women participation in decisions on production, income, assets? 3.4 **Leadership and empowerment**; women in groups, leadership positions, influence, speak in public? 3.5 **Gender roles and division of labour**; workloads of men and women, strenuous work minimised?	• Review of Gender policy and strategy • Key informant interviews with administrative leaders at different tiers (Central, district and chiefdom) • Key informant interviews with NGOs /CSOs personnel, education officers, health workers, social workers. • Focus group discussions with men and women producers and processors • Interviews with producer group leaders. • Interviews with labourers. • Survey with groundnut traders /intermediaries in the marketing chain
4. **Food and nutrition** Are Food and nutrition conditions acceptable and secure?	4.1 **Availability of food**; local food production and supplies increasing? 4.2 **Accessibility**; more income to allocate to food, consumer food prices decreasing? 4.3 **Utilisation and nutritional adequacy**; nutritional quality of food and nutritional practices improving, dietary diversity increasing? 4.4 **Stability**. Is risk of periodic food shortage reduced, food price variation reduced?	• Market data on food prices • Review of secondary data and literature on food and nutrition surveys • Key informant interviews with administrative leaders at different tiers (Central, provincial, district and chiefdom) • Key informant interviews with NGOs /CSOs personnel, education officers, health workers, social workers. • Focus group discussions with men and women producers on food purchases and consumption.
5. **Social capital** Is Social capital enhanced and equitably distributed throughout the VC?	5.1 **Producer organizations**; Organisations in VC? Inclusive membership, accountable leadership, negotiate in input/output markets? 5.2 **Trust and confidence**; extent of trust in the community, trust in value	• Focus group discussions with Farmer Based Organisations - group members and leadership. • Key informant interviews with NGOs and projects. • Survey with groundnut traders /intermediaries in the marketing chain

Social Domains	Sub Domains and Questions	Tools /methods used
	chain actors outside the community? 5.3 **Social involvement;** participation in decisions; traditional knowledge/ resources, communal activities?	
6. **Living conditions**	6.1 **Health services;** households access to health facilities and services in rural areas, health services affordable? 6.2 **Living conditions;** households access to good quality accommodation, water, and sanitation facilities 6.3 **Education, training & information;** primary, secondary and vocational education/training, information on technologies, policies, markets? 6.4 **Livelihood opportunities and mobility;** does VC provide opportunities for men, women, and youth? Alternatives ? Migration to other areas/countries ?	• Review of secondary data and surveys on living standards, Demographic and health surveys. National statistics • Key informant interviews with health workers and education officers. • Key informant interviews with administrative leaders at different tiers (Central, provincial, district, and chiefdom) • Focus group discussions with men and women producers and processors

4.3 Findings - Social Analysis (framing question 3)

Overall assessment (2018) of social sustainability of the groundnut value chain in Ghana generates a profile (web diagram) as presented below. The assessment has provided scores from 1 to 4, where score of 1 means that the VC carries high risk on a parameter. A score of 4 means that the VC carries no or little risks. As shown in Figure 17, the social analysis conducted in 2019 shows that the groundnut value chain, at the present juncture, carries low to moderate social risks and offers vast opportunities for pro-poor, pro-women and pro-youth economic development in the country. However, as highlighted by this analysis, realisation of the economic potential of the value chain requires many efforts for inclusive and sustainable expansion of the sector, for which a very large potential exist.

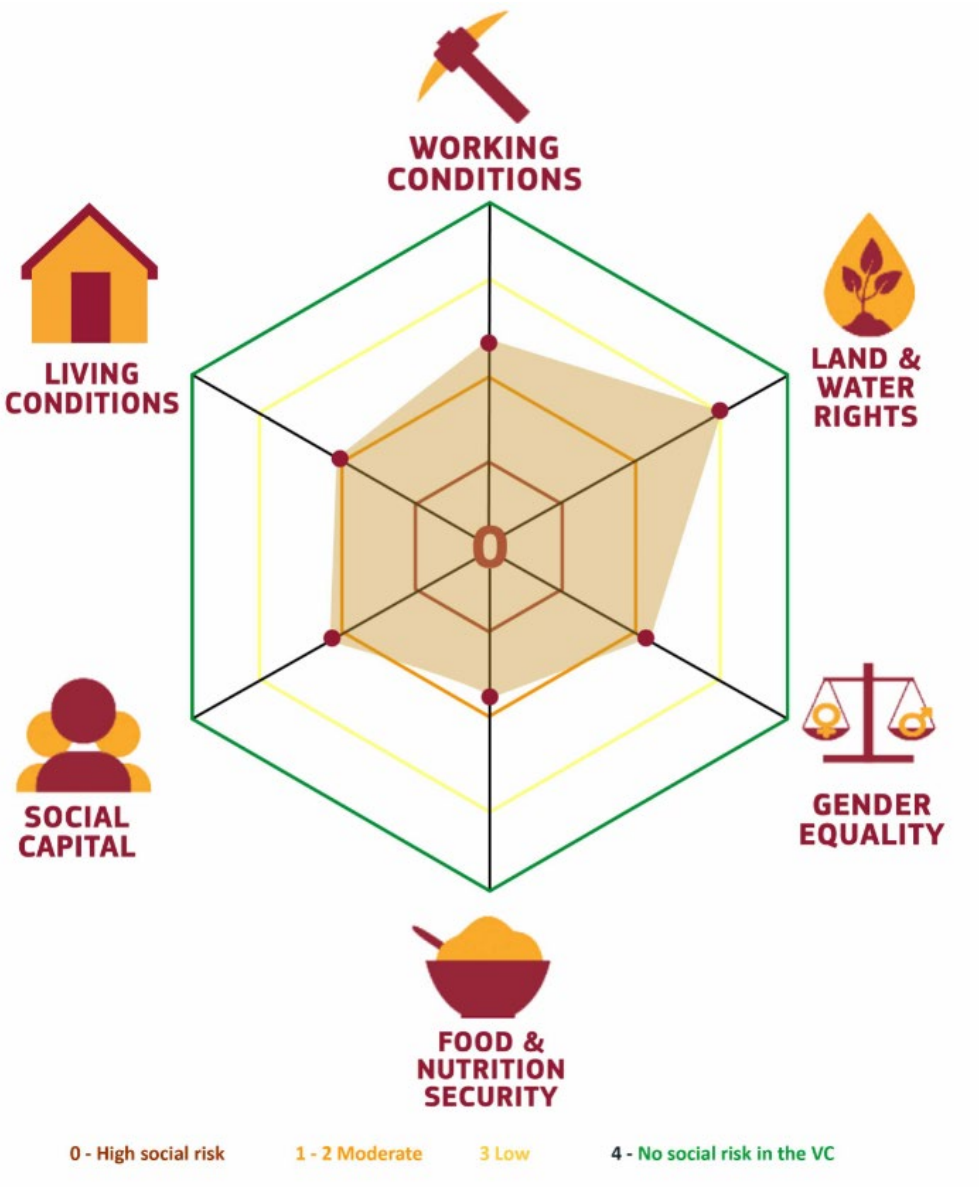


FIGURE 16: THE SOCIAL PROFILE

4.3.1 Working conditions

The assessment summary on the working conditions in the groundnut value chain in Ghana is captured in the table below.

TABLE 19: SUMMARY OF SOCIAL ANALYSIS ON WORKING CONDITIONS IN THE GROUNDNUT VALUE CHAIN IN GHANA

1.1 Respect of labour rights	**Moderate/Low**
1.1.1 To what extent do companies involved in the value chain respect international labour conventions?	Moderate/Low
1.1.2 Is freedom of association allowed and effective (collective bargaining)?	Not at all
1.1.3 To what extent do workers benefit from enforceable and fair contracts	Not at all
1.1.4 To what extent are risks of forced labour in any segment of the value chain minimised?	High
1.1.5 To what extent are any risks of discrimination in employment for specific categories of the population minimised?	High
1.2 Child Labour	**Substantial**
1.2.1 Degree of school attendance in case children are working (in any segment of the value chain)?	Substantial
1.2.2 Are children protected from exposure to harmful jobs?	Substantial
1.3 Job safety	**Not at all**
1.3.1 Degree of protection from accidents and health damages (in any segment of the value chain)?	Not at all
1.4 Attractiveness	**Substantial**
1.4.1 To what extent are remunerations in accordance with local standards?	Substantial
1.4.2 Are conditions of activities attractive for youth?	Substantial

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Respect of labour rights

Ghana has ratified 51 conventions (out of 190 conventions) including all 8 fundamental conventions[16]. The fundamental conventions ratified by the country include forced labour convention (No. 29), freedom of association (No. 87), Minimum age (No. 138), and worst form of child labour (No. 182). While the laws are in place, their implementation is constrained due to the fact that the country is largely and predominantly an informal and factor-driven[17] economy. As

16 http://ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:103231. The details of fundamental conventions ratified by the country are given at the ILO website: http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:103269

17 As per World Economic Forum – the global competitiveness index, factor-driven economies mostly compete based on their factor endowments -primarily unskilled labour and natural resources. Maintaining competitiveness

per Ghana Labour Force Survey (2015), 96.2 percent of the currently employed population 15 years and older in the rural areas are in the informal sector (84.1 percent in the urban areas). The proportion of females in informal employment in both rural and urban areas is higher than males. The majority (62.5 percent) of employed individuals aged 15–64 in rural areas work in agricultural self-employment. Another 33.7 percent work in non-agricultural self-employment, mostly in micro-enterprises as traders or shopkeepers.

Whether the labour laws are effective or fit for purpose is difficult to gauge in the context of large sphere of the economy operating informally. Also, tracking of compliances to labour laws and conventions are non-existent or non-visible though ILO or GoG sources of information[18].

Who are the workers in the groundnut value chain?

The workers in the groundnut VC are found at production, processing and trading levels, the majority being at the 'production' level. The study estimates that there are about 293,000 to 439,000 entrepreneurs / owners (producers, processors and traders) and about 358,000 workers engaged in different segments of the groundnut value chain. This suggest that about 650,000 to 800,000 peoples' livelihoods in Ghana are likely to be intrinsically dependent on groundnut. The study estimates[19] that about 87 percent of these workers at production segment, 7 percent at processing segment and 6 percent at trading segment of the VC (see the graphic below).

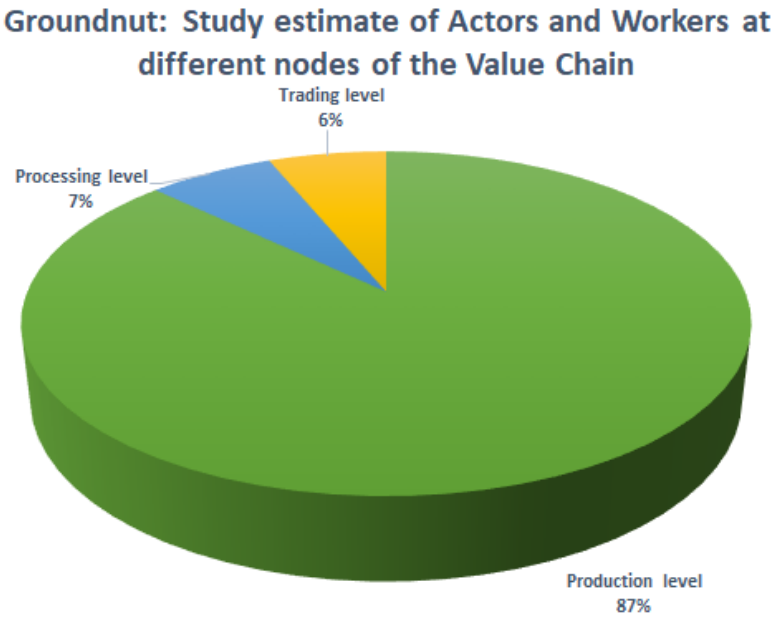


FIGURE 17: ESTIMATED ACTORS AND WORKERS AT DIFFERENT NODES OF THE GROUNDNUT VALUE CHAIN

Based on the ground-level observations and discussions with several actors in the value chain, it is very evident that the VC is dominated by women, especially in the production and processing

at this stage primarily hinges on well-functioning public or private institutions, a well-developed infrastructure, a stable macro-economic environment and a healthy workforce that has received at least a basic education. With low achievements on all these counts, the global competitiveness index places Ghana above most countries in Sub Saharan Africa, but still at low rank of 111 out of 137 countries.

[18] The website of the Ministry of Employment and Labour relation (http://www.melr.gov.gh/) of the Govt of Ghana was found to be non-functional when accessed on 24th November 2019.

[19] Estimates are derived from using primary data generated through two field missions, analysed together with the Government of Ghana statistics on groundnut production and productivity

segments. Overall we estimate that about 90 percent of all actors and workers in the value chain are women. This has clear policy implication as any initiative for value chain upgradation has significant likelihood of benefitting women and consequently health, education and food and nutrition security of large number of families in Ghana. This suggest that priority placed on groundnut value chain development by the GoG is likely to be a highly relevant and inclusive socio-economic development strategy. The specific category of workers at different segment of the value chain are captured in the table below.

TABLE 20: TYPE OF WORKERS IN THE GROUNDNUT VALUE CHAIN IN GHANA

Actors and workers in the VC	Relevant examples from the study	Estimated % of women
Production segment of the VC:		
Producers	Non-Aggregator linked smallholders (NASH); Aggregator linked smallholders (ASH) and Commercial Farmers (CF)	90 to 95%
Labourers /workers	Workers engaged in harvesting (uprooting and plucking) and planting	90 to 95%
Processing segment of the VC:		
Micro scale processors and workers	Women owned micro enterprises as seen in Techiman and other places	95 to 100%
Small scale processors and workers	Women owned businesses, generally involving 10 other women as seen in Wa, Kumasi, Tamale, Bolgatanga	95 to 100%
Medium scale processor and workers	B-diet, AUB Dasaan Ventures, Savannah Food Empire, Good and Goodness Enterprises	50%
Industrial scale processor and workers	Golden web Kumasi, Project Peanut Butter, Ghana Nut company, Savanah Agri Chain Ltd	50%
Trading segment of the VC:		
Aggregators, formal /informal and their workers	As seen in Accra wholesale Timber market, Neemah market, Farmer Pride, and many other aggregators	5 to 10%
Wholesalers and their workers	Accra Makola market, in Wa, Tamale, Bolgatanga and other places	5 to 10%
Retailers and their workers	As seen in different markets in Accra, Kumasi, Tamale, Wa, Bolgatanga and other places	80 to 90%

What is the status of workers and their working conditions?

The stipulated minimum wage by the GoG for agriculture workers is 10.65[20] GHS ($1.9) per day. This works out to 287 GHS ($52) per month and 3450 GHS ($628) per year. The VC analysis suggests that majority of workers across different part of the value chain are earning wages which are equal to or above the daily minimum wage. However, as data from sample investigations in the groundnut growing districts shows, majority of workers in the VC are not earning enough groundnut income equal to expected minimum wages on annual basis. The worse-off are farm owners and workers involved in groundnut production. The study estimates[21] that the groundnut producers (owners and workers, mostly women) are probably earning between 1270 GHS (231 USD) per annum. This excludes commercial farmers who are earning relatively much better (~14,153GHS; roughly 2577 USD) from their groundnut production. Groundnut processers are earning relatively more than the producers while groundnut traders and aggregators are earning more than the processors. Among the processors, owners and workers in industrial processing companies are earning comparatively more than the owners and workers of artisanal processing enterprises. The owners of artisanal processing enterprises (micro and small scale) are earning in the range of 8,000 to 20,000 GHS (1457 to 3652 USD) per annum.

The aggregators and wholesalers (mostly men) draw the best incomes among all actors /workers in the VC. Second best incomes are derived by owners of industrial processing companies (medium /large scale) who on an average can obtain an annual income of about (see economic analysis section 3.3, Table 16). Owners of industrial processing companies are also likely to be men in most cases. Third best incomes are obtained by artisanal processors. Artisanal processors can derive an income of nearabout 15000 GHS (2731 USD) per annum from their processing enterprise. As 90 to 95% of artisanal processing is carried out by women, groundnut processing has been a significant contributor for many women in wealth building and consequently enhanced social and economic status of women involved.

[20] Source: https://wageindicator.org/salary/minimum-wage/ghana/

21 Estimations are based on interviews with workers across the value chain and groundnut statistics from the GoG sources.

FIGURE 18: GROUNDNUT FARM OWNER AND WORKERS

Most workers in the VC have no full-time /permanent employment. Most are working on temporary work, which is paid on a daily or weekly basis. Most workers have no benefits except the daily wages (except sprayers who get food also). Most workers' work requires sitting for long-hours and doing patient demanding work in challenging conditions. Working conditions are especially harsh for small scale processing workers (typical for roasting), with extreme heat and smoke. Children of workers also live in this working environment and are expected to inhale smoke potentially posing dire health and safety risk for both mothers and children. This requires attention as roasting technologies can be improved, new roasting equipment can be introduced, working with Alliance for Improved Cookstoves /other platforms in the country.

FIGURE 19: ROASTING OPERATIONS CAUSING EXCESSIVE HEAT AND SMOKE

Many other workers in the value chain work under appalling working conditions. *Kulikuli* processing enterprise generally involve an owner working with 7 to 10 other women in semi-closed compound. The owner generally participates in the activities to a limited extent and lives in a reasonably good house within the compound. The workers bear the brunt of excessive amount of heat and smoke generated from wood burning for roasting and other operations of making *kulikuli*.

The study team also met a man sprayer whose services are used on groundnut farms for insecticide /pesticide sprays. While the sprayer does get better wages than other workers in the value chain, he has to spray continuously without needed protection and awareness on health and safety risks.

Table 21 provide a summary account of working conditions for different category of workers in the groundnut value chain.

TABLE 21: WORKING CONDITIONS OF WORKERS IN THE GROUNDNUT VALUE CHAIN

VC segment	Worker	Working condition	Rating
Production	Women labourers	Women work long-hours in uprooting, plucking and planting operations. This causes them body ache and poses other health and safety risks	
	Men sprayer	The pesticide /insecticide sprayer on groundnut crop get sick after continuous spraying. He has received some dress from a government programme but have no personal protective equipment and also have no awareness of the health and safety risks that precautions that he need to take	
Processing	Women roaster	Women work under extreme heat and smoke in a poorly ventilated compound. Long hours of on-the-ground sitting for women workers.	
	Kuli Kuli roaster, preparer	Women work under extreme heat and smoke in a poorly ventilated compound. Long hours of on-the-ground sitting for women workers.	
	Women and men workers at industrial processing sites	Working conditions for men and women workers at these sites are reasonable fine, complying with requirements of ILO conventions. Workers generally get health and safety training and support as needed, though more would need to be done to improve protection of workers from industrial incident that may happen.	
	Men paste mill worker	Poorly ventilated and unhygienic working conditions can pose health and safety risks for the mill worker	
Trading	Women worker at aggregator sites	Generally good /relatively better working condition than seen elsewhere in the value chain. Though here also women work in a compound, with long hours of sitting and without any health and safety training or protection. Women get paid on a daily basis.	
	Women retailers and workers in various markets	As retailing generally happen in open markets, here working conditions for women workers tends to be relatively better than seen elsewhere. However, here also, women need to sit long hours and do not get any health and safety training or protection. Women get paid on a daily basis.	

***Working conditions assessed based on rewards, occupational health & safety, hygiene and environmental conditions of the work spaces. Traffic light rating scale used in following way:**

Working conditions reasonably comply with the requirements of the national and international labour laws and conventions; Health, safety and other concerns are being partially taken care of, instances of forced labour or child labour are not observed

Working conditions partially comply with the requirements of the national and international laws and conventions; health, safety, hygiene and environmental conditions can pose risks to the workers at different parts of the value chain

Working conditions does not comply with the requirements of the national and international laws and conventions; Unsafe work spaces were observed, which are prone to high degree of health and safety risks

Along the groundnut value chain, respect of labour rights is observably better in the formal enterprises found in industrial scale processing. Here workers are likely to have enforceable and

fair contracts, which are absent across most parts of the value chain. Respect of 8 fundamental conventions of ILO are observably better at industrial segment than in any other segment of the value chain. Wages of workers are much higher than the minimum wages at the industrial segment of the VC. However, even at industrial scale operations, freedom of association (ILO convention 087), collective bargaining (ILO convention 098) are not allowed. This is symptomatic of the context in Africa and more specifically in Ghana. As per ILO estimates[22], in Africa, collective bargaining generally covers a relatively low proportion of wage employees. In Ghana, trade union density[23] is 20.6 (ILO, 2016) and workers estimated to have collective bargaining coverage[24] is 14.7 (ILO, 2016). No forced labour /no bonded labour is observed in the value chain. Youth are involved in supporting farming and processing activities as part of a family or extended family network. The discrimination in employment based on kinship, sex, other affiliations was not observed in the value chain.

The present situation on 'respect for labour rights' in the groundnut value chain is captured in the Table 22 below.

[22] Source: https://www.ilo.org/wcmsp5/groups/public/---africa/---ro-addis_ababa/---sro-cairo/documents/publication/wcms_728363.pdf

[23] ratio of the number of employees who are union members to the total number of employees in the country

[24] ratio of the number of employees covered by collective bargaining to the number of employees with the right to collective bargaining

Groundnut value chain Actors /Node	Specific VC actors and workers	Number of owner and workers *(study estimates - 2019)*	Estimated annual income /wages of owners and workers *(estimated based on level of involvement in specific activities and wages/income obtained)*	Respect of labour rights				
				Respect of Intl. conventions	Freedom of association	Enforceable & fair contract	No forced labour	Minimised risk of discrimination
Non-Aggregator Linked Smallholders (NASH)	Family labour + hired labour for planting and harvesting	467,611	Owners: 1270 GHS (231 USD) Workers: 1200 GHS (218 USD)	n/a	n/a			
Aggregator Linked Smallholders (ASH)	Family labour + hired labour for planting and harvesting	34,180	Owners: 2180 GHS (396 USD) Workers: 1200 GHS (218 USD)	n/a	n/a			
Commercial Farmers (CF)	Family labour + hired labourers - Permanent and seasonal part time workers	1,530	Owners: 14153 GHS (2577 USD) Workers: 1200 GHS (218 USD)	n/a	n/a			
Artisanal processors (micro and small scale)	Processing enterprise owners and workers engaged in sorting, roasting, making paste, snack, flour and *kuli kuli.* Also include milling	37,138	Owners: 15000 GHS (2731 USD) Workers: 3000 GHS (546 USD)					
Industrial processors (medium and large scale)	Owners and workers in formal enterprises	1,375	Workers: 6000 GHS (1092 USD)					
Aggregators and wholesalers	Aggregators, wholesalers and their workers	3,927	Workers: 3300 GHS (601 USD)					
Retailers	Retailers in various markets of the country, including their workers, transporters, loaders etc.	36,105	Owners: 10000 GHS (1821 USD) Workers: 3000 GHS (546 USD)		n/a			

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

TABLE 22: RESPECT FOR LABOUR RIGHTS IN THE GROUNDNUT VALUE CHAIN

Child labour

In Ghana, legal regulation of child work was enacted by the Children's Act of 1998. Section 89 sets the minimum age for child work at 15 years of age and section 90 sets the minimum age for light work – defined as work that "is not likely to be harmful to the health or development of the child and does not affect the child's attendance at school or the capacity of the child to benefit from school work" – at 13 years of age. Children are banned from working on a farm for more than "three hours per day or more than 18 hours per week (for children on weekends, holidays and/or children who have completed school)" or "more than 2 hours/day on a school day." (quoted from Tulane, 2015).

Ghana has ratified most key international conventions concerning child labor. The ILO Convention 182 goal is to eliminate the worst forms of child labor (WFCL). ILO Convention No. 138 defines the minimum age for admission to employment and work as 15 (basic work) and 13 (light work). In compliance to these conventions, lot of sensitisation has happened, and children are going to school regularly (KII). This is evident in primary school enrollment at 95.36 percent as per the data collected in many large-scale household surveys. However, it dramatically reduces at the secondary level, where enrolment is 59 percent. The statistics produced by Ghana Labour Force Survey (GLSS, 2014) provide some indication of prevalence of child labour, in agriculture and other sectors, possibly during the transition period of children moving from primary to secondary schools:

- 21.8 percent of children aged 5-17 years are engaged in child labour.
- About fourteen percent (14.2%) of the children (13.5% in Western region) covered in the survey were engaged in hazardous forms of child labour.
- About 10.9 per cent (0.57 million) of children ages 5-14 participate in the labour force and do not attend school. The percentage is slightly higher for boys (11.2 per cent) than for girls (10.5 per cent).
- Economically active children are less likely to attend school than those who are not working (59.7 vs. 86.5 per cent).
- More than half of the working children (57.3%) were exposed to dangerous tools such as knives at the place of work. About two out of every five children (42.7%) was exposed to dust and fumes while 27.8 percent were exposed to extreme cold or heat.

Child labour in groundnut value chain

A WFP report states that the children who never receive an education face significant constraint in accessing better paid employment opportunities when they enter the labour force, and they are highly vulnerable to becoming engaged in child labour activities, though this phenomenon is not specifically seen in groundnut value chain. While the child labour prevalence is reported in other value chains (such as cocoa) in agriculture and other sectors of the economy, it does not seem to be the case in groundnut. Even though, the children of age 12-17 are commonly seen to be working on the groundnut farm but these are family farms. There is some likelihood that these children could be school dropouts especially when they belong to a family (generally migrants with low land holding and farm workers) with dire food insecurity situation. In these situation, young children are expected to earn something for contributing to family's food requirements and are forced to work from a very early age.

A specific phenomenon is seen in the groundnut value chain at the roasting sites, where mothers are involved and where children are also around. As these roasting sites are emitting considerable smoke and heat, it is likely to be a health and safety risk for the children around. This is not child labour but can potentially create conditions similar to worst form of child labour with persistent exposure to heat and smoke on a daily basis.

The artisanal and industrial processors in groundnut VC reported that there is no child labour on their sites. The policies against child labour are strictly enforced by these companies.

Job safety

The working definition of 'job safety' for this social analysis is "the degree of protection from accidents and health damages in any segment of the value chain". The job safety in the value chain is assessed based on the working conditions (occupational health & safety, hygiene and environmental conditions) of the work spaces at farm, small-scale processing and industrial scale processing. The study findings on job safety are captured in the Table 21 and in the above section on working condition of workers in the value chain. Main occupational health and safety risk in the value chain are observed at the processing segment. As women are the main workers at processing sites, they could be potential target for occupational harm due to excessive heat and smoke in the spaces where they work. As the groundnut value chain develops in Ghana, processing activities will naturally be expanded, leading to higher likelihoods of occupational health and safety risks for the women. This suggest tackling of 'job safety' issues from the beginning, as part of ongoing groundnut value chain development to not let them become bigger in due course of time is critical. Collaboration with Rural Enterprise Programme[25] (IFAD funded) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in Groundnut. The goal of REP is to improve the livelihoods and incomes of rural poor micro and small entrepreneurs. The development objective is to increase the number of rural MSEs that generate profit, growth and employment opportunities[26].

Job attractiveness

The attractiveness of the job is assessed based on remunerations received. Herein the study uses the concept of living wages. A living wage[27] of a typical family in Ghana is estimated[28] to be in the range of 1090 to 1720 GHS per month. Comparing this benchmark living wage with what actors /workers in the value chain get is informative of the inclusivity of the value chain and the economic potential of groundnut. This analysis suggest that groundnut producers are only able to earn about 15 to 20 percent of the living wage benchmark from their groundnut production. Further the study analysis based on sample investigations suggest that the groundnut workers at production level are only able to earn 10 percent of the living wage. The downstream VC actors are estimated to be better placed. The owners of artisanal and industrial processing enterprises and also aggregators /wholesalers and retailers are probably able to earn 1.5 to 5 times living wage benchmark from their groundnut business. However, the workers at groundnut processing

[25] https://rep.org.gh/
[26] Source: https://rep.org.gh/
[27] The Living Wage is based on the concept that work should provide an adequate income to cover the necessary living costs of a family.
[28] Source : https://wageindicator.org/salary/living-wage/ghana-living-wage-series-january-2018

Key messages on 'Working Conditions' in the groundnut value chain:

The workers in the groundnut value chain are found at production, processing and trading levels, the majority being at the 'production' level. The study estimates that there are about 293,000 to 439,000 entrepreneurs / owners (producers, processors and traders) and about 358,000 workers engaged in different segments of the groundnut value chain. This suggest that about 650,000 to 800,000 peoples' livelihoods in Ghana are likely to be intrinsically dependent on groundnut. Overall we estimate that about 90 percent of all actors and workers in the value chain are women. This suggest that a priority placed on the groundnut value chain development by the GoG is likely to be a highly relevant and inclusive socio-economic development strategy.

There are three main risks related to 'working conditions' of workers in the value chain. Firstly, key occupational health and safety risk in the value chain are observed at the processing segment. As women are the main workers at processing sites, they could be potential target for occupational harm due to excessive heat and smoke in the spaces where they work. Roasting technologies /equipment demand urgent review and up-gradation. Collaboration with Rural Enterprise Programme (REP) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in groundnut. Secondly, groundnut producers and workers throughout the value chain are only able to earn about 15 to 20 percent of the living wage benchmark from their groundnut production. There is a significant potential to increase returns of producers and workers if right conditions are developed. Thirdly, most workers in the VC have no full-time /permanent employment. Most are working on temporary work, which is paid on a daily or weekly basis. Most workers have no benefits except the daily wages. To ameliorate this situation, the study analysis suggest that certain parts of the value chain could be targeted by incentivising 'collectivisation /formalisation' which can then lead to better wages for the workers

and trading businesses are able to earn about 25 to 50% of the living wage benchmark. The conditions in the groundnut value chain are potentially attractive to youth (boys and girls) as there are higher-income earning opportunities in processing and trading segments of the VC. Under right conditions (such as business incentives, favourable financing arrangements, seed market development, addressing quality constraints related to aflatoxin etc.) a segment of youth looking to start their agribusinesses would find the groundnut value chain attractive for their new ventures.

The farmers in the groundnut growing districts earn cash incomes from many other crops (such as maize, sorghum, soya bean, rice, shea nut) as well as from engagement in other economic activities. A minimum wage or living income analysis for groundnut, as conducted above, is meant to provide an indication of the inclusiveness as well as the potential of groundnut in contributing to household economy of VC actors such as groundnut growers and workers across the VC.

4.3.2 Land and Water Rights

The social analysis on land and water rights in the groundnut value chain in Ghana provides the following picture.

TABLE 23: SUMMARY OF SOCIAL ANALYSIS ON LAND AND WATER RIGHTS IN THE GROUNDNUT VALUE CHAIN IN GHANA

2.1 Adherence to VGGT	**n/a**
2.1.1 Do the companies/institutions involved in the value chain declare adhering to the VGGT?	n/a
2.1.2 In large scale investments for land aquisition, do the involved companies/institutions apply the due diligence guide?	n/a
2.2 Transparency, participation and consultation	**n/a**
2.2.1 Level of prior disclosure of project related information to local stakeholders?	n/a
2.2.2 Level of accessibility of intervention policies, laws, procedures and decisions to all stakeholders of the value chain?	n/a
2.2.3 Level of participation and consultation of all individuals and groups in the decision-making process?	n/a
2.2.4 To what extent prior consent of those affected by the decisions was reached?	n/a
2.3 Equity,compensation and justice	**Substantial**
2.3.1 Do the locally applied rules promote secure and equitable tenure rights or access to land and water?	Substantial
2.3.2 In case disruption of livelihoods is expected, have alternative strategies been considered?	Substantial
2.3.3 Where expropriation is indispensable: is a system for ensuring fair and prompt compensation in place?	**n/a**
2.3.4 Are there provisions foreseen to address stakeholder complains and for arbitration of possible conflicts ?	**n/a**

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Adherence to VGGT

The general context

In Ghana, as per a key informant interviewed, land is held in trust at chieftain level and "land tenure is ambiguous". Two broad tenure arrangements exist: customary tenure and public land tenure. It is estimated that 80 percent of Ghana's lands is held under customary land tenure systems (Sarpong, 2006, quoted from Landac 2012 publication). Provincial land tenure is in fact vested in the Paramount Chief for the benefit of future generations. Provincial land cannot be sold; it can only be leased, the potential timeframe for a lease is 25 to 50 years. Because of this arrangement, potential investors can lobby the chief and have likelihood of getting long-term lease of the land. The Ghanaian Government guarantees customary tenure arrangements. Customary land

secretariats have been established to administer land rights but only a few are operational (Landac, 2012). Customary Land Secretariats (CLS) lack legal framework needed to function as decentralized land governance structures performing important land functions (Bugri, 2012). The mandate of these hybrid quasi-formal bodies does not extend to receipt of or accounting for 'drinks' money paid to traditional chiefs, and the CLS programme has lacked sustained political, financial and technical support as a key component of Ghana's land administration system (Quan et al., 2008).

The GoG have invited and promoted large-scale land-based investments in many agricultural commodities – jatropha, mango etc. Many of these concessions /large scale land acquisitions have not followed due diligence /VGGT principles. An extensive research (Elias Danyi Kuusaana, 2017) conducted through community consultations have established that in Ghana certain land transactions were negotiated and completed at the chief's palace, and community chiefs were invited for few, short discussions. The study quoted from Fiadzigbey (2006:7), according to which in Ghana, "chiefs and heads of families collect huge sums of money which they term 'drink'. There have been many factors responsible for this state of affairs. Negotiation of the terms of the lease comes very last in the generic process followed for large-scale land investments in the country. Landowners also comes into the picture at the very last step of the land acquisition process. Free, Prior and Informed Consent (FPIC) are conspicuous by their absence in this process. An analytical paper by L Koechlin, J Quan and others (2016) highlighted a range of issues pertaining to this – "There is need for comprehensive and clear guidelines and standards for investors to follow in large-scale land acquisitions as often land deals with transnationals are conducted with chiefs as representatives of their communities but who only seek personal gains in the process of deals negotiation. This often leads to displacement of families from their lands and thereby sources of livelihoods' (LGAF country report Ghana, 2013: 30)".

The Ghanaian constitution (1992) removed all pre-existing public lands in the three northern regions (incidentally groundnut growing areas) from state control and their transfer to customary law (as in the south) has had broadly negative consequences for women's control of land (Landac, 2012). An extensive analysis of land sector governance in Ghana by Dr John Tiah Bugri (2012) states that the three northern regions (Northern, Upper East and Upper West) differ considerably from of the rest of the country. These regions have similar ethnic, cultural and ecological conditions as to occupy a tenure niche in which land inheritance is predominantly patrilineal. Here, a mixture of chiefs and *tendamba* (earth-priests), depending on the locality, occupy the apex of the tenure group to exercise land governance responsibilities in a fiduciary capacity (Bugri, 2007). On the other hand, the report states, in the other regions of the country, popularly referred to as the South, the dominant land inheritance pattern is matrilineal; and mainly chiefs are at the apex of the tenure group exercising their fiduciary responsibilities in respect of land.

A report on improving land governance in Ghana (Bugri, 2012) says that the attempts by Ghana at improving land governance have achieved modest results under Land Administration Project Phase-1 (2002-2012). It further states that a lot remains to be done if Ghana is to become an example of best practice in land governance in Africa. It recommends that a concerted effort is needed in execution of the phase 2 of Land Administration Project which if executed and well monitored can have a strong chance of further improving land governance in the country.

The situation in the groundnut value chain

In the groundnut value chain, the scenario depicted above is not seen so far, primarily due to the fact that the VC has not seen any large-scale land acquisitions. This presents a clean slate to begin groundnut VC development – learning from experiences in other crops (e.g. jatropha, mango etc.)

in Ghana and from other countries in Africa. Arrival of non-native investors and large-scale land investments in groundnut is not a very clear possibility given the nature of the value chain. However, commercial farms in groundnut could be a distinctly possible future scenario if the demand for groundnut continues to increase and if existing value chain constraints are addressed leading to higher realization of returns from the investments. There have been attempts made earlier by Ghana nuts and other companies in the value chain to export groundnut to European countries. However quality concerns related to aflatoxin levels have restricted international trade in groundnut from Ghana. This process can be reinitiated if aflatoxin and other quality concerns get addressed through seed, harvest and storage related interventions. Conditions would then become favourable for native and non-native large-scale investments as lands are available in the North Ghana regions and district and chiefdom authorities are willing to welcome investors, farmers are willing to lease land to the investors, district level agriculture administration are aware of past mistakes and are keen to be facilitators for overseeing smooth land acquisition processes, complying with VGGT and new land policy. The groundnut value chain development needs to take a path based on learning from past experiences of VGGT violations in other commodities in the country. Kuusaana (2017) says that to maximize expected benefits from large-scale agricultural investments in Ghana, it may also be proper to explore public-private partnership arrangements that allow for government to directly contribute to the investment package and protect the rights of its citizens, while securing the investors' investments and needs. For example, land ownership may remain with the local population while use rights are transferred to the investors. Alternatively, host communities should be directly involved as partners of these large investments and their equity contribution will be the land. Interestingly, this is being done in groundnut value chain in Ghana by significant initiatives - MADE[29] (DFID funded) and MOAP[30] (GiZ and EU co-funded) projects are developing 'aggregator-based smallholders' model, which could potentially provide an alternative to large-scale land acquisition by 'non-natives'. Both projects are working with agribusiness entrepreneurs or companies who are acting as 'aggregators'. Aggregators work with a base of 200 to 2000 farmers who are mobilised into farmer based groups or co-operatives. This accumulates the production base for aggregators but it is not an acquisition of land or a change in ownership of lands as farmers continue to cultivate their land and in fact get support from aggregators in land tenure documentation. Aggregators offer buy-back guarantee of groundnut produced by their suppliers /farmer base. Aggregators also provide capacity building and inputs (including finance) support to farmers. MOAP have experimented with a revolving fund providing finance to aggregators so that they can provide inputs to their supplier base of farmers. Default rates so far have been low in this model. The number of farmers covered under this arrangement is expanding and it could reach around 20,000 groundnut farmers by 2022.

Transparency, participation and consultation

Secondary literature analysis on transparency, participation and consultation on large scale investments for land acquisitions in other commodities (not groundnut) present a dismal picture. Kuusaana (2017) quote Schoneveld et al. (2011) and Wisborg (2012) as per which the strong customary system in Ghana enables large land acquisition through traditional authorities at the expense of the local citizenry. Chiefs have been very conspicuous in attracting, negotiating and alienating customary land to large-scale agriculture investors. Kussaana further states that allodial titleholders (i.e. paramount stools) have by these actions, flouted the above basic customary principle regarding land alienation in Ghana. Following these revelations, customary land tenure in Ghana has been perceived as one that has disempowered smallholders, while promoting an egalitarian system, which is unrepresentative of the interests of the community (Amanor, 2008:78).

[29] See more at https://ghana-made.org/
[30] See more at https://moapghana.com/

Clearly, compromises on transparency, participation and consultation can happen in the groundnut sector as well. In the prevailing context, the process of transparency, participation and consultation in land acquisition can possibly be compromised if companies do not follow self-regulation and /or if VGGT framework is not applied. The country rankings on protection of property rights by various international indices provide some general (not specific to groundnut VC) indication of transparency of and adherence to rules and procedures in large-scale land acquisition processes.

TABLE 24: RANKING OF THE COUNTRY ON PROTECTION OF PROPERTY RIGHTS BY INTERNATIONAL INDICES

Ranking by	Year	Country Rank on protection of property rights
World Economic Forum Global Competitiveness Report	2017-18	**70** out of 137 countries; *Overall ranking on competitiveness is at 111 among 137 countries (overall ranking is down 3 places from 2016-17)*
Ibrahim Index of African Governance (IIAG)	2018	**3** out of 54 African countries; *Significant improvement over the years however improvement rate have slowed down over last five years*
World Bank – Ease of Doing Business	2019	**123** out of 190 countries on registering property; *Improvement seen over the years, 114 overall ranking on ease of doing business in the country*

There is no law regulating private company-smallholder partnerships. A National Land Bill was brought in 2018, which when passed into law, can potentially address the challenge related to the land acquisition. In practice, "companies are learning to work with the smallholders through trial and error", according to a key informant. He suggested that the private companies should negotiate the land lease directly with the land owners. The challenge in increasing transparency, participation and consultation lies in the existing legal and regulatory framework for land governance. The approach to build up a strong legal and regulatory framework for land governance is to have a longer term, broader vision for the country.

Equity, compensation and justice

In Ghana, ~80 percent of land is governed by customary law. This means that for most citizens, the unwritten traditional rules and practices determine who is able to hold, use or transfer land (LGAF, 2015). In this dispensation, generally, it is seen that equity, compensation and justice have been hostage to the discretions of chieftains and other authorities which have led to compromises on legitimate tenure rights of individuals and communities. The groundnut value chain is too nascent to assess whether this can happen or not happen. However, if past experiences are any guide to the future and in the absence of proper awareness, capacities and bargaining power, the landowners in groundnut value chain also could find themselves short-shrifted. To guard against this happening in the groundnut sector, a key functionary from a civil society organization says that the regulatory framework needs to allow alternative business models for land investors to ensure proper tenure assessments and tenure security. Aggregator linked smallholder model (ASH) highlighted in earlier sections could be one the way to ensure sector efficiencies and at the same land tenure security for smallholders.

The iniquitous and inadequate compensation for land-leases, if not reformed, can potentially generate conflicts and confrontations in groundnut sector as well. If large-scale land acquisitions or agri-business investments materialise (low likelihood) and /or commercial farming expand (high likelihood) in the groundnut sector, then the socio-economic benefits realised by affected groundnut growers and workers could be low, leading to dissatisfaction. Therefore, unless current land governance regime gets reformed, affected communities will not get redressal of their complaints and grievances. The new land bill needs to reconsider equity, compensation and justice aspects highlighted by this value chain study.

4.3.3 Gender Equality

The summary of social analysis on gender equality in the groundnut value chain in Ghana is presented in the table below.

TABLE 25: SUMMARY OF SOCIAL ANALYSIS ON GENDER EQUALITY IN GROUNDNUT VALUE CHAIN IN GHANA

Key messages on 'Land and Water Rights' in the VC:

The examples of large-scale land leases in other agricultural commodities in the country suggest history of violations and non-compliances with the principles of VGGT. This is not the case in groundnut value chain. This presents a clean slate to begin groundnut VC development – learning from experiences in other crops (e.g. jatropha, mango in Ghana) and from other countries in Africa. A category of actors and initiative needs to be supported that are searching for solutions such as aggregator linked smallholders (ASH) model, being developed by MADE and MOAP programme for the groundnut sector.

Arrival of non-native investors and large-scale land investments in groundnut is not a very clear possibility given the nature of the value chain. However, commercial farms in groundnut could be a distinctly possible future scenario if the demand for groundnut continues to increase and if existing value chain constraints are addressed leading to higher realization of returns from the investments. The VC needs to capitalise on promising business models such as the ones being developed by MADE (DFID funded) and MOAP (GiZ and EU co-funded) projects which could potentially provide an alternative to large-scale land acquisition by 'non-natives'.

There is no law regulating private company-smallholder partnerships. A National Land Bill was brought in 2018, which when passed into law, can potentially address the challenge

3.1 Economic activities	**High**
3.1.1 Are risks of women being excluded minimised?	High
3.1.2 To what extent are women active in the value chain?	High
3.2 Access to resources and services	**Moderate/Low**
3.2.1 Do women have ownership of assets (other than land)?	Moderate/Low
3.2.2 Do women have equal land rights as men?	Not at all
3.2.3 Do women have access to credit?	Moderate/Low
3.2.4 Do women have access to other services?	Moderate/Low
3.3 Decision making	**Substantial**
3.3.1 To what extent do women take part in production decisions?	Substantial
3.3.2 To what extent are women autonomous ?	Substantial
3.3.3 Do women have control over income?	Substantial
3.3.4 Do women earn independent income?	Substantial
3.2.5 Do women take part in decisions on the purchase, sale or transfer of assets?	Not at all
3.4 Leadership and empowerment	**Moderate/Low**
3.4.1 Are women members of groups, farmers' organisations?	Moderate/Low
3.4.2 Do women have leadership positions within organisations?	Moderate/Low
3.4.3 Do women have the power to influence services, territorial power and policy decision making?	Moderate/Low
3.4.4 Do women speak in public?	Moderate/Low
3.5 Hardship and division of labour	**Not at all**
3.5.1 To what extent are the overall work loads of men and women equal (including domestic work and child care)?	Not at all
3.5.2 Are risks of women being subject to strenuous work minimised (e.g. using labour saving technologies…)?	Not at all

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Stated in a Gender Policy document (2015), Ghana's goals towards achieving gender equality targets are guided by its commitment to International Instruments, the 1992 Constitution and national development frameworks. Specifically, Article 17(1) and (2) of the 1992 Constitution guarantees gender equality and freedom of women and men, girls and boys from discrimination on the basis of social or economic status among others.

The specific situation of gender equality in the value chain is likely to be reflective of existing status (and progress achieved over the years) on some generic indicators of gender equality, as captured by many international databases, shown below.

TABLE 26: GHANA - GENDER EQUALITY STATUS

Indicator	What it measures	Source	Year	Country Status /Rank; *progress over the years*
Gender Development Index (GDI)[31]	Ratio of female to male Human Development Index (HDI) values.	UNDP	2017	GDI value – **0.910** HDI value – 0.592, HDI rank – **140** out of 190 countries *GDI value have improved from 0.838 (1995) to 0.910 (2017)*
Gender Inequality Index (GII)	A composite measure reflecting inequality in achievement between women and men in three dimensions: reproductive health, empowerment and the labour market	UNDP	2017	**GII Value – 0.538** *The index value has improved from 0.628 in year 1995*
Gender - Ibrahim Index of African Governance (IIAG)	The Gender score looks at gender equality, women's political participation, Gender balance in education, women's labour force participation, work place gender equality, women in the judiciary, laws on violence against women, women's political empowerment	IIAG	2018	**Gender ranking 15 out of 54** African countries *showing increasing deterioration over last ten years* Overall ranking of Ghana on Governance is 6 out of 54 countries.
Social Institution and Gender Index (SIGI)	The SIGI covers five dimensions of discriminatory social institutions, spanning major socio-economic areas that affect women's lives	SIGI	2014	SIGI Value: 0.2988; *meaning* ***Very high gender discrimination in social institutions in Ghana*** *Discriminatory family code: medium discrimination* *Restricted physical integrity: high discrimination* *Restricted resources and assets: very high discrimination*

Women's economic role in the groundnut value chain

In Ghana, as in the rest of West Africa, groundnut is termed as the woman's crop due to the major roles women play in its production, processing and trading. They function as farmers, traders and in some cases as labourers in planting, harvesting and shelling (Ellen Owusu-Adjei et al, 2017). The women are economically very active in groundnut value chain and play significant roles throughout the VC. Table 27 illustrates women's economic participation in various segments of the VC.

[31] Source : http://www.hdr.undp.org/en/countries/profiles/GHA

TABLE 27: WOMEN'S ECONOMIC INCLUSION AND EXCLUSION IN THE GROUNDNUT VALUE CHAIN

VC segment	Women's role	Description of role	Significance and recognition of the role
Farm level production	As farm worker, working on family farm, wage labour in some cases	Women play significant role in planting and harvesting of groundnut (KII, FGDs). Men provide support in some cases in planting, uprooting, weeding etc.	Women play main role in almost all agricultural operations for growing and harvesting groundnut. Women have direct control over income earned from groundnut production. 90 to 95% groundnut is produced mainly by women.
Artisanal or industrial scale processing	Women as processor /entrepreneur running groundnut processing enterprise on a small scale	Women carry out most of processing operations such as shelling, sorting and grading, roasting, blanching, oil extraction, rolling and frying into kulikuli, packaging and labeling etc. Men contribute in operations such as gathering, transporting etc.	Most processing enterprises are run almost single-handedly by women that contribute average of 30% to total family income in processing families. Processing income for owners of processing enterprises range from 15000 to 35000 GHS (2700 to 6500 USD) per year. Processing incomes for workers range from 3000 to 6000 GHS (550 to 1100 USD) per year. 90 to 95% artisanal processing is done mainly by women while 50% industrial scale processing enterprises are run by women. Women have direct control over incomes earned from processing.
Trading	Trader /intermediary; retailing groundnut in different markets of the country	Buying groundnut from farmers and selling it onwards to other traders in Ghana, also to local processors; Retailing groundnut snacks, paste, kulikuli in small packaging at various markets	Though men play dominant role as aggregators or wholesale traders in the groundnut VC, women also play significant role especially in the retail segment of the chain. While only 5 to 10% wholesale traders are women, the retail segment is dominated by women (80-90% women). Women have direct control over income earned from trading activities.

In North, UE and UW, women in the focus group discussion shared that there is a strong belief that all women must do groundnut, otherwise life would be miserable. Most women have their own farms. Husbands have their own farms (for maize, rice and other cereal /tuber crops). In the focus group discussions with a mixed group of women and men, it is learnt that they used to do farming together. But husbands presumably used to hide about the sale and were reluctant to share income with the family. This resulted in financial problems in terms of paying for food, household expenses, school fees etc. Now men and women have their separate farms, own produce and own income. Women also raise ruminants and do poultry as well. This gives them more income to allocate to family needs and education of their children.

Men do farm clearing, leveling and uprooting when harvesting while women do rest of the operations in groundnut cultivation such as planting, weeding, plucking etc. (FGDs). Men are engaged to clear the field when grass is over-grown. Where women are unable to do sowing, weed control on their own, they call in for help from their husband. When it comes to harvesting, even though it used to be men, some women are now doing together as a group, move from one field to another, and support each other in uprooting and plucking. Women also hire labour for some operations such as planting, spraying or uprooting.

Access to resources and services

A key point to note in the indices (presented above) is the level of discrimination as captured by the SIGI. One of the SIGI parameter is 'restricted access to resources and assets. The SIGI country profile[32] for Ghana says that the land tenure system is currently governed by customary law. Women's access to land and to agricultural inputs is relatively poor, although women in matrilineal communities can inherit land from either their female ancestors or fathers. Article 22(2) of the 1992 Constitution provides that the Parliament should "as soon as practicable" enact legislation to regulate the property rights of spouses during and at dissolution of marriage. To date, no such legislation has been put in place, which means that married women's property rights are unclear and their access to land is often restricted (however, see below). Strong regional disparities are apparent regarding access to land: the percentage of female landholders ranges from 2% in the north to 50% in the Ashanti region, where property is distributed according to a matrilineal system. Therefore, women's access to resources and services generally and in the VC specifically are predisposed by the historical context, socio-cultural norms and systems of the Ghanaian society. The principal ways in which women acquire land is through their lineage, inheritance, marriage or by contractual arrangements (O A Lourdes, 2018). Women's land rights under customary law in rural areas, tend to be secondary rights, derived through their membership in households and lineages and secured primarily through marriage. These rights are not clearly defined or documented, tend to be subject to change, are of uncertain duration and are often subject to the maintenance of good relations between the parties involved (Runger, 2008, quoted from Landac, 2018). O A Lourdes (2018) further states that this exclusion is a worrying phenomenon that has existed for many years. Without land, women are considered not credit worthy and makes it difficult for them to access funds available to expand their business. A case study quoted by O A Lourdes report that in the case of Savelugu – Nanton, existing gender inequality in accessing resources has affected women's ability to take advantage of the commercialization of small-scale groundnut production (Tsikata and Yaro 2014).

[32] Source : https://www.genderindex.org/country/ghana-2014-results/

The above context is clearly reflected in the situation seen in the groundnut value chain. Even though women play significant economic roles in groundnut value chain and, yet they have very limited access to resources and services. Land is inherited by men and women do not have any formal rights of their land. As per several key informants interviewed, women tend to get marginal or non-premium lands for their groundnut cultivation. While women are not denied access to land but women's role and engagement in household activities necessitate that they get land parcels which are not far-off from the house. These land parcels tend to be less fertile.

This is clearly manifest in the VC e.g. financial inclusion of women is reduced due to lack of ownership of land. Her abilities and confidence are reduced in accessing agriculture extension, financial and other services from formal government and other institutions. The discussions with producers and processors of groundnut indicate that groundnut value chain development will critically depend on how access to finance issue is resolved for women producers, processors and traders. MOAP is striving to do so. MOAP has established a revolving fund from where aggregators are provided a soft loan for onward lending to women producers. So far this pilot has been successful with good recovery rate. This would need to be expanded to more women producers. At the same time, a mechanism of financing women processors and traders would need to be developed. MOAP has already begin on this as well and is now experimenting with matching grant funds wherein investments in processing technology can be part-funded by the project. A MOAP team is developing this business model carefully so that the financing structure is market driven for imparting sustainability to lending operations. However, it is challenging to design such a mechanism in Ghanaian context where agriculture investments are considered 'risky business' by financial institutions.
Groundnut processing is predominantly women's business. Women processors are using very rudimentary equipment and technologies for processing. In the groundnut value chain, there are a number of initiatives aimed at improving groundnut seed and agronomic practices. However, there has been limited emphasis on post-harvest technologies. This is one of the reasons why MOAP wants to concentrate on post-harvest technologies in terms of harvester, shelling machine, roaster, storage solutions etc. This is a critical area of attention as current technologies are not only inefficient but also pose significant occupational health and safety for the women workers involved in processing operations. MOAP is now collaborating with MADE, SNV (GDLC platform, working with a local NGO), MEDA (Canadian supported), USAID and other initiatives in the countries to develop mechanisms to support women processors with new post-harvest technologies.

One of Govt of Ghana (GOG) flagship program - Planting for Food and Jobs (PFJ) supports farmer productivity enhancing measures, including improved seeds, fertiliser, extension services and market linkages. The purpose of the PFJ program is to mobilize access to both input and output markets and thereby directly motivate farmers to increase their crop yields and indirectly generate employment opportunities along the value chains. The program document says that the priority will be given to value chains that are important for women and young people. However, the program has not selected Groundnut for intervention as there is no mention of Groundnut in the strategic document published by the GoG. The focus crops for the program are maize, rice and sorghum. The program also includes onion, tomato and chilli and soya bean.

Decision-making

Groundnut value chain offers a lesson in enhancing women empowerment. As women cultivate their own plot, do their own processing and engage in trading activities on their own, women have considerable control over incomes earned. This is confirmed in several discussions with women producers, processors and traders. We conducted a survey of 48 farmers and processors, wherein

88 percent farmers reported that women have control over income earned through groundnut production. Similarly 90 percent farmers reported that women have control over income earned through groundnut processing. This is also confirmed by other studies in groundnut value chain e.g. a study by OA Lourdes (2018) reported that majority of the women interviewed indicated that, they were able to make decisions concerning their production from cultivation to selling of the produce to the final consumer. The study by Lourdes (2018) further confirmed that processing of groundnut into several food products such as *kulikuli* in community as a key livelihood strategy contributes in reducing women's vulnerability. Processing of groundnut and other activities enable women to gain a source of revenue, improve on their skills and also grow their social linkages.

Apart from economic reasons, social construct also defines women's decision-making independence and control over incomes. Being in a polygamous relationship reduces women's say in household decision-making. The study team met several women who were in polygamous relationships and are facing many constraints in household level conflicts and decision-making. With education, however, women's control over income and household decision-making increases.

The decision-making role of women is also predicated by the type of decision to be taken. In focus group discussions, women reported that they have more decision-making independence in household level decisions related to food consumption, children's education, and other household expenditure. Women have limited decision-making independence in relation to own care, and social mobility. Most women have reported that these decisions are made jointly with their

husbands. Women have no decision-making authority related to sale, purchase or transfer of household assets, including land.

Box 2: Profile of a women processor cum trader and her demands

The study team met a women processor cum trader in the Techiman market. The trader is selling about 600 packets of groundnut paste @1 cedi each in a polythene. She sells a 2 kg paste in plastic container for 15 cedis ($2.7). She is not educated as she was born in Techiman but was sent to Northern Ghana by her mother for her grandmother to look after. Grandmother could not afford her education, and given family financial condition, she did not force her grandmother to send her to school, even though she wanted to go to school. She started working and earning early in her life and eventually supported two of her brothers to get education up to Senior Secondary. She got married early (she do not remember the age at marriage) and have five children now. Her husband is a farmer, who produces groundnut which she uses for making paste. She also buys from outside once in-house groundnut production is finished. She is selling about a bag of groundnut paste daily earning about 60-100 GHS (11 to 18 USD) profit a day. Her major expenditure is food, which almost take away half of her earnings. Each of her five children need at least 4 cedis ($0.7) for food and about 10 cedis ($1.8) each are needed for two adult members in the family. She has no bank account but do not borrow from other sources also. She takes her raw material on credit which she returns back every day after sales.

In terms of diet, family generally eat rice and beans in the morning, Yam in the afternoon. They do have beef and fish once in a while. The family has so far not observed any significant health issues though they do have Govt assisted health insurance for which they are paying about 14 cedis ($2.5) for adults and 5 cedis ($0.9) for children as premium per year. This health insurance provides very limited coverage (just hospital bed and some basic medicines).

For improving her processing operations, she expressed need for support. She employs workers who carry out roasting using firewood based cylindrical operation which she understands is not a very

Box 3: A women entrepreneur and a key decision-maker in the family

The study team met a women entrepreneur Stella Nartey in Techiman, who exhibit all signs of being an 'emblem' for women empowerment in the groundnut value chain. Stella is JSS (middle school) educated and could not continue her education due to financial problems of her family. The family also sold their land some 12 years ago and did some farming on leased lands which they could not sustain.

She is now running her roadside informal enterprise making paste and selling them in small polythene packs for 1 cedi ($0.18) which sells like hot cakes. She is incidentally not aware about aflatoxin issue in groundnut even though she makes sure buying only good quality groundnut. She is doing sand based roasting by using charcoal /coal. She, along with workers employed, process about 36 bowls (2.5 kg each) of groundnut every day except Sundays. She employs 2 workers who are paid 12 cedis ($2.18) each. As the roasting is done in the open, this is much better for her workers than for those who roast groundnut in close compounds heating cylinders through wood-based burning. Her method offers a better alternative to roasting in terms of health and safety of her workers. After roasting, she sends it to nearby mill for making paste. The mill is incidentally run by her husband. She is able to earn about 50 -100 cedis ($9 -18) from her groundnut business. Though she has other retail business also, but groundnut business brings her about 74 percent of total income. Groundnut business have critically helped her and her family to come out of poverty.

While her husband contributes 50 percent to household expenditure, she is the one running the house, and spending on children's education, health and other expenditures of the family. Given her economic and other contributions, she has considerable say in the family level decision-making.

One of her daughter is a teacher. All other children are in school. She wants all her children to go to university and she does not think they will come back and run her reasonably successful business. The family is able to afford a reasonable diverse diet as they normally have tea in the morning with bread, afternoon yam with rice, evening fufu with fish. The family do face some health issue once in a while, especially Malaria. She has now built resistance to Malaria. She never stops working irrespective of health issues.

Leadership and empowerment

The women are very significant contributors to their household economy as producer, processor or trader in groundnut value chain. Given their economic and other contributions, the study team found that women have exhibited exemplary leadership qualities in various parts of the groundnut value chain on an individual level. However, women are still very limited in number as part of farmer based organisations. In a survey with 48 groundnut farmers, we found 20 farmers

are part of groups or a cooperative; the rest 28 (~58%) are not part of any farmer-based organization. Among these 20 groups, women constitute 29 percent of the total membership. Though 19 of these groups have at least one woman in their leadership role, overall only 8 percent of women members in the groups are playing leadership roles. So, while women are showing their

Box 4: A women entrepreneur and a role model

The study team met Gladys Naabsigna, Chief Executive Officer of The Good and Goodness Enterprise. She deals in groundnut paste, brown rice, dawadawa tea, dawadawa (Parkia Biglobosa). She started this business in 2012 when prices of groundnut were lower. Now that prices are higher she travels to Burkina Faso to get her shelled groundnut to making paste. Through her business, she earns a profit of about 3580 GHS ($652) per month from paste only. Her shop is self-owned. She has come to this level of success through many hardships. She grew up in the Western region and is JHS educated. Her father was in the army and so grew up in the barrack. After her father dies, she came back to Bolgatanga to help her mother in small ways. The family saw very bad days in those time and she has to many works, including on construction sites. At one point in time, she was so short of food and facing real hunger that she used to tie cloths to the stomach. She considers it as divine intervention that she got the idea of getting into groundnut business, which slowly picked up and helped her and family not only come out of poverty but also become a role model for other women in the area. She now has four children and is actively involved in supporting many women groups. She wants to bring joy to those who are currently in the same situation as she has seen in the past. She is helping a large number of orphan children also. Her groundnut business is growing very well and she has hopes to do better for her family and for her community and people around. It seems that the name of her company – The Good and Goodness Enterprise -is very apt and reflect her way of working and living.

strength in running their groundnut businesses almost singlehandedly, their contributions are less recognized at group/community /societal levels. Women are being provided limited opportunities to engage and contribute as part of farmer-based groups. Being part of groups and platforms has considerable potential to benefit women and their groundnut businesses and so it is important to promote more women members and more leadership opportunities for women. However, this is easier said than done, as most groups are focused on maize, rice and other crops, where men tend to have a greater say. Several literature and gender studies have captured an important lesson that 'women in development' requires 'women in groups'. Women's ability to speak in public is dependent upon their abilities and on enabling opportunities available to them. Participation in different types of groupings enhances both their abilities and opportunities. The entrepreneur in the groundnut business, when she becomes successful, starts to get that visibility and access to various groupings. However, there are many women who could be more successful if they become part of groups or social forums /platform that can provide them solidarity, advice and other forms of support to improve their socio-economic status. These platforms can also provide voice and a public profile to women. The challenge, however, remains of promoting increased women's participation and leadership roles in such social groups and platforms, as currently, it is very limited. As of now, women have limited presence, visibility and voice within the groups where they are members.

Hardship and division of labour

As stated above, women' role is pervasive and dominant in many segments of the groundnut value chain. Women work on the groundnut farm, do groundnut processing, and are trader /intermediaries in shelled groundnut or groundnut products, and at the same time are running

many retail businesses for selling groundnut paste, *kulikuli* etc. Women take on most of the responsibilities related to domestic work and childcare as men play very limited role in these spheres. The strenuous activities in groundnut production are mostly carried out by women. Can women hire agriculture labour as well to help them in groundnut production? A research by Lourdes (2018) states that men who are entitled to own lands in Northern Ghana were the ones in a position and able to hire labour outside the home to work on their fields for financial remuneration, due to the large acreages they had for production. However, interviewed women, on the other hand, were found experiencing a lack of labour for their work, due to the cost involved and also the small size of their farmlands. Most of the men are normally working on their fields during the peak of the season, which makes it difficult for the women to get labour to weed their lands. The women tend to be more overburdened than their male counterparts, which indicates that, allocation of domestic duties to women becomes part of a prevailing division of labour pattern, traditionally assigned to men and women (O A Lourdes, 2018).

Do women get help from their men in household level work? In our survey of 48 farmers, 98 percent reported that in their opinion, between men and women, women have more workload (including domestic work and childcare). An author, O A Lourdes quoted above, says that for women, family duties such as care giving, preparing food for the family and making the home comfortable for living, is their responsibility, which they cannot escape. These are socially constructed norms, which is a common phenomenon for people from a patrilineal system, as males do not do household chores; which are rather meant for females at the household level. In as much as they want to make the home comfortable, they must empower themselves as women by combining this household activity with their businesses. A discussion with female producers, processors and retailers in groundnut production revealed that, they all rise up early to prepare the family before they leave for their businesses. The author concludes that as a result of women's productive and reproductive duties, much of the time is consumed, hence there is less time to engage in large processing and marketing of their produce, which contributes to the inability for the females to partake intensively in the groundnut value chain (O A Lourdes, 2018).

As per an ILO report, one of the greatest barriers to gender equality in the labour market is the difficulty women face in reconciling work with family and personal life (ILO African wage and gender pay gap report, 2019). The women in the groundnut value chain are subjected to strenuous working conditions, as highlighted in section 4.3.1. Interviews and group discussions with the women operating in different parts of the value chain indicate that women work for approximately 10 to 12 hours daily, outside their homes, as wage labour or running their processing or retail business. In a processing factory in Kumasi, we observed about 10 women working together in a slum type area. Roasting here is done by the cylindrical wood burning method, generating immense heat and smoke. It could clearly be an extreme health safety hazard and can be considered as a modern slavery. Women here work on roasting and sorting alternately. Those working on roasting experiences high levels of heat and smoke on a continuous basis till they exchange role with other women doing sorting. Children are also roaming around the site and so are likely to face health issues. The study team witnessed many such processing enterprises at different places of the country. Aflatoxin contamination possibility is very high here as the groundnut being roasted includes many moldy pieces.

To address the dire situation in the value chain, modern roasting technologies need to be first piloted and then implemented on a large scale. Doing this can reduce health safety hazards being faced by large numbers of women working at a large number of processing sites in the country. Further, labour savings technologies are needed in groundnut production (e.g. for groundnut harvesting) and processing (e.g. mechanical processing tools), so that women's strenuous workload in groundnut activities can be reduced.

Key messages on 'Gender Equality' in the VC:

In Ghana, as in the rest of West Africa, groundnut is termed as the woman's crop due to the major roles women play in its production, processing and trading. Groundnut provides self-esteem, and financial independence to women involved either as producers, processors or traders.

While women are economically very active in the groundnut value chain, their access to resources and services is not commensurate. Land is inherited by men and women do not have any formal rights of their land. As per several key informants interviewed, women tend to get marginal or non-premium lands for their groundnut cultivation. This indicates a gender-disparity in access to land and non-land assets, as well as assistance and services from government /NGOs. For providing financial access to women, MOAP is rather supporting the formation and operation of Village Savings and Loans Associations (VSLA's) as a way of improving access to finance for women. Also, MOAP has experimented with an aggregator-based lending approach through a revolving fund. This would need to be better designed and its implementation would need to be improved and expanded.

Barriers to a greater decision-making role of women in the VC are related to prevailing economic risks such as access to lands and other resources, social risks due to the position of women in the families, lack of opportunities for education for women and policy risks such as groundnut not formally identified as a priority crop for various programs of the GoG.

Given their economic and other contributions, the study team found that women have exhibited exemplary leadership qualities in various parts of the groundnut value chain on an individual level. However, women have limited presence, visibility and voice within the groups where they are members.

Women processors are using very rudimentary equipment and technologies, causing significant health and safety risks. To address the dire situation in the value chain, modern roasting technologies need to first piloted and then implemented on a large scale. Doing this

4.3.4 Food and Nutrition Security

The summary of social analysis on food and nutrition security in groundnut value chain in Ghana is presented in the table below.

TABLE 28: SUMMARY OF SOCIAL ANALYSIS ON FOOD AND NUTRITION SECURITY IN THE GROUNDNUT VALUE CHAIN IN GHANA

4.1 Availability of food	**Moderate/Low**
4.1.1 Does the local production of food increase?	Moderate/Low
4.1.2 Are food supplies increasing on local markets?	Moderate/Low
4.2 Accessibility of food	**Moderate/Low**
4.2.1 Do people have more income to allocate to food?	Moderate/Low
4.2.2 Are (relative) consumers food prices decreasing?	Moderate/Low
4.3 Utilisation and nutritional adequacy	**Moderate/Low**
4.3.1 Is the nutritional quality of available food improving?	Moderate/Low
4.3.2 Are nutritional practices being improved?	Not at all
4.3.3 Is dietary diversity increased?	Moderate/Low
4.4 Stability	**Moderate/Low**
4.4.1 Is risk of periodic food shortage for household reduced?	Moderate/Low
4.4.2 Is excessive food price variation reduced?	Moderate/Low

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Before getting into the specific situation in the groundnut value chain, a useful context is provided here on key general indicators which are considered drivers of food and nutrition insecurity. As per the Global Food Security Index (GFSI)[33], 11 percent of the population in Ghana is under the global poverty line ($3.10 /day) and GDP per capita is $4,953. Food consumption as a share of household expenditure is as high as 44 percent. Post-harvest food loss is around 19 percent and 78 percent of the population have access to potable water. These statistics puts Ghana at 3rd rank, as per GFSI, among 28 countries of Sub Saharan Africa. This looks impressive. However, Gini Index[34] is another measure which indicates equality or inequality of wealth distribution. Gini index is measured from 0 to 100 (0 means perfect equality and 100 means perfect inequality). A World Bank Poverty Report (V Molini, 2015) reported that in 1991, Ghana was in the bottom 20 percent of the Gini distribution in Africa, and, despite some deterioration, in 2012, it was still below the

[33] The Global Food Security Index, developed by the Economist Intelligence Unit and sponsored by Corteva Agriscience, the Agriculture Division of DowDuPont, considers three core pillars of food security—Affordability, Availability, and Quality & Safety—across 113 countries. The index is a dynamic quantitative and qualitative benchmarking model, constructed from 28 unique indicators, that provides an objective framework for evaluating food security across a wide range of countries worldwide. The Global Food Security Index (GFSI) has several different components, all of which can be found at http://foodsecurityindex.eiu.com/

[34] Gini index measures the degree of inequality in the distribution of family income in a country. The more nearly equal a country's income distribution, the lower its Gini index, e.g., a Scandinavian country with an index of 25. The more unequal a country's income distribution, the higher its Gini index, e.g., a Sub-Saharan country with an index of 50. If income were distributed with perfect equality the index would be zero; if income were distributed with perfect inequality, the index would be 100 – Source: https://www.cia.gov/library/publications/the-world-factbook/rankorder/2172rank.html

median and amongst the lowest among the rapidly growing African economies. Further the report says that 'much of the increase in inequality is the reflection of increased regional disparities, although within the region inequalities are also pronounced. Poverty rates have fallen below 20 percent in the large area that includes the Ashanti, Eastern, Greater Accra, and Western regions, southern Brong Ahafo Region, and coastal Volta Region. Poverty has also declined, to well below 40 percent, in the central belt. Recent improvements notwithstanding, the poverty rate is far above 40 percent in most districts in the north (where the groundnut is grown). As a result, poverty has increasingly become concentrated in rural areas and in the Northern part of the country: one out of three poor people lives in the northern rural areas in 2012 while in 1991 it was only one out of five. The increasing concentration of the poor in the north is also quite clear; the highest poverty rate in the country is in the Upper West Region. Moreover, while in 1991, 25 percent of the poor were living in the north, the share had increased to about 40 percent by 2012, despite the stabilization in the population share of the north at around 17–18 percent. In 2012, as a result of this gap, nearly 40 percent of the poor were living in the north, which accounted for only 17 percent of the country's population and despite the large outflows to the richer south. The number of the poor was rising in the north, while it was declining everywhere else. (V Molini et al , WB Poverty Report, 2015).

The above statistics related to key drivers of food and nutrition insecurity, indicate that Ghana has made reasonable progress over the years, but that progress has been uneven due to regional disparities. A considerable degree of challenge still remains, especially in the North, where, incidentally, groundnut is grown. The FAO gave the country an award "for reducing the level of its malnourished population from 7 million in the early 1990s to less than 1 million today" (Matilda Steiner-Asiedu et al, 2018[35]). The report stresses that hunger and poverty are, however, still problems in Ghana, especially in the Northern, Upper East and Upper West Regions, while several pockets of hunger exist in rural and urban areas in other parts of the country. About 1.2 million Ghanaians are estimated to be food insecure (MICS, 2011). Nearly 20 percent of children under five in Ghana are stunted (too short for their age). This indicates chronic malnutrition. Stunting is more common in the Northern Region where about 33 percent of children are stunted and less common in the Greater Accra Region where about 10 percent are stunted (Matilda Steiner-Asiedu et al, 2018).

Availability of Food

Local production of food and trends in food supplies in local markets can be deduced from household expenditure on food. If the household food expenditure is increasing, then it can indicate decreasing local production of food and local food supplies. This is indeed the case. In a survey, with 48 groundnut farmers, we collected average monthly /annual food expenditure data and also their perception regarding the trend in prices of key food items and overall expenditure on food. It shows that the majority of households surveyed, believe that food expenditure is on the increase over the last five years. A majority (90 percent) of groundnut farmers, believe, that their food expenditure, as a proportion of total household expenditure, has increased over the last five years. The graph shown below is indicative of groundnut farmers' perception regarding increase in food prices over the last five years:

[35] Kufour Foundation (2018) Addressing Sustainable Development Goal 2: The Ghana zero hunger strategic review 2018

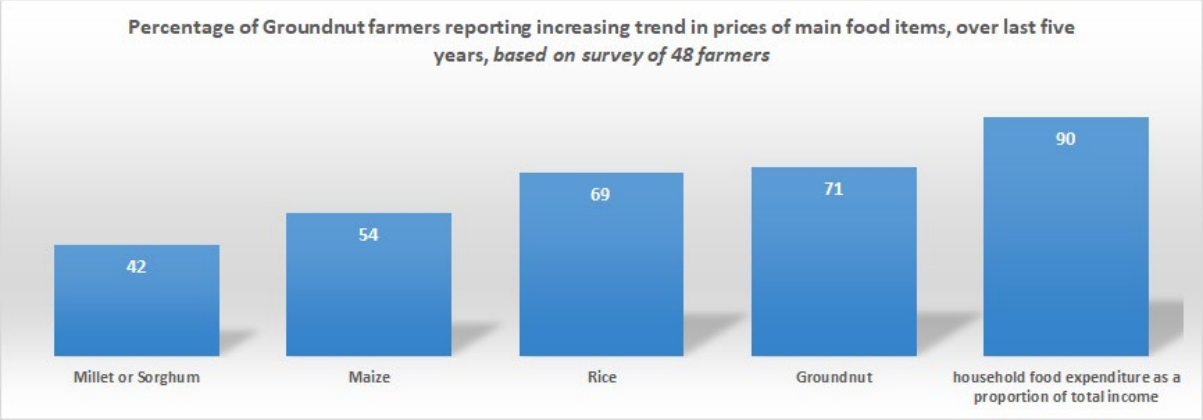


FIGURE 20: GROUNDNUT FARMERS' PERCEPTION REGARDING INCREASING TREND OF FOOD PRICES

A household's ability to buy the same food basket from the market, irrespective of costs, is clearly dependent on household inflows and outflows of money. In the same survey, we asked 48 groundnut farmers regarding whether their family faced any deficit situation in terms of inflows and outflows (which can potentially lead to reduced food consumption, indebtedness or other coping strategies). 23 of these respondents (48 percent) replied 'yes'. This is possibly indicative of a food deficit situation being faced by many families. This is also indicative of a reduced per capita local production of food and downward trend in food supplies in local markets.

Ghana does not produce enough food for its requirement. Ghana is not a self-sufficient country when it comes to the cereal market, and various cereals are imported from other countries to satisfy domestic needs[36]. Therefore, it relies on food imports e.g. local rice cultivation does not meet local demand. Rice and wheat are the most widely imported cereal crops in Ghana. 698,507 metric ton of rice was imported into Ghana in 2016[37]. Ghana does not produce much wheat and most of it is imported. As per agriculture census, areas under production for most of the crops have increased over ten years. In case of rice, the area under production has increased by 80 percent. The priorities of the GoG to support maize, rice, soya bean and other crops (through various policies and programmes such as Planting for Food and Jobs) have paid off in terms of increased production and better self-reliance. However, the area under production of highly nutritious food crops such as groundnut, millets and sorghum has reduced over the years. The dietary pattern in Ghana has been changing over time, with increasing reliance on wheat and rice in a family diet. This has negative consequences for nutrition as per capita consumption of millets have decreased[38]. However, groundnut demand and consumption have been on the increase, primarily due to Northern diets which include groundnut soup and snacks. As the area under groundnut production has reduced by 9 percent, over the last 10 years, the country is increasingly relying on groundnut imports from Burkina Faso, Nigeria and other neighboring countries, to meet its domestic demand.

[36] Source : https://www.mordorintelligence.com/industry-reports/grain-market-in-ghana
[37] Source : https://www.mordorintelligence.com/industry-reports/grain-market-in-ghana
[38] Source: https://www.indexmundi.com/ghana/agriculture/millet.html

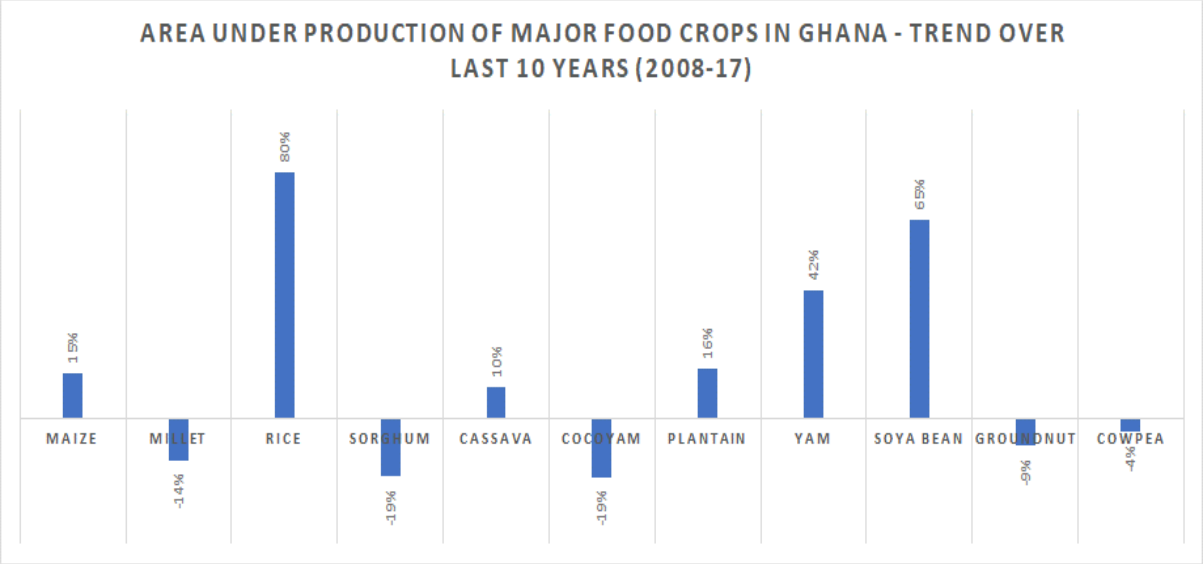


FIGURE 21: TEN YEARS TREND OF AREA UNDER PRODUCTION OF MAJOR FOOD CROPS IN GHANA (SOURCE: AGRICULTURE CENSUS 2018)

Accessibility of Food

The cost of food in Ghana[39] has increased by 7 percent in October of 2019 over the same month in the previous year. Food inflation in Ghana averaged 7.55 percent from 2013 until 2019, reaching an all-time high of 9.70 percent in December of 2016 and a record low of 5 percent in July of 2014. In 2018, food imports[40] for Ghana was 20.1 percent of total merchandise import. Though Ghana food imports fluctuated substantially in recent years, it tended to increase through 1996 - 2018 period ending at 20.1 % in 2018, an increase from 13.1 percent in 2005. The statistics probably means that groundnut producers and processors have experienced an annual food inflation of about 8 to 10 percent. This indicates local production and supply of food to local markets have decreased over the years. Consequently, and in line with inflation, consumer food prices have been increasing, as is confirmed by a survey of groundnut farmers. In the survey, 31 percent of farmers reported that they have faced economic deficit (income minus expenditure). Seen together with inflation, this status is indicative of increasing distress and reduced accessibility to food. In several focus groups discussions with men and women farmers, it is known that farmers face many months of food scarcity from June-September as during this time reserve food stocks are finished. Groundnut farmers tend to resort to loans from traders and other informal lenders and are likely to become indebted due to high rate of interest.

Utilisation and nutritional adequacy

Nutritional quality and dietary diversity:

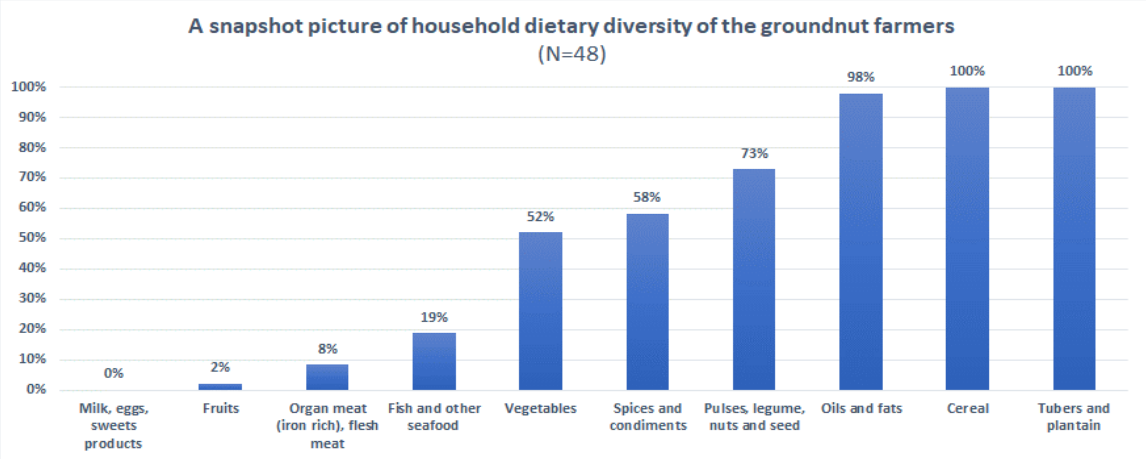
As per a policy brief[41], North Ghanaian diets include cereals, roots and tubers which are considered main commodities, as on an average, 87 percent of households are consuming these, 7 times a week, while vegetables and fruits are consumed by only 1 percent of households, 3 days in a week. This also applies to meat, fish, milk or dairy, whose related commodities are not ranked as key for production by households. Milk or dairy are absent from meals an average of 6 days in

[39] Source: https://tradingeconomics.com/ghana/food-inflation ; data sourced from Ghana Statistical Service
[40] Source: https://knoema.com/atlas/Ghana/Food-imports
[41] Source: SNV Voice for Change Partnership Policy Brief

a week, while meat and fish are absent an average of 3 days in a week. We conducted a survey on Household Dietary Diversity Score (HDDS), as per the methodology developed by FAO42. The survey was conducted with 48 groundnut farmers. The FAO guidance note says that HDDS is meant to reflect, in a snapshot form, the economic ability of a household to access a variety of foods. The guidance note mentions that studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (household energy availability) (Hoddinot and Yohannes, 2002; Hatloy et al., 2000). Following the guidelines, we included 12 food groups in the survey instrument. HDD score is measured from 0 to 12. A score of less than or equal to 3 is considered 'lowest dietary diversity'. A score of 4 to 5 is considered 'medium dietary diversity' and a score of more than or equal to 6 is considered 'high dietary diversity'. The result of the survey, though unrepresentative, as based on a small sample of 48 farmers, indicates that groundnut farmers dietary diversity is 'medium', with HDD score at 5.1. A small variability is noticed in the score of different categories of farmers e.g. commercial farmers have a better HDDS at 5.4, followed by aggregator linked smallholders at 5.0 and lowest HDDS is for non-aggregator smallholders at 4.8. Based on this limited survey, a snapshot picture[43] of dietary diversity of groundnut farmers is as shown in Figure 20.

Interestingly, a SNV policy brief says that the production and consumption are correlated. 30 percent of the food Northern households consume comes from their own production (consumption of own production). It is understandable that households would depend significantly on their own production. While the average dependence is 30 percent, there are districts in the North that record about 50 percent dependence. A strategic review of zero hunger (WFP, 2018) says that Ghana has done relatively well with respect to reducing both food insecurity and malnutrition compared to other countries on the continent, but it is still confronted with the triple burden of malnutrition (i.e. Protein and Energy Malnutrition, Macronutrient Malnutrition and Overweight and Obesity). Protein and Energy Malnutrition and Macronutrient Malnutrition are still prevalent in rural areas, especially in the Northern, Upper East and Upper West regions.

Several discussions with a range of key informants and consumers have confirmed that groundnut is a major ingredient for the Northern diet, as in most households, soups are taken almost daily. Its seeds are a rich source of edible oil (43-55 percent) and protein (25-28 percent). Therefore, groundnut and its products have potential to address some of the nutritional deficiencies cited above.



[42] HDDI methodological guidance note - http://www.fao.org/3/a-i1983e.pdf

[43] Question asked in the survey: - Please describe the foods (meals and snacks) that you and your family ate or drank yesterday during the day and night, whether at home or outside the home during the last 24 hours.

FIGURE 22: HOUSEHOLD DIETARY DIVERSITY OF GROUNDNUT FARMERS

Nutritional practices:

As noted above, groundnut is widely consumed and provides a nutrition supplement to producers and their families (especially children) and also to non-producing consumers in the country. Groundnut makes a high contribution to family food and nutrition needs, especially in Northern Ghana. The study team observed many instances (see Figure 24) of aflatoxin contaminated groundnut being used in the making of paste and contaminated groundnut being used in making of *kulikuli*. Women making paste and *kulikuli*, have a view, that whether broken or contaminated, all groundnut pieces anyway would get mixed up once it is roasted and /or milled and it would not affect the overall quality of the resulting product (FGD). This view of the women is not found to be correct as per a scientific research[44] as aflatoxin molds are not eliminated, even when corn, grains, peanuts or other foods are processed or roasted, and can be detected in peanut butter and many processed products. Agricultural procedures used in the processing of corn, legumes, soy and peanuts can help to reduce contamination, but the risk still cannot be totally eliminated.

As per a strategic review of zero hunger in Ghana (WFP, 2018), aflatoxin has been implicated in the occurrence of stunting and underweight among children (Beesabathuni 2014). Unsafe food may cause diseases which will inevitably affect food utilization and predispose an individual to under-nutrition (Matilda Steiner-Asiedu et al, 2018). Northern Development Authority, in an interview with the study team, acknowledged that aflatoxin contaminated groundnut paste is a mega problem existing in the country, even though the Ghana Standards Board has set the standards and the FDA is doing its best in enforcing the standards. However, making enforcement work has been challenging.

[44] Source: https://draxe.com/nutrition/aflatoxin/

The presence of aflatoxin in groundnuts is a serious threat to human health. It has been cited[45] in suppression of the immune system, stunted growth in children, lowered milk and egg production in animals and death. A USAID programme publication[46] says that preventing aflatoxin contamination in groundnuts can significantly contribute to stunting reduction in Northern Ghana.

FIGURE23: AFLATOXIN CONTAMINATED PIECES BEING MILLED FOR MAKING GROUNDNUT PASTE

Efforts are being made to address this serious issue e.g. the MoFA team in Bolgatanga explained how they are trying to introduce "Aflasafe®" but are facing challenges such as availability of the product. Input dealers would have a key role to play here to get the product to the farmers. But more than the supply, demand from the farmers is the main challenge to be addressed. To this end, Bolgatanga MoFA team have made documentaries on the aflatoxin issue in collaboration with Digital Green. Farmers are being sensitized on the necessity to maintain the quality of the groundnut being sold in the market as well as consumed at home. Data presented in a MADE progress report suggest that 1,704 kg of aflasafe material has been distributed to 426 SHF (171 female) seed out-growers. This disappointing uptake highlights the unwillingness of the market to pay a premium for aflatoxin-free groundnuts as the primary impediment to increasing the adoption and application of aflasafe. Going forward, MADE will work with partner firms to complete the execution of the protocols in partnership with IITA, and identify with the help of the Ghana Commodity Exchange (GCX) key end markets (e.g. Nestle Ghana) for aflatoxin-free groundnuts, and maize. The programme will facilitate partners' hosting field days targeted at conducting tests to ascertain aflatoxin levels on treated and control farms. The events will provide a platform to encourage investment in the production of aflatoxin-free products. Following the two seasons of trials using "Aflasafe®", the programme will partner with IITA to document key lessons on "Aflasafe®" use for wider dissemination (MADE report, 12).

Situation in Ghana on "Aflasafe®" uptake is at the starting level. A key informant said that, 'we are at early stage for "Aflasafe®" for market development and demonstrating value for stakeholders." Consumer awareness continues to be low. There is no structure or system to organize the value chain in Ghana. Senegal have traders /exporters serving the China market and now some of them are exploring to enter the European market. Therefore, they consider it important to meet regulations, which is not the case in Ghana, as most traders are unable to meet the demands of

[45] Source: https://www.myjoyonline.com/news/2017/September-25th/new-disease-resistant-groundnuts-introduced-to-boost-production-export.php

[46] Source : https://www.spring-nutrition.org/publications/briefs/ghana-reducing-aflatoxin-risks-part-multi-sectoral-approach-nutrition

the domestic market itself and are not that much interested in serving the export markets. In other West African countries, exporters are willing to reward farmers for meeting the quality standards. This is not the case in Ghana. Either the market or the policy regulation can address compliance – Ghana would need an informed policy actor working in different ministries such as agriculture, health and trade as they together can then set the direction. Ghanaian policy may want to make it mandatory to test everything that goes into the national food reserve, or school feeding; also provide a signal to farmers and other value chain actors to comply with the regulation. It can happen gradually over time as the scale of the challenge is large. The starting point could be large-scale consumer and producer awareness raising.

Ghana can also learn from experiences of other countries such as Nigeria, the Gambia and Senegal where uptake of "Aflasafe®" is high. There is now an aflasafe factory in Senegal. Nigeria, Senegal and the Gambia groundnut is serving an export market. Processors and exporters are demanding aflatoxin free products which is driving the use of aflasafe in these countries. There are pressures from multinational companies such as Nestle, resulting in relatively better levels of compliance and food safety in these countries. Gambia, for example, is progressively increasing its uptake of aflasafe every year, reaching about 65t this year, as per one key informant.

Box 5: A remarkable story of Project Peanut Butter in Ghana and other countries

Project Peanut Butter (PPB) produces Ready to Use Therapeutic Food (RUTF) in local factories in Malawi, Sierra Leone, and Ghana that are internationally accredited. The study team visited world-class facility of PPB located in a non-descript place in Kumasi. Reviewing the infrastructure and operating principles, it can be said with high degree of confidence that this is a model factory ensuring high-quality RUTF products which are unlikely to have aflatoxins levels beyond what is permissible by WHO or Ghana standard. As per PPB staff, their products adhere to strict nutritional, microbiological, chemical, and organoleptic standards. PPB distributes this RUTF at their own mobile clinics and also sells a large amount at the cost of manufacture to multiple governments and aid organizations in order to reach more children in need of treatment. PPB Butter currently operates about 20 mobile clinics in southern Malawi alone and many more in Ghana and Sierra Leone, where PPB nurses assess children for malnutrition and provide life-saving treatment to those who qualify at no cost. At a typical PPB mobile clinic, a child's height, weight, and mid-upper arm circumference (MUAC) are measured and compared to international standards. Each child is checked for edema, a painful swelling indicative of severe malnutrition. Recent health history is reviewed. Nurses counsel mothers after their children are measured. If a mother's child is malnourished, she is given a 2-week supply of RUTF that the child may eat at any time during the 2 weeks. The idea behind this is to catch malnutrition in its earliest stages, before it has become life-threatening. To begin these efforts, a USAID nutrition programme called SPRING contributed to the public-private partnership between USAID/Ghana and The Hershey Company, supporting the establishment of a Project Peanut Butter nut-paste production facility and

SNV with its partners, under its Voice for Change programme, is using a network approach to build field capacities, generate evidence and do advocacy. SNV-supported Ghana Trade and Livelihoods Coalition is working towards disseminating a post-harvest storage solution called PICS bags – Purdue Improved Crop Storage bags – whole logic behind this product is to have airtight storage solution, stopping the growth of insects and moulds, preserving the produce contained in the sack. The cost of a PICS bag (offering up to 50 or 100 kgs grain storage) is about 10 cedis ($1.8). SNV is working with partners for advocating with the Government to provide subsidy on the cost of the PICS bags for ensuring wider uptake, as many farmers have shown interest, but currently price is

cited as a barrier. Interested programs and agencies can work with the SNV network to advocate for change in uptake of this post-harvest technology and changes in the existing regulatory framework and enforcement mechanism.

For aflatoxin contamination control, WHO has set a maximum of 20 ppb in human food and 100 ppb in animal food. Joshua Muradzikwa et al (2019) says developed countries enforce these maximum limits with some higher degree of efficiency, while developing countries are facing serious problems in enforcing the standards due to dysfunctional poorly resourced institutions and high corruption levels. This reduces most noble laws and regulations into 'paper instruments' that are not being implemented (Joshua Muradzikwa et el, 2019). Several discussions and assessment across the value chain confirms that awareness and enforcement of aflatoxin issues remain low. As per a report[47], the members of the National Steering Committee for Aflatoxin Control, have met to review the draft National Policy for Aflatoxin Control in Food and Feed. It is being spearheaded by the Council for Scientific and Industrial Research-Science and Technology Policy Research Institute (CSIR-STEPRI) and is expected to guide the country on how to address Aflatoxins and touches on research, awareness creation, consumer protection and surveillance issues. Overall, National Nutrition Policy document (2013) says that the key actors and institutions that are responsible for ensuring that the quality of food consumed by Ghanaians is safe and contributes to the overall health and nutrition of inhabitants are grappling with many challenges related to poor capacity and enforcement of regulations and laws. Control programmes and actions are not driven by any uniform food safety policy to allow effective co-ordination and evaluation through the value chain. Another concern is the fact that the Ghanaian food value chain is dominated by the informal sector, which plays a major role in food delivery to large segments of the population and involves activities in food production, food trade, food processing, and food distribution and marketing. Ghana does not have a robust and responsive surveillance system that can effectively inform the managers of food safety. The food safety situation analysis also revealed fragmented and poorly co-ordinated institutions in respect to food safety activities, leading to sub-optimal food safety conditions in the country and the calls for efforts to harness their collective skills and strength (National Nutrition Policy, Ghana 2013). Ghana Food Safety Policy enacted in 2015, emphasises co-ordination, establishing infrastructure for effective food safety management[48]. However, this policy intent seems to have not been achieved in the Groundnut value chain.

The study investigations reveal that an FDA level advocacy is needed with evidence. The study team approached FDA and asked for their perspective. The food safety department in FDA was not cognizant of the aflatoxin issues in the groundnut value chain. They asked for evidence, which within the duration of the value chain analysis, could not be provided to them. This study report could be an evidence as it captures data and perceptions from actors across the value chain. FDA accreditation for formal and informal enterprises could be better enforced, however doing that FDA would face constraints in terms of having testing facilities and other necessary infrastructure, staffing and other resources in place. At the moment, as per a key informant, FDA has laboratories /testing facilities in Kumasi and Accra only.

There is currently limited transparency in the regulatory system that requires manufacturers of groundnut product to reveal and display their PPB level written on the product. Importantly, small or medium scale processors face challenges in getting their products tested, given the costs involved. The observations across the value chain shows that, often, processors are processing

[47] Source: https://www.myjoyonline.com/lifestyle/2019/October-1st/national-aflatoxin-policy-will-protect-ghanaians-from-food-contamination.php

[48] Source: https://www.afro.who.int/news/ghana-adopts-food-safety-policy

groundnut without the necessary certification. Ghana Standards Authority do the tests for products meant for export only. Otherwise there is very limited testing of several groundnut products, including paste, being consumed in the local markets. The magnitude of the problem could be very large, and situation is seemingly alarming, given the negative implications of consuming affected products with high levels of aflatoxins. As aflatoxin in groundnut products, being consumed on a large-scale in the domestic market in Ghana, is a public health issue, it will require inter-ministerial co-ordination among health, agriculture and trade ministries, along with FDA and GSA.

Overall, a strong need has emerged for measuring aflatoxin levels across the value chain as this can guide the design of appropriate responses – both regulatory (including policy enforcements) and market level. At the same time, nutritional outcomes need to be assessed more rigorously to provide more evidence of the impact of aflatoxin contaminated food items. And finally, all development programme and initiatives in Ghana would need to measure and improve their nutrition sensitiveness.

Stability

As reported above, the food shortages are commonplace, especially during June-Sep, as not enough storage is left for the period. In the survey with 48 farmers, 31 percent reported to be experiencing economic deficit (outflows are more than inflows). The groundnut producers and processors are resorting to taking loans at that time. Groundnut currently contributes – on average – 43 percent of total income of the family (survey data, 2019). Income contribution varies by category of farmers e.g. commercial farmers gain 55 percent of their income from groundnut, while smallholders gain about 37 percent.

Does, then, groundnut value chain development, in Ghana, have a potential to address food and nutrition insecurity? Groundnut is a savior for families in the North. As per MADE, this is one of the more profitable crops grown by smallholder farmers in Northern Ghana. It has the potential of producing higher incomes than cereals. Northern Ghana produces 94% of Ghana's groundnuts. The crop is produced under rain-fed conditions; the dry post-harvest season in the northern savannah zone is ideal for post-harvest practices. Despite its importance as a subsistence crop, groundnut is one of the most profitable commercialised crops for all farming households. Gross profits for groundnut production stand at GH¢2,449 / ha, making groundnuts second only to Yam in terms of returns per hectare in the North[49].

Groundnut's case for increasing stability of incomes and food security is strengthened by the nutritional benefits provided. The stakeholders interviewed by the study team are very positive about the potential of groundnut in terms of increasing gross earning of farm families which will translate into increased incomes and thereby improved food consumption – both quantity and quality.

[49] Source : https://ghana-made.org/market-sectors/groundnut/

Key messages on 'Food and Nutrition Security' in the VC:

A majority of groundnut farmers surveyed believe that their household food expenditure is on the increase over the last five years. 90 percent of groundnut farmers believe that their food expenditure as a proportion of total household expenditure has increased over the last five years. This is indicative of reduced per capita local production of food and a downward trend in food supplies in local markets.

The priorities of the GoG to support maize, rice, soya bean and other crops have paid off in terms of increased production and better self-reliance. However, areas under production of highly nutritious food crops such as groundnut, millets and sorghum have gone down over the years. The area under groundnut production has also gone down by 9 percent, over the last 10 years, and the country is increasingly relying on groundnut imports from Burkina Faso, Nigeria and other neighboring countries, to meet its domestic demand.

Food inflation in Ghana averaged 7.55 percent from 2013 until 2019, reaching an all-time high of 9.70 percent in December of 2016 and a record low of 5 percent in July of 2014. In line with inflation, consumer food prices have been increasing, as is confirmed by a survey of groundnut farmers. In the survey, 31 percent of farmers reported that they have faced economic deficit (income minus expenditure). Seen together with inflation, this status is indicative of increasing distress and reduced accessibility to food.

Several discussions with a range of key informants and consumers have confirmed that groundnut is a major ingredient for the Northern diet, as in most households soups are taken almost daily. North Ghanaian diets include cereals, roots and tubers, which are considered main commodities, as on an average, 87 percent of households are consuming these, 7 times a week, while vegetables and fruits are consumed by only 1 percent of households, 3 days in a week. With this pattern of diet, Ghana is confronted with the triple burden of malnutrition (i.e. Protein Energy Malnutrition, Macronutrient Malnutrition and Overweight and Obesity). Protein Energy Malnutrition and Macronutrient Malnutrition are still prevalent in rural areas, especially in the Northern, Upper East and Upper West regions.

The study team observed many instances of aflatoxin contaminated groundnut being used in the making of paste and contaminated groundnut being used in making of kuli kuli. Aflatoxin has been implicated in the occurrence of stunting and underweight among children (WFP report). Overall, a strong need has emerged for measuring aflatoxin levels across the value chain as this can guide design of appropriate responses – both regulatory (including policy enforcements) and market level. At the same time, nutritional outcomes need to be assessed more rigorously to provide more evidence of impact of aflatoxin contaminated food items. And all development programme and initiatives in Ghana would need to measure and improve their nutrition sensitiveness.

- *VCA4D groundnut VC study in Ghana, 2019*

4.3.5 Social Capital

The summary of social analysis on social capital in the groundnut value chain in Ghana is presented in the table below.

TABLE 29: SUMMARY OF SOCIAL ANALYSIS ON SOCIAL CAPITAL IN THE GROUNDNUT VALUE CHAIN IN GHANA

5.1 Strength of producer organisations	**Moderate/Low**
5.1.1 Do formal and informal farmer organisations /cooperatives participate in the value chain?	Moderate/Low
5.1.2 How inclusive is group/cooperative membership?	Substantial
5.1.3 Do groups have representative and accountable leadership?	Moderate/Low
5.1.4 Are farmer groups, cooperatives and associations able to negotiate in input or output markets?	Moderate/Low
5.2 Information and confidence	**Moderate/Low**
5.2.1 Do farmers in the value chain have access to information on agricultural practices, agricultural policies, and market prices?	Moderate/Low
5.2.2 To what extent is the relation between value chain actors perceived as trustworthy?	Moderate/Low
5.3 Social involvement	**Moderate/Low**
5.3.1 Do communities participate in decisions that impact their livelihood?	Moderate/Low
5.3.2 Are there actions to ensure respect of traditional knowledge and resources?	**n/a**
5.3.3 Is there participation in voluntary communal activities for benefit of the community	**n/a**

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Strength of producer organisations

Ghana has following main types of farmers or producer organisations:

- Farmer Based Organisation (FBOs)
- Farmer Co-operatives
- Village Savings and Lending Association (VSLA)
- Others – Peasant Farmer Association, Farmer Organization Network in Ghana (FONG) etc.

The GoG Food and Agriculture Sector Development Policy (FASDEP) and the Agricultural Extension Policy of the Ministry of Food and Agriculture (MoFA) emphasizes on the use of Farmer Based Organizations (FBOs) for agriculture service delivery for a more cost effective and rapid dissemination of technologies to small scale farmers. These organisations have been promoted /mobilized in large numbers across the country. Though these organisations are not specific to any value chain or crop, many of them tends to focus on specific crops, such as maize and rice. An FBO database maintained by MoFA shows only one FBO working on groundnut (United Farmers Association from Eastern Region). Clearly this database is incomplete for groundnut. Overall the database (2017-18) shows 4,743 active FBOs in the country, with 98,239 members (58 percent men, 42 percent women). In the regions (NW, NE, Northern) which are predominant groundnut

areas, the database shows 1,764 FBOs, with 36,778 members (48 percent men, 52 percent women). Accurate data on farmer groups and their businesses is not available even though a dedicated website and database has been created for the purpose. A survey of 48 groundnut farmers revealed that 42 percent are currently members of any FBO. In the same survey, only 8.3 percent reported to have used VSLA for taking credit for groundnut cultivation or processing.

VSLAs are generally women organisations at village level, collecting a weekly contribution which varies from 3 to 20 cedis ($0.54 to 3.64). Women can get credit at 10 percent interest rate for 3 months (Focus group discussions at Chabaa community, 42 kms from Wa). Ghana has recently seen problems with the micro finance industry and as per a key informant, many micro finance operations in the country have collapsed due to liquidity challenges, high cost of finance and farmer level distress due to microfinance lending. Traditional financial institutions, banks, do not want to increase their operational costs, getting to rural lending, as earlier experiments in rural lending have seen some failures. Women in particular have a huge gap in financial inclusion. Bank account opening requires tax identification number (TIN). To avoid these problems, women do not go to the bank. Telecom companies /mobile banking services is another promising avenue for women to access lending, but its reach is currently limited as accessing mobile banking services is found to be difficult by women in difficult to access areas. Can VSLAs replace micro finance and provide financial inclusion and access to women producers and processors? Several NGOs shared that they are now mainstreaming savings and lending in their activities by strengthening VSLAs (NGO interviews in Tamale, Bolgatanga).

There are some examples of failure. A marketing company SAVBAN is a partnership between the Savannah Farmers Marketing Company established by the NGO Association of Church Based Development Project (ACDEP) and the Bandaayili farmers union. It was intended that 20,000 farmers sign with their respective Farmer Based Organisations (FBOs), who would subsequently sign contracts with SAVBAN to supply their produce to market. However, these alternative channels established by the NGO have not proved effective. Both SAVBAN and the Savannah Farmers Marketing Company have had trouble making the enterprise profitable and both are currently moribund waiting for ACDEP to decide on their future.

There have been some examples of success also. In Techiman in the Brong Ahafo region, Technoserve (an international NGO) has assisted some women processors to organize themselves into cooperatives. This enables them to take up large orders and maintain a continuous supply to institutional buyers and wholesalers from cities like Sunyani, Kumasi and Takoradi (Ellen Owusu-Adjei et al, 2017).

There are new approaches being developed, which if found successful can increase the returns for the VC actors. The MOAP (GiZ and EU funded) has developed an approach /model of working with farmers through a market-based mechanism of aggregators. Aggregators are agribusiness entrepreneurs or companies operating in groundnut trading and /or value addition. MOAP offers capacity building and encouragement to aggregators to invest in the groundnut (and other priority VCs for the programme) value chain and work directly with groundnut producers. Many aggregators have come forward over the last three years and have become engaged with groups of groundnut farmers (mostly women) to provide them input support as well as buy back guarantee for their produce. As per MOAP, this 'direct farm' model of procuring supplies of groundnut by aggregators /agribusiness companies has proven to be effective so far. MOAP intends to expand the number of farmers linked to aggregators to 50,000 by 2020. One of the key constraints observed in the groundnut value chain is the availability of finance to producers and processers. Aggregator-linked smallholder farmers can access agricultural inputs through the aggregator, from the revolving fund established by MOAP. This is an alternative market-based

approach to provide financial access to groundnut farmers. MOAP team expressed that giving the revolving fund directly to groups may also be a serious option to think through, but then a mechanism would need to be created so that the revolving fund continues to revolve without involvement of GiZ, which is operating as a project and would continue only for a few years. Aggregator based provision of agricultural inputs on credit, currently has an 84 percent recovery rate from all value chain aggregators. The MOAP team feels that a due diligence is needed to select the aggregator and then it could work out to be a very good approach. It's early days to systematically assess the effectiveness of the aggregator-based lending approach. However, an extensive review of the pilot can be carried out to provide ways forward.

A key informant opined that peasant farmers associations and other network organisations in Ghana, often, are loose arrangements, with only weak links to smallholders farmers and their interests. National level umbrella groups such as FONG – farmers organization network in Ghana – are also unable to strongly represent farmers interest at relevant fora. Generally, farmer groups that are focused on specific value chains (such as rice, soyabean) are doing well. But sometimes the challenge about these groups are that they are project-based groups, and they tend to shift crops based on project-based opportunity. As per a key informant, groups that are most sustainable are those which are doing village savings and lending (VSLAs). Commodity based groups are not stable groups, and the only stable groups are those which are directly linked with a project or service provider e.g. rice group linked with a rice mill. This suggests that farmer groups need market linkages for which MOAP and MADE project have made a good start.

Information and Confidence

The groundnut farmers are facing difficulty in accessing quality seed. A key informant stated that groundnut research is not considered a priority for a research institution, and therefore foundation seeds are very scarce, and because farmers are used to recycle seed, the market for groundnut seed is not developing well. This is an area that needs urgent attention from the public and private sectors and other development partners. Policy can break this cycle if the groundnut value chain is prioritized. Government can provide instruments that facilitate access to credit for adoption of technology. However, the current extension system needs to improve. The existing extension system in Ghana is weak, and not able to effectively support uptake of new research innovations. In a survey of 48 farmers, 52 percent reported to have received assistance or participated in a rural development programme undertaken by an external organisation. Most of these received basic training related to groundnut production or processing. Even to train the groundnut farmers, level of knowledge of extension agents is also highlighted by key informants as a limiting factor. Extension agents lack logistics support. Policy is another constraint, as subsidy is providing for seed and fertilizer for cereal crops, but not for groundnut crop; ie. there is no subsidy on TSP fertilizer for groundnut crop.

Aggregator linked smallholders though are able to get information and support through the aggregator support. The study team met Farmer Pride – an aggregator supported by both MADE and MOAP project. Farmer Pride is supporting about 1,500 farmers in 37 communities, providing a range of services: tractor, farming inputs, seed, etc. All of these services are costed, and farmers pay back only when the crop is ready. The contract is about paying back through selling the harvest or through paying back by other means. Farmer Pride experience shows that all communities have paid back except one, with whom Farmer Pride has stopped doing business with. Tractor services are an essential component of Farmer Pride service as no one provides that service in that area. Pride does certified seed production (225 t done last year), with breeder or foundation seed procured from ICRISAT, Nigeria, through online purchase. Pride is licensed to provide certified seeds to the farmers. Farmer Pride sells seeds at 10 cedis ($1.8)/kg; (grain price is about 6 cedis ($1.1)/kg). Pride is expanding the business for certified seed production to 330 t this year and will

establish a warehouse to store the seeds. Pride trains its out-growers of seed production, in farm management, weed control etc. The seed production farms are regularly supervised. Farmer pride is selling grain to different markets, and to different traders directly coming to Pride to procure grain. This is a very trustworthy relationship between farmers /out-growers and aggregator involving about 5 percent of groundnut farmers. The rest of the farmers are facing serious challenges in getting certified seed, fertiliser (due to a policy constraint), and support for improved agronomy and marketing of their produce.

Box 6: Aggregator linked smallholders drawing better benefits from groundnut production, than those not-linked with aggregators

Aggregator-farmer linkages are proving to be mutually beneficial arrangement as aggregator can grow his /her business through assured supply of quality groundnuts, while farmers can get a range of benefits such as certified seeds, tractor services, low cost finance, fertilisers etc. Most of these services are provided to farmers on credit. Cost of ploughing, certified seed and fertilisers are paid by farmers based on agreed terms of portion of the harvest (number of bags). It is a fair system even though not cash based as the farmers are also supported through training and guidance to achieve right plant populations, proper agronomy of the crop. Aggregator has number of extension workers to support farmers on a regular basis. Interactions with the farmers reveal they immensely value this support. Several farmers expressed that due to linkages with the aggregator, their groundnut farm productivity have improved by 50 to 100 percent. The study assessment (including survey with 48 farmers) clearly indicate that aggregator-linked smallholders are in a relatively better-off position than those not linked with the aggregator.

The evidence for above comes from a success story seen in a community of women groundnut producers at West of Bolgatanga. The community is linked with an Aggregator, who is also a community chief. The chief is working with groups of groundnut producers, who are mostly women. The women used to plant through manual tilling of soil, now once the rain start, chief comes with the tractor, and help them plant timely. They expressed that if they have not been working with the chief, most of them would have found it difficult to pay for seeds and other inputs. In fact, chief has helped some women to get land also. A widow told us that having a meal a day was a problem, now every year she gets income through support of chief and support her two children. Women expressed they have asked chief to provide support in harvesting machines. The women in this community want the chief to grow as they feel that without him they won't be able to survive. The idea of rearing livestock also came from chief. Women also do vegetable. Women want to improve quality of their groundnut for which they need access to drying platform, poly sacs, and they believe they can get it through support from the chief. The chief is trying to mechanise irrigation on a small scale, MADE project is working with a company (Interplast) and assessment of a site is completed to establish one acre model farm. The chief says that he and his group of women are will continue to grow and continue to look for opportunities like this to expand.

Clearly, aggregators have proven to be a pillar of support to women groundnut producers in other

Social involvement

The agriculture system in Ghana is project based. When a funded project supports MoFA and other actors, then value chain upgradation happen as has been seen in rice, soya bean and other crops. A MoFA official in Bolgatanga expressed that under a rice project, they established rice nurseries to ensure large-scale propagation of improved varieties. Groundnut has also seen specific project

investments (such as MOAP, MADE) recently, which are emphasizing community involvement and participation in value chain development. The impact of these initiatives is already visible. If the GoG policy and programme places more priority on the groundnut value chain, there is higher likelihood of addressing current constraints and improving community involvement and livelihoods.

The study team met Savelugu Iggini Suglo Nboribuni Cooperative Sheabutter Processing and Marketing Society Limited, on the way from Bolgatanga to Tamale. The group consist of 30 members (25 women, 5 men), who are both groundnut producers and processors. The group have been supported by Korea International Cooperative Agency, MADE and other projects earlier. The group processes groundnut oil, groundnut flour, *kulikuli* and shea butter. The group procures raw material from among the group members and processes them collectively. The group has a functional VSLA. The group has an account at ADB bank. The group members shared that about 50 percent of their total family income comes from groundnut processing. There is very high demand locally for what they produce. The group wants to expand its business and they demand a modern roasting facility (current roaster uses firewood and their women members are exposed to high amount of heat and smoke). The group is looking for a storage facility and a processing shed. As the business is making money, the members are willing to invest to address these

challenges gradually. However, they are also looking for subsidy support from a project or Government program to make it happen quickly.

4.3.6 Living conditions

The summary of social analysis on living conditions in the groundnut value chain in Ghana is presented in the table below.

Key messages on 'Social Capital' in the VC:

A large number of farmer based organisations are mobilised /promoted in Ghana, with very few of them actually working in the groundnut value chain. A survey of 48 groundnut farmers revealed that 42 percent are currently members of an FBO. In the same survey, only 8.3 percent reported to have used VSLA for taking credit for groundnut cultivation or processing. The study has noted some examples of successes, some examples of failures and some new alternative approaches to building social capital in the groundnut value chain. Even though the FBOs providing support to groundnut farmers are currently limited in number, an alternative aggregator linked smallholder support mechanism has been developed well by MoAP and MADE projects. This approach is working very well to support farmers to access input and output markets. Their coverage though is only about 5 percent of total groundnut farmers in the country. The rest of the farmers are facing serious challenges in getting certified seed, fertiliser (due to a policy constraint), and support for improved agronomy and marketing of their produce.

Women membership in FBOs is around 42 percent of total membership. Structures such as VSLAs are largely women-centric. Many producer and processing groups being promoted have women as their main members. Aggregator based out-grower model also include mainly women.

Existing extension system in Ghana is weak, not able to effectively support uptake of new research innovations. In a survey of 48 farmers, 52 percent reported to have received assistance or participated in a rural development programme undertaken by an external organisation. Most of these received basic training related to groundnut production or processing. Even to train the groundnut farmers, inadequate knowledge of extension agent is also highlighted by key informants as a limiting factor. Extension agents lack logistics support. Policy is another constraint as subsidy is provide for seed and fertilizer for cereal crops but not for groundnut crop e.g. there is no subsidy on TSP fertilizer for groundnut crop.

The agriculture system in Ghana is project-based. Groundnut has seen specific project investments (such as MOAP, MADE) recently which are emphasizing community involvement

TABLE 30: SUMMARY OF SOCIAL ANALYSIS ON LIVING CONDITIONS IN THE GROUNDNUT VALUE CHAIN IN GHANA

6.1 Health services	**Moderate/Low**
6.1.1 Do households have access to health facilities?	Moderate/Low
6.1.2 Do households have access to health services?	Moderate/Low
6.1.3 Are health services affordable for households?	Not at all
6.2 Housing	**Moderate/Low**
6.2.1 Do households have access to good quality accomodations?	Moderate/Low
6.2.2 Do households have access to good quality water and sanitation facilities?	Moderate/Low
6.3 Education and training	**Moderate/Low**
6.3.1 Is primary education accessible to households?	Substantial
6.3.2 Are secondary and/or vocational education accessible to households?	Moderate/Low
6.3.3 Existence and quality of in-service vocational training provided by the investors in the value chain?	Moderate/Low

Rating Scale used:	
Meaning	***Scale***
High likelihoods of this happening, no or little risks in the VC	**High**
Substantial likelihoods of this happening, low risks in the VC	**Substantial**
Moderate to low likelihoods of this happening, medium risks in the VC	**Moderate/Low**
Unlikely of this happening, high risks in the VC	**Not at all**
The parameter is not applicable for the VC	**n/a**

Health services

Basic health infrastructure in rural areas especially in North Ghana is limited. Community Health Intervention Planning and Services (CHIPS) is the basic unit of health delivery in Ghana for preventive care managed by a community health officer. As per a key informant, there are challenges and lot of factors that make health systems work improperly. Health care financing system and health insurance payment modalities are very weak, that tends to make the health care chain dysfunctional. Community Development Alliance (an NGO in Wa) have launched a report highlighting petty corruption in the healthcare delivery system. The report looked at how poor are denied basic health care because the facility does not have funds to run. Some facilities are collecting money and justifying it for good reason. The report emphasizes on the need to empower local health service consumers so that they understand their basic rights, so that they know what they are entitled to.

Primary health centers are available approximately 2-3 miles from a village. The secondary hospitals are further away from villages. The first line of treatment in most cases is CHIPS or private doctors. The cost of local treatment is around 10 to 100 cedis ($1.8 to 18), depending on the disease. The health services are rudimentary and increasingly less affordable.

Malaria, waist pain, hernia are some of the common ailments experienced by groundnut farmers. Malaria incidence in Ghana is high at 285 per 1000 people (Human Development Report UNDP, 2019) Some groundnut families reported to have taken health insurance (Govt scheme), but some have not renewed it (annual subscription – 25 cedis per head, children – 8 cedis). In the survey of 48 groundnut farmers, average annual health expenditure for a family was reported to be 186 cedis ($34).

Housing

In Ghana, a majority of groundnut producers and processors live in compound houses. Compound houses dominate the type of dwelling occupied by households as per Ghana Labour Force Report (2015). The three northern regions, Northern (23.2%), Upper East (17.6%) and Upper West (23.3%), recorded low proportions of households living in dwellings whose outer wall is constructed with cement. Mud bricks/earth is the second main construction material used for the outer walls of buildings in the country. The Upper East region has more than four in five (81.8%) households living in buildings whose outer wall is constructed using mud bricks/earth. This is followed by the Upper West (75.0%) and Northern (68.4%) regions. (Ghana Labour Force report, 2015).

A UNICEF report[50] says that in spite of the progress that has been made to ensure that children and families every part of the country have access to safe drinking water, data has shown that 76 per cent of households are at risk of drinking water contaminated with faecal matter. As at 2015, only one rural household out of ten were using improved household toilets while three in every ten of them practiced open defecation and not a single district in Ghana has achieved an open defecation-free status. A Water.org report[51] says that 81 percent of Ghanaians lack access to improved sanitation or are entirely without toilet facilities. In absolute numbers, the report says that 5 million in Ghana lack access to safe water and 23 million people lack access to improved sanitation.

Education and training

Most groundnut producers are illiterate, and most groundnut processors are literate only up to Junior Secondary (JHS). Groundnut production by smallholders is hampered, in terms of both quantity and quality, by limited education and training, as highlighted in earlier sections. The farmers need to improve their knowledge and skills related to groundnut production and processing.

Several focus group discussions with groundnut farmers and processors revealed that most of their children are now going to school. A survey of 48 groundnut farmers revealed that 73 percent of school age children are actually going to the school. This means that 27 percent children of groundnut farmers are still not getting educated. The primary education from the Government school is free in Ghana, while it cost about 50 cedis a month to send children to a private school. Many women reported that they are sending their children to a private school as they are expected to provide better education than a Government school. Some women still have their children in Government school (Bolgatanga women FGD). School enrolment data suggest dropout rate is high for children transitioning from primary to secondary schools. This is evident in primary school enrollment at 95.36 percent as per the data collected in many large-scale household surveys. However, it dramatically reduces at the secondary level, where enrolment is 59 percent.

[50] Source: https://www.unicef.org/ghana/water-sanitation-and-hygiene
[51] Source: https://water.org/our-impact/ghana/

Key messages on 'Living Conditions' in the VC:

Basic health infrastructure in rural areas especially in North Ghana is limited. Community Health Intervention Planning and Services (CHIPS) is the basic unit of health delivery in Ghana for preventive care managed by a community health officer. As per a key informant, there are challenges and lot of factors that make health systems work improperly. Health care financing system and health insurance payment modalities are very weak, that tends to make the health care chain dysfunctional. Primary health centers are available approximately 2-3 miles from a village. The secondary hospitals are further away from villages. The first line of treatment in most cases is CHIPS or private doctors. The cost of local treatment is around 10 to 100 cedis ($1.8 to 18), depending on the disease. The health services are rudimentary and increasingly less affordable.

In Ghana, majority of groundnut producers and processors live in compound houses. The three northern regions, Northern (23.2%), Upper East (17.6%) and Upper West (23.3%), recorded low proportions of households living in dwellings whose outer wall is constructed with cement.

Access to safe water and improved sanitation is poor in Ghana. A Water.org report says that 5 million (~18 percent) in Ghana lack access to safe water and 23 million (~82 percent) people lack access to improved sanitation.

Most groundnut producers are illiterate, and most groundnut processors are literate only up to Junior Secondary (JHS). The situation is changing now with children of groundnut farmers and processors. Several focus group discussions with groundnut farmers and processors revealed that most of the children are now going to school. A survey of 48 groundnut farmers revealed that 73 percent of school age children are actually going to the school.

4.4 Findings - Social Analysis (framing question 2)

Framing Question 2: Is this economic growth inclusive?

The study estimates that there are 580,000 workers (producers, processors and traders) engaged in different segments of the groundnut value chain. This suggests that about 500,000 to 800,000 peoples' livelihoods in Ghana are likely to be intrinsically dependent on groundnut. Overall, we estimate that about 90 percent of all actors and workers in the value chain are women. This suggests that any initiative for value chain upgradation has significant likelihood of benefitting women and consequently health, education and food and nutrition security of large number of families in Ghana. This suggests that priority placed on groundnut value chain development by the GoG is likely to be a highly relevant and inclusive socio-economic development strategy.

The study also uncovered areas where 'inclusivity' of the value chain can be improved:

- There are three main risks related to 'working conditions' of workers in the value chain. Firstly, key occupational health and safety risk in the value chain are observed at the processing segment. As women are the main workers at processing sites, they could be potential target for occupational harm due to excessive heat and smoke in the spaces where they work.

Roasting technologies /equipment demand urgent review and up-gradation. Collaboration with Rural Enterprise Programme (REP) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in Groundnut. Secondly, groundnut producers and workers throughout the value chain are only able to earn about 15 to 20 percent of the living wage benchmark from their groundnut production. There is a significant potential to increase returns of producers and workers if right conditions are developed. Thirdly, most workers in the VC have no full-time /permanent employment. Most are working on temporary work, which is paid on a daily or weekly basis. Most workers have no benefits except the daily wages. To ameliorate this situation, the study analysis suggest that certain parts of the value chain could be targeted by incentivising 'collectivisation /formalisation' which can then lead to better wages for the workers.

- Groundnut value chain development needs to avoid policy-pitfalls and regulatory shortcomings experienced by other value chains in the country. The VC needs to capitalise on promising business models such as the ones being developed by MADE (DFID funded) and MOAP (GiZ and EU co-funded) projects which could potentially provide an alternative to large-scale land acquisition by ‘non-natives’.
- Women's access to resources and services are not commensurate to their economic role in the VC. This indicate gender-disparity in access to land and non-land asset as well as assistance and services from government /NGOs.
- The challenge remains of promoting increased women’s participation and leadership roles in various groupings as currently it is very limited.
- Reduction in per capita production of food locally is a cause for concern. Another risk factor is a decreased per capital production of millets, sorghum and groundnut, leading to higher imports from neighbouring countries. This represent a drain on the exchequer and reduces nutrition-sensitive behaviours on dietary patterns.
- Aflatoxin residues in groundnut products across the value chain represent a serious food safety and health risk to the Ghanaian population. Lower awareness of the risk across the value chain is in itself a greater risk as 'ignorance' can lead to higher exposure to contaminated groundnut products for human and animals, leading to severe negative consequences across the food chain.

Overall, the Groundnut value chain is showing signs of exemplary pro-women, pro-poor and pro-youth value chain development. However, as highlighted above, many constraints need to be addressed for inclusive and sustainable expansion of the groundnut sector in Ghana, for which a very large potential exist as is evident from experiences of other countries (Senegal, The Gambia and Nigeria) in West Africa.

5. Environmental analysis

This chapter focuses on the environmental analysis of the groundnut value chain in Ghana. This analysis is based on Life Cycle Assessment (LCA) methodology, following as much as possible the ISO standard 14040 and 14044/2006 and the ILCD guidelines from the Joint Research Centre of the European Commission (EC-JRC, 2010; ISO, 2006).

5.1 Goal and scope of the study

5.1.1 Objectives and scope of the study

The generic framing question of the environmental LCA studies carried out under the VCA4D project is to evaluate the potential environmental impacts of groundnut value chains in Ghana. According to the Terms of Reference (ToR) of the Groundnut Value Chain Analysis in Ghana, the specific objective of this study is to "highlight the most relevant strengths, risks and opportunities in the value chain, the points to be further analysed in depth, and the aspects that are difficult to inform". The intended application of the results of this work is to "help the European Commission structuring their policy dialogue around the strategic issues that might hinder the sustainable development and growth of the groundnut chain in Ghana". More specifically, the target audience for this study is the DG DEVCO of the European Commission and the Delegation of the European Union in Ghana. The EU delegation to Ghana and the MoFA have requested an analysis of the groundnut value chain given the lack of a complete and updated diagnostic of the sector, so the study is aimed at improving the understanding of the functioning of the VC and to provide a baseline against which to measure future changes in the groundnut production. Based on these generic and specific elements, three main objectives are formulated for the LCA study to be undertaken:

- To quantify the potential environmental impacts of the current groundnut value chains in Ghana, based on available knowledge,
- To calculate the contribution of the main stage of the life cycle for the main products and to highlight the environmental hotspots;
- To provide elements for discussion on the sustainability of current groundnut value chains in Ghana.

5.1.2 Scope definition

The recommended approach for system description and Life Cycle Inventory (LCI) modelling is then attributional. Groundnut in Ghana is important for both household food consumption and as cash crop and plays a major role in the Ghanaian diet as a source of protein. While the cultivation is mostly in the northern regions, mainly Upper West, Upper East and Northern region, groundnut consumption through several different products is widespread all over the country, from the North to the South. Therefore, the temporal and geographical coverages selected for this study are for the whole country.

Even if all the products analysed in this study are made of groundnuts as only ingredient and have the same system boundaries, these products are not comparable in terms of hedonic, nutritional and economic values. Thus, from an LCA point of view they are not comparable. However, considering that the general aim of this study is to understand the environmental sustainability of groundnut value chain, we think that, from a decision-making point of view, contributing to answer to the question: "for 1 kg raw groundnuts produced in Ghana, what is the most environmentally friendly option?" is important. Thus, all the products were evaluated independently, but in section

5.8.4 a discussion is proposed with caution and limitations on the comparison of the results of the two sub-chains and also with results of other studies on groundnuts found in literature.

It has to be underscored that only few case studies on the environmental impacts of groundnut cultivation and groundnut products were found in the literature, namely two papers on groundnut cultivation in Iran (Nikkha, 2015; Noorhosseini, 2018), one on peanut butter (McCarty, 2014) and one on groundnut oil at global scale (Schmidt, 2015).

5.2 System boundaries

Given the objectives of this LCA study, the system boundaries were set from cradle-to-retailer gate in Ghana, since the market for groundnut-based products is mostly national with export only in few cases. Due to feasibility issues and time constraints, we choose to stop the analysis at market-gate, but a cradle-to-grave analysis would have been even more informative. In Figure 24 are reported the main life cycle stages of cradle-to-market gate groundnut value chain and their respective potential by-products.

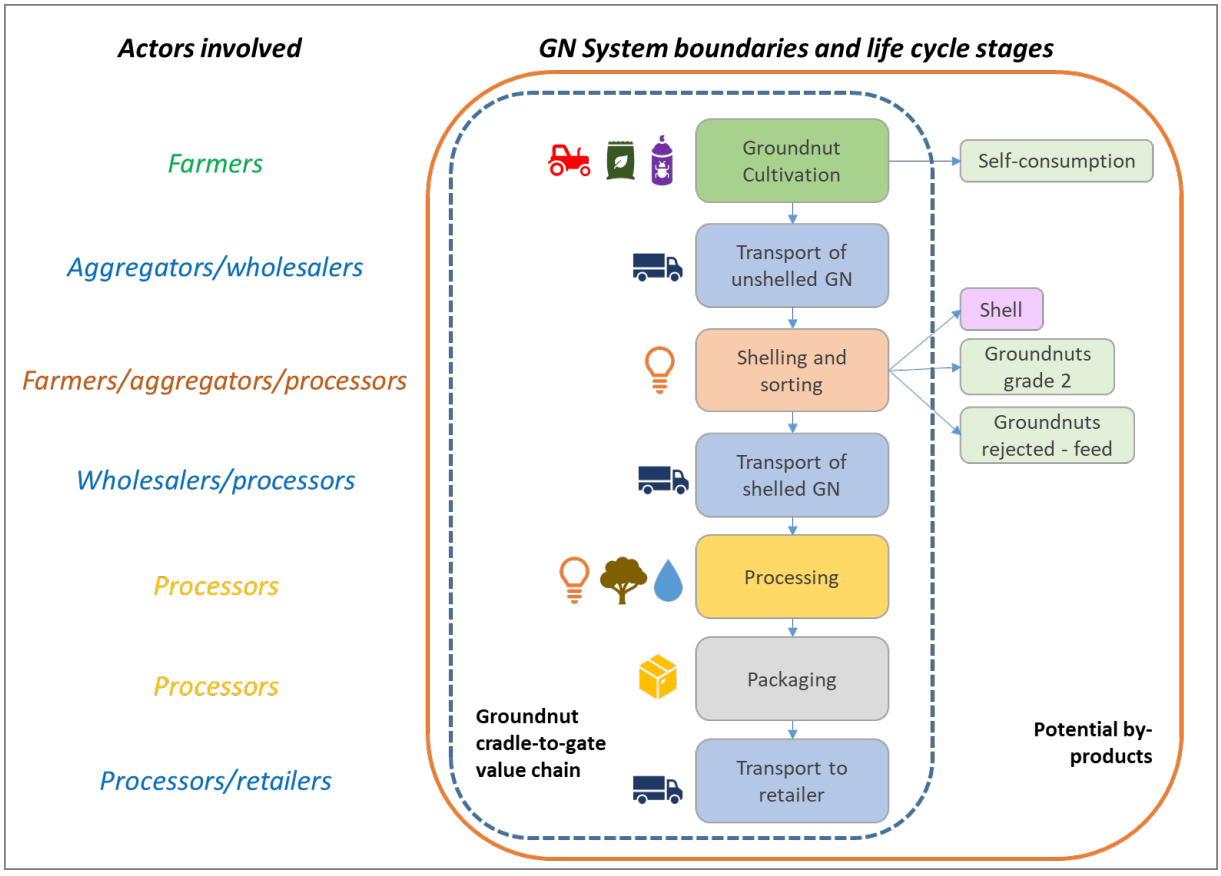


FIGURE 24: SYSTEM BOUNDARIES OF THE "CRADLE-TO-RETAILER GATE" GROUNDNUT VALUE CHAIN IN GHANA AND ACTORS INVOLVED FOR LIFE CYCLE STAGE.

The production of key inputs in all the life cycle stages is included, as well as their use and emissions. Moreover, the transportation of unshelled, shelled groundnuts and of the final product to the retailer was included. The transportation of inputs was included, while infrastructure was excluded, with exception of tractors and trucks.

5.3 Studied value chains and functional units

Considering that the export of groundnut products outside Ghana can be currently regarded as almost exceptional, the value chain falls completely within national borders. In Ghana, groundnuts are processed into a variety of forms, including raw, roasted, flours and snacks. The majority of groundnut products are made by artisanal processors, although there is also a commercial groundnut processing industry (Meng et al., 2017). Thus, two main types of value chains can be defined from the functional analysis:

- A value chain dedicated to the informal/artisanal production, mostly depending on non-aggregator smallholder farmers (NASH) and in part on aggregator-based smallholder farmers (ASH), on artisanal processors and local markets, mainly located in the Northern of the country (**Unformal Artisanal VC**).
- A value chain dedicated to formal SME production, based both on smallholder farmers (aggregator based (ASH) and commercial farm (CF), on SME processors and national market (**Formal SME VC**).

As highlighted in the functional analysis, the artisanal value chain produces several products, among which the most important are: groundnut paste, roasted groundnuts (as snacks), kulikuli, oil, flour. Only paste and snacks are produced at formal SME level, but only paste was included in the environmental analysis due to lack of data for snacks. We considered two different levels of formal paste production, one for national market and one both for national market and for export. Below, a short description of the selected groundnut-based products is reported.

Groundnut paste: is made by shelled groundnuts, that are cleaned and graded to select good-quality, sound kernels. Groundnuts are then roasted to a desired level to develop appropriate flavour. The roasted groundnuts are then ground with the skins included to make groundnut paste, although sometimes the skins are removed. The paste is an essential ingredient in groundnut soup, a well-liked and often eaten dish in Ghana and throughout West Africa.

Roasted groundnuts: Shelled groundnuts are simply roasted and packaged in plastic bottle. Small scale processors in Ghana may employ one of two simple approaches (Meng et al., 2017). The simplest method is using a wok-type or a similar utensil for roasting a 1–5 kg batch of raw groundnuts. Another method applies a rotary drum mounted on an axle with a handle to rotate the drum. The heating of the batches is carried out on an open wood-burning fire. Formal SME processors normally employ rotary drums for roasting. In this case, the heating source may be wood, natural gas and/or electricity.

Kulikuli is groundnut cake left after pressing oil. Freshly obtained cake is rolled and shaped into balls or rings that are fried in groundnut oil. Kulikuli is an artisanal popular snack, widespread in northern regions.

Oil: groundnut oil is manually extracted from grinded groundnuts, is available in Ghana only as an artisanal product. A vegetable oil plant in Kumasi (Golden Web Ltd) used to process also groundnut oil but interrupted the production some years ago.

Flour: groundnut cake can be turned into powder and used as a condiment to flavour roasted meats.

The functional unit (FU) used for all the products was 1 kg of product plus its packaging at retailer, then the FU are:

- Informal/artisanal sub-chain:
  - 1 kg of artisanal paste in plastic bag
  - 1 kg of groundnut snack in plastic bottle

- 1 kg of kulikuli in plastic bag
- 1 kg of groundnut oil in plastic tank
- 1 kg of groundnut flour in plastic bag

- Formal SME sub-chain:
  - 1 kg of SME paste in plastic bucket from small enterprise
  - 1 kg of SME paste in plastic bottle from medium enterprise

5.4 Data quality

The Life Cycle Inventory (LCI) of the environmental assessment was built on:

- Primary data: data and information collected during the field missions (1st: 26 May – 5 June 2019; 2nd 29 September – 10 October 2019) and during a field survey conducted by local expert Seth Yawlui and Joseph Apeeliga in August and September 2019.
- Secondary data: material provided by MoFA, MADE, national statistics; and life cycle inventory databases, for the background data, namely ecoinvent (version 3, allocation, cut-off by classification), Agribalyse (v 1.3), Agrifootprint, and USLCI.

Data used in this study to characterize and to evaluate the groundnut value chain have good geographical distribution, both for groundnut cultivation and groundnut processing, thanks to the wide coverage during the two missions (3 farmer communities representing more than 30 farmers, 15 processors) and to the survey (48 farms, 29 processors). Data collected cover all the regions where groundnut cultivation is important (Upper West, Upper East, Northern, Bono East, Oti) and also the main centres of processing (Tamale, Kumasi and Accra). With such a limited sample of farms and factories surveyed, representativeness for such a large value chain cannot be claimed. However, the coverage was well in line with the resource and timeframe of this study, and we consider that our dataset constituted the best possible compromise.

5.5 Main assumptions

Land cover change:
Laws exist in Ghana that require stakeholder engagement in land use planning. The Local Government Act empowers the District Assemblies to develop local development plans and by-laws for their jurisdiction, but this has largely not been applied for planning forest and agricultural production which affect land use (FAO, 2016). Thus, an environmental aspect very important for all the agricultural chains in Ghana is the role of the expansion of agricultural areas in pushing deforestation and degradation of primary and secondary forests. The four most highly ranked causes of deforestation in a study carried out in Ghana are poverty-driven agriculture, lack of alternative rural wage employment other than farming, household population levels, and conflict in traditional land practices (Appia et al., 2009).
Agricultural lands often represent a radical transformation from a diverse variety of vegetation types and natural habitats to crop-dominated landscapes. In Ghana, savannas experienced a large loss, from about 51 to 40 percent of the total land area from 1975 to 2013. The formerly uninterrupted savanna landscapes of the Central Sudan Savanna, Main Transitional Zone, and Central Transitional Zone are now highly fragmented, with large tracts of natural habitat broken into myriad patches of farmland, reducing habitat suitability for many types of wildlife.

Another important land cover change in Ghana is forest areas. The forest class (represented primarily by Ghana's dense evergreen rain forest and moist deciduous forest) shows a small decline in area from about 16,400 km^2 in 1975 to 15,500 km^2 in 2000, a reduction of 5%. This

decline accelerated rapidly between 2000 and 2013, as forests were reduced by an additional 20%, to 12,400 km^2 in 2013.

The degraded forest, which occurs mainly in the off-reserve areas, represents a vegetation type that was derived from the dense and deciduous forests, modified by human activity. The traditional slash and burn method of agriculture, logging, annual wildfires, and recently commissioned opencast mining are the major disturbing factors that have diminished vegetation extent and composition in the southern ecoregions. Degraded forests continued to decrease in area, losing 17% of their cover between 1975 and 2013. The expansion of cocoa farms, other crops, and fallow lands was the primary driver of the decline in degraded forest area.

The gallery forest, which represents the most biologically rich habitat in the savanna zones of central and northern Ghana, also experienced a decline that has accelerated, mainly because of clear-cutting for agriculture, from 6,200 km^2 in 1975 to 3,750 km^2 in 2013. If we add all forest classes together, we see a significant decline of 25% of forests over the 38-year period. However, historical imagery confirms that a much larger loss of forest occurred during the 1960s, what remains today is primarily contained in the biological reserves (CILSS, 2016) (Figure 25).

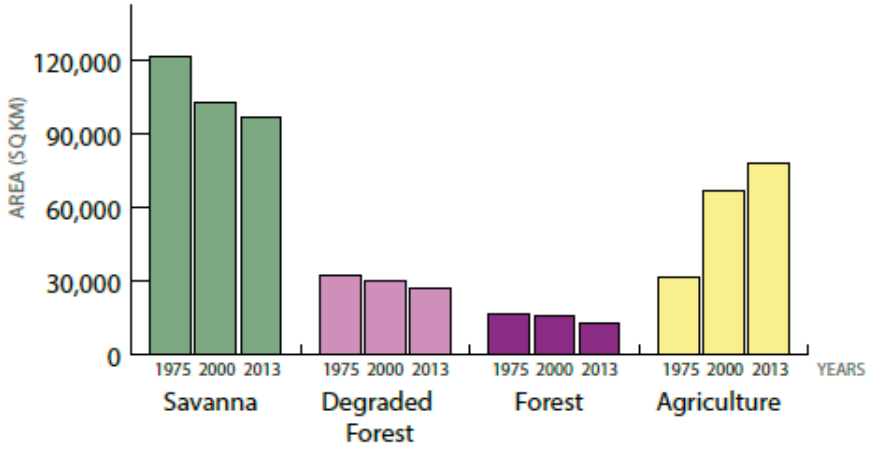


FIGURE 25: TREND IN LAND USE COVER IN GHANA FROM 1975 TO 2013 (CILSS, 2016).

With respect to this issue, we know that it is quite difficult to attribute the environmental burden of deforestation between deforestation products and agricultural land, since once the forest is cut it is possible to use the wood and, at the same time, land becomes also available as land for agriculture. We assumed here to attribute the burden of deforestation to forest products (fuelwood), since we have assumed that the groundnut cultivation is not directly responsible for the increase in agricultural areas considering that groundnut is almost always grown on the most marginal areas of farms and that they are used also to improve soils degraded by the cultivation of cereals. However, we cannot know and exclude that the soil on which the groundnuts are grown was covered by forests 10 or 20 years ago. According to the IPCC methodology for accounting land use change, the reference period to account land use change is 20 years, so in this case land use change should be considered.

Following our assumption, we loaded the impact of land use change due to deforestation to fuelwood. As reported in section 5.7.2, in Ghana there is a strong use of fuelwood throughout the country that lead to have consumptions almost higher than production. The main origin of the fuelwood is the Transition Zone and the Woody Savannah. The land use change associated with the use of firewood was therefore considered in the life cycle stages of the supply chain in which there is use of firewood, such as the roasting of the groundnuts or in the frying of kulikuli.

Losses

Other important assumptions are those related to the groundnut losses along the value chain, as reported in the functional analysis. Post-harvest outflows and losses are quite important in the value chain of groundnuts, mainly at farm stage, at shelling, sorting and roasting (Figure 26). Both outflows (self-consumption for food and seeds, grade II) and losses have been estimated considering data and information collected during the field missions and fortified with data come from the survey. We used averaged values, however it has to be pointed out that there is a significative variability in these estimated values, depending on many variables, i.e. on meteorological conditions of the growing season for groundnut yield, with heavy losses in rainy years, and depending on seed quality and variety, and mostly on storage for the losses due to shelling and sorting. Indeed, excess moisture promotes activities of *Aspergillus flavus* increasing level of mould and consequently aflatoxin in groundnuts. Details on losses types are reported in appendix 8.5.

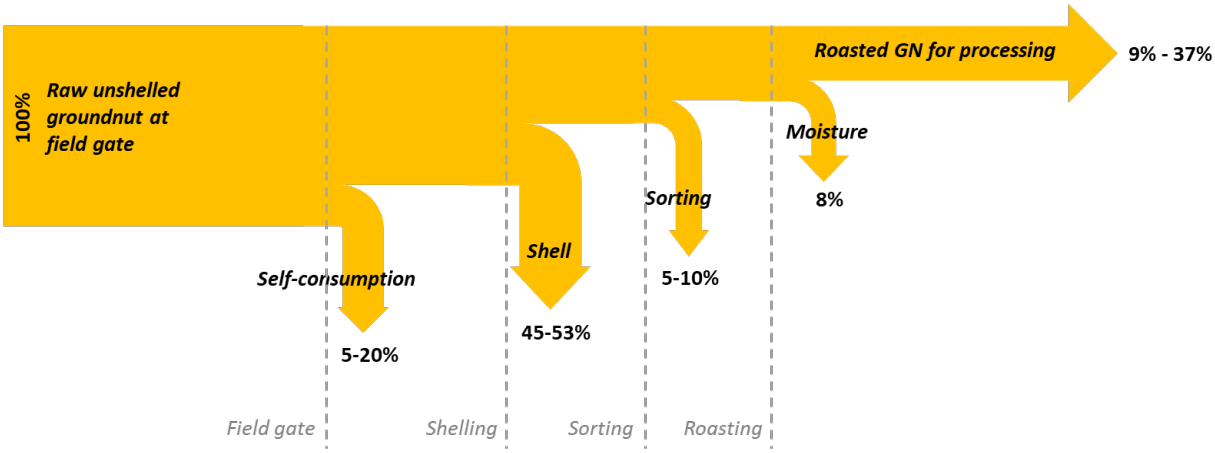


FIGURE 26: GROUNDNUT OUTFLOWS AND LOSSES IN MASS PERCENTAGE (WORST CASE – BEST CASE) ALONG THE VALUE CHAIN FROM UNSHELLED RAW GROUNDNUTS UNTIL ROASTED GROUNDNUTS BEFORE FINAL PROCESSING.

5.6 Life-cycle impact assessment methods

In order to answer to the three questions asked by DEVCO regarding the environmental dimension, an endpoint life cycle impact assessment method was selected. Indeed, an endpoint LCIA method allows calculating integrated environmental impacts for the three commonly used areas of protection: Human Health, Ecosystem Quality and Resources Depletion. We selected the endpoint version of the ReCiPe2016 (Hierarchist) LCIA methodology (Huijbregts et al., 2017 and 2016), normalization was set as World (2010) H/A. Indicators included in each area of protection are reported in Table 31.

TABLE 31: ENDPOINT IMPACT CATEGORIES INCLUDED IN EACH AREA OF PROTECTION OF THE RECIPE 2016 METHOD.

Impact Category	Human Health	Ecosystems	Resource scarcity	Description
Climate change	X	X		Greenhouse gas emissions causing disturbances on the global climate system
Stratospheric ozone depletion	X			Emissions of compounds such as chlorofluorocarbons or halons, which are responsible for the ozone hole phenomenon
Ionising radiation	X			Release of radioactive substances into the environment
Particulate matter formation	X			Emissions of particulate matter or particulate precursors, which contribute to respiratory disorders
Photochemical ozone formation	X	X		Emissions of ozone precursor pollutants such as nitrogen oxides or volatile organic compounds, causing human health problems (irritation, asthma) or damage to plants
Terrestrial acidification		X		Emissions of acidifying pollutants, causing phenomena such as acid rain, and damage to terrestrial ecosystems
Freshwater eutrophication		X		Emissions of nutrients into the natural environment, causing disequilibria in freshwater ecosystems (proliferation of plant or animal species at the expense of other species)
Toxicity and ecotoxicity	X	X		Emissions of pollutants toxic to human health and ecosystems
Water consumption	X	X		Effects for human population and ecosystems of freshwater consumption
Land use		X		Biodiversity changes due to land transformations and occupations
Mineral resource scarcity			X	Depletion of mineral ores
Fossil resource scarcity			X	Cumulated primary energy demand from fossil and nuclear sources

5.7 LIFE CYCLE INVENTORY

5.7.1 Production of the groundnut-based products

The 7 groundnut-based products investigated in this study share mostly the same production processes, which include: groundnut cultivation, groundnut shelling, shelled groundnut sorting, groundnut roasting, roasted groundnut grinding, packaging and transport, except for roasted groundnuts that does not need grinding. The data used for the LCI of each life cycle stage will be detailed below.

5.7.1.1 Groundnut cultivation

Groundnut is an annual legume widely cultivated in Northern regions, since about 94% of production is located in Northern Ghana. Production is mainly rainfed and labour intensive. Through the interviews conducted during the field missions and thanks to the survey carried out by the national experts, it was possible to identify three main types of farms cultivating groundnut, on the basis of their dimension and organization:

- Non aggregator-based Smallholders (NASH): include farms with an overall agricultural area less than 2 ha, without aggregator. These farms cultivated on average 0.76 ha of groundnuts both for self-consumption (20%) and to sell the production (80%) to buy other foods or necessary goods. These farms use very few external inputs, they recycle seeds from the previous season, and they do not use any fertiliser or chemical product. Average yield (1.3 t ha^{-1}) is lower than the national average (about 1.4 t/ha) (MoFA, 2018). A worst-case scenario was analyzed in paragraph 5.8.5, setting groundnut yield equal to 0.8 t ha^{-1}.
- Aggregator-based Smallholders (ASH): include farms with an overall agricultural area less than 2 ha, with an aggregator that can provide service for ploughing, credit for seeds and fertilizers, extension services. These farms cultivated on average 0.96 ha of groundnuts both for self-consumption (10%) and to sell the production (90%) to buy other foods or necessary goods. These farms use some external inputs, such as improved seeds (100% of the farms), phosphorus fertilisers and herbicides (25% of the farms). Farmers follow aggregator advices and therefore adopt good agricultural practices. Average yield (1.6 t/ha) is slightly higher than the national average (about 1.4 t/ha) (MoFA, 2018).
- Commercial farms (CF): include farms with an overall agricultural area more than 2 ha, aimed at selling the production. These farms cultivated on average 3.1 ha of groundnuts both for few self-consumption (5%) and mainly to sell the production (95%). These farms use some external inputs at higher rates compared to ASH farms, such as improved seeds (100% of the farms), phosphorus fertilizers and herbicides (50% of the farms). Farmers follow the good agricultural practices. Average yield (2.2 t/ha) is quite higher than the national average (about 1.4 t/ha) (MoFA, 2018).

Many organizations and programmes are active in Ghana on the training of farmers and the dissemination of good agricultural practices for several crops. A specific reference for groundnuts is the manual published by the Ghana Export Promotion Authority (GEPA, 2015), specific to increase the potential for the export of groundnut products and aimed at increasing the yields and reducing the risk of aflatoxin contamination.

For all the three farm types it was considered that the previous land use was already cultivated land or fallow, based on the answers obtained from the interviews and the survey results. Therefore, it was not considered any change in land use, considering that groundnuts are normally grown in the most marginal lands of the farm and that groundnut is considered as a crop capable of improving impoverished soils thanks to its ability to fix nitrogen and improve the soil fertility. Nevertheless, these beneficial effects (i.e. ecosystem services) are out of scope of this LCA. However, land clearing is almost always carried out before cultivation, which has been explained to be not as a new cultivation of non-agricultural land but as the cultivation of an agricultural land not cultivated in the last few years (fallow land). In this case it is necessary to remove the spontaneous vegetation (grasses and bushes) that has grown back and, in most cases, even on ASH and CF farms, land clearing is done manually and only rarely an herbicide treatment is used. Beyond the cost of the chemical treatment, farmers are prevented to use herbicides due to the risk of compromising groundnut seed germination, if herbicide is not used according to product indications. Thus, we considered an herbicide treatment only in the 25% of ASH and 50% of CF farms carried out before or after ploughing. The herbicide treatment is carried out by hand, using

a manual pump and 2.5 L of herbicide product per hectare. One of the most used products is Bayer's Stomp, that is sold in bottle of 1 L containing 36 g of pendimethalin. One bottle is diluted in 16 liters of water during application.

All farms (NASH, ASH, CF) perform a light ploughing (10 cm depth) with a tractor that is normally owned by an aggregator or an extension service. The estimated diesel consumption for ploughing one hectare is about 10 L/ha, based on data collected in interviews. Ploughing is the only agricultural operation that is carried out mechanically with a tractor, as in all three types of farms both sowing, fertilising, weeding and harvesting are carried out manually, with the use of family or external labour.

Sowing on NASH farms is carried out through broadcasting and subsequent ploughing to bury the seeds or planting with a stick not in line. In both cases this sowing leads to a low planting density which is reflected in low crop yields. In ASH and CF farms, the planting is carried out with sticks, both not in line and in line, the latter system helps in improving the planting density of groundnuts and the competition between groundnut and weeds, and consequently in increasing the yield. Groundnut sowing normally occurs at the beginning of rainy season, in the months of May-June.

The aspect related to the quantity and quality of the seeds planted is very important to obtain a good groundnut yield. In NASH farms, groundnuts from the past season are used as seeds. The quality of these seeds, recycled countless times, is rather low and involves very small grain yield and little filled pods. The quantity of seeds used is 20 kg per acre or 50 kg ha^{-1}. The ASH and CF companies have started using improved seeds in recent years. The improved seeds are produced by a few aggregators that use their farmers to reproduce the foundation seeds provided by the researchers of the Savanna Agricultural Research Institute (SARI) in Tamale. The main difficulty in increasing the use of these seeds lies in their availability, because SARI researchers cannot cope with the increase in improved seeds demand. The quantity of seed used by the ASH and CF farms is around 25 kg/acre or 63 kg/ha. The cultivation of the improved seeds follows agricultural practices very similar to that of the ASH farms, even if a higher seed amount is used, equal to 32 kg/acre or 80 kg/ha of foundation seeds.

Regarding the use of fertilizers, NASH farms do not use any type of fertilizer, as they consider groundnuts as a crop capable of producing without the need for any type of nutrient. ASH and CF farms use phosphate fertilizers, generally Triple Superphosphate (TSP) (NPK: 0 - 45 - 0) or, preferably but more expensively and less available, Yaralegume (0–18–13 NPK + 3 CaO + 2 MgO + 4 S). We considered a fertilizer use of 50 kg $acre^{-1}$ or 125 kg ha^{-1} of TSP in 25% of ASH farms and in 50% of CF.
Since most farms also have some farmyard animals (goats, chickens ...), there would be the possibility of using the manure on crops, but in fact the animals are free to move around on the farmland and there is no collection point for excrements. Thus, it can be said that generally the manure is not used in the cultivation of groundnuts.

Weeds are one of the main problems in the cultivation of leguminous crops, capable of compromising the yield of the crop due to a strong competition for nutrients and water. Indeed, groundnut is not aggressive in the early stage of growth so early weeds control is very crucial. Weed management in groundnut is carried out manually in all three types of companies, generally with manual intervention before flowering.

As reported in functional and in social analyses, groundnuts are highly susceptible to aflatoxin contamination, a group of toxins that pose serious health threats to humans and animals. The toxins are produced by *Aspergillus* species (mainly *A. flavus* and *A. parasiticus*) under the influence

of high temperature, high relative humidity/moisture content, mechanical and pest damage, as well as poor storage practices - conditions characteristic of tropical and subtropical areas. Infants and young children, in particular, are very susceptible to the toxins and their attendant negative effects. In a study carried out in Ghana on complementary foods, all samples were contaminated with aflatoxin (Opoku et al., 2018). Concentrations in cereal-legume blends ranged from 1 to 1094 ppb while those in cereal-only samples ranged from 1 to 11.7 ppb, while the national limit for aflatoxin is 20 ppb. In 2018 the International Institute for Tropical Agriculture in Tamale (IITA) started to develop a Ghanaian version of Aflasafe, a natural product to be applied to soil to reduce the contamination of aflatoxin in groundnut. Aflasafe is a safe natural solution to the problem of aflatoxin allowing to cut aflatoxin levels in maize and groundnuts by 80% to 100%, down to safe levels with one application per year. Each country has its own version of Aflasafe using a mixture of four fungal strains, all found growing naturally in local soils. The friendly fungi are coated onto ordinary sorghum grain, which acts as a vehicle to help them get established and can easily be broadcast onto fields. Since Aflasafe for groundnut has recently been released it was not possible to assume that farmer use this product in 2018, so the use of Aflasafe is not included in the cultivation of groundnuts in this study.

Groundnut harvesting takes place between August and October, after the pod is well formed but before the soil becomes too dry and therefore unfavorable to the uprooting of groundnut plants. Even the groundnut harvest takes place manually, and it involves several operations which are: plant uprooting and pod plucking. The vines can be used as feeds for animals so they can be left directly in the field to let them graze it, as a green manure or they can be not used at all. The vines could be a potential by-product but, in this analysis, they were considered only as a green manure that returns to the field.
The groundnuts are sun-dried for some days at home or farm. The appropriate groundnut moisture for a good storage should be about 7-9%. After drying, unshelled groundnuts are packed in jute or plastic bags and then stored at the farmer's homes until they are sold.

About 20%, 10% and 5% of the groundnut harvested and packaged is destined to self-consumption in NASH, Ash and CF, respectively, for preparing meals for the family and, in case of NASH farms also as a seed for the following agricultural growing season. The rest of the produce is sold at the time considered most appropriate by the farmer from December to June, when the price is higher. An allocation based on mass was considered between the amount destined for self-consumption and the one sold. Therefore the 80%, 90, 95% of the produce was allocated to sold groundnuts in NASH, Ash and CF, respectively.

With regard to the estimate of direct emissions in the field, soil N_2O emissions (direct and indirect), phosphorus emissions due to erosion and phosphate due to run-off have been included. No other air or water emissions of nitrogen compounds were considered as none of the farms used a nitrogen fertilizer. Details on calculation of direct emissions of nitrogen and phosphorus from soil are reported in Annex 8.3.

Since no nitrogen fertilizers are used for groundnut cultivation, soil direct and indirect N_2O emissions depend completely on the nitrogen supplied to the soil with groundnut residues, which are rich in nitrogen[52].
Sources of soil N_2O direct and indirect emissions are reported in Table 32.

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TABLE 32: SOURCES OF SOIL N_2O EMISSIONS, DIRECT AND INDIRECT, DUE TO GROUNDNUT CULTIVATION.

All values refer to 1 ha.

N_2O emissions	N input	Unit	NASH	ASH	CF
Soil N_2O direct emissions	Mineral fertilizers	kg N_2O ha^{-1}	0	0	0
	Organic fertilizers	kg N_2O ha^{-1}	0	0	0
	Residues	kg N_2O ha^{-1}	0.465	0.465	0.465
Soil N_2O indirect emissions	Mineral fertilizers	kg N_2O ha^{-1}	0	0	0
	Organic fertilizers	kg N_2O ha^{-1}	0	0	0
	Residues	kg N_2O ha^{-1}	0.003	0.003	0.003
Total soil N_2O emissions		kg N_2O ha^{-1}	0.468	0.468	0.468

The phosphorus and phosphate emissions were calculated using the approach developed by Nemecek and Kagi (2007), so three different kinds of phosphorus emissions to water were considered, the leaching and the run-off of soluble phosphate, and the erosion of phosphorus. Sources of phosphate and phosphorus emissions are reported in Table 33.

TABLE 33: PHOSPHATE AND PHOSPHORUS EMISSIONS DUE TO GROUNDNUT CULTIVATION. ALL VALUES REFER TO 1 HA.

Emissions to environment	Unit	NASH	ASH	CF
Leaching of phosphate to ground water	kg PO_4	0.07	0.07	0.07
Run-off of phosphate to river	kg PO_4	0.175	0.181	0.187
Erosion of soil particles containing phosphorus to river:	kg P	45.5	45.5	45.5

The life cycle inventory of groundnut cultivation in the three types of farms is reported in Table 34 on hectare basis.

TABLE 34: LIFE CYCLE INVENTORY OF GROUNDNUT CULTIVATION IN THE THREE FARM TYPES.

All values are based on 1 ha.

INPUT	Unit	NASH	ASH	CF	Sources of data
Land occupation	m^2/yr	10000	10000	10000	
Ploughing	MJ/ha	446	446	446	primary data
Recycled seeds (self-production)	kg/ha	50	0	0	primary data
Improved seed (purchased)	kg/ha	0	63	63	primary data
Phosphorus fertiliser (TSP)	kg/ha	0	30.9	61.8	primary data + assumption
Herbicide	L/ha	0	0.625	1.250	primary data + assumption
Input transport	tkm	0	2.801	3.728	primary data
Production and waste management of packaging	kg/ha	0	0.065	0.130	primary data
Transport of inputs for cultivation (Transport, freight, light commercial vehicle, RoW)	tkm	0	1.68	2.6	primary data
OUTPUT	**Unit**	**NASH**	**ASH**	**CF**	
Groundnut yield (unshelled)	t/ha	1.296	1.620	2.268	primary data
Groundnut sold	t/ha	1.037	1.458	2.155	primary data
Groundnut for self-consumption	t/ha	0.259	0.162	0.113	primary data
Total soil emission of N_2O (direct and indirect)	kg ha^{-1}	0.469	0.469	0.469	IPCC 2006 Vol 4, Ch 11
Emissions of P from erosion	kg ha^{-1}	45.5	45.5	45.5	Nemecek and Kagi 2007
Emissions of PO_4 from leaching and run-off	kg ha^{-1}	0.328	0.336	0.344	Nemecek and Kagi 2007

5.7.1.2 Shelling and sorting

As mentioned above, groundnuts are stored packed at farmers' house until they are sold, without any material or energetic input or losses. Groundnuts are always stored unshelled (with the shell, in the pods) to improve conservation and they are still sold unshelled by the farmer to the local market or to an aggregator that will shell them only immediately before processing them, to avoid quality loss. The average distance that an unshelled groundnut bag can travel from the farm to the place where it will be shelled has been estimated on average about 100 km both for informal artisanal and formal SME products.

Shelling corresponds to the process of shell removal from unshelled groundnut in order to obtain the groundnut grain, namely shelled groundnuts and it can be manual or mechanical. Shelling machines fed by electricity or diesel are quite available in the villages, but sometime the quality of the machine is not good and there could be grain damage and/or a high grain loss. For this reason, manual shelling is preferred by some processors, especially for roasted groundnuts and snacks. However, since the sheller machine is available in the villages and in the markets, we hypothesized that groundnut is shelled mechanically, with the use of electricity. The electricity consumption was recorded in interviews and the process is very fast since it takes 3 minutes to shell a bag of unshelled groundnuts (64 kg) with an electrical sheller of 5 HP of power, so that the consumption was 0.18 kWh to shell a 64 kg of unshelled.

At shelling the pod is separated from the grain and the portion of shelled groundnuts that can be obtained from an unshelled bag can change depending on the variety of groundnuts but above all on the quality of the seeds used. The proportion of shelled groundnuts thus varies between NASH farms, which use recycled seeds, compared to ASH and CF which use improved seeds. From the data collected in the interviews and from those collected through the survey, it was possible to

hypothesize that the shelled share is 47% in the case of NASH and 55% in the case of ASH and CF. This shelling rate includes grain losses during shelling (1.5% of unshelled groundnuts).

Shells do not have a precise use, but from the information gathered during interviews it can potentially undergo to several destinations:

- It can be spread in the field as an organic input;
- it can be used as a feed for farm animals;
- it can be a reliable source of energy;
- it can simply be left on the ground near the houses where the shelling take place, at farmer home or in the markets.

In cases where shelling occurs in markets for large quantities of groundnuts there may be significant accumulations of organic material. Since in most cases shells are left on the ground and they can be considered as a soil improver and not a waste, it was decided to consider only the transport of shells to the field and to not to include a waste treatment for shell disposal. The LCI for shelling life cycle stage is reported in Table 35.

TABLE 35: LIFE CYCLE INVENTORY OF GROUNDNUT SHELLING FOR GROUNDNUT TYPE. ALL VALUES REFER TO 1 BAG OF UNSHELLED GROUNDNUTS.

INPUT	Unit	NASH	ASH	CF	Sources of data
Unshelled groundnuts at field gate	kg	65	65	65	Primary data
Electricity, produced in Ghana	kWh	0.184	0.184	0.184	Primary data
Transport of unshelled groundnuts from local villages (small lorry, max 3.3 t)	tkm	1.04	0.39	0.39	Primary data
Transport of unshelled groundnuts from market (lorry, 7.5-16 t, euro 3)	tkm	2.6	3.9	7.8	Primary data
Transport of unshelled groundnuts from farm to Accra (lorry > 32 t, euro 3)	tkm	0	0	3.9	Primary data
Transport of shell to field (small lorry, max 3.3 t)	tkm	0.069	0.059	0.059	Primary data
OUTPUT	**Unit**	**NASH**	**ASH**	**CF**	
Shelled groundnuts	kg	30.5	35.8	35.8	Primary data
Shell **and loss of grain**	kg	34.5	29.2	29.2	Primary data

After shelling, groundnut grain needs to be sorted to discard cracked grains, the ones affected by mould or attacked by insects. Sorting is done manually by groups of women who generally work for an aggregator, a wholesaler or a processor or they can offer this service for companies that need it. Therefore, sorting does not involve the use of material or energy input, but it influences in a decisive way the amount of groundnuts that can continue to the processing stage. Groundnut

quality, storage conditions and also sheller quality can influence the quality of groundnuts that is sorted.

Through interviews in the markets to the groups of women who make the sorting and to several processors that ask for sorting as a service, it was possible to hypothesize that rejected groundnuts are about 5-10%, including in this percentage 1.5% of grain loss.

Groundnuts that are discarded may have different uses. A part with an intermediate quality characteristic (grade 2 or 3) can still be used for other groundnut-based food products, while the rest, characterized by worse quality is generally destined for animal feed. This destination is ordinarily used despite Research Institutes on groundnuts and MoFA officials do not recommend it to avoid the re-introduction of groundnuts contaminated by aflatoxin in the food chain through the consumption of the meat of livestock. Both grade 2 groundnut and those destined to feed have an economic value, so an allocation based on mass was necessary. The LCI for sorting life cycle stage is reported in Table 36.

TABLE 36: PERCENTAGE OF REJECTED GROUNDNUT AT SORTING DEPENDING ON GN SOURCE AND PRODUCT DESTINATION.

Value chain	Product	NASH	ASH	CF
Informal/artisanal	GN snack	10	5	
	Paste	10	5	
	Kulikuli	10	5	
	Oil	10	5	
	Flour	10	5	
Formal/SME	Paste (small enterprise)		10	10
	Paste (medium enterprise)		10	10

5.7.1.3 Electricity production

Within this study, the production of electricity used in the value chain has been modelled and used in replacement of the process available from the Ecoinvent database (Electricity, high voltage {GH}| market for electricity, high voltage | Cut-off) which was last updated in 2014. In recent years, in Ghana, there has been an important reduction in the energy produced by the hydroelectric power and an increase in thermal energy (Energy Commission in Ghana, 2018) (Figure 27), for this reason it was decided to update the process with the percentages to 2017, taken from the National Energy Statistics 2018 (Energy Commission of Ghana, 2018) (Table 37).

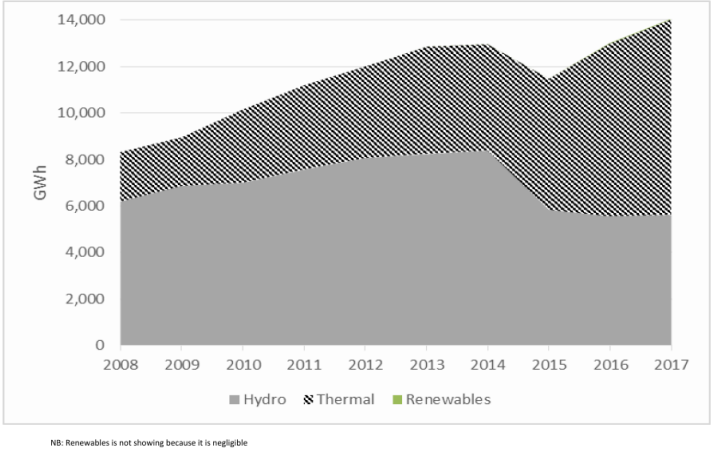

FIGURE 27: RECENT TREND IN GRID ELECTRICITY GENERATION.

TABLE 37: INSTALLED GRID ELECTRICITY GENERATION CAPACITY IN GHANA IN 2017

	Installed	Dependable	Installed	Dependable
	MW	MW	%	%
Hydro	1580	1380	36	35
Thermal	2796	2568	64	65
Renewables	23	18	1	0

The fraction produced from thermal energy was composed by 60% from natural gas and 5% from light oil, according to the information provided by the Director of Public Utilities Regulatory Commission (PURC), met in Accra. The transformation from high voltage to low voltage electricity and the distribution losses in the grid cause an overall loss equal to 22.4%, so that 1.224 kWh of high voltage electricity are necessary to have 1 kWh of low voltage electricity (Indexmundi, 2018). The average price of 1 kWh for a non-residential user is about 2 GHS, considering different tariff categories and including fixed costs. This information is necessary as the electricity consumption is always provided by the processors in economic terms and not in kWh.

5.7.1.4 Roasting

After sorting, groundnuts are roasted for the processing of all products. There are different ways to roast groundnuts, ranging from an almost household level to an industrial level[1]. Four main types are listed below:

1. a wok type utensil for roasting 1-5 kg of sorted groundnuts. It is used at very small level or at household level, using wood or more often charcoal;
2. a rotary drum mounted on an axle with a handle to rotate the drum. It is widely used by group of women who work on shelling/sorting/roasting groundnuts. It can roast a batch of 20 to 40 kg of groundnuts in a time and it is fed by firewood;
3. rotary drums, of different sizes, that is fed by electricity for rotating and with firewood for the heat production;
4. industrial roaster, fed by natural gas and electricity.

In this study were included the last three methods of roasting groundnuts, considering that the first one is used only at a very small level.

The roasting based on the use of a rotary drum, rotated manually, is largely the most used and it is considered the one used for all groundnut-based artisanal products (paste, roasted, kulikuli, oil and flour). It was possible to gather information directly from the groundnut roasting companies and on the basis of the data collected it was possible to estimate inputs and outputs of this life cycle stage of production.

The most difficult aspect in the roasting life cycle stage was to quantify the amount of wood used per kg of groundnuts since processors do not know the amount in terms of mass but only in economic value. From a processor located in Tamale, able to quantify more precisely her consumptions, it has been possible to estimate firewood consumption. She is processing about 6 bags of shelled groundnuts in a month that is equal to 552 kg of shelled groundnuts and reporting a consumption of a full Motorking of firewood in a month. It was possible to estimate roughly that a motorking corresponds to about 210 kg of firewood thanks to a visit to a wood market in Tamale. In the market, we tried to measure the amount of firewood that can fit in a Motorking, using a portable scale, and economic value was registered. Thus, it was possible to calculate that there is a consumption of 0.38 kg of firewood for roasting for each kg of raw groundnuts. This value was compared to other data registered in other interviews and what emerges is that this value can vary greatly depending on the processor and the cost of wood in the different cities and markets.

The rotary drum feed by electricity and firewood is not very widespread and from the information collected we can assume that it is used by a maximum of 25% of processors. We have the opportunity to visit one company in Wa (Savannah Food and Buyer) that provide the service of roasting for groundnuts and soybean. They have two roasters, one vertical and one horizontal (faster), powered by electricity for the rotary movement and by firewood for the heat. These roasters are able to process 3 bags of 50 kg in one time, and the roasting process takes 45 minutes. The estimated amount of firewood consumed for one batch was of 20 kg, so the firewood consumption is 0.13 kg firewood per kg of groundnuts. It was not possible to collect information about the electricity consumption, so assuming that the power of the roasters is 1 kW, the roaster would consume 0.75 kWh per one batch, that is 0.005 kWh / kg groundnut.

The industrial roaster fed by natural gas was part of the processing facilities of Samba Foods Limited located in Tema, an industrial food processing company that produce groundnut paste and it is the reference for ME Paste. It is estimated that in Ghana there are at the most other 18 food processing companies similar to Samba Food in terms of size and amount of groundnut processed. This company processes about 26 t of raw groundnuts in a month and it uses about 10 cylinders of 45 kg of natural gas to roast them. There is also a consumption to rotate groundnuts, but it was not possible to extract it from the overall electricity consumption that is need also for grinding.

During roasting, groundnuts lose their residual moisture after storage and therefore a weight loss of 8% was estimated. The LCI for roasting of artisanal, formal SME processors is reported in Table 38.

TABLE 38: LIFE CYCLE INVENTORY OF GROUNDNUT SORTING FOR GROUNDNUT TYPE. ALL VALUES REFER TO 1 BAG OF SHELLED GROUNDNUTS.

INPUT	Unit	artisanal roaster	semi-industrial roaster	industrial roaster	Sources of data
Sorted groundnut	kg	100.0	100.0	100.0	Primary data
Firewood	kg	38.0	13.3		Primary data
Electricity	kWh		0.5		Primary data
Natural gas	MJ			82.8	Primary data
Transport of firewood	tkm	1.9	0.7		Primary data
Transport of natural gas	tkm			2.3	Primary data
OUTPUT	Unit	artisanal	semi-industrial	industrial	
Roasted groundnut	kg	92.0	92.0	92.0	Primary data

5.7.2 Firewood production and its impact on land use change

Fuelwood constitute one of the main energy sources in Ghana, being biomass the 41% of total primary energy supply (Energy Commissions of Ghana, 2018; Obiri et al., 2014). About 69% of all urban households in Ghana use charcoal for cooking and heating and the annual per capita consumption is around 180 kg. The total annual consumption is about 700,000 tons, 30% of which is consumed in the capital, Accra. Firewood and charcoal production are concentrated in the Transition Zones between the forest and the woody savannah. Most of the wood comes from savannah trees, which are felled for this purpose, and also from logging residues. It has been estimated that of the total round wood production in Ghana, 91% is used as firewood and for charcoal, while the remaining (9%) is used as industrial round wood (FAO, 2018).

As reported in section 1.2.4, deforestation and forest degradation are important environmental issues in Ghana, linked both to fuelwood production and to expansion of agricultural lands. In agreement with our main assumption on this issue, we loaded the environmental burden of deforestation, namely land use change, to fuelwood, and in particular to firewood, that is a fundamental energy source in the groundnut value chain, especially for the roasting life cycle stage, as explained above.

The process of firewood production and use includes the operation of tree cutting and felling with the use of a chainsaw feed by petrol and the transport of wood to the nearest wood market, at an average distance of 50 km. It was estimated that the wood is cut in woody savannah, close to villages or in the secondary or degraded forest and not in the primary forest, as this activity is illegal in Ghana and many areas of primary forest are protected reserves.

We consider that only the 50% of the woody biomass of one hectare of woody savannah was cut, since we know from interviews that bigger trees and trees with an economic value (shea tree) are not cut. This hypothesis is supported by the fact that agricultural fields in Northern Ghana usually include many trees, with the crops sown among the trees, close to an agroforestry system.
The land use change caused by trees cutting was modelled including in the inputs two land transformation flows, included in the ReCiPe 2016 method:

- Transformation, from forest, secondary (non-use)
- Transformation, to shrub land, sclerophyllous

The flow "Transformation, to shrub land, sclerophyllous" does not correspond exactly to a field with trees, but it is the closest land use change flow that was available in the ReCiPe 2016 method. The land subjected to land use change was calculated considering that half of one hectare was subjected to land use change (5000 m^2) and that in that area there is a production of wet wood equal to 87.6 t. Diving the area for the amount of wood the amount of area necessary for 1 kg of wet wood is obtained (0.057 m^2 kg^{-1}).
For the accounting of carbon loss due to land use change, reference was made to the Net Primary Production (NPP) of the Woody Savannah. Measured data on the carbon stock of Woody Savannah in Ghana are from a recent paper published with the collaboration of researcher of the Forestry Research Institute of Ghana, Council for Scientific and Industrial Research, Kumasi (FORIG-CSIR) (Moore et al., 2018). The methodology used for the accounting of the emissions to environment related to land use change for firewood production is reported in Annex 8.3.

Summarizing, the calculated carbon loss of firewood includes the carbon contained in wood plus the carbon loss of soil due to land use transformation (Table 39).

TABLE 39: CARBON LOSSES AND CO_2 EMISSIONS OF 1 KG OF WOOD DUE TO LAND USE CHANGE AND WOOD COMBUSTION.

Source	kg C kg^{-1} wood	kg CO_2 kg^{-1} wood
Land use change	0.071	0.262
Wood combustion	0.342	1.256
Total emissions	0.414	1.517

The LCI of firewood cutting and combustion is reported in Table 40.

TABLE 40: LIFE CYCLE INVENTORY OF FIREWOOD PRODUCTION AND COMBUSTION. FU: 1 KG OF FIREWOOD.

INPUT /Output	Unit	value	Sources of data
Wood, feedstock	kg	1	Primary data
Chainsaw use, hand felling	hr	0.0000986	Estimated from literature

INPUT /Output	Unit	value	Sources of data
Transport from the forest to the wood market (lorry 22 t euro 0-4)	tkm	0.05	Average distance of 50 km was estimated
Transformation, from forest, secondary (non-use)	m^2	0.057	Calculated considering the productivity of woody savannah
Transformation, to shrub land, sclerophyllous	m^2	0.057	Calculated considering the productivity of woody savannah
OUTPUT	**Unit**	**value**	**Sources of data**
Firewood, at wood market	kg	1	
Emission of CO_2 due to land use change	kg	0.262	Estimated using data from Moore et al, 2018
Emission of CO_2 due to wood combustion	kg	1.256	Estimated using IPCC 2006 default values
Emission of CH_4 due to wood combustion	g	1.24	Estimated using IPCC 2006 default values
Emission of N_2O due to wood combustion	g	0.113	Estimated using IPCC 2006 default values
Emission of CO due to wood combustion	g	35.1	Estimated using emission factor from EMEP-EEA guideline
Emission of NO_2 due to wood combustion	g	0.678	Estimated using emission factor from EMEP-EEA guideline
NMVOC due to wood combustion	g	7.94	Estimated using emission factor from EMEP-EEA guideline
Emission of SOx due to wood combustion	g	0.146	Estimated using emission factor from EMEP-EEA guideline
Particulates, <10um due to wood combustion	g	11.1	Estimated using emission factor from EMEP-EEA guideline

5.7.3 Processing

From this point onwards, the different groundnut-based products undergo different type of processing and therefore the necessary information and calculations will be presented separately. A different origin of groundnuts has been hypothesized for artisanal products compared to SME products. For artisan products, it has been assumed that the origin is mainly from NASH farms

(80%) and to a lesser extent from the ASH farms (20%). For the two SME products, a greater contribution from ASH farms (57%) and a portion of the CF farms (3%) was assumed (Table 41).

TABLE 41: ORIGIN OF GROUNDNUTS, FARM TYPE, IN THE GROUNDNUT-BASED PRODUCTS.

Origin of groundnut, farm type (%)	Informal/Artisanal					Formal/SME	
	Roasted	Paste	Kulikuli	Oil	Flour	Paste SE	Paste ME
NASH	80	80	80	80	80		
ASH	20	20	20	20	20	71	71
CF	0	0	0	0	0	29	29

Formal/Artisanal products

- Snack (Roasted groundnuts)

Roasted groundnuts are a quite simple product since there is no other process after roasting. Roasted groundnuts, as showed in Table 8, are made from NASH and ASH groundnuts, and after roasting in the manual rotary drum are cooled to ambient temperature and packaged. Roasted groundnuts are usually commercialized in plastic bottle of 0.5 L (0.012 kg) and the packaging operation is done manually. The final product is a bottle of 0.33 kg of groundnuts (Figure 28).

FIGURE 28: ROASTED GROUNDNUTS IN PET BOTTLE OF 0.5 L.

We hypothesized a transport from processor to retailer of 30 km by small lorry, considering a local consumption of this kind of product. The LCI referred to 1 kg of roasted groundnuts is reported in Table 42.

TABLE 42: LIFE CYCLE INVENTORY OF 1 KG OF ROASTED GROUNDNUTS WITH PACKAGING.

INPUT	Unit	value
Roasted groundnuts	kg	1
PET bottle	kg	0.036
Transport of bottle (small lorry, 7.5 t, 0-4 euro)	tkm	0.0072
Transport to the retailer (small lorry, 7.5 t, 0-4 euro)	tkm	0.031
OUTPUT	Unit	value
1 bottle of roasted groundnut	kg	1.036

- Artisanal paste

Roasted groundnuts are processed with a fine grinding, generally including a part of skins. The grinding process is generally outsourced by processors that ask for this service to the closest mill. From a mill in the Mokaka market (Accra), we collect data to understand that the consumption to grind a bag of 92 kg of groundnuts is about 1.2 kWh, even if a big variability in consumption has been found (0.89 – 1.56 kWh/bag). The paste is then stored in a big bucket of about 30-50 kg and then it is sold in small amount of the value of 1 GHS (Figure 29).

FIGURE 29: ARTISANAL PASTE IN SMALL PLASTIC BAG OF 1 GHS AT RETAILER IN THE MARKET.

We hypothesized transport from processor to retailer of 30 km by small lorry, considering that this product is for very local consumption. The LCI referred to 1 kg of artisanal paste is reported in Table 43.

TABLE 43: LIFE CYCLE INVENTORY OF 1 KG OF GROUNDNUT PASTE AT RETAILER.

INPUT	Unit	value
Paste	kg	1
Plastic bag	g	10
Electricity for grinding	kWh	0.112
Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	tkm	2.0E-05
Transport to the retailer (Lorry 3-7 t, euro 3)	tkm	7.3E-02
Transport to the retailer (Lorry 7-16 t, euro 3)	tkm	1.8E-02
OUTPUT	Unit	value
Paste at retailer	kg	1.01

- Kulikuli

Roasted groundnuts are processed with a coarse grinding, generally including a part of skins. The grinding process is generally outsourced by processors that ask for this service to the closest mill. The same electricity consumption was considered for the grinding used also for the paste, as it was not possible to collect more detailed data. A manual extraction of oil is carried out from the grinded groundnuts. The groundnut dough is then moulded into the desired shape (round balls or rings). A part of the oil removed in the process is then heated and used to fry the shaped

groundnut dough until it solidifies. Kulikuli is then removed from the oil and allowed to cool down until ready to be packed in plastic bag (Figure 30).

FIGURE 30: KULIKULI PRODUCTION (LEFT) AND AT RETAILER IN THE MARKET IN PLASTIC BAG (RIGHT) IN WA.

The oil extraction process produces two products, groundnut dough and groundnut oil, on average 76% and 24%, respectively. Since the two products have comparable economic value the allocation was made by mass. It has been considered that all the produced kulikuli was sold locally, with an average distance from processor to retailer of 30 km. In Table 44 LCI of kulikuli was reported.

TABLE 44: LIFE CYCLE INVENTORY OF 1 KG OF KULIKULI AT RETAILER.

INPUT	Unit	value
Groundnut dough	kg	1
Groundnut oil for frying	kg	0.109
Electricity for grinding	kWh	0.083
Firewood for frying	kg	0.547
Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	tkm	4.00E-05
Transport of firewood (small lorry, 7.5 t, 0-4 euro)	tkm	0.028
Transport to retailer (small lorry, 7.5 t, 0-4 euro)	tkm	0.030
OUTPUT	Unit	value
Kulikuli at retailer	kg	1

- Artisanal groundnut oil

Groundnut oil comes from manual oil extraction of grinded groundnuts. On average oil is the 24% of the grinding output of 92 kg of roasted ground is possible to obtain 5 gallons of oil, equivalent to 22.5 L and 20.7 kg. Groundnut oil is then packed in plastic tank of 1 gallon (4.5 L) (Figure 31) and it is transported to retailer.

FIGURE 31: GROUNDNUT OIL IN PLASTIC TANK AT RETAILER.

Since packed oil can travel easily, it has been assumed that 80% of the oil is sold locally and 20% is sent to Accra. In Table 45 LCI of kulikuli was reported.

TABLE 45: LIFE CYCLE INVENTORY OF 1 KG OF GROUNDNUT OIL AT RETAILER.

INPUT	Unit	value
Groundnut oil	kg	1
Electricity for grinding	kWh	0.026
Plastic tank	kg	0.038
Transport of plastic tank (small lorry, 7.5 t, 0-4 euro)	tkm	2.28E-02
Transport to retailer (small lorry, 7.5 t, 0-4 euro)	tkm	0.017
Transport to retailer (Lorry, 7-16 t, 3 euro)	tkm	0.125
OUTPUT	Unit	value
Oil, at retailer	kg	1

- Artisanal flour

There are several types of groundnut flours in Ghana, some used to produce mixed flour for porridge (mixed with sorghum, maize, rice or millet flour) and another type make from the groundnut cake, after oil extraction, also known as kulikulisim, used as a condiment to flavour roasted meats. (Meng et al., 2017). The one to which this study refers is this last one. The cake obtained after oil extraction is dried and pulverized manually into flour (Figure 32), with a yield in flour of 95% of the cake. Flour is packed in plastic bag and then transported to retailer. It has been assumed that flour is transported for 40% to local retailers and 60% to Accra, since this product can be preserved for long time and it is very used in all the country.

FIGURE 32: GROUNDNUT FLOUR AT A PROCESSOR COOPERATIVE IN SAWELUGU.

In Table 46 LCI of groundnut flour was reported.

TABLE 46: LIFE CYCLE INVENTORY OF 1 KG OF GROUNDNUT FLOUR AT RETAILER.

INPUT	Unit	value
Groundnut cake	kg	1.05
Plastic bag	kg	0.003
Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	tkm	6.00E-05
Transport to retailer (small lorry, 7.5 t, 0-4 euro)	tkm	0.087
Transport to retailer (Lorry, 3-7 t, 3 euro)	tkm	0.298
OUTPUT	Unit	value
Groundnut flour at retailer	kg	1

Formal/SME products

- Paste produced in small enterprise (SE)

Data regarding the production of SE Paste were collected in 5 different processors, 1 in Tamale (Sima Essentials), 1 in Wa (Nsoroma), 2 in Bolgatanga (Good and Goodeness, Noyine Naturals) and 1 in Techiman (processor name Stella). A remarkable variability was found in the size of this type of processor, since it goes from processors slightly bigger than artisanal (about 100 kg groundnut in a month) to processors capable of processing important volumes of groundnut (about 2000 kg of groundnut in a month). We assumed that paste processors use shelled groundnuts from ASH (71%) and from CF (29%). From data collected in interviews we understand that they usually buy groundnuts from aggregators or at the market but sometime also from farmers to whom some of them provide the service for ploughing. The roasting is outsourced and generally they use firewood or charcoal, even if sometime processor can also have own roasters and ask only for workers. We assumed that this kind of processor can also afford the cost of more developed roasting facilities and we decide to model the roasting stage of SE paste using the roasting facilities fed both by wood and electricity (paragraph 2.1.4, roaster type 3). Roasted groundnuts are processed with a fine grinding, generally including a part of skins, and also this process can be outsourced, or processors can have own mill. We used the same consumption for grinding calculated for artisanal paste, since the machine is quite similar and no other information was available. The paste is then packet in several different format, one of the most used in the families, with a big size, is a bucket of 4.5 kg. This SE paste can be sold at processor shop or distribute to retailer, depending on the size of the processor (Figure 33).

FIGURE 33: PASTE PRODUCED IN A SMALL ENTERPRISE PACKED IN PLASTIC BUCKET OF 4.5 KG GHS AT RETAILER.

We hypothesized an average transport from shelling to retailer of 370 km, 111 kg (30%) to local retailer by small lorry and 259 km (70%) to retailer in Accra, considering that this product can be transported easily. The LCI referred to 1 kg of paste is reported in Table 47.

TABLE 47: LIFE CYCLE INVENTORY OF 1 KG OF SE PASTE AT RETAILER.

INPUT	Unit	Value
Roasted groundnut	kg	1.05
Electricity for grinding	kWh	0.01
Tap water	kg	0.28
Plastic bucket	g	40.00
Transport of plastic bucket	kgkm	27.00
Transport to the retailer (Lorry 3-7 t, euro 3)	kgkm	115
Transport to the retailer (Lorry 7-16 t, euro 3)	kgkm	269
OUTPUT		
1 kg of paste with packaging	kg	1.04

Paste produced in medium size enterprise (ME)

Data for the modelling of paste produced in medium size enterprise (ME) were collected at Samba Foods Limited, located in Tema, that is an industrial food processing company that produce groundnut paste. It is estimated that in Ghana there are at the most other 18 food processing companies similar to Samba Food in terms of size and amount of processed groundnuts.

Samba Food produces paste both for Ghanaian market and for export, mainly in United States and Brazil, even if they are experiencing big problems in finding good quality groundnuts, in particular referring to aflatoxin content, since they have to respect the aflatoxin limit (5 ppb for export). Samba Food processes about 26 t of shelled groundnuts in a month coming from Tamale for producing about 20 t of paste in the same period, with an average yield in paste of 77% of shelled groundnuts. They have an internal roaster feed by natural gas and electricity that uses 10 cylinder of 45 kg each of natural gas plus electricity. It was not possible to disaggregate electricity consumption for each process, they the company operation director has able to estimate an overall consumption for groundnut of 2-3000 kWh in a month, for roasting and grinding and about 30 m^3 of water to wash the machine. ME paste was packaged in many different formats, from 0.5 kg and 1 kg plastic bottle to 40 kg plastic bucket for national and international market.

We considered the transport from shelling to a national retailer with 900 km travelled, with 450 km (50%) to local market by small truck and 450 km (50%) to the north part of the country by big truck. The LCI referred to 1 kg of ME Paste is reported in Table 48.

TABLE 48: LIFE CYCLE INVENTORY OF 1 KG OF ME PASTE AT RETAILER.

INPUT	Unit	value
Shelled groundnut (ASH, CF)	kg	1.299
Electricity for roasting and grinding	kWh	0.064
Natural gas for roasting	MJ	1.075
Tap water	kg	1.525
Plastic bottle	g	12.000
Transport of groundnuts from Tamale	tkm	0.805
Transport of natural gas	tkm	0.029
Transport of plastic bottle	kgkm	0.240
Transport to the retailer (Lorry 3-7 t, euro 3)	tkm	0.455
Transport to the retailer (Lorry 7-16 t, euro 3)	tkm	0.455
OUTPUT	Unit	value
1 kg of paste with packaging at retailer	kg	1.012

Main data gaps and uncertainty in GN dataset

The main gaps and uncertainties of our dataset are as follows:

- Potential mistakes on primary data themselves given the lack of formal records for farm type, especially about groundnut yield;
- Potential underestimation of impacts due to no land use change loaded to land clearing before groundnut cultivation (all the impact is attributed to firewood production);
- The uncertainty due to the use of default emission factors for estimating field emissions and the emissions of phosphorus due to soil erosion;
- The uncertainty on input data for groundnut processors: amount of firewood used for roasting and frying and energy for grinding for artisanal and small processor; overall input consumption for large enterprise.
- The uncertainty of the losses of groundnut across the supply chains.

However, we do not expect these gaps to change drastically the main conclusions of our study, with a necessary exception in the case the land used for groundnut cultivation was obtained through deforestation. In Annex 8.3, the entire life cycle inventory of all the products is reported normalized for each functional unit (1 kg of groundnut product plus the packaging) and for life cycle stage.

5.8 EVALUATION OF ENVIRONMENTAL IMPACTS AND INTERPRETATION OF RESULTS

Environmental impacts of groundnut-based products are reported below for each impact category and area of protection. In Table 49 the acronyms used in the figures are reported.

TABLE 49: ACRONYMS USED FOR EACH IMPACT CATEGORIES.

Area of protection	Impact categories	Acronim
Human health (HH)	Global warming, Human health	GW, HH

	Stratospheric ozone depletion	SOD
	Ionizing radiation	IR
	Ozone formation, Human health	OF, HH
	Fine particulate matter formation	PM
	Human carcinogenic toxicity	HC_tox
	Human non-carcinogenic toxicity	HNC_tox
	Water consumption, Human health	WC, HH
Ecosystem quality (E)	Global warming, Terrestrial ecosystems	GW, TE
	Global warming, Freshwater ecosystems	GW, FE
	Ozone formation, Terrestrial ecosystems	OF, TE
	Terrestrial acidification	TA
	Freshwater eutrophication	FE
	Marine eutrophication	ME
	Terrestrial ecotoxicity	T_ecotox
	Freshwater ecotoxicity	F_ecotox
	Marine ecotoxicity	M_ecotox
	Land use	LU
	Water consumption, Terrestrial ecosystem	WC, TE
	Water consumption, Aquatic ecosystems	WC, AE
Resource depletion (R)	Mineral resource scarcity	MRS
	Fossil resource scarcity	FRS

5.8.1 Results on environmental impacts of groundnut cultivation

Groundnut cultivation has been modelled according to the three types of farms. Endpoint results are showed in terms of 1 ton of unshelled groundnuts at field gate for each impact category Figure 34) and in area of protection (Figure 35).

Groundnut cultivation affected mostly ecosystem quality among the three areas of protection with the 95.4% of the total impact, mainly due to land use and freshwater ecotoxicity. High land use is due to relatively low crop yields, which lead to high levels of land occupation, with decreasing values from NASH to ASH and CF farms. Impact of freshwater eutrophication was mainly due to soil erosion that has naturally high value in arable crops in Ghana, and not to phosphate fertilisers application. Indeed, phosphate fertilizer are applied at low rate only in ASH and CF. This is the reason why no differences are accounted in term of freshwater eutrophication impacts among the three farm types.

Impact on Human Health constitutes the 4.4% of total impact and it is mainly related to global warming, due to diesel burning in ploughing. The diesel consumption due to ploughing is the same for the three farms, so the decreasing impact from NASH to CF is due to increasing groundnut yield from NASH to CF. No other impacts are relevant for human health since no chemicals are used in NASH and very few in ASH and CF, as herbicides. Impacts on resource depletion are less than 0.1% of total impact, since very few material and energy are used in groundnut cultivation.

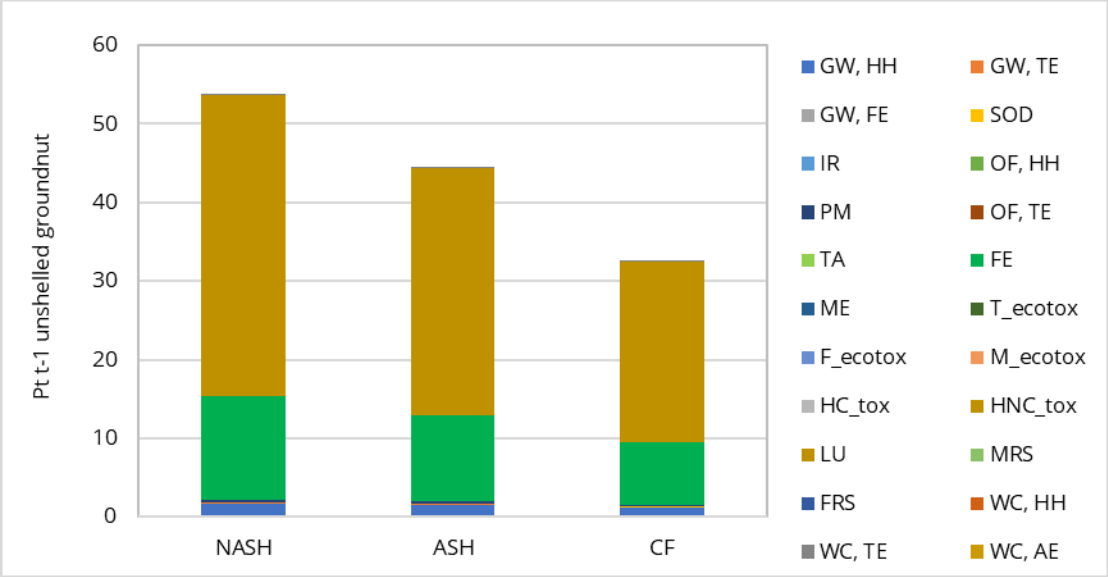

FIGURE 34: ENDPOINT IMPACT FOR IMPACT CATEGORIES OF 1 TON OF UNSHELLED GROUNDNUT AT FIELD GATE CULTIVATED IN NASH, ASH AND CF FARMS.

FIGURE 35: ENDPOINT IMPACT FOR AREAS OF PROTECTION OF 1 TON OF UNSHELLED GROUNDNUT AT FIELD GATE CULTIVATED IN NASH, ASH AND CF FARMS.

5.8.2 Results on environmental impacts of informal/artisanal value chain

The results of the 5 products of the artisanal value chain are reported below separately.

5.8.2.1 Snack (roasted groundnuts)

Endpoint indicator results of snacks are reported for life cycle stage in Figure 36 and 37, for impact categories and areas of protection, respectively.

Cultivation is responsible of the 79% of total impact, followed by roasting (9%) and transport (8%). The main impact categories in cultivation are land use (71%), freshwater eutrophication (25%) and global warming (3%), in agreement with the results showed above for groundnut cultivation. Roasting impact is due to global warming HH (590%) due to combustion of firewood and emissions related to land use change. Also land use is important (29%) due to deforestation for firewood

production. Even if roasted groundnuts are considered a product for local use, transport is an important life stage for impact of global warming and particulate matter, since groundnuts travelled a lot from the field to the retailer.

Very few impacts were observed for shelling and sorting stage and also for packaging.

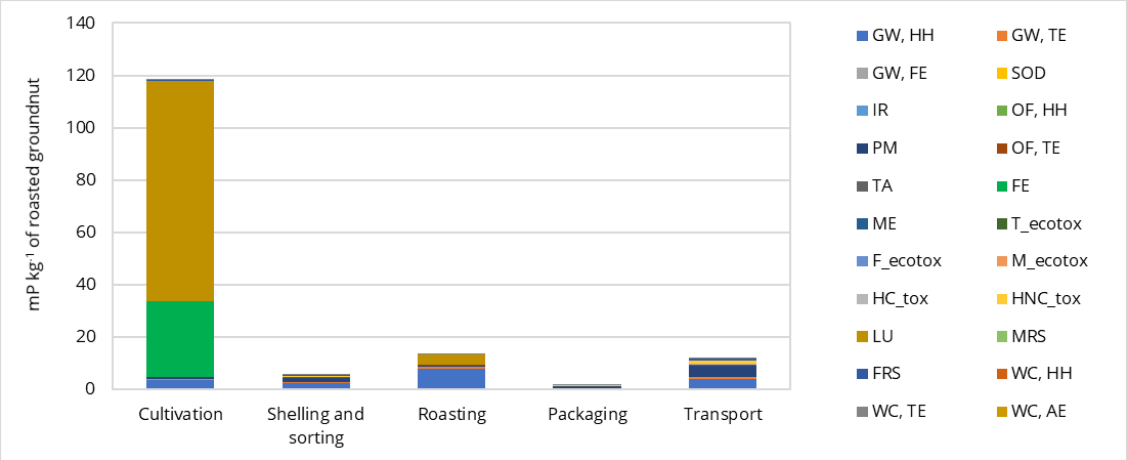

FIGURE 36: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF ROASTED GROUNDNUTS.

Overall, impact on ecosystem accounted for 80% of the impact and impact on human health for 19%, while impact on resource depletion was only 1%.

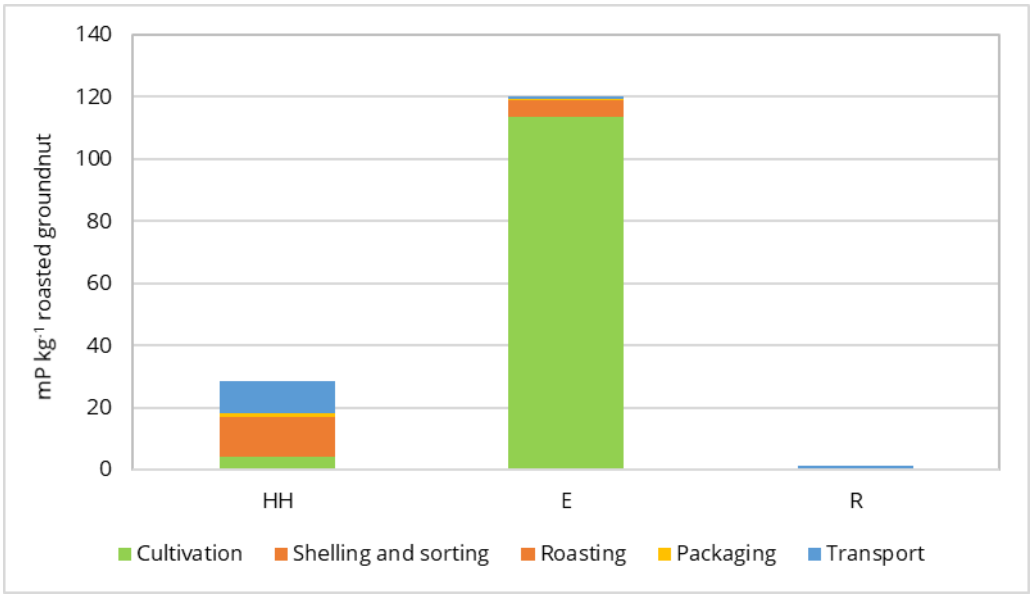

FIGURE 37: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF ROASTED GROUNDNUT.

3.3.2 Artisanal Paste

Endpoint indicator results of artisanal paste are reported for life cycle stage in Figure 38 and Figure 39, for impact and areas of protection, respectively.

Cultivation is responsible of the 79% of total impact, followed by roasting (9%) and transport (7%). The main impact categories in cultivation are the same reported above for the groundnut

cultivation. Even if artisanal paste is considered a product for local use, transport is an important life stage for global warming, particulate matter, since groundnut travelled a lot from the field to retailer. Roasting impact is due to global warming HH (59%) due to combustion of firewood and related emissions of land use change, as also to land use (29%), due to deforestation for firewood production. Very few impacts were observed for shelling and sorting, grinding and packaging stages.

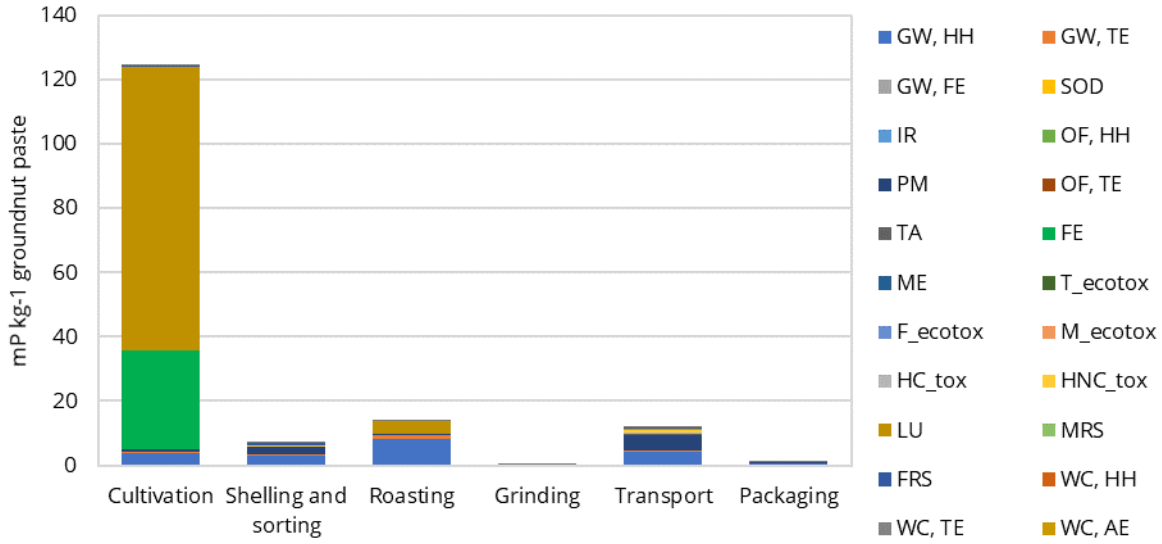

FIGURE 38: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF ARTISANAL PASTE.

Overall, impact of artisanal paste on ecosystem accounted for 82% of the impact and impact on human health for 18%, while impact on resource depletion was only 1%.

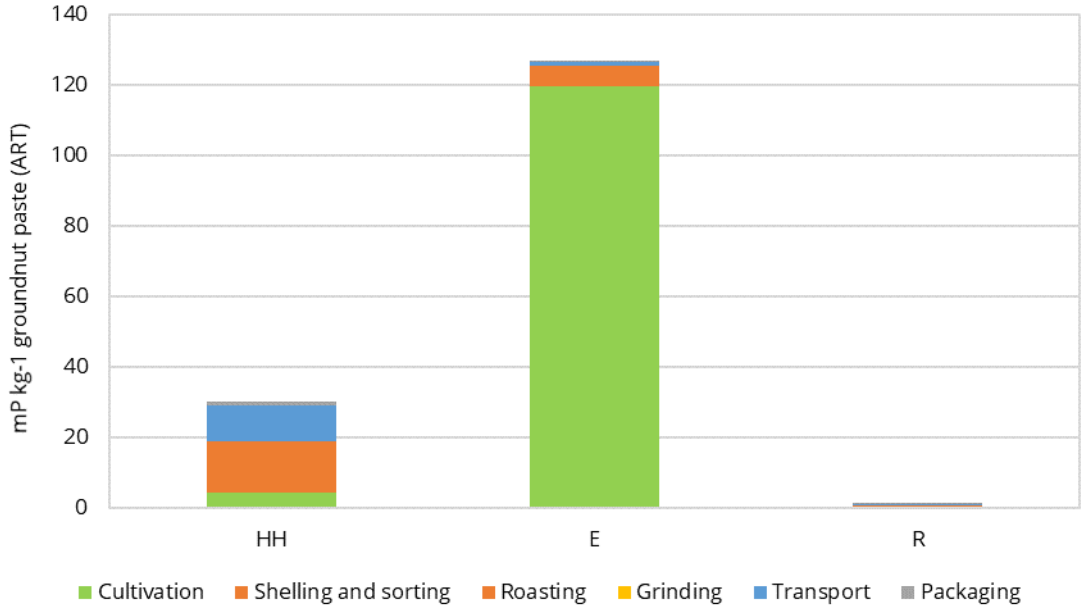

FIGURE 39: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF ARTISANAL PASTE.

3.3.2 Kulikuli

Endpoint indicator results of kulikuli are reported for life cycle stage in Figure 40 and 41, for impact and areas of protection, respectively.

Cultivation is responsible of the 70% of total impact, followed with similar values by transport (9%), frying (9%), roasting (8%). The main impact categories in cultivation are the same reported above for the groundnut cultivation (land use and freshwater eutrophication). As for the other artisanal products, transport is an important life stage for impact on particulate matter (38%), global warming (34%) and human toxicity non cancer (10%), since groundnuts travelled a lot from the field to the retailer. Roasting and frying impact is due to the combustion of firewood and related emissions of land use change, as also to land use due to deforestation for firewood production. Together roasting and frying accounted for the 63% of impact on global warming potential HH and 9% on land use, since 90% of this impact category is related to cultivation. Very few impacts were observed for shelling and sorting, grinding and packaging stages.

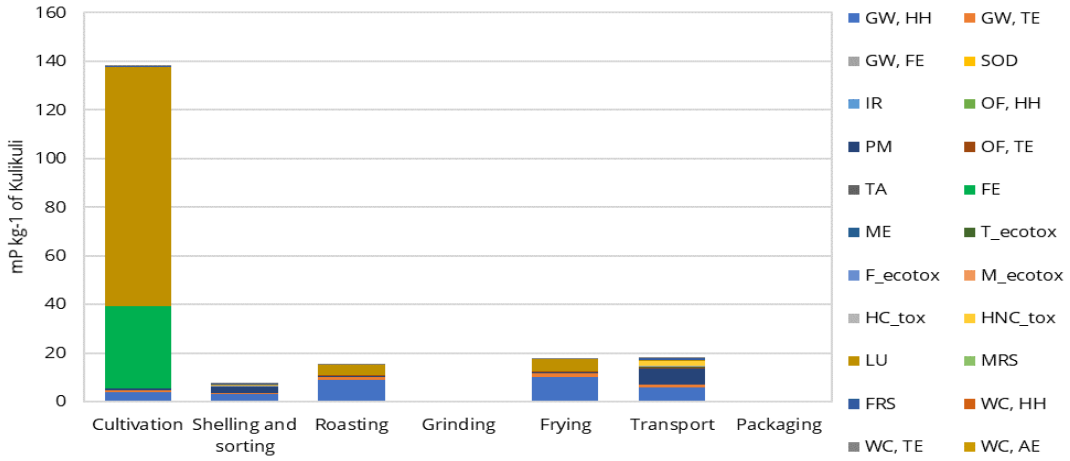

FIGURE 40: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF KULIKULI.

Overall, impact of kulikuli on ecosystem quality accounted for 75% of the impact and impact on human health for 24%, while impact on resource depletion was only 1%.

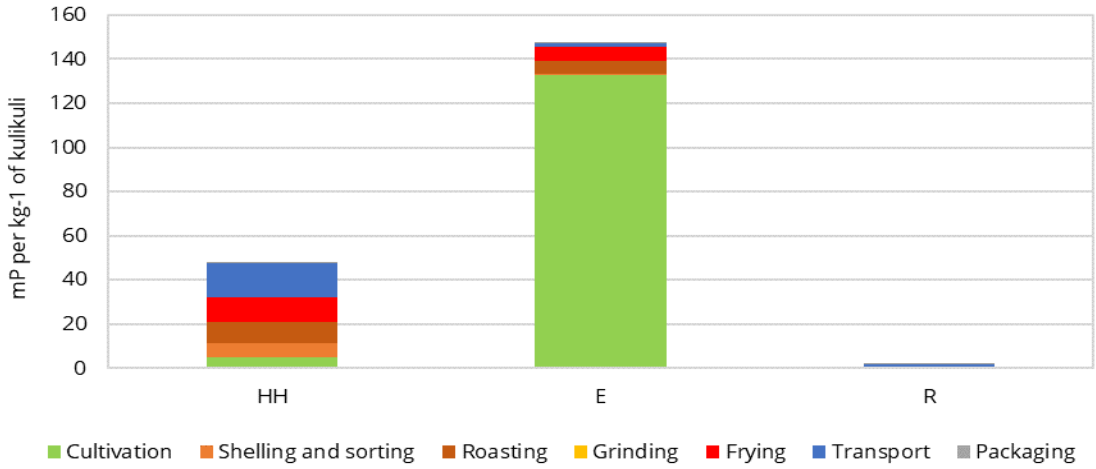

FIGURE 41: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF KULIKULI.

3.3.2 Groundnut oil

Endpoint indicator results of groundnut oil are reported for life cycle stage in Figure 42 and 43, for impact and areas of protection, respectively.

Cultivation is responsible of the 77% of total impact, followed with similar values by roasting (9%) and transport (8%). The main impact categories in cultivation are the same reported above for the groundnut cultivation (land use and freshwater eutrophication). Even for groundnut oil, transport is an important life stage for impact on particulate matter (39% of impacts of transport stage), global warming (35%) and human toxicity non cancer (9%), since groundnuts travelled a lot from the shelling to the retailer, and in particular from processor to retailer since this product can travel easily. Roasting impact is due, as for other products, to global warming and land use, for the combustion of firewood and related emissions of land use change.

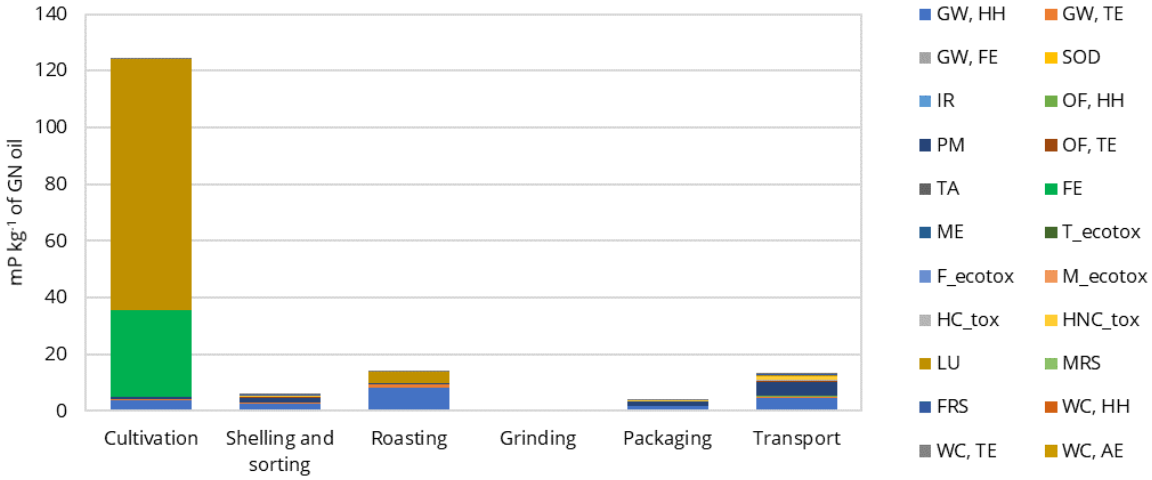

FIGURE 42: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF GROUNDNUT OIL.

Overall, impact of groundnut oil on ecosystem quality accounted for 79% of the impact and impact on human health for 20%, while impact on resource depletion was only 1%.

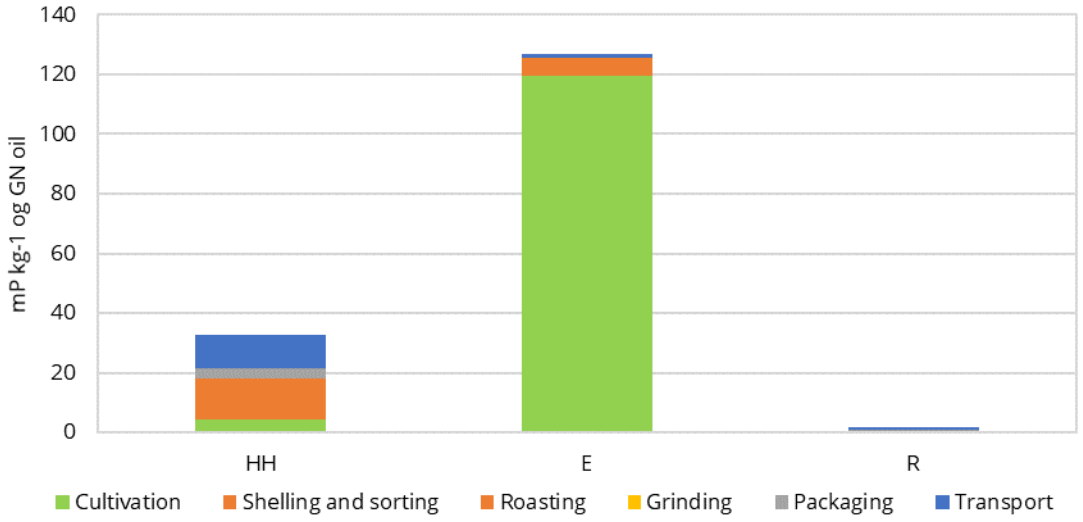

FIGURE 43: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF GROUNDNUT OIL.

3.3.2 Groundnut flour

Endpoint indicator results of groundnut oil are reported for life cycle stage in Figure 44 and 45, for impact and areas of protection, respectively.

Cultivation is responsible of the 73% of total impact, followed by transport (14%), roasting (8%). The main impact categories in cultivation are the same reported above for the groundnut cultivation (land use and freshwater eutrophication). Groundnut flour in plastic tank can travel easily, so transport is a life stage with significative impacts on human health, and in particular on particulate matter (38% of impacts of transport stage), global warming (35%) and human toxicity non cancer (11%), since groundnuts travelled a lot from processor to retailer. Roasting impact is due, as for other products, to global warming (59%) and land use (29%), for the combustion of firewood and related emissions of land use change.

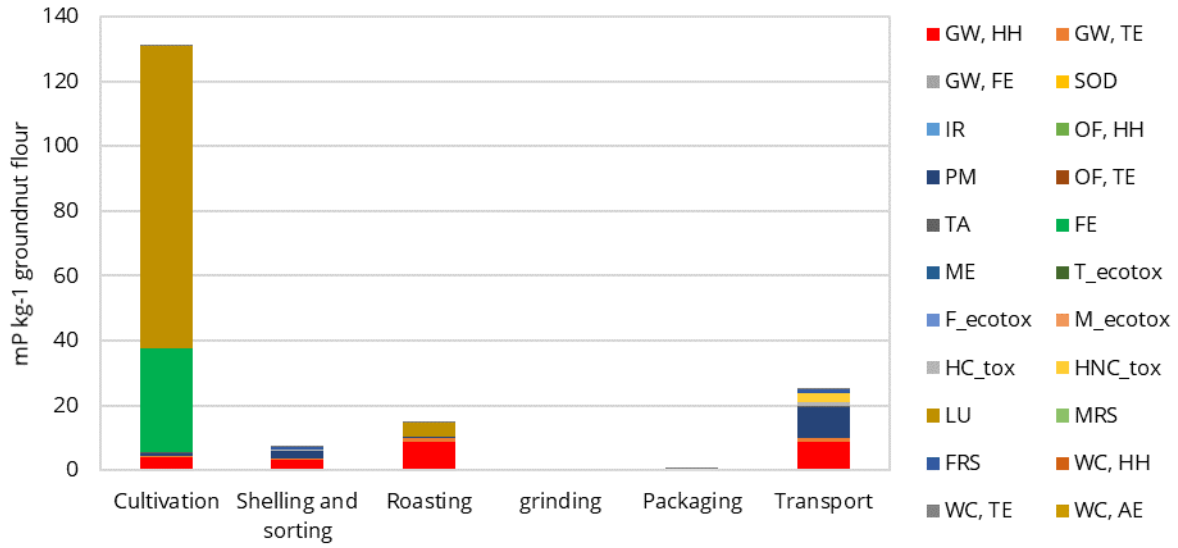

FIGURE 44: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF THE VALUE CHAIN OF 1 KG OF GROUNDNUT FLOUR.

Overall, impact of groundnut oil on ecosystem quality accounted for 75% of the impact and impact on human health for 24%, while impact on resource depletion was only 1%.

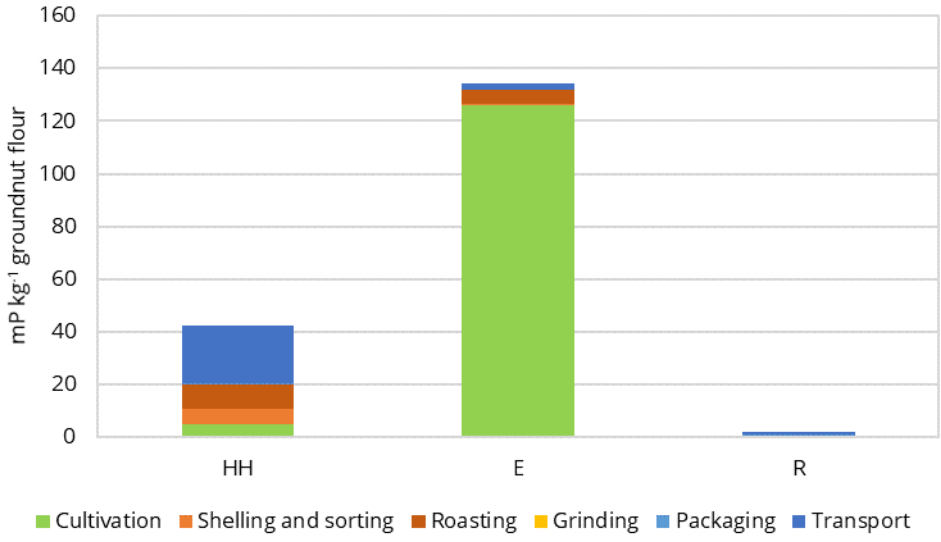

FIGURE 45: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF GROUNDNUT FLOUR.

5.8.3 Environmental impacts for formal SME value chain

3.4.1 SE Paste

Endpoint indicator results of SE paste are reported for life cycle stage in Figure 46 and 47, for impact and areas of protection, respectively.

Also, in SE paste it was observed a relevant impact of cultivation stage (58%), even if lower than in artisanal products, and secondarily for transport (31%). Cultivation was responsible even in this case of high impact on land use and freshwater eutrophication. Since SE paste can travel across all the country, transport registered high impact, in particular on particulate matter (41%) and in global warming (36%). In this case roasting was done using roasters fed by electricity and wood that had a lower impact compared to the one fed only by wood. Indeed, roasting of SE paste was responsible only of 11% of global warming while for artisanal product this value was on average 40%. Shelling/sorting, grinding and packaging showed also in this case very low impacts.

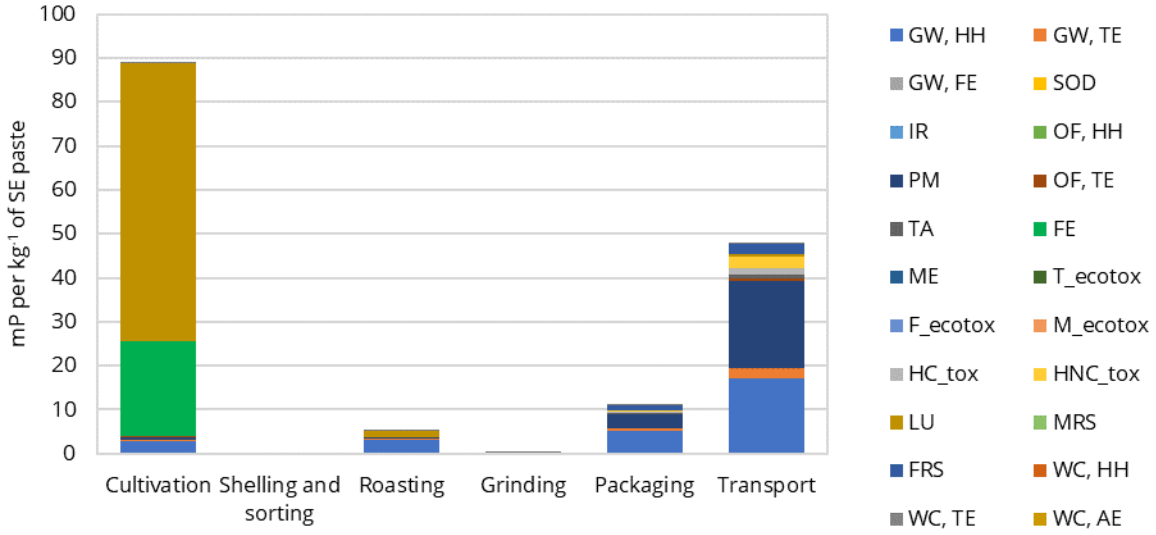

FIGURE 46: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF SE PASTE.

Overall, impact of SE paste on ecosystem quality accounted for 60% and on human health for 37%, while impact on resource depletion was only 1%.

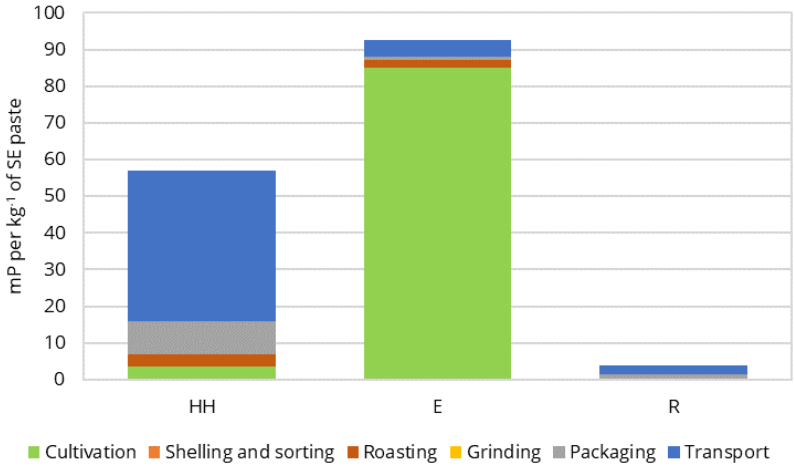

FIGURE 47: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF SE PASTE.

3.4.1 ME Paste

Endpoint indicator results of ME Paste are reported for life cycle stage in Figure 48 and Figure 49, for impact and areas of protection, respectively.

Cultivation (59%) and transport (35%) in ME paste were the life cycle stage with the higher impacts, as for ME paste. The impact of transport increased even more, since long distance travels

increased compared to short distance ones, but only within the national market. Conversely, processing that include also roasting had very low impacts (3%), even if it used more inputs (electricity, natural gas, water) than artisanal products and SE paste. Shelling/sorting and packaging had very low impacts.

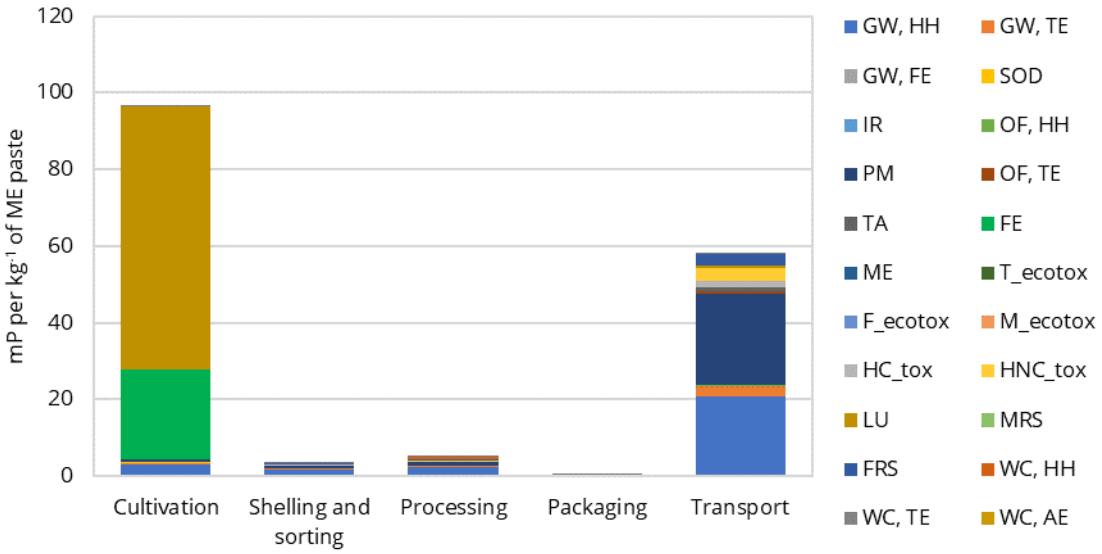

FIGURE 48: ENDPOINT IMPACT CATEGORIES FOR LIFE CYCLE STAGE OF 1 KG OF ME PASTE.

Overall, impact of ME paste on ecosystem quality accounted for 60% and on human health for 37%, while impact on resource depletion was only 2%.

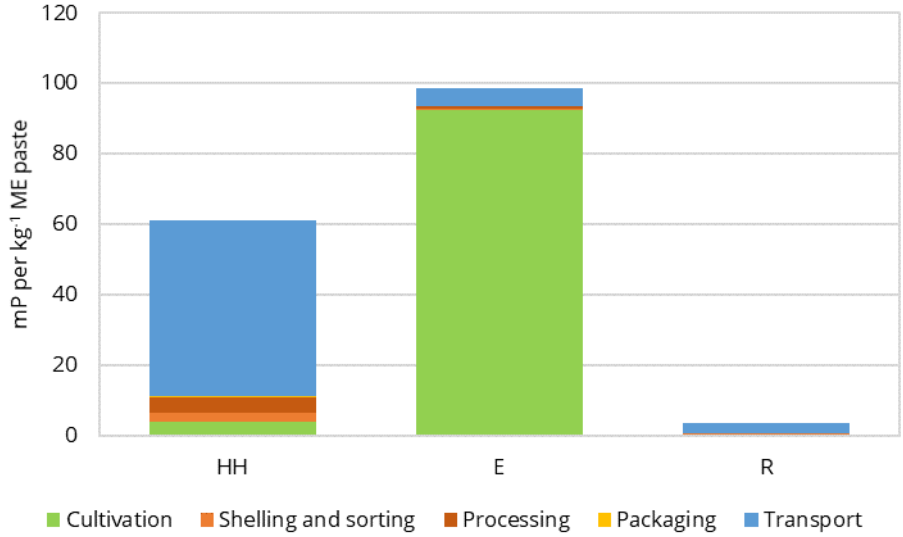

FIGURE49: ENDPOINT AREAS OF PROTECTION FOR LIFE CYCLE STAGE OF 1 KG OF ME PASTE.

5.8.4 Inter-comparison and benchmarking of groundnut value chains

Intercomparison among groundnut products

Overall, as it is possible to understand from Figure 50 and 51, which report the endpoint results by impact category of the products of the artisanal and formal SME sub-chains, there are no important differences in terms of environmental impacts between the two chains and, overall, between all products. Indeed, even if the efficiency of the value chain is higher both at cultivation,

shelling, sorting and processing, this partially compensate the higher requirement of inputs, both in term of energy and materials.

Land use is the main impact category in all products, both informal/artisanal and formal SME. In artisanal products land use (on average 57%) is followed by freshwater eutrophication (18%) and global warming (14%) while in formal SME products land use (on average 42%) is followed by global warming (18%), particulate matter (16%) and freshwater eutrophication (14%). The difference in global warming potential is mainly due to kulikuli, which uses about twice as much wood as all other products.

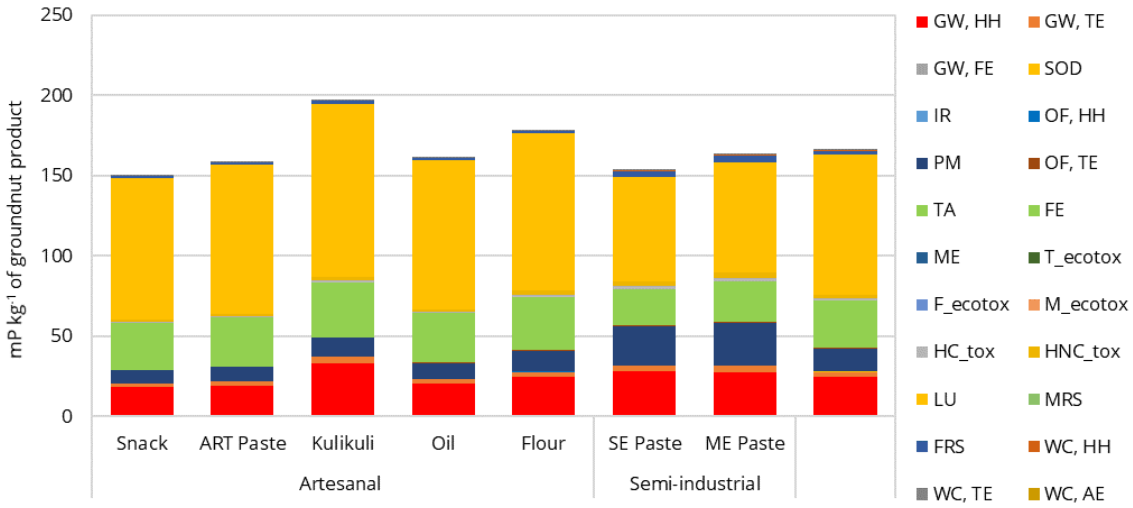

Figure 50: Endpoint impact categories 1 kg of artisanal products: roasted groundnut, ART paste, kulikuli, groundnut oil, groundnut flour; and formal SME product: SME paste, ME paste.

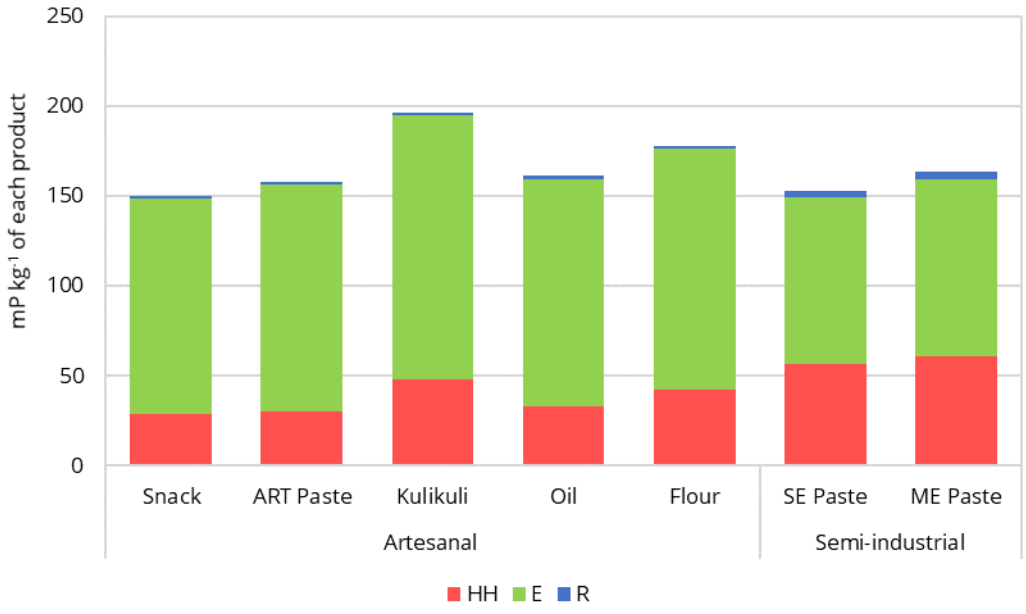

Figure 51: Endpoint areas of protection of 1 kg of artisanal products: roasted groundnut, ART paste, kulikuli, groundnut oil, groundnut flour; and formal SME product: SME paste, ME paste.

Comparison with other values from literature

We tried to compare the results obtained for products of groundnut value chain in Ghana with results from other LCA studies in the literature. We found very few studies on groundnut and referred almost only to the global warming impact category: two studies were about groundnut products (one referring to peanut butter in the USA and one on groundnut oil in India) (Table 21) and two on the groundnut cultivation in Iran (Table 50).

TABLE 50: COMPARISON OF GROUNDNUT LCA RESULTS WITH VALUES FOUND IN LITERATURE CONSIDERING THE SAME SYSTEM BOUNDARIES (FROM CRADLE TO RETAILER).

VC	Product	Country	Impact category	Value	Unit	Source
Informal/artisanal	Snack	Ghana	Global Warming Potential (GWP) (midpoint)	1.563	kg CO_2eq kg^{-1}	this study
	ART paste	Ghana	GWP (midpoint)	1.665	kg CO_2eq kg^{-1}	this study
	Kulikuli	Ghana	GWP (midpoint)	2.823	kg CO_2eq kg^{-1}	this study
	Oil	Ghana	GWP (midpoint)	1.771	kg CO_2eq kg^{-1}	this study
	Flour	Ghana	GWP (midpoint)	2.093	kg CO_2eq kg^{-1}	this study
Formal/SME	SE paste	Ghana	GWP (midpoint)	2.403	kg CO_2eq kg^{-1}	this study
	ME paste	Ghana	GWP (midpoint)	2.381	kg CO_2eq kg^{-1}	this study
	Peanut butter	USA	GWP	2.040	kg CO_2eq kg^{-1}	McCarty et al. 2014
	Groundnut oil (at refinery gate)	India	GWP	2.124	kg CO_2eq kg^{-1}	Schmidt et al, 2015

The values obtained in this study are quite close to the value found in the study on peanut butter and groundnut oil. Regarding the groundnut cultivation, we found two papers from Iran, testing different fertilizer rate. Value obtained from groundnut cultivation in Ghana, are quite low, due to the very low input use (fertilizer, pesticide, mechanical operation), even with lower yield, since in Iran the yield was from 1.6 to 3.5 t ha^{-1}.

TABLE 51: COMPARISON OF LCA RESULTS ON GROUNDNUT CULTIVATION WITH VALUES FOUNDED IN LITERATURE.

Product	Country	Impact category	Value	Unit	Source
NASH groundnuts	Ghana	GWP (midpoint)	137.3	kg CO_2eq t^{-1}	this study
ASH groundnuts	Ghana	GWP (midpoint)	123.0	kg CO_2eq t^{-1}	this study
CF groundnuts	Ghana	GWP (midpoint)	94.5	kg CO_2eq t^{-1}	this study
Groundnut cultivation	Iran	GWP	301-327	kg CO_2eq t^{-1}	Nikkha et al., 2015
Groundnut cultivation	Iran	GWP	340-370	kg CO_2eq t^{-1}	Noorhosseini et al, 2018

5.8.5 Scenario analysis with lower groundnut yield in NASH farms

A scenario analysis with lower groundnut yield in NASH farms was carried out to include a worst-case scenario. In this scenario groundnut yield of NASH farms was reduced from 1.3 t ha^{-1} to 0.8 t ha^{-1} (38%), and this has a clear impact on artisanal/informal products. Results for artisanal/informal products are reported in Figure 52. All products showed an increase in total impact on average of 33%, with the increase of impact on ecosystems due to higher land requirement per ton of groundnuts.

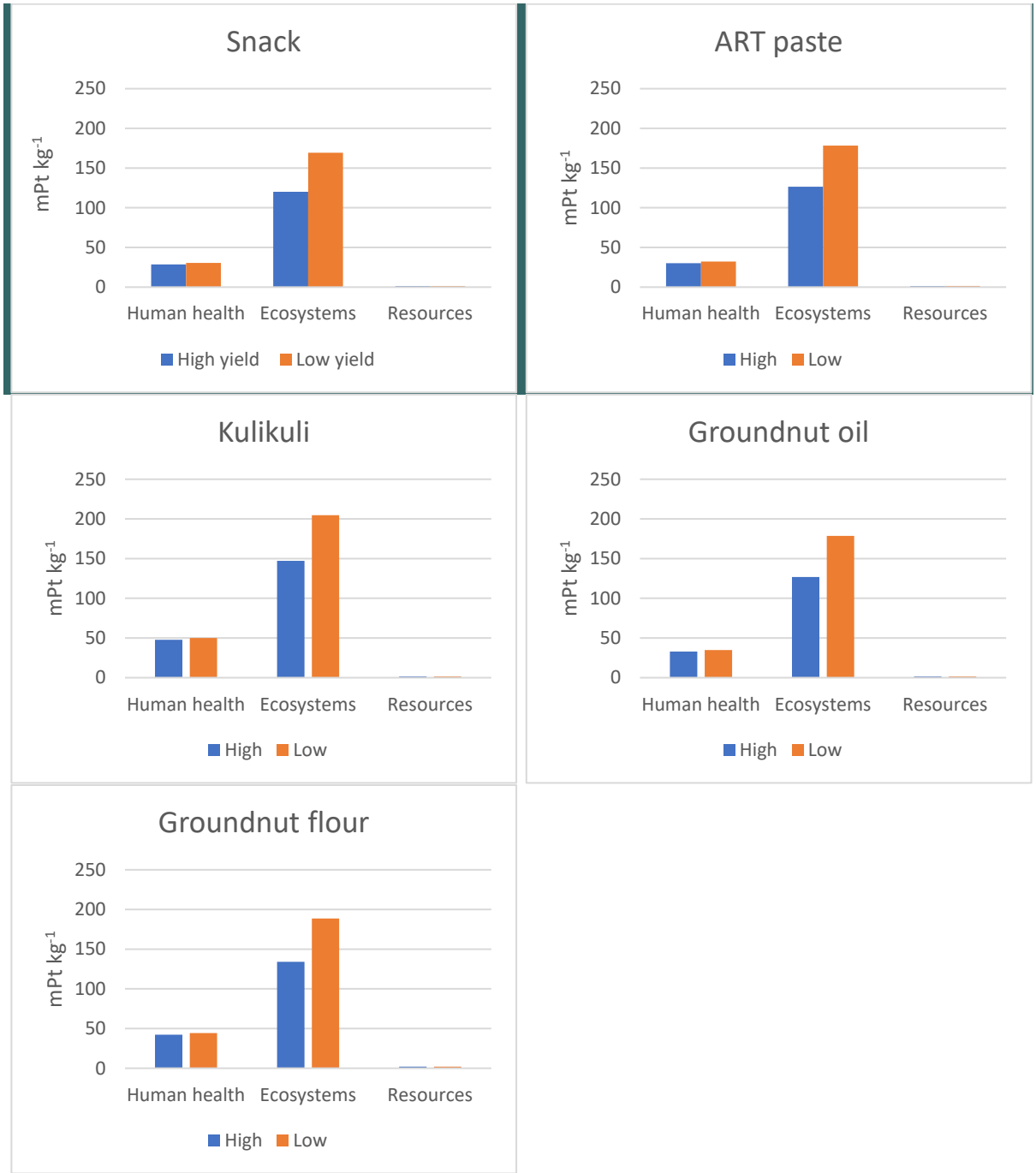

FIGURE 52: SCENARIO ANALYSIS CONSIDERING HIGH CROP YIELD (1.3 T HA^{-1}) AND LOW CROP YIELD (0.8 T HA^{-1}) FOR NASH FARM. RESULTS ARE REPORTED FOR ENDPOINT AREAS OF PROTECTION OF 1 KG OF ARTISANAL PRODUCT.

5.9 Conclusions of environmental analysis

Overall, there were no important differences in terms of environmental impacts between the two chains and between all products. For all the products, main impacts were due to Ecosystem quality and Human Health, while Resource depletion showed very low impact in all products.

The main impact categories contributing to Ecosystem quality were land use (73%) and freshwater eutrophication (24%), while for Human health the main categories were global warming (59%) and particulate matter (32%). The contribution of 5 life cycle stages revealed that cultivation had generally a major contribution, particularly in artisanal products, due to impact of land use and freshwater eutrophication. Shelling and sorting have low impact, even if can affect the value chain, since in these two phases there are important losses of groundnuts. Roasting is responsible for most of the impact due to climate change, since the land use change caused by firewood extraction was included in the firewood production. For kulikuli, the impact due to firewood is doubled since also the frying stage uses firewood. Conversely, for ME paste the roasting has a very low impact, since firewood is substituted by natural gas and electricity, that have a lower impact than firewood. For formal SME products, transports have a more important impact, contributing to Human Health (water consumption, global warming and fine particulate matter formation) and Ecosystem quality (global warming).

Although all systems have many margins of improvement, the substitution of roasting machines fed by firewood, (used for all products) with machines fed by electricity can have very positive consequence both for Human health and Ecosystem quality, contributing to the reduction of firewood consumption, then directly to forest degradation and deforestation, and to the improvement of working conditions.

Moreover, high land use of groundnut cultivation is due to relatively low crop yields, which lead to high levels of land occupation, decreasing from NASH to ASH and CF farms. Therefore, it is important to highlight that any improvement in crop yields would lead to a potential reduction in land use. In this regard, the adherence to the Good Agricultural Practices, such as use of improved seeds, use of adequate sowing density and fertilization can have a positive impact on yields. However, it is important to highlight that high land use is also due to the significative groundnut losses during the value chain, due to storage conditions, sheller type, overall quality of grain. Thus, it is fundamental to work on reducing the groundnut losses to effectively reduce the land occupation.

6. Conclusion

6.1 Functional Analysis

In addition to the domestic production of 420,000 tonnes of unshelled groundnuts (or about 200,000 tonnes of shelled GN), there are imports from neighbouring ECOWAS countries of 34,000 tonnes.

Farmers are grouped into non-aggregator linked smallholder farmers, who represent the bulk of the production; aggregator-linked smallholders, and commercial farmers, abbreviated as NASH, ASH, and CF.

Traders include aggregators, wholesalers, and retailers. Whilst aggregators tend to operate at a medium-scale mostly in groundnut producing areas of Northern Ghana, wholesalers would transport substantial quantities of groundnuts to Southern Ghana and sell them in urban centres such as Accra or Kumasi. The majority of retailers operate in the informal sector, selling products such as groundnut paste or snacks. Formal sector outlets include supermarkets, marts, and exports.

Processing of groundnuts mostly takes place in the informal sector by artisanal enterprises producing groundnut paste, snacks, kulikuli, flour, oil, and other products. Observations and fieldwork have shown that many enterprises operate using manual or strenuous technologies (e.g. sorting and roasting of groundnuts). Whilst this may reduce waged labour opportunities in the sector, the recommendations include further mechanisation of the value chain, also to make better use of the existing opportunities in the value chain.

6.2 Economic analysis

The economic analysis of the groundnuts value chain shows that it is an important contributor to the agricultural GDP. Not only form groundnuts part of the daily diet of Ghanaians, the value chain is also an important provider in terms of income and employment.

Analyses have shown that the value chain is sustainable in that the main agents in the chain make a profit, i.e. farmers (grouped into non-aggregator linked smallholder farmers, who represent the bulk of the production; aggregator-linked smallholders, and commercial farmers, abbreviated as NASH, ASH, and CF). If yields of 800 kg/ha are considered in NASH farms (i.e. sensitivity case), the profit would still be positive for NASH farmers.

Overall, the groundnut value chain contributes GHS 2.7 billion of production and GHS 2.38 billion in the form of value added. Net operating profits (NOP) represent GHS 1.6 billion (including the remuneration of many small-scale producers, processors, traders, and their family members), whereas wages for hired workers contribute GHS 466 million. NASH farmers, informal retailers and informal processors of paste and snacks/roasted groundnuts are the main contributors to VA creation (39%, 20%, 14%). Net operating profits constitute the main element of value addition created by the VC (mainly reflecting the income of the large number of self-employed, small-scale entrepreneurs in the value chain), followed by wages for workers employed as part or full-time workers in production, processing, and trading of groundnuts. A DRC of 0.28 indicates that the value chain is viable within the global economy with a DRC ratio less than 1 (0.28). There are about 293,000 to 439,000 entrepreneurs/owners (producers, processors and traders) and about 310,000 workers, meaning that about 650,000 to 800,000 peoples' livelihoods in Ghana are dependent on

groundnut production. The number of producers is higher if a yield of 800kg/ha is assumed in the case of NASH farmers (sensitivity case scenario), resulting in about 608,000 NASH farmers (rather than 374,000 NASH farmers in the standard case scenario).

Imports in the value chain represent GHS 283 million (in the form of shelled groundnuts but also production inputs), and further measures are required to stimulate production and value addition in the chain. Recommendations in this respect are made below.

6.3 Social analysis

We estimate that about 90 percent of all actors and workers in the value chain are women. This suggest that any initiative for value chain upgradation has significant likelihood of benefitting women and consequently health, education and food and nutrition security of large number of families in Ghana. The study also uncovered areas where 'inclusivity' of the value chain can be improved:

- There are three main risks related to 'working conditions' of workers in the value chain. Firstly, key occupational health and safety risk in the value chain are observed at the processing segment. As women are the main workers at processing sites, they could be potential target for occupational harm due to excessive heat and smoke in the spaces where they work. Roasting technologies /equipment demand urgent review and up-gradation. Collaboration with Rural Enterprise Programme (REP) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in Groundnut. Secondly, groundnut producers and workers throughout the value chain are only able to earn about 15 to 20 percent of the living wage benchmark from their groundnut production. There is a significant potential to increase returns of producers and workers if right conditions are developed. Thirdly, most workers in the VC have no full-time /permanent employment. Most are working on temporary work, which is paid on a daily or weekly basis. Most workers have no benefits except the daily wages. To ameliorate this situation, the study analysis suggest that certain parts of the value chain could be targeted by incentivising 'collectivisation /formalisation' which can then lead to better wages for the workers.
- Groundnut value chain development needs to avoid policy-pitfalls and regulatory shortcomings experienced by other value chains in the country. The VC needs to capitalise on promising business models such as the ones being developed by MADE (DFID funded) and MOAP (GiZ and EU co-funded) projects which could potentially provide an alternative to large-scale land acquisition by 'non-natives'.
- Women's access to resources and services are not commensurate to their economic role in the VC. This indicates gender-disparity in access to land and non-land assets as well as assistance and services from government /NGOs.
- The challenge remains of promoting increased women's participation and leadership roles in various groupings as currently it is very limited.
- Reduction in per capita production of food locally is a cause for concern. Another risk factor is a decreased per capital production of millets, sorghum and groundnut, leading to higher imports from neighbouring countries. This represents a drain on the exchequer and reduces nutrition-sensitive behaviours on dietary patterns.
- Aflatoxin residues in groundnut products across the value chain represent a serious food safety and health risk to the Ghanaian population. Lower awareness of the risk across the value chain is in itself a greater risk as 'ignorance' can lead to higher exposure to contaminated groundnut products for human and animals, leading to severe negative consequences across the food chain.

Overall, the Groundnut value chain is showing signs of exemplary pro-women, pro-poor and pro-youth value chain development. However, as highlighted above, many constraints need to be addressed for inclusive and sustainable expansion of the groundnut sector in Ghana, for which a very large potential exist as it is evident from experiences of other countries (Senegal, The Gambia and Nigeria) in West Africa.

6.4 Environmental analysis

To answer to the three questions asked by DEVCO regarding the environmental impacts of groundnut value chains in Ghana on the three areas of protection, Human health, Ecosystem quality and Resource depletion, an up-to-date LCA study was done for the two main groundnut value chains in Ghana: artisanal VC and formal SME VC.

Groundnut products were evaluated from cradle-to-retailer gate in the national market. The results were expressed per 1 kg of each product, plus packaging, at retailer. The life cycle of the products consisted of 5 main stages: 1) agricultural production (cradle-to-farm-gate); 2) shelling and sorting including transport from field to shelling; 3) processing into paste, roasted, kulikuli, oil and flour; 4) packaging; 5) transport to retailer. Three farm systems were identified considering the size and the organization of farmers: non aggregator-based smallholders (NASH) farm, aggregator-based smallholders (ASH) farm, commercial farms (CF).

The environmental inventory was based on data collected in two field missions in Ghana and on the data collected with the survey carried out by national experts on 48 farms and 29 processors in 5 regions. However, a full representativeness for the two value chains and 7 products cannot be claimed for such a small sample of farms and processor, particularly for the formal SME value chain.

An endpoint assessment of the impacts in each area of protection was carried out with the ReCiPe 2016 method. Overall, there were no important differences in terms of environmental impacts between the two chains and overall between all products. For all the products, main impacts are due to Ecosystem quality and Human Health, while Resource depletion showed very low impact in all products.

The main impact categories contributing to Ecosystem quality were land use (73%) and freshwater eutrophication (24%), while for Human health the main categories were global warming (59%) and particulate matter (32%). Regarding Resource depletion, fossil fuel scarcity covered the 99.5% of the impact.

The contribution of 5 life cycle stages revealed that cultivation had generally a major contribution, particularly in artisanal products, due to impact of land use and freshwater eutrophication. Shelling and sorting have low impact, even if can affect the value chain, since in these two phases there are important losses of groundnuts. Roasting is responsible for most of the impact due to climate change, since the land use change caused by firewood extraction was included in the firewood production. For kulikuli, the impact due to firewood is doubled since also the frying stage uses firewood. Conversely, for ME paste the roasting has a very low impact, since firewood is substituted by natural gas and electricity, that have a lower impact than firewood.

For formal SME products, transports have a more important impact, contributing to Human Health (water consumption, global warming and fine particulate matter formation) and Ecosystem quality (global warming).

Global Warming Potential in kg CO_2-eq/kg of paste (compared with peanut butter) and groundnut oil were in line or slightly lower than existing literature at market-gate while GWP or raw groundnuts was much lower than the values reported in literature.

This LCA study of groundnut-based products in Ghana provided an up-to-date reference regarding their environmental performance and allowed identifying margins for improvement. Although all systems have many margins of improvement, the substitution of roasting machines fed by firewood, (used in all products) with machines fed by electricity can have very positive consequence both for Human health and Ecosystem quality, contributing to the reduction of firewood consumption and directly to forest degradation and deforestation.

Moreover, high land use of groundnut cultivation is due to relatively low crop yields, which lead to high levels of land occupation, decreasing from NASH to ASH and CF farms. Therefore, it is important to highlight that any improvement in crop yields would lead to a potential reduction in land use. In this regard, improved agricultural practices such as use of improved seeds, use of adequate sowing density and fertilization can have a positive impact on yields. However, it is important to highlight that high land use is also due to the significative groundnut losses during the value chain, due to storage conditions, sheller type, overall quality of grain. Thus, it is fundamental to work on reducing the groundnut losses to effectively reduce the land occupation.

6.5 Recommendations

The groundnuts value chain represents an important creator of employment for Ghana and different groundnut products are also a key ingredient in local dishes consumed by all social classes. In view of this, the following recommendations are made to further develop the groundnut value chain, taking into account associated aspects such as social and environmental considerations. The recommendations are equally important.

- Groundnut value chain development
    - ***Place priority on groundnut value chain development:*** The economic and social analyses suggest that any initiative for groundnut value chain upgradation has significant likelihood of benefitting women and consequently health, education and food and nutrition security of large number of families in Ghana. Many areas of value chain development can transform the inclusivity and economic impact of the value chain. These could be - business incentives, favourable financing arrangements, seed market development, addressing quality constraints related to aflatoxin etc. Under right conditions, a segment of youth looking to start their agribusinesses would find the groundnut value chain attractive for their new ventures. This suggests that priority placed on groundnut value chain development by the Government of Ghana (GoG) is likely to be a highly relevant and inclusive socio-economic development strategy. One of GOG flagship programmes (Planting for Food and Jobs, PFJ) should include groundnut in its priority crop as the programme document itself says that the priority will be given to value chains that are important for women and young people. While the GoG policies and programmes for promoting cereal crop production locally have been somewhat successful, it has had the unintended effect of downscaling the production of nutritious crops. The GoG would need to review its priorities in the light of importance of groundnut for food and nutrition security of the population, especially in the North of Ghana. Policy constraints can be removed to unleash groundnut value chain development. The extension system should get capacity building to support groundnut farmers and processors.

- ***Integration of the groundnut value chain between SME/larger-scale operators such as formal processors, retailers, or exporters, with operators on the ground (e.g. farmers and aggregators):*** This is to convey extension information (e.g. about good agricultural practices) as well as information about price, quantity, and quality requirements on groundnuts. Also, actors such aggregators should make available inputs required by farmers (or guide them to where they can obtain them) and encourage producers to supply raw material meeting buyers' requirements. As part of the aforementioned initiative, it is suggested to train aggregators and other traders on fair trading practices (e.g. approximate value of produce at each stage in the value chain), and that better-quality produce should attract higher buying prices. The initiative should encourage buyers to pay prices to farmers recognising the efforts in producing good quality output (i.e. better-quality output should fetch higher prices). Further modernisation of the value chain, would, for example, entail shelling and roasting of groundnuts using more mechanised equipment producing a good quality output. Further training of equipment manufacturers and engineers in Ghana is recommended in this context.
- ***Conduct a comprehensive review to refine the aggregator linked smallholder model***: The study has highlighted potential of the ASH model and documented some impact stories. More work is needed to further develop this model especially regarding its potential to provide financial access to smallholders through a revolving fund as is established by MOAP. A comprehensive review in this regard could be timely for designing the upscale model. Better design and improved and expanded implementation of MOAP pilot on financial inclusion through aggregators is the need of the hour.
- ***Develop a multi-stakeholder partnership platform on land policy and its implementation:*** Multi-actor partnerships and experimentation with alternative business models need continued support. At the same time, new land policy bill would need to address private sector, smallholder relationships. Also, the new land bill needs to be effectively implemented. The regulatory framework for land governance - though improving over the years - needs an implementation framework, capacities and mechanisms to ensure fairness, transparency, participation and consultations in land deals and in guiding alternative business models as is seen in the groundnut value chain. The model framework of implementation of the new land bill needs to go through democratic process of consultation, awareness and capacity building throughout the country.

- <u>Adherence to good agricultural practices</u>
  - ***Good agricultural practices (GAP)*** should be adhered to as far as pre- and post-harvest value chain activities are concerned. Aggregators and extension staff have an important role to play in this context. Aggregators are expected to supply (or identify someone who can supply), inputs such as seed, fertiliser, packaging material, and groundnuts production and processing equipment to farmers or their groups. In collaboration with MoFA extension staff they will also provide extension on good agricultural practices (GAP).
  - The production and use of certified groundnut seed is to be encouraged.
  - Institutions responsible for development and production of foundation seeds should be supported to produce and supply sufficient foundation seeds of groundnut.
  - The availability for farmers and aggregators of fertilisers suitable for legume crops, and the application of more agroecological practices can help in increasing groundnut yield.
  -

- Farmer based organisations – increase inclusion and participation of women as members and leaders of FBOs
    - ***Increase efforts for greater inclusion and participation of women as members and leaders of FBOs***: While gender policy framework could provide minimum (and mandatory) representation of women in different groupings, the action could be more at grassroots in terms of promoting and supporting women's participation and capacities in groups, as this will enhance their access to services and resources. The Ministry of Gender, Children and Social Protection in Ghana can review the need to establish social protection funds for women and their families who slide into further 'impoverishment' due to extraneous circumstances.

- Social development – reduce health and safety risks and improve working conditions
    - ***Reduce health and safety risks across the value chain and introduce modern roasting technologies***: Roasting technologies can be improved, new roasting equipment can be introduced, working with Alliance for Improved Cookstoves /other platforms in the country. Modern post-harvest technologies (harvester, shelling machine, roaster, storage solutions etc.) in groundnut should be promoted on a large-scale by MOAP, MoFA and other projects /agencies in the country. These will not only improve production /processing efficiency but also ameliorate hardships of women in terms of health and safety risks being faced currently. Further it is suggested that a detailed health, environment and safety audit of the value chain is carried out, the results of which should be used in informing strategies for addressing occupation health and safety risks in the groundnut value chain. Accompanying this, an awareness campaign should be conducted, engaging owners and workers at processing segment of the value chain so that they understand the risks of current operations and are willing to change behaviours and take up safe technologies for their processing operations. Collaboration with Rural Enterprise Programme (REP) of Ministry of Trade and Industry in Ghana could be one way to explore modern processing equipment and support to micro enterprises in groundnut value chain.
    - ***Improve working conditions, wages and promoting entrepreneurship in the value chain:*** It is an economic challenge to alter the current situation on working conditions and wages with supply of labour being higher than the demand. Nonetheless certain parts of the value chain could be targeted by incentivising 'collectivisation /formalisation' which can then lead to better wages for the workers. Youth engagement in the value chain development should be promoted through incubation funds providing them initial risk capital. This will create a 'pull' factor and some incentives to unleash innovation and entrepreneurship in the sector.

- Environmental sustainability
    - ***Impact on Land Use:*** High land use in groundnut-based products is due to relatively low crop yields, which lead to high levels of land occupation per unit of GN-based product. Therefore, it is important to highlight that any improvement in crop yields would lead to a potential reduction in land use. In this regard, improved agricultural practices such as use of improved seeds, use of adequate sowing density and fertilization can have a positive impact on yields. Moreover, it is important to support the adoption of agricultural practices that can improve soil quality and nutrient availability and at the same time reduce external input requirements, following the principles of agroecology, for example using crop residues (i.e. groundnut shell) as compost for soil. Overall, a wider adoption of Good Agricultural Practices for groundnut cultivation among farmers can help both in increasing groundnut yield and

in reducing the risk of aflatoxin contamination. However, it is important to highlight that high land use is also due to the significative groundnut losses during the value chain, due to storage conditions, sheller type, mould infection and overall quality of grain. Thus, it is fundamental to work on reducing the groundnut losses to effectively reduce the land occupation.

- ***Impact on Global Warming:*** Global warming impact was mainly due to groundnut roasting stage, and also to frying stage for kulikuli. Indeed, groundnut roasting and frying are carried out using firewood, that is associated to deforestation and land use change in Transitional Zone and Woody Savannah. The substitution of open fire roasting drums fed by firewood, used in all products with exception of ME paste, with improved oven or, even better, with roasting machines fed by electricity and natural gas can have a very positive consequence on ecosystem quality, contributing to the reduction of firewood consumption and directly to forest degradation and deforestation, as well as better working conditions.

- Infrastructure development
  - Given that a lot of trading and processing happens in facilities and markets which lack infrastructure, it is recommended to consider **further infrastructure investment** to fulfil these tasks (e.g.to improve equipment used for groundnut paste and minimize the risk of cross contamination due to milling of other products (e.g. maize milling), to ensure water supply (for cleaning the equipment) and energy supply, to encourage further investments in market facilities where processors and traders can undertake their business in hygienic conditions allowing them to respect standards and regulations). Investments can go hand-in-hand with training and awareness raising at processor and trader levels as far as quality and food standards are concerned. Investment initiatives involving development partners should be carried out in collaboration with the Government of Ghana, and take lessons learned in other sectors into account (e.g. road sector).

- Aflatoxin reduction
  - ***Measure, control and reduce aflatoxins across groundnut value chain***: A strong need has emerged for measuring aflatoxin levels across the value chain as this can guide design of appropriate responses – both regulatory (including policy enforcements) and at market level. At the same time, nutritional outcomes need to be assessed more rigorously to provide more evidence of impact of aflatoxin contaminated food items. All development programmes and initiatives in Ghana would need to measure and improve their nutrition sensitiveness.
  - Because much aflatoxin contamination occurs in particular during **post-harvest operations**, harvesting the crop at the right time, rapid drying on platforms to avoid contact with soil, restricting humidity during storage, sorting at various stages (including removing damaged, shrivelled, and immature pods) and using new or clean storage bags could potentially reduce fungal growth and toxin production. Also, appropriate infrastructure and equipment for food trading and processing needs to be encouraged. The promotion of Aflasafe use on groundnut fields can reduce the source of aflatoxin contamination.

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8. Annexes

8.1 Groundnut production of major producing countries

2019, year of estimate

Rank	Country	Production (1000 MT)
1	China	17,500
2	India	5,200
3	Nigeria	3,500
4	United States	2,563
5	Sudan	1,800
6	Myanmar	1,375
7	Argentina	1,255
8	Senegal	1,100
9	Tanzania, United Republic Of	1,100
10	Indonesia	990
11	Chad	850
12	Guinea	750
13	Cameroon	600
14	Brazil	550
15	Niger	500
16	Viet Nam	469
17	Burkina Faso	450
18	Ghana	440
19	Mali	425
20	Congo, The Democratic Republic Of The	420
21	Malawi	325
22	Uganda	300
23	Côte D'ivoire	210

Source: https://www.indexmundi.com/agriculture/?commodity=peanut-oilseed&graph=production,
Based on data from United States Department of Agriculture (USDA), Year of Estimate, 2019.

8.2 Additional information on aflatoxin levels and prevention

Aflatoxins are regulated in part per billion (ppb), with the maximum allowable level varying with country and intended use of the commodity. The European Union limits for total aflatoxins ranges from 4-15 ppb. The United States food safety regulations include a limit of 20 ppb for total aflatoxins. Both Australia and Canada set limits of 15 ppb for total aflatoxins in nuts (Akwasi Kanyam, 2016).

Aflatoxins are carcinogenic toxins produced by the Aspergillus flavus and parasiticus fungi, and consumption of groundnuts contaminated with aflatoxins has been linked to liver cancer, hepatitis, increased anaemia, susceptibility to HIV/AIDS and stunting in children (Emmott and Stephens, 2012; PACA, 2015). According to Masters et al (2013), aflatoxins are a naturally occurring mycotoxin produced by many species of *Aspergillus*, a fungus, the most notable ones being *Aspergillus flavus* and *Aspergillus parasiticus*.

Aflatoxin contamination tends to occur when crops are exposed to stresses such as high rainfall, high temperatures, drought, and insect infestation which allows the fungi to grow on the outer surface of the peanut pod and spreads inward reaching the kernel. Equally, poor post-harvest operations (e.g. insufficient drying, rough handling, damage to the peanut shell, transport or storage of shelled peanut which have not been sufficiently dried) spread aflatoxin contamination.

The recommended moisture content for storage of groundnuts (unshelled) is 9% while that for shelled groundnuts is 7% (Odogola, 1994; Waliyar et al., 2007; 2008; quoted in Akwasi Kanyam, 2016).

Table A3.1: Aflatoxin levels in selected peanut products, 2010

Type of product	Average total aflatoxin content (ppb)
Raw peanuts	
New crop	1.7
In shell	7.6
Unknown crop	8.6
Old crop	88.8
Rejects	288.8
Cottage industry processed products	
Roasted peanuts	1.0
Dawadawa	2.9
Nkati cake	7.6
Dakwa	10.9
Pounded raw peanut	15.8
Paste	52.6
Kulikuli	76.9
Manufactured groundnut products	
Crispy Nut Cracker	1.1
Uni-mix (product #1)	1.9
Burger®	5.0
Tom Brown	104.0
Uni-mix (product #2)	296.0

Source: Extracted from Figures 1, 2 and 3 of W.J. Florkowski and S. Kolavalli, Aflatoxin control strategies in the groundnut value chain in Ghana. Accra: IFPRI, June 2013. (19)

Source: Masters et al (2013)

Table A3.2: Nutrient composition of raw peanuts

Nutrient	Unit	Amount per 100 g
Energy	kcal	567
Protein	g	25.8
Fat	g	49.2
Fatty acids, total saturated	g	6.8
Fatty acids, total monounsaturated	g	24.4
Fatty acids, total polyunsaturated	g	15.5
Carbohydrate	g	16.1
Fiber	g	8.5
Calcium, Ca	mg	92
Iron, Fe	mg	4.6
Magnesium, Mg	mg	168
Phosphorus, P	mg	376
Potassium, K	mg	705
Sodium, Na	mg	18.0
Zinc, Zn	mg	3.27
Thiamin	mg	0.64
Riboflavin	mg	0.13
Niacin	mg	12.1
Vitamin B-6	mg	0.35
Folate, DFE	µg	240
Vitamin E (alpha-tocopherol)	mg	8.3

Source: Masters et al, 2013

Table A3.3: Quality Requirements for Groundnuts

Characteristics	In-shell	kernels		
		Grade 1	Grade 2	Grade 3
Extraneous matter content % (m/m) max	2	1	3	5
Damaged pods/kernels % (m/m) max	0.5	0.5	0.5	3
Shriveled pods/kernels % (m/m) max	3	3	3	3
Skinned kernels % (m/m) max	-	0.5	0.5	0.5
Broken and split kernels % (m/m) max	-	8	10	12
Empty pod % (m/m) max	2	-	-	-
Admixtures of other varieties	5	5	5	5
Aflatoxin content (ppb max)	20	20	20	20

Source: GEPA (no date)

It is understood that there are GoG plans to reduce the acceptable aflatoxin content to 15 ppb.

8.3 Methodology for accounting direct soil emissions

Considering N_2O emissions, biological nitrogen fixation has been removed in IPCC 2006 guidelines as a direct source of N_2O emissions because of the lack of evidence of significant emissions arising from the fixation process itself (Rochette and Janzen, 2005). These authors concluded that the N_2O emissions induced by the growth of legume crops/forages may be estimated solely as a function of the above-ground and below-ground nitrogen inputs from crop/forage residue (the nitrogen residue from forages is only accounted for during pasture renewal). Thus, no N_2O emissions are accounted for the nitrogen fixing process during the crop growth.

Since no nitrogen fertilizers are used for groundnut cultivation, soil direct N_2O emissions depend completely on the nitrogen supplied to the soil with groundnut residues, which are rich in nitrogen[53]. The estimate of direct emissions was carried out by multiplying the amount of nitrogen supplied with the residues by the N_2O emission factor of the IPCC 2006 guidelines, equal to 1% of the nitrogen supplied. The estimation of the amount of nitrogen from residues in the aboveground and belowground biomass was made considering the groundnut yield of each farm type and using the IPCC equation 11.6 (Vol. 4, Chapter 11) "N from crop residues and forage/pasture renewal (Tier 1)".
Soil indirect N_2O emissions are produced only from nitrogen supplied with residues, given that there are no other direct emissions of ammonia and nitrates. The quantity of nitrogen in the residues was then multiplied by the emission factor EF_5 [leaching/runoff], kg N_2O–N (kg N leaching / runoff), equal to 0.0075 kg N_2O-N / kg N. The small differences in crop yield among the three farms did not allow to highlight differences in N_2O emissions. Sources of soil N_2O direct and indirect emissions are reported in Table 2.
The phosphorus and phosphate emissions were calculated using the approach developed by Nemecek and Kagi (2007), so three different kinds of phosphorus emissions to water were considered.

Leaching of soluble phosphate to groundwater (phosphate to ground water):

$$P_{leach} = P_{leach\ in\ arable\ land} \times (1+0.2/80*P_2O_{5slurry})$$

since there is no use of slurry in groundnut cultivation and no better estimation of these emissions for Ghana was available, phosphate emissions due to leaching are equal to the default value for arable land of 0.07 kg P ha^{-1} $year^{-1}$.

Run-off of soluble phosphate to surface water (phosphate to river):

$$Prun = P_{average\ for\ arable\ land} \times (1+02/80*P_2O_{5mineral}+0.7/80*P_2O_{5slurry}+0.4/80*P_2O_{5manure})$$

Phosphate emissions due to run-off considers the default value for arable land (0.175 kg P ha^{-1} yr^{-1}) multiplied for a correction factor for the input of phosphorus both with mineral fertilizer, slurry and manure. Only mineral fertilizer has been considered for groundnut cultivation

Erosion of soil particles containing phosphorus (phosphorus to river):
These emissions refer to the quantity of soil eroded, considering the amount of soil eroded, the P content in soil eroded, an enrichment factor and the fraction of eroded soil that that reaches the river.

$$P_{eroded} = 10000 \times \text{quantity of soil eroded} \times \text{P content in the top soil} \times \text{enrichment factor for P} \times \text{fraction of eroded soil that reaches the river}$$

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Default values were used for P content in the top soil (0.00095 kg P/kg soil), for the enrichment factor (1.86) and fraction of particle that reaches the river (0.2). The quantity of soil eroded was calculated specifically for Northern Ghana, since the value can differ a lot from the European default value. It was calculated multiplying potential soil loss for the crop management factor (0.31 for groundnut), according to Oberholzer et al. 2006. The quantity of soil eroded specific for Northern Ghana was calculated from values reported in the report of the IFPRI (2007) "Cost Implications of Agricultural Land Degradation in Ghana", averaging the values for Norther and Upper West regions to a final value of 415 t ha^{-1} yr^{-1}. Sources of phosphate and phosphorus emissions are reported in Table 3.

2. Methodology used to account emissions to due land use change

For the accounting of carbon loss due to land use change, reference was made to the Net Primary Production (NPP) of the Woody Savannah. Measured data on the carbon stock of Woody Savannah in Ghana are from a recent paper published with the collaboration of researcher of the Forestry Research Institute of Ghana, Council for Scientific and Industrial Research, Kumasi (FORIG-CSIR) (Moore et al., 2018). A parallel monitoring campaign was carried out in four different forest types in Ghana to measure forest biomass, productivity and carbon cycling along a rainfall gradient with the eddy co-variance approach. The study was carried out to monitor carbon fluxes with an eddy covariance tower and to obtain a Net Primary Production (NPP) dataset from lowland African tropical forests, as part of the Global Ecosystems Monitoring network. The study was carried out in four vegetation types with low or no logging impact at 1 ha scale; evergreen forest (EF), semi-deciduous forest (SDF), dry forest (DF) and woody savanna (WS), while unfortunately a forest-savanna transition type was not reported. The carbon stock of these four different forest types are reported in Figure 5, considering the carbon stock in all the components of the aboveground and belowground biomass and in soil.

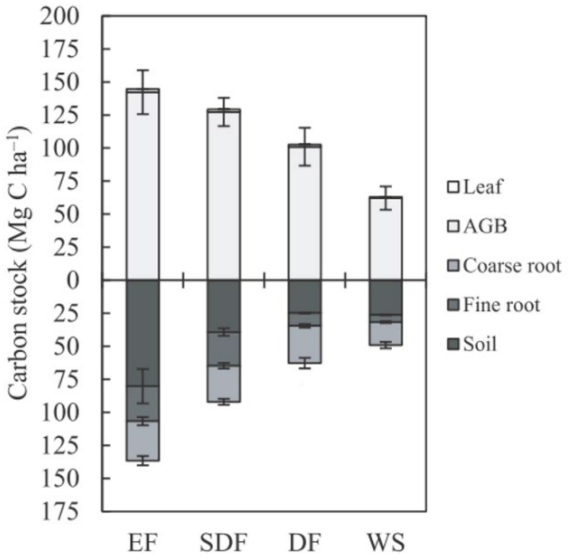

Figure 5: Mean aboveground biomass (stem, branches and leaves), belowground biomass (fine and coarse root carbon stock) and soil carbon stocks (0 – 30 cm depth) of the four vegetation types (EF – evergreen forest, SDF – semi-deciduous forest, DF – dry forest, WS – woody savanna) along the rainfall gradient (modified from Moore et al, 2018).

As explained above, it has been assumed that there is a partial removal (50%) of trees from a woody savannah forest, thus we considered a land use transformation from a secondary forest to an arable land with trees, since some trees remain in the harvested land. We assumed that the carbon stock lost during forest cutting is the one of aboveground biomass and in soil, while it has

been assumed that the coarse and fine roots remain in the soil, since eradication is not carried out. The degradation of root biomass in soil is not included in the carbon lost since it is very uncertain to estimate the amount of carbon that will be oxidized to CO_2 and the amount that will be humified to organic carbon. According to the value reported in literature about the mean value of organic carbon in agricultural soil in the Transitional Zone and Woody Savannah (from 4 – 25 t C ha^{-1}: on average 14.5 t C ha^{-1}) (Bessah, E. et al., 2016; Boakye-Danquah, J. et al., 2014) and comparing with the value measured in the woody savannah in Moore et al. (25 t C ha^{-1}), it is possible to estimate that half of the soil carbon stock is lost in the land use change.

An average content of carbon in dry woody biomass has been considered, equal to 50% and an average moisture of wood equal to 46% has been considered. The carbon lost, both from the biomass and from the soil, calculated for 1 kg of firewood is reported in Table 9.

Table 9: Estimate of carbon loss for firewood extraction, including land use change.

Variable	Equation	Unit	Value	Note
Aboveground biomass (AGB)	A	Mg C ha^{-1}	60	Include carbon in stem and branches
Soil carbon stock loss	B	Mg C ha^{-1}	12.5	Include carbon in soil organic matter
100% loss of C stock	C = A + B	Mg C ha^{-1}	72.5	100% of the carbon of 1 ha is cut. It includes aboveground biomass carbon + soil carbon
50% loss of C stock	D = C / 2	Mg C ha^{-1}	36.2	50% of carbon of 1 ha is cut. It includes aboveground biomass carbon + soil carbon
Dry woody biomass	E = A / 2	Mg C ha^{-1}	30	50% of the carbon in AGB of 1 ha is harvested
Dry woody biomass	F = E x 2	Mg ha^{-1}	60	From carbon to dry wood. It is considered a carbon content in biomass equal to 50%
Fresh woody biomass (46% moisture)	G = F + F x 0.46	Mg ha^{-1}	87.6	From dry wood to wet wood. It is considered a moisture in wet wood equal to 46%
Carbon loss for kg of wood	H = (D / G) x 1000	kg C loss kg^{-1} wood	0.414	kg of C loss in 1 ha divided the wood obtained in 1 ha.

The emissions related to combustion of wood, other than CO_2, have been calculated starting from the emissions factor of IPCC 2006 guideline for CH_4, N_2O (EF for woody savannah, tab 2.5 vol. 4, Chapter 2) and from the EMEP-EEA guideline for CO, NO_2, NMVOC, SO_x and particulates (EF, Fuel, Wood, technology: Open Fireplaces) (EMEP-EEA, 2019).

8.4 Life Cycle Inventory for the seven groundnut-based products

In the following table the life cycle inventory for the informal/artisanal and formal SME products is reported.

Life cycle stage	INPUT/OUTPUT	Unit	Artisanal					Formal SME	
			Paste	Roasted	Kulikuli	Oil	Flour	SME Paste	Paste LE
Cultivation	INPUT								
	Land occupation	m^2/a	23.69	22.51	29.62	93.79	31.18	19.54	18.56
	Ploughing	MJ/ha	1.06	1.00	1.32	4.18	1.39	0.87	0.83
	Recycled seeds (self-production)	g ha^{-1}	94.77	90.03	118.47	375.14	124.70	39.08	37.13
	Improved seed (purchased)	g ha^{-1}	29.85	28.36	37.32	118.17	39.28	73.86	70.17
	Phosphorus fertiliser (TSP)	g ha^{-1}	14.64	13.91	18.30	57.96	19.27	38.04	36.14
	Herbicide	ml/ha	0.30	0.28	0.37	1.17	0.39	0.77	0.73
	Input transport	kgkm	1.33	1.26	1.66	5.25	1.75	3.34	3.17
	Production and waste management of packaging	g ha^{-1}	0.03	0.03	0.04	0.12	0.04	0.08	0.08
	Transport of inputs for cultivation	kgkm	0.80	0.76	1.00	3.15	1.05	2.02	1.92
	(Transport, freight, light commercial vehicle, RoW)		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OUTPUT	Unit							
	Groundnut yield (unshelled)	kg/ha	3.22	3.06	4.03	12.76	4.24	2.95	2.80
	Groundnut sold (90%)	kg/ha	2.90	2.76	3.63	11.48	3.82	2.65	2.52
	Groundnut for self-consumption (10%)	kg/ha	0.32	0.31	0.40	1.28	0.43	0.30	0.28
	Total emission of N_2O (direct and indirect)	g ha^{-1}	1.11	1.06	1.39	4.40	1.46	0.92	0.87
	Emissions of P from erosion	g ha^{-1}	107.80	102.41	134.76	426.73	141.85	88.91	84.46
	Emissions of PO_4 from leaching and run-off	g ha^{-1}	0.78	0.74	0.98	3.09	1.03	0.65	0.62
Shelling	INPUT								
	Unshelled groundnut at field gate	kg	2.90	2.76	3.63	11.48	3.82	2.65	2.52

Life cycle stage	INPUT/OUTPUT	Unit	Artisanal					Formal SME	
			Paste	Roasted	Kulikuli	Oil	Flour	SME Paste	Paste LE
	Electricity consumption	Wh	8.21	7.80	10.27	32.51	10.81	7.52	7.14
	Transport of unshelled groudnut from local villages (small lorry, max 3.3 t)	kgkm	40.61	38.58	50.77	160.76	53.44	26.55	25.22
	Transport of unshelled groundnut from market (lorry, 7.5-16 t, euro 3)	kgkm	127.64	121.26	159.56	505.26	167.95	142.84	135.70
	Trasport of unshelled groudnut from farm to accra (lorry > 32 t, euro 3)	kgkm	0.00	0.00	0.00	0.00	0.00	4.78	4.54
	Transport of shell to field (small lorry, max 3.3 t)	kgkm	2.99	2.84	3.74	11.84	3.93	2.57	2.44
	OUTPUT								
	Shelled groundnut	kg	1.41	1.34	1.76	5.58	1.85	1.38	1.31
	Shell	kg	1.30	1.42	1.87	5.91	1.96	1.28	1.22
Sorting	INPUT								
	Shelled groundnut	kg	1.41	1.34	1.76	5.58	1.85	1.38	1.31
	OUTPUT								
	Sorted groundnut	kg	1.14	1.08	1.43	4.52	1.50	1.14	1.08
	Grade 2 groundnut	kg	0.14	0.13	0.18	0.56	0.19	0.14	0.13
	Rejected groundnut	kg	0.13	0.12	0.16	0.50	0.17	0.10	0.09
Roasting	INPUT								
	Sorted groundnut	kg	1.14	1.08	1.43	4.52	1.50	1.14	
	Firewood	kg	0.43	0.41	0.54	1.72	0.57	0.15	
	Electricity for roasting	kWh						0.01	
	OUTPUT								
	Roasted groundnut	kg	1.05	1.00	1.31	4.15	1.38	1.05	
Paste (grinding, packaging and transport)	INPUT								
	Roasted groundnut	kg	1.05					1.05	
	Shelled groundnut (NASH, ASH, CF)	kg							1.31
	Electricity for grinding	kWh	0.11					0.01	
	Electricity for roasting and grinding	kWh							0.06

Life cycle stage	INPUT/OUTPUT	Unit	Artisanal					Formal SME	
			Paste	Roasted	Kulikuli	Oil	Flour	SME Paste	Paste LE
	Natural gas for roasting	MJ							1.08
	Tap water	kg						0.28	1.53
	Plastic bag	g	10.00						
	Plastic bottle	g							12.00
	Plastic bucket	g						40.00	
	Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	kgkm	0.02						
	Transport of plastic bottle	kgkm							0.24
	Transport of plastic bucket	kgkm						27.00	
	Transport of groundnuts from Tamale	kgkm							805.19
	Transport of natural gas	kgkm							29.22
	Transport to the retailer (Lorry 3-7 t, euro 3)	kgkm	72.70					0.10	99.30
	Transport to the retailer (Lorry 7-16 t, euro 3)	kgkm	18.20					0.24	232.00
	OUTPUT								
	1 kg of paste with packaging	kg	1.01					1.04	1.01
Roasted (packging and transport)	INPUT								
	roasted groundnut (artisanal)	kg		1.00					
	PET bottle	kg		0.04					
	Transport of botlle	tkm		0.01					
	Transport to the retailer	tkm		0.03					
	OUTPUT								
	1 kg of roasted groundnut in a plastic bottle			1.03					
Kulikuli (gringing, frying, packaging, transport)	INPUT								
	Roasted groundnuts	kg			1.31				
	Groundnut oil for frying	kg			72.70				
	Electricity for grinding	kWh			0.08				
	Firewood for frying	kg			0.17				
	Plastic bag	g			2.00				
	Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	kgkm			0.04				

Life cycle stage	INPUT/OUTPUT	Unit	Artisanal					Formal SME	
			Paste	Roasted	Kulikuli	Oil	Flour	SME Paste	Paste LE
	Transport of firewood (small lorry, 7.5 t, 0-4 euro)	kgkm			27.50				
	Transport to retailer (small lorry, 7.5 t, 0-4 euro)	kgkm			30.00				
	OUTPUT								
	1 kg of kulikuli with packaging at retailer				1.00				
OIL (grinding, manual extraction, packaging, transport)	INPUT								
	Roasted groundnuts	kg				4.15			
	Electricity for grinding	kWh				0.03			
	Plastic tank	kg				0.04			
	Transport of plastic tank (small lorry, 7.5 t, 0-4 euro)	tkm				0.02			
	Transport to retailer (small lorry, 7.5 t, 0-4 euro)	tkm				0.02			
	Transport to retailer (Lorry, 7-16 t, 3 euro)	tkm				0.13			
	OUTPUT								
	1 kg of groundnut oil at retailer	kg				1.04			
Flour (grinding, drying and pulverization, packaging, transport)	INPUT								
	Roasted groundnut	kg					1.38		
	Electricity for grinding	kWh					0.08		
	Plastic bag	kg					0.00		
	Transport of plastic bag (small lorry, 7.5 t, 0-4 euro)	tkm					0.00		
	Transport to retailer (small lorry, 7.5 t, 0-4 euro)	tkm					0.09		
	Transport to retailer (Lorry, 3-7 t, 3 euro)	tkm					0.30		
	OUTPUT								
	Groundnut flour at retailer	kg					1.00		

8.5 Assessment of conversion rates, losses and wastes of groundnut products for chain phase

	-	Input	Production	Sales	Losses	Waste	Self-consumption	Oil/cake extraction
Cultivation	**NASH unshelled**	0	1300 kg/ha	1040 kg (80%)			260 kg 241 kg (20% self consumption for food and seeds)	
	ASH unshelled	0	1600 kg/ha	1440 kg (90%)			160 kg 136 kg (10% self consumption for food and seeds)	
	CF unshelled		2200 kg/ha	2090 kg (95%)			110 kg 77 kg (5% self consumption for food and seeds)	
Shelling	**NASH shelled**	1040 kg unshelled	489 kg	489 kg (47%)	16 kg (1.5% grain loss during shelling)	536 kg (51.5% shell)		
	ASH shelled	1440 kg unshelled	792 kg	792 kg (55%)	22 kg (1.5% grain loss during shelling)	626 kg (43.5% shell)		
	CF shelled	2090 kg unshelled	1150 kg	1150 kg (55%)	31 kg (1.5% grain loss during shelling)	909 kg (43.5% shell)		
Processing	**Roasted GN (snack)**	100 kg shelled GN (80% nash + 20% ash)	84 kg	84 kg (84%)	8.8 kg (sorting 7.3% and transport 1.5%)	7.3 kg (moisture loss during roasting)		

	Artisanal paste	100 kg shelled GN (80% nash + 20% ash)	80 kg	80 kg (80%)	13 kg (sorting of II° grade or bad quality grain 7.3%, transport 1.5% and grinding 4.2%)	7.3 kg (moisture loss during roasting)		
	Kulikuli	100 kg shelled GN (80% nash + 20% ash)	61 kg	61 kg (61%)	13 kg (sorting of II° grade or bad quality grain 7.3%, transport 1.5%, grinding 4.2%)	7.3 kg (moisture loss during roasting)		oil extraction 19%
	Oil	100 kg shelled GN (80% nash + 20% ash)	19 kg	19 kg (19%)	13 kg (sorting of II° grade or bad quality grain 7.3%, transport 1.5%, grinding 4.2%)	7.3 kg (moisture loss during roasting)		cake extraction 60.6%
	Flour	100 kg shelled GN (80% nash + 20% ash)	58 kg	58 kg (58%)	16 kg (sorting of II° grade or bad quality grain 7.3%, transport 1.5%, grinding 7.2%)	7.3 kg (moisture loss during roasting)		oil extraction 19%
	SME paste (SE)	100 kg shelled GN (71% nash + 29% ash)	79 kg	79 kg (79%)	14.1 kg (sorting of II° grade or bad quality grain 8.5%, transport 1.5%, grinding 4.1%)	7.2 kg (moisture loss during roasting)		
	SME paste (ME)	100 kg shelled GN (71% nash + 29% ash)	79 kg	79 kg (79%)	14.1 kg (sorting of II° grade or bad quality grain 8.5%, transport 1.5%, grinding 4.1%)	7.2 kg (moisture loss during roasting)		

8.6 Sensitivity analysis of groundnuts production

GHS/farm				GHS/farm
	Non-aggregator based SHF		Aggregator	Commercial
	Sensitivity case	Standard case	based SHF	farms
Type of production	NASH, sensitivity	NASH, standard	ASH	CF
GN farm size (hectares)	0.76	0.76	0.96	3.12
Value of production				
Yield (kilograms), main product	608	988	1,536	6,864
Sales price, main product (unshelled GN per kg)	2.2	2.2	2.5	2.8
Sales revenue + home consumption	**1,338**	**2,174**	**3,840**	**19,219**
Intermediate Goods and Services (IGS)				
Tools (hoe, cutlasses)	38.0	38.0	48.0	156.0
Transportation of inputs (e.g. seed, fertiliser)	28.5	28.5	36.0	
Tractor hire for ploughing (@ GHS100/acre)	190.0	190.0	240.0	
Seed, traditional	91.2	91.2		
Seed, certified			240.0	780.0
Chemicals (herbicides)			36.0	117.0
Fertilisers (TSP)			264.0	858.0
Transportation of GN to farm	28.5	38.0	60.0	
Fuel (diesel for tractors, trucks)				252.7
Electricity (Irrigation)				
Water (Irrigation)				
Transport of GN to market (long-distance)	19.0	24.7	36.0	156.0
Other Intermediate Goods and Services (IGS)				
Total IGS	**395.2**	**410.4**	**960.0**	**2319.7**
Value addition				
Value of land				
Value of labour inputs				
Land clearing (no chemicals, cutlass	114.0	114.0	144.0	468.0
Burning of leaves	76.0	76.0	96.0	312.0
Land preparation 1 - ploughing				62.4
Land preparation 2 - ripping				
Land preparation 3 - harrowing				62.4
Transport of inputs from market	28.5	28.5	36.0	117.0
Planting, sowing	22.8	22.8	48.0	156.0
Fertiliser application			9.6	31.2
Weeding (manual)	91.2	91.2	115.2	374.4
Harvesting (pulling/uprooting)	45.6	76.0	115.2	468.0
Harvesting (plucking)	54.7	91.2	144.0	561.6
Total labour	432.8	499.7	708.0	2613.0
Financial charges				
Taxes / duties				
Subsidies				
Gross profit	**510**	**1,264**	**2,172**	**14,286**
Depreciation				
Tractor				70.2
Motorking				46.8
Sprayer (chemicals)				15.6
Total depreciation				**132.6**
Net operating profit (GHS per farm per season)	**510**	**1,264**	**2,172**	**14,154**