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Food loss analysis: causes and solutions

Case study on the groundnut value chain in the Republic of Malawi

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Foreword

Widescale global food losses and waste affect the sustainability and efficacy of food and nutrition systems. Currently, high loss estimates in developing countries are linked to food supply chain failures but insufficient data limit the scale and scope of food loss measurements.

While numerous studies have been undertaken to quantify food losses at the national level, information regarding the critical loss points, or areas where food loss in a specific food supply chain is most prevalent, is often unclear. Compounding the challenge, the underlying reasons for loss-inducing food supply chain failures also require further examination.

To improve global, regional and local knowledge about the underlying reasons for food loss, as well as to assess where critical loss points occur, FAO undertook a series of case studies involving

numerous food supply chains in developing countries. Utilizing a defined food loss and waste analysis framework, the Organization and its partners identified nationally-important food products and commissioned local-level studies of the losses in these chains. The findings of the study will be used to develop technically, economically, environmentally and socially feasible solutions to reduce food losses. These solutions will be developed both in the chains examined, as well as in similar chains in other countries, with due considerations for economic parity, agro-ecology and social conditions.

Though facing low productivity, groundnut is considered as one of the most important food crops in Malawi. The Government of Malawi has identified groundnut as one of the main livelihoods sources in terms of income, employment, and also as one of the commodities most requiring reductions of post-harvest losses. In the past, Malawi was a major of exporter of groundnut to Europe but this collapsed due to aflatoxin contamination issues and food safety concerns. In recent years, the Government and other stakeholders have moved to improve the groundnut production across the country. This food loss assessment study has uncovered some sources of losses in the groundnut chain examined and identifies potential solutions to counter these losses.

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Abbreviations and acronyms

ACE	Agricultural Commodity Exchange for Africa
ADD	Agricultural Development Division
ADMARC	Agricultural Development and Marketing Corporation
AHCXL	Auction Holdings Commodity Exchange Limited
ASWAp	Agriculture Sector Wide Approach
CARD	Centre for Agricultural Research and Development
CGIAR	Consortium of International Agricultural Research Centres
CIMMYT	International Maize and Wheat Improvement Centre
CLP	Critical Loss Point
CTI	Compatible Technology International
DAES	Department of Agricultural Extension Services
DARS	Department of Agricultural Research Services
DCD	Department of Crop Development
DoEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
EPA	Extension Planning Area
ERP	Economic Recovery Plan
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus group discussion
FISP	Farm Input Subsidy Programme
FSC	Food Supply Chain
FUM	Farmers Union of Malawi
GAP	Good Agricultural Practice
GBI	Green Belt Initiative
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHP	Good Hygiene Practice
GMP	Good Manufacturing Practice
GoM	Government of Malawi
HACCP	Hazard Analysis Critical Control Point
HLPE	High Level Panel of Experts on Food Security and Nutrition
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund

LGB	Large Grain Borer
LLP	Low Loss Point
LUANAR	Lilongwe University of Agriculture and Natural Resources
MAFAP	Monitoring African Food and Agricultural Policies
MDG	Millennium Development Goal
MGDS	Malawi Growth and Development Strategy
MK	Malawi Kwacha
MIRTDC	Malawi Industrial Research and Technology Development Centre
MoAIWD	Ministry of Agriculture, Irrigation and Water Development
NAP	National Agricultural Policy
NASFAM	National Association of Smallholder Farmers in Malawi
NES	National Export Strategy
NFRA	National Food Reserve Agency
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute
PCB	Pesticide Control Board
PHL	Post Harvest Losses
PHLM	Post-Harvest Loss Management
PICS	Purdue Improved Crop Storage
PO	Producer Organisations
ReNAPRI	Regional Network for Agricultural Research Institutes
RBM	Reserve Bank of Malawi
RLEEP	Rural Livelihoods Economic Enhancement Project
SAM	Severe Acute Malnutrition
SAPP	Smallholder Agriculture Productivity Project
SAPS	Structural Adjustment Programmes
SC	Supply Chain
USD	United States Dollar
UNJP	United Nations Joint Project
WHO	World Health Organization
WRS	Warehouse Receipt System

Introduction to the case studies

About 1.3 billion tonnes of food losses and waste are estimated to occur every year globally (FAO, 2011), affecting the efficiency and sustainability of global food systems and nutrition. Accurate estimates of the magnitude of losses and waste are still lacking, especially in developing countries where most smallholder farmers produce and consume grains and pulses as staple food; nevertheless, the high loss estimates suggest that food losses are significant and are having a negative impact on food and nutrition security.

In light of the above, the Food and Agriculture Organization of the United Nations (FAO) and its partners launched the Global Initiative on Food Loss and Waste, which uses various approaches including awareness-raising, developing a methodology to research post-harvest losses among other initiatives. Multiple partners have been supporting efforts at the national and regional levels through various projects including the project 'Food loss reduction through partnerships and evidence-based interventions', also known as the United Nations Joint Project (UNJP).

The UNJP, is funded by the Government of Ireland and implemented by the FAO and the International Fund for Agricultural Development (IFAD) to address food loss reduction issues by providing technical support. The Project is linked with IFAD-led field-based activities including: national loss assessments in Ethiopia, Malawi and Timor-Leste; a regional workshop on food losses; and the development of awareness and knowledge materials to support projects designed and implemented by IFAD.

*Food losses r*efer to the decrease in edible food mass throughout the different segments of the food supply chains – production, post-harvest handling, agroprocessing, distribution (wholesale and retail), consumption. Food losses and their prevention impact the environment and climate change, food security and the livelihoods of the poor and economic development. The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country, region or production area.

During recent decades, numerous studies have been undertaken to assess the quantities of food losses in many countries of the world. Most of these studies were conducted at the national level, and based on a literature review, statistical data and stakeholder interviews (Golob, 1981 and Chibwe *et al*., 1997).

The analysis of the literature and overall reports reveals the existent knowledge gap: while quantitative estimations of food losses have been produced, and there is certainty about the major causes of food losses, it is unclear which are the most important losses in specific supply chains, or the impact of eventual solutions and which solutions are economically, environmentally and socially feasible. It is clear that food loss reduction will greatly benefit all actors in the food production and supply chains, including ensuring food security for the poor, improving resilience to climate change and ensuring the more efficient use of natural resources. The solution to food loss, however, should not be more expensive than the food loss itself, should not cause any negative impact or risk to consumer health, should not place a higher burden on the environment and greenhouse gas (GHG) emissions, should make more food available to the people who need it most, and should be socially and culturally acceptable.

Therefore, the Save Food Initiative designed the 'food supply chain' case studies, for the most important food subsectors in developing countries. In these case studies, primary and empirical data are generated for the different causes of food losses, and solutions are analysed for their feasibility. Up to now, no standardized methodology has been used to conduct loss assessments. This has made it very difficult to compare results between countries and regions. Using a standardized methodology across the participating countries will be very useful in terms of comparing results and sharing information.

A case study is just a recording of one-moment of what is happening in a specific food supply chain in a specific season; next season and in a different location the situation can be very different again. Therefore, it is important that the Save Food Initiative can undertake many case studies in many different locations, so that the multitude of study results show significant trends and solutions. Further, the strategy aims to use the results of the case studies to target opportunities for investment programmes and interventions, during its formulation a wider geographical scope and the seasonality will be analysed.

The assessment of post-harvest losses along the groundnut supply chain used the methodology developed by FAO under the Save Food initiative and adapted it to the specific conditions and local context.

This study focused on the informal groundnut supply chains. Groundnut, consumed in various forms, is one of the crops that is most cultivated by smallholder farmers in Malawi, and it is a major source of income. In recent years, the GoM, along with other partners, has increased efforts to promote the production and marketing of groundnut. Moreover, the choice between informal and formal food supply chains (FSC) was determined by the fact that because of limited resources, including finances and storage infrastructure, it is difficult for the players in the non-regulated supply chains to comply with the grades and standards required in the regulated supply chain. It is therefore expected that losses will be greater in the informal supply chains than in those that are regulated, therefore jeopardizing the goals of food and nutrition security.

> *The objective of the present study is to identify the main causes of food losses in the selected food supply chains, and to analyse various options to reduce food losses, their technical and economic feasibility, social acceptability and environmental impact, leading to concrete proposals to implement a food-loss reduction programme. Although attempts have been made to quantify actual losses after an activity along a supply chain, the final loss figures used are mostly estimates. Where there is the need to use accurate loss figures, for instance in tracking achievements in loss reduction efforts, this requires a more detailed statistical analysis, which is beyond the scope of this study.*

METHODOLOGY

The assessment of post-harvest losses along the groundnut chain used the methodology developed by the Save Food Initiative. The supply chain food loss assessment involves the collection of data and their analysis, using qualitative and quantitative field methods. Subsequently, solutions to food losses are formulated from the results and conclusions of the assessment. The methodology of the 'food supply chain' case studies is described below.

Selection of countries and subsectors

Countries and subsectors selected are based on existing and ongoing programmes that the project can work with by collaborating with partners in the field. Subsectors are chosen from the important food commodities: cereals, roots and tubers, fruits and vegetables, oilseeds and pulses, animal products (meat, milk, eggs, etc.), fish and seafood.

Identification of consultants

A team of two or three national consultants conducts the fieldwork: a subsector specialist (who could be an actor in the food supply chain), an agricultural economist and a rural sociologist.

Selection of food supply chains

The main supply chains in the subsectors are ranked by their importance in terms of economic impact and food security, as well as their contribution to national development objectives such as employment, poverty reduction and generation of foreign exchange. Based on the information obtained, one or two food supply chains in the subsector are selected for in-depth survey and sampling.

The basic criteria for the selection of FSCs are:

- based on smallholder producers;
- significant scale of food production;
- preferably including agroprocessing and urban market; and
- if possible, included in an on-going support programme for the subsector.

Uniform methodology

The methodology of the case studies needs to be uniform for all countries to enable results to be comparable and make extrapolation possible. The methodology has been developed specifically for this purpose. It is based on four ('S') elements:

- *Preliminary Screening of Food Losses ('Screening').* Based on secondary data, documentation and reports, and expert consultations without travel to the field.
- *Survey Food Loss Assessment ('Survey').* A questionnaire is differentiated for producers, processors or handlers/sellers (i.e. warehouse manager, distributor, wholesaler, retailer) and other people who are knowledgeable of the supply chain being assessed, complemented with ample and accurate observations and measurements.
- *Load Tracking and Sampling Assessment ('Sampling').* For quantitative and qualitative analyses at any step in the supply chain.
- *Monitoring and Solution Finding ('Synthesis').* Used to develop an intervention programme for food losses, based on the previous assessment methods.

The consultants physically follow the product for four weeks, from production site to final retail outlet, making direct observations and measurements, and discussing the causes and solutions for food losses with supply chain actors. The consultants draft a proposal for a food loss reduction strategy or plan.

Stakeholder validation

In a one-day workshop with stakeholders from public and private sectors, the study results and proposed food loss reduction strategy are discussed and endorsed. A concept for a programme to finalize and implement the food loss reduction strategy or plan is prepared.

Methodology applied in this study

The study involved a literature review, key-informant (expert) interviews and fieldwork.

The literature review focused on food loss studies in Malawi, particularly focussing on groundnut. The desk study covered aspects such as the status and importance of the groundnut to the economy; the policy formulation process and framework in Malawi; relevant institutions and their respective roles in terms of policy, organizational structure, mandates and activities in the groundnut subsector. The existing marketing system in the subsector was also reviewed.

Fieldwork involved consultations and interviews with various stakeholders in the groundnut subsector. 20 households were randomly selected from each of the three villages of Gomani, Mgubo and Mikayere within the Zulu Extension Planning Area (EPA) involving 60 households in total. Questionnaires were used for household interviews with the farmers while checklists were used for other stakeholders, including focus group discussions (FGD) with farmer representatives in the study areas. The stakeholders included marketing agents, policy-makers, farmers, traders, assemblers, transporters and processors. A team of research assistants and enumerators was recruited and trained on the study tools for the fieldwork under the supervision of the principal researchers.

Load tracking and sampling

Quality analysis – Groundnut samples of about 1 kg each were collected from several bags as representative samples. The analyses were conducted in the Crop Storage Laboratory for evaluation of quality losses. The percentage of damaged grains was determined, as well as the causal factors: presence of insect pests such as weevils and presence of fungal spores on the shells as a sign of aflatoxin contamination. Unshelled groundnuts were shelled first before assessing the quality parameters.

Load tracking – The load of four farmers was followed at the farm storage stage in Kamwendo (Mchinji district). The load comprised a specific quantity of polypropylene bags of 45 to 50 kg capacity (a bag was considered the sampling unit). Quantitative and qualitative losses of groundnut, before and after one month of storage, were measured and the respective causes were identified. The load was weighed just before storage and after. Samples were also collected from the 45 to 50 kg bags for laboratory analysis, using a bag-sampling spear. Each sample was about 1 kg and another 200 g of a working sample was extracted using a sample divider.

Food losses were estimated along the FSC using the results of the interviews with various actors, field observations, as well as qualitative and quantitative analyses of samples collected at different stages of the supply chains.

Policy-making and national strategies

After the worldwide food crisis in the mid-1970s, considerable development investment went into post-harvest loss (PHL) reduction for staple crops. Various policies, strategies and initiatives were put in place globally, regionally and nationally as a way of reducing PHL. Malawi has a number of policies and strategies that are related to the agricultural sector. It was noted, however, that most of these policies and strategies focus on the drive for food self-sufficiency, and programme financing has given priority to the production of the staple food crops, maize and legumes, through the Farm Input Subsidy Programme (FISP) (Chirwa and Dorward 2013). No specific policy aims to promote and improve post-harvest loss management (PHLM) interventions and technologies.

The policies and strategies that take into account the objective of PHL reduction and have a direct impact on post-harvest management are:

- The Green Belt Initiative (GBI) was developed in 2011 to use the available abundant water resources for irrigation farming, thereby mitigating the effects of climate change on food and nutrition security. The GBI strategies for minimizing PHL include the following interventions which, however, need to be backed by regulations and Environmental Impact Assessments (EIA):
  - improved storage structures such as metallic silos;
  - integrated pest control measures;
  - agroprocessing for value addition and increased shelf-life; and
  - climate-change mitigation and adaptation.
- The Agricultural Sector Wide Approach (ASWAp) was developed in 2010 with the objective of increasing agricultural productivity, contributing to 6 percent annual growth in the agricultural sector, improving food security, diversifying food production to improve nutrition at the household level, and increasing agricultural incomes of people living in rural areas. ASWAp states the country will increase maize productivity, reduce post-harvest losses and diversify food production. ASWAp is promoting the adoption of post-harvest management technologies such as the use of pesticides to control the Large Grain Borer (LGB) in maize, and storing the maize in appropriate silos.
- The draft National Agricultural Policy (NAP) of 2011–2016 considered various production factors such as the use of improved technologies, the use of hybrid crop varieties that are high yielding and resistant to pests, and the use of pesticides as a way of reducing PHL. In this way, the draft policy had a direct impact on production and post-harvest management in the agricultural sector. The draft National Agriculture Policy 2016–2020 incorporates some strategies for PHL.
- The good results of the FISP strategies increased maize productivity and led the GoM to introduce improved PHLM technologies, mainly for storage, as one of the strategic options for reducing PHL. Four improved PHLM technologies or interventions have been promoted to complement the FISP outcome in the quest to attain sustainable food security at the household and national levels. They include:
  - air tight hermetic bags;
  - small metallic silos;
  - brick or cemented silos, to replace the traditional granary made from bamboo; and
  - application of pesticides.

The effectiveness of these promotion campaigns has not been well documented. The Warehouse Receipt System (WRS), as implemented by the Agriculture Commodity Exchange for Africa (ACE), is also a viable PHLM marketing initiative.

Policies that do not specifically address PHL but may address it indirectly are:

- The Malawi Growth and Development Strategy (MGDS II), which is the Government's overarching medium-term strategy, was drafted for implementation from 2011 to 2016 to attain the nation's 'Vision 2020'. In the context of the MGDS II, Agriculture and Food Security is one of the key priority areas where the country was expected to accelerate the attainment of the Millennium Development Goals (MDGs). In the area of productivity, the MGDS II mainly focuses on increased agricultural production but does not directly indicate how PHLM interventions are to be incorporated and implemented as a way of reducing PHL (GoM, 2011).

- The National Export Strategy (NES) is a five-year (2013-2018) national strategy, which provides a clearly prioritized road map for building Malawi's productive base to generate sufficient exports to match the upward pressure on Malawi's imports (GoM, 2012c).
- The National Food and Nutrition Policy (2005), has a direct linkage with availability and access to food in the country.
- The National Agricultural Extension Policy (2000), the Crop Production Policy (1987), the Nutrition Policy (2006) and the National Seed Policy (2007) all either do not address PHL or address it indirectly, and
- the Economic Recovery Plan (ERP, 2012-2017).

Study areas

The study took place in Zulu EPA in Mchinji district. The choice of this geographic area was based on the fact that IFAD is supporting agricultural productivity in these areas through the Smallholder Agriculture Productivity Project.

Executive Summary

Groundnut is one of the crops most commonly grown by smallholder farmers in Malawi. The crop serves as a source of income and is also consumed in various forms. In the 1960s and 1970s, Malawi was one of the major exporters of groundnuts to Europe. This trend collapsed during the 1980s because of problems with aflatoxin and increasing consumer awareness of food safety issues. In addition, production levels declined as a result of a number of factors, including small landholdings where the crop was cultivated, poor agronomic practices, low-yielding varieties and low prices offered to farmers in the era of liberalized marketing. Furthermore, high post-harvest losses, estimated at around 30 percent also contributed to low volumes of the commodity available for sale as well as household consumption.

Despite low productivity, groundnut is considered as one of the most important food crops. Freeman *et al*. (1999) noted that groundnut is used in various forms, including direct consumption, boiled, roasted, fried, or as ingredients in other foods. Groundnut is also used as a major ingredient in the manufacture of ready-to-use therapeutic food, which is used in the treatment of severe acute malnutrition (SAM) in young children and the chronically ill. The GoM identifies groundnut as one of the main livelihoods sources in the form of cash income, employment, and also as one of the commodities for reduction of post-harvest losses. In recent years, the Government and other partners have made increasing efforts to promote the production and marketing of groundnuts.

In recognition of the high levels of post-harvest losses in the groundnut subsector, FAO, in collaboration with IFAD and the Centre for Agricultural Research and Development (CARD) of the Lilongwe University of Agriculture and Natural Resources, commenced a study to assess quantitative and qualitative losses along the groundnut supply chain.

Specifically, the objective of the study was to identify and assess the main causes of food losses along a selected groundnut supply chain. The study also aimed to identify measures to reduce food losses along the supply chain and at the policy level.

The study was undertaken in the Zulu EPA in Mchinji district and used the FAO methodology developed in 2014, which was described under Methodology.

Formal and informal supply chains were identified in the groundnut subsector. The formal supply chain is more organized, complying to formal rules and regulations resulting in minimal losses and waste. On the other hand, the informal supply chain is less organized and often does not comply with formal rules and regulations and uses unconventional forms of measurement such as pails and buckets when selling the groundnuts. The informal supply chain therefore has a greater chance of incurring higher losses. It was on this basis that the study focused on the informal supply chain to better understand the different activities along the supply chain, which could lead to developing measures to reduce losses.

Four critical loss points were identified along the selected supply chain, which are drying, stripping, shelling and storage. The combined quantitative and qualitative losses for the different critical loss points were estimated at 17.8 percent.

Provision of proper extension messages about good post-harvest management practices, provision of drying facilities within the communities, and increasing the number of post-harvest specialists to support the farming communities are a few of the measures employed to reduce drying-related losses. Introduction of labour saving stripping equipment will minimize the use of under-age child labour, thereby minimizing losses at the stripping stage.

Measures that can reduce losses during shelling include the introduction of affordable shelling machines, extension messages addressing the implications of sprinkling water during shelling, affordable credit schemes and addressing the issue of trust regarding the use of weighing scales.

Interventions to reduce storage losses would include awareness-raising among farmers as to recommended moisture content for safe storage of groundnut, introduction of technologies to verify moisture content, termite control using pesticides in the field, control of rodents using rodenticides, the use of cats and metal rat guards, and promoting the use of these strategies.

Some of the recommendations made by the study include:

- The provision of suitable extension services on groundnut post-harvest management along the chain.
- The introduction and use of appropriate equipment and technologies for various operation such as digging, shelling and storage to minimize losses, which should also include the use of appropriate weighing scales to avoid cheating during buying and selling of groundnuts.
- Enforcing compliance to recommended moisture levels for groundnuts at various stages of the supply chain to avoid aflatoxin contamination.
- Promoting the establishment of farmer organizations such as associations and cooperatives to facilitate technology transfer as well as access to inputs and other services.
- Development of capacity at different stages of the supply chain through training of post-harvest professionals and introduction of post-harvest related courses at the various levels of academic institutions; and
- Provision of affordable credit facilities for different operations along the supply chain. This can be achieved through the establishment of credit schemes with reasonable interest rates as opposed to the current interest rates, which are over 35 percent.

Chapter 1
Introduction and background

STATUS AND IMPORTANCE OF THE GROUNDNUT SUBSECTOR

Malawi's population is an estimated 17.3 million people, over 80 percent of the population largely depend on agriculture for their livelihoods. The agricultural sector is subdivided into smallholder and estate[1] subsectors. The smallholder subsector is predominantly subsistence crop farming cultivating maize and legumes[2] for home consumption and selling the surplus for cash. Agricultural production in Malawi is mainly rainfed; as such the agricultural calendar starts around November, which is the onset of the rain season.

Being an agrobased economy, Malawi heavily relied on tobacco over the years as it was the main foreign currency earner. However, the

FIGURE 1.1
Map showing area the Mchinji district Zulu extension planning area covered by the study

[1] Also referred to as large-scale or commercial subsector

[2] Such as groundnuts, beans, soybeans and bambara nuts

tobacco industry is facing a number of challenges including fluctuation in production and prices. In addition, anti-smoking lobbying including the World Health Organization (WHO), is a threat to Malawi's tobacco industry.

In response to the declining performance of the tobacco industry, the Government of Malawi, in collaboration with other partners, is scaling-up efforts to diversify the economic base through the promotion of other commodities that could replace tobacco. One such commodity is groundnut, which, the Government and other partners have been increasingly promoting the production and marketing of the crop.

The groundnut crop has been cultivated in Malawi since the mid-nineteenth century, mostly by an estimated 3 million families of smallholder farmers. The crop is often grown in rotation with other crops such as maize and tobacco. About twelve varieties are cultivated in different areas. The main varieties grown in the study area are Chalimbana and CG7, which are grown at medium altitude ranging from 1 000 m to 1 500 m above sea level. Areas include the Lilongwe district, the Kasungu Plai including Mchinji district, the Upper South Rukuru Valley, Shire Highlands and the Chitipa Plain. These areas are characterized by moderate temperatures and a fairly long rainy season of between four to five months with an average rainfall of about 875 mm per year (GoM, 2012a). Pound and Phiri (2011) observed that beginning in the mid-1970s, groundnut became a subsistence crop with male farmers abandoning the crop for more profitable cash crops such as tobacco, thereby leaving greater responsibility for the crop with female farmers.

The harvested area increased from about 203 000 ha in 2006 to 360 000 ha in 2015. Similarly, production increased from 245 000 tonnes in 2006 to 381 000 tonnes in 2014 and fell dramatically from 2014 to 2015, reaching 286 000 tonnes in 2015, which was the total production of the main varieties (Chalimbana, Malimba, CG7, JL 24, Nsinjiro and Baka), produced by smallholder farmers (FAOSTAT, 2015; GoM, 2012b). Increased production has been hampered by several factors including unpredictable climatic conditions, pests and diseases, poor soil fertility and cultural practices. Production during the 2014/2015 season fell, mainly because of poor rainfall in most parts of the country.

Pound and Phiri (2011) further observed that groundnut yields in Malawi (0.79 tonne/ha in 2015) are poor compared to other groundnut producing countries, and exports have been hard hit by the stringent aflatoxin regulations imposed by importing countries, particularly the European Union (EU) and Japan.

Groundnut is considered to be one of the most important food crops as it is used in different forms including as a snack in its raw form, roasted, boiled, or used to season different types of leafy vegetables. Groundnut is also used as a main ingredient in the manufacturing of a ready-to-use therapeutic food, which is used in the treatment of Severe Acute Malnutrition (SAM) in young children and the chronically ill. Moreover, groundnuts are a good source of vegetable oil and protein in addition to being used as raw material in the production of animal feed and as an ingredient in a variety of confectionary products.

Groundnut culture is also a source of foreign exchange, although the crop's export potential has not been exploited fully because of low production.

TABLE 1.1
National production information on the groundnut subsector

	Annual production (tonne/year)	**Cultivated area** (ha)	**Average yield** (tonne/ha)	**Value** (USD/year)
Raw material, data for 2015	286 081[3]	359 975	0.790	191 674 270[4]
Average annual growth over the last 10 years (%)[5]	5.3	5.0		
Average cost of production (USD / tonne)	222.29			

Source: Literature search and interviews with key informants

[3] The figure is for the 2014/2015 production season.

[4] At the exchange rate August to November 2015: USD 1 = Malawi Kwacha (MWK) 670

[5] Calculated using data from the Ministry of Agriculture agricultural production estimates.

TABLE 1.2
Food safety management mechanisms

Controller	Control	Actual situation in the FSC		Responsible agent
Government regulation and requirements	National food safety/ quality standards	Exists and applies to the whole FSC		Malawi Bureau of Standards
		Exists but not rigorous	Yes	
		None		
	Frequency of checking (None, Low, Medium, High)	Harvest	None	Malawi Bureau of Standards
		Transport	None	
		Storage	Low	
		Process	High	
		Market	None	
	Obligatory registration of the food processing/ preparation unit	Exists	Yes	Malawi Bureau of Standards
		None		
FSC actors - food safety management system	GHP/ GAP/ HACCP/ voluntary standards	GHP/GAP/Voluntary standards		
	Identification of potential hazards	GHP		Malawi Bureau of Standards

Source: Preliminary screening data

The GoM has identified groundnut as one of the main livelihood sources in form of cash income, employment, also it is one of the commodities selected for reduction of post-harvest losses. Further, in recent years, the Government and other partners have increased efforts to promote the production and marketing of groundnuts. Table 1.1 gives the national production information for the groundnut subsector and Table 1.2 gives an overview of food safety mechanisms.

INVENTORY OF ACTIVITIES AND LESSONS LEARNED FROM PAST AND ONGOING INTERVENTIONS

In addition to government strategic approaches (see *Relevant institution and their roles*), several projects, including the Rural Livelihoods Economic Enhancement Project (RLEEP), have been implemented to promote groundnut production and processing. NASFAM pursues the same objective through various associations across the country.

Recently, the GoM recommended smallholder farmers use Purdue Improved Crop Storage bags or PICS to minimize post-harvest losses during storage caused by aflatoxin and weevil infestation. *Aflasafe*, a biocontrol, was introduced into Malawi in an effort to prevent aflatoxin contamination in groundnut and to minimize losses in the field and during storage.

Moreover, studies are ongoing regarding the mechanization of some farm operations, including lifting of groundnuts. On-farm trials using Compatible Technology International's (CTI) ox-powered lifters were conducted, resulting in the technology being promoted in Kasungu in 2012 (Spieldoch *et al*., 2013).

The Department of Agricultural Research Services (DARS) in collaboration with NASAF continue to conduct studies on production practices that minimize field aflatoxin contamination.

RELEVANT INSTITUTIONS AND THEIR ROLES

The Ministry of Agriculture, Irrigation and Water Development (MoAIWD) is the main institution involved in the development and dissemination of PHLM technologies. The three technical departments, the Department of Agricultural Research Services, the Department of Crop Development (DCD) and the Department of Agricultural Extension Services (DAES) are involved in disseminating PHLM technologies.

The Pesticide Control Board (PCB), in collaboration with the Department of Environmental Affairs (DoEA), monitors the safety standards of pesticides used to ensure they are within acceptable health and safety levels.

Some private sector institutions and non-governmental organizations (NGOs) also offer exten-

FIGURE 1.2
One of the trials – Improved grain storage structure

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FIGURE 1.3
Informal roadside sales of groundnuts and other

©FAO/ CARD

sion services for PHLM technologies, though at a lower scale, and usually in collaboration with the MoAIWD.

Research into PHLM technologies is conducted by DARS through three of its research stations. Research is coordinated under the Plant Protection Commodity Group, mainly through the Crop Storage and Produce Inspection Units. Trials using PHLM technologies include: timely harvesting of the crop, use of various pest control measures for example application of pesticides and storage in bags, use of modern mini silos (Nkhokwes), smear-mudded granaries (Figure 1.2), metallic silos, etc.

The Consortium of International Agricultural Research Centres (CGIAR) and international organizations such as the International Maize and Wheat Improvement Centre (CIMMYT), the Natural Resources Institute (NRI), and the Lilongwe University of Agriculture and Natural Resources (LUANAR) are among some of the institutions involved in PHLM.

OVERVIEW OF THE MOST IMPORTANT GROUNDNUT SUPPLY CHAINS

The groundnut subsector comprises two main supply chains, the informal or non-regulated and the formal or regulated. The informal supply chain is mostly made up of smallholders, small-scale traders and vendors.

The formal supply chain comprises smallholder farmers, assemblers who buy groundnuts from individual smallholder farmers and small-scale traders who in turn sell the groundnuts to large-scale traders. Other major players are the cottage shellers.

The informal groundnut supply chain was selected for a detailed case study. Unlike the formal supply chain, which is more organized and complies with formal rules and regulations resulting in minimal losses and waste, more losses are found in the informal supply chain because rules and regulations are not followed. One common feature of the informal supply chain is the use of pails and buckets to measure the groundnuts. Further, selling by the roadside exposes the groundnuts to excessive heat from the sun, resulting in over drying and loss of quality (Figure 1.3).

The selected supply chain (Table 1.3) is in Mchinji district, the three villages of Gomani, Mgubo and Mikayere in the Zulu EPA.

The study site was chosen because there is an ongoing IFAD project in the area, the Smallholder Agriculture Productivity Project (SAPP) also, in the same area, RLEEP is promoting groundnut production and marketing.

Estimation of the quantities produced involved asking the sampled individual households about how much groundnut was produced during the 2014/2015 growing season. The 60 sample households in the three selected villages produced an estimated 6.3 tonnes. A total of 9 059 tonnes was produced by farmer households throughout the EPA. Table 1.4 shows the importance of the supply chain nationally and Table 1.5 indicates its importance for the actors.

PRESUMED FOOD LOSSES IN THE INFORMAL GROUNDNUT SUPPLY CHAIN

The findings revealed that lifting and marketing are the low loss points (LLP) along the groundnut supply chain for both quantitative and qualitative losses. There are critical loss points (CLP) during drying, farm storage, hand or

TABLE 1.3
Food supply chains in the subsector

Type of Food Supply Chain	Geographic area of production	Final product	Volume of final product (tonne/year)	No. and gender of smallholder producers	Market for final product location, buyers	Project support
Informal	Gomani village	Groundnuts	2.80	120 Female headed 183 Male headed	Multiple locations and buyers	SAPP[6]
Informal	Mgubo village	Groundnuts	1.80	66 Female headed 183 Male headed	Multiple locations and buyers	SAPP
Informal	Mikayere village	Groundnuts	1.73[7]	57 Female headed 116 Male headed	Multiple locations and buyers	SAPP
Informal	Zulu EPA	Groundnuts	9 059	17 902 Female headed 1 852 Male headed		
Formal	Country wide	Groundnuts	286 080	> 2.5 million	Domestic and export markets	Predominantly by the Government

Source: Preliminary screening data, field survey

TABLE 1.4
Importance of the groundnut supply chains at national level

Type of Food Supply Chain	Economic importance	Generation of foreign exchange	Contribution to national food consumption	Contribution to national nutrition	Environmental impact
Informal	2	1	2	3	1
Formal	2	3	3	3	2

Source: Preliminary screening data

TABLE 1.5
Importance of the groundnut supply chains for the actors

Type of Food Supply Chain	Percentage of produce by smallholders	Income-generation	Involvement of the poor	Employment provision
Informal	100	3	3	1
Formal	95	3	3	2

Source: Preliminary screening data

machine shelling and warehouse storage, where both quantitative and qualitative losses were reported (Table 1.6).

Furthermore, stripping was recorded as a low lost point. It was emphasized that development of aflatoxin mostly occurs on the groundnut shells during drying and not on the grains. Pest-infestation is common during storage where the groundnut is held for most time in the supply chain. The common pests include rodents and groundnut weevils; the insects are found to be less problematic when groundnuts are stored in the shell. The presumed critical and low loss points are summarized in Table 1.6 below.

[6] The Smallholder Agriculture Productivity Project is jointly supported by the GoM and IFAD and operating in Zulu EPA where the study was conducted in the three selected villages.

[7] The volumes of final product in the three first rows are estimates from the sampled households with an average landholding size of 0.6 ha.

TABLE 1.6
Presumed food losses in the FSC

Step in the FSC	Expected Loss Points		Comments /Remarks
	Quantitative CLP or LLP	Qualitative CLP or LLP	
Lifting	LLP	LLP	Almost all smallholder farmers use hand hoes
Drying	CLP	CLP	Aflatoxins occur at the time of drying if the conditions are humid (because of light rains at the time of harvesting) and are conducive to the development of fungus (leading to loss of quality). Pests also damage pods, resulting in loss of quality and quantity.
Stripping	CLP	LLP	Quantity losses are common during stripping because under-age child labour is used. Pods are not stripped and are left on the haulms.
Storage	CLP	CLP	Both types of losses (quantitative and qualitative) commonly occur because of pests such as rodents because they can easily enter most storage structures. Many smallholder farmers store groundnuts in polypropylene bags in their dwellings, the rodents easily enter the structures.
Hand/Machine Shelling	CLP	CLP	Conducted at farmers' premises where water is sprinkled to soften the pods for easy shelling. This results in both losses of quality and quantity. The use of machine shellers commonly results in a high percentage of broken or damaged nuts; hence there are both quality and quantity losses when nuts are taken to the market.
Marketing	LLP	LLP	At this point, farmers or small traders are extra careful when handling the groundnuts. Selling is commonly in bulk where the commercial buyers use weigh bridges, which minimizes quantity losses. The use of clean polypropylene bags ensures there are fewer losses-
Storage	CLP	CLP	Shelled nuts are stored in warehouses for a longer period and the major issues are rodent and weevil infestations, resulting in quality and quantity losses. This also affects the export volume of groundnuts after grading. Normally rejection occurs where pest control becomes a problem for some warehouse operators, when rodents and weevils migrate from heavily infested warehouses to other warehouses (in an area where cross infestation is common).

Source: Preliminary screening data, field survey

Chapter 2

Groundnut supply chain – situation analysis

DESCRIPTION OF THE INFORMAL GROUNDNUT SUPPLY CHAIN

The selected informal supply chain is in Mchinji district, the three villages of Gomani, Mgubo and Mikayere in the Zulu EPA.

In 2015, fieldwork was undertaken between August and November and 20 households were randomly selected from each of the three villages.

Most crops, including groundnuts, are planted in December and weeding, disease and pest control take place up to March. Harvesting of groundnuts, which includes digging using hand-hoes, sun-drying and hand-stripping, starts between April and May, which is also the onset of the marketing season. Marketing commences around April, reaches a peak between June and August and then slackens from September onwards until the next harvest.

There are four main final products in the informal supply chain and these are fresh boiled nuts (unshelled), raw nuts (both shelled and unshelled), roasted nuts (shelled and unshelled) and groundnut flour, which is used in food seasonings, especially vegetables and porridge.

Groundnuts are taken from primary producers to the consumers through several players including small-scale and large-scale traders, assemblers, transporters, warehouse agents, vendors, cottage shellers and processors. The main activities undertaken by the various players along the supply chain are harvesting, drying, transportation, shelling, storage, trading or selling and processing.

FIGURE 1.4
'Mandela Corks' in the Field

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Harvesting – The study revealed two important steps in the harvesting of groundnuts: lifting the groundnut haulm from the ground and plucking the nuts from the haulms. Lifting requires digging up the groundnut haulms and stacking them in heaps with the nuts facing up. The *Mandela Cork* (Figure 1.4) is one of the most recently introduced methods used to dry the nuts in the field.

Stacking with haulms facing up facilitates fast drying of the groundnuts in the pods and avoids development of moulds. The heaps are left in the field for the groundnuts to dry and the pods are harvested once the groundnuts are confirmed dry. A hoe is used for lifting, which is the only tool farmers use to lift the nuts. In the second stage of groundnut harvesting, the pods are plucked off the haulms by hand one by one.

Transportation to homestead – After harvesting, the next stage in the groundnut food supply chain, is transportation to the homestead. The respondents said that most groundnuts are transported as head-loads. A few farmers use bicycles and ox-carts.

Shelling – Groundnut shelling is another important step in the groundnut FSC, which involves removing the nut from the pod. In the past Chitedze Research Station promoted groundnut shellers, but they are not popular among smallholder farmers because of the high level of breakage. Commercial shellers are available on the market but many smallholder farmers cannot afford them, hence shelling by smallholder farmers is 100 percent by hand (Figure 1.5).

FIGURE 1.5
Hand shelling of groundnuts

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FIGURE 1.6
Groundnuts contaminated by mixing with maize

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FIGURE 1.7
Shelling Machines at Mgona Township in Lilongwe City

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FIGURE 1.8
Women winnowing groundnuts at Mgona in Lilongwe city

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Shelling is time-consuming and causes blisters on the thumbs. To make hand shelling easier, many smallholder farmers sprinkle water on the pods to soften them. This may cause mould, which results in aflatoxin contamination of the nuts. The hand shelling of groundnut is sometimes concurrent with maize shelling. This practice is a likely cause of losses through contamination (Figure 1.6). Study of the informal supply chain, therefore, provides a greater opportunity for understanding some of the critical loss points and helps in identifying specific strategies to minimize post-harvest losses.

The 'Cottage shelling centre' – was identified in Mgona Township in the city of Lilongwe. Small and large-scale traders from around Lilongwe, and other parts of the country, including the study site (Zulu EPA), bring their groundnuts to this centre for shelling. In the cottage industry, individuals own one or more shelling machines (Figure 1.7), which are locally made and a fee is charged for shelling. Women are also involved as casual workers who winnow the shelled nuts as portrayed in Figure 1.9.

Selling – The groundnuts are sold at various stages of the supply chain, including right from the farmgate where smallholder farmers sell some of the nuts to individuals and traders. The traders in turn sell to processors. Selling tools and practices are often unconventional along the informal supply chain, including the use of buckets instead of standardized weighing scales and selling by the roadsides.

Storage – Ordinarily, groundnuts are stored on-farm unshelled or shelled. Some of the storage structures include the traditional granary and polypropylene bags for unshelled and shelled groundnuts respectively (Figures 1.10 and 1.11). Most smallholder farmers store the un-shelled groundnuts in polypropylene bags, which are kept inside houses.

FIGURE 1.9
Traditional granary

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FIGURE 1.10
Groundnuts stored in polypropylene bags

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Transport to the market – Most smallholder farmers transport their groundnuts to the market using ox-carts, bicycles, vehicles or the crop is carried on the head. The groundnut is either in unshelled or shelled form and normally packed in polypropylene bags. The ox-carts and bicycles are commonly owned by the smallholder farmers or hired within the community.

Industrial processing – In addition to the cottage shellers, there are industrial processors who process the nuts into various products such as peanut butter, cooking oil and snacks (roasted and packaged). The nuts are also used as an ingredient in various confectionery products. Groundnut cake is a by-product of oil production, after pressing, and is used as an ingredient in livestock feed. The processed products: peanut butter, cooking oil and livestock feed are sold on the domestic and export markets.

Shelled groundnuts are the main intermediary product after harvesting and before industrial processing. Consultations with C-To-C Engineering, which manufactures shelling equipment indicated that, whole kernels after shelling have an estimated 98 percent efficiency, implying that 2 percent is the allowable waste as breakage.

DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – BASICS

It usually takes between 10 to 31 days to complete each of the field post-harvest activities (e.g. lifting, drying, stripping and transportation), using either hired or family labour. Men dominate as labour for all the activities except stripping, which is mostly done by women (Table 1.7).

At the homestead, primary processing is made up of the following steps: in-shell storage, shelling, cleaning and grading, and lasts between 10 to 15 days. These activities occur from August to December. The use of polypropylene bags is common for storing groundnuts at the smallholder level, though some farmers use traditional temporary storage structures before packaging the shelled groundnuts into polypropylene bags for storage indoors. The longest storage period occurs in the grain warehouses (Table 1.7).

THE GROUNDNUT MARKETING SYSTEM

Groundnut marketing in Malawi, including the study area, is conducted under a liberalized marketing system, influenced by the International Monetary Fund (IMF) and the Structural Adjustment Programmes (SAPS) that were sponsored by the World Bank and took effect in the early 1980s. The liberalization of agricultural input and output markets aim to enhance competitiveness in the domestic and international markets through private sector participation. Prior to liberalization, smallholder farmers sold their produce through the state-owned Agricultural Development and Marketing Corporation (ADMARC), which was the sole buyer of groundnuts and dictated the price until 1987 (Derlagen and Phiri, 2012).

Minde *et al.* (2008) noted that poor pricing structure is a disincentive to increased groundnut production because groundnut is a labour intensive crop and the low prices mean that farmers

TABLE 1.7
Detailed description of the informal groundnut supply chain

	FSC stage	Location	Period			Number of actors		Products	Quantity (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services
			Start date	End date	Days	Men	Women					
	Primary production											
Harvesting	Uplifting	Field	April	June	31	40	20	Pods	6.3	Hand hoes	10-31 days	Hired/Family labour
	Field drying	Field	June	July	21	45	15	Pods	6.3	Baskets	14-21days	Hired/Family labour
	Stripping	Field	July	Aug.	20	12	48	Pods	6.3	Baskets	2-20days	Hired/Family labour
	Transportation	Field	Aug.	Aug.	3	55	5	Pods	6.3	Ox-cart, Bicycles	3 km	Hired
	In-shell storage	Homestead	Aug.	Dec.	150	54	6	Pods	6.2	Polypropylene bags, traditional granary	61 days	
Primary processing	Shelling	Homestead	Oct.	Nov.	60	17	43	Pods	6.1	Hands, mats	15 days	Hired/Family labour
	Cleaning	Homestead	Sept.	Oct.	30	10	50	Grain	6.1	Baskets	10 days	Hired/Family labour
	Grading	Homestead	Sept.	Nov.	30	5	55	Grain	6.0	Baskets, mats	20 days	Hired/Family labour
	Bagging	Homestead	Sept.	Nov.	30	45	15	Grain	5.9	Polypropylene bags	5 days	Hired/Family labour
	Household storage	Homestead	Aug.	Jan.	150	50	10	Grain/Pods	5.4	Polypropylene bags	200 days	Family labour
	Vendors	Homestead	April	Jan.	150	40	20	Grain/Pods	4.2	Polypropylene bags	60 days	
	Traders/Intermediaries	Market	April	Jan.	150	45	15	Grain/Pods	3.1	Polypropylene bags	60 days	
	Transporting	Market	July	Jan.	150	55	5	Grain/Pods	3.5	Trucks, Polypropylene bags	120 days	Hired
	Informal markets	Market	April	Oct.	215	45	15	Grain/Pods	2.5		180 days	
	Centralized storage	Warehouses	May	Dec.	245	50	10	Grains	4.2	Warehouses, Polypropylene bags	300 days	
	Distribution/resale	Market	Oct.	March	186	50	10	Grains	2.5	Polypropylene bags, Trucks	300 days	
	Processing	Millers	May	March	335	55	5	Grains	2.1	Electric shellers, Processing Plants	250 days	Hired labour, water, packaging materials
	Wholesale	Market	Aug.	March	243	5	5	Grains	3.0	Warehouses	300 days	Hired labour
	Retail	Market	May	March	335	7	3	Grains	2.4	Polypropylene bags,	300 days	

Source: Field Survey

FIGURE 1.11
Fenced open space at Walilanji

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cannot make a profit and therefore cannot increase the area that drives production.

The onset of SAPS led to an influx of private traders of different magnitudes with respect to the scale of operation. There are different categories of traders who buy groundnuts from smallholder farmers. Among them are itinerant or mobile buyers, assemblers and large-scale traders. The itinerant buyers are mostly indigenous Malawians who travel from household to household and buy small quantities of groundnuts from the smallholder farmers. These traders usually use bicycles for transport and often sell their groundnuts to the assemblers and larger-scale traders. The assemblers either own or rent the premises where they operate, buying groundnuts from individual smallholder farmers and itinerant traders. Some of these assemblers have warehouses where they store the groundnuts while others store the groundnuts in open fenced premises.

In addition to the itinerant buyers and assemblers are the large-scale traders. These are either indigenous Malawians or foreigners, who are mostly from Burundi, Rwanda and Tanzania. Such buyers usually operate several satellite buying points and normally buy from smallholder farmers, itinerant buyers and assemblers. In some

FIGURE 1.12
The structure of the groundnut supply chain

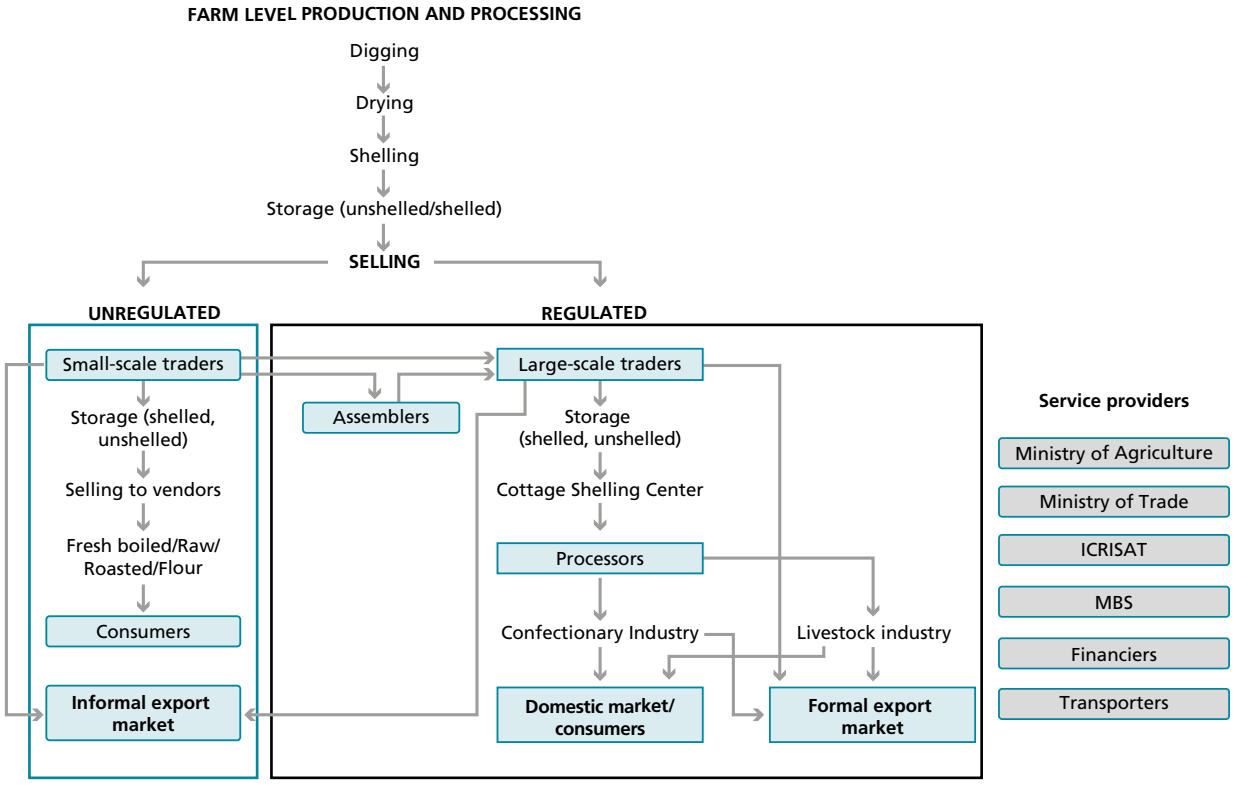

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TABLE 1.8
Stakeholders in the selected supply chain

Stakeholder	Number	Volume of product (tonnes) in the 2014/15 Season	Estimated income (USD)* per year	Estimated Jobs created
Smallholder farmers	725[8] 60[9] 19 754[10]	- 6.3 9 059	- 3 545 5 097 378	- Family labour is usually employed
Traders including assemblers	11	Ranges from 1 to 120	560 to 67 200	Various categories of employees, including security guards, clerks and casual labour
Transporters[11]	5	11 to 17.5	6 160 to 16 800	10[12]
Warehouse agents[13]	5	60-6 000	33 600 to 3 358 589	Various categories of employees including security guards, clerks and casual labour
Cottage shellers	>10	Not estimated	Not estimated	Several people employed as casual workers, including women winnowing the shelled groundnuts
Processors (including the confectionary and livestock industry)	Several of them ranging from small, medium to large-scale processors	Not Estimated	Not estimated	Several jobs are created
Consumers	Numerous	Difficult to estimate the benefits from the nutritional viewpoint		No employment is involved

Source: Field survey
*Average price range of 0.56 USD/kg

cases, the large-scale traders employ buying agents who operate in the same way as itinerant buyers. The large-scale traders often own warehouses and trucks for transporting their produce. The large-scale traders sell their groundnuts mostly to local processors as well as to export markets. The structure of the informal (unregulated) and formal (regulated) supply chains is depicted in Figure 1.12.

ACTORS IN THE SUPPLY CHAIN: INVOLVEMENT, BENEFIT, JOB CREATION AND INCOME

Various stakeholders are involved in the groundnut supply chain as shown in Figure 1.12. As indicated earlier in the report, major stakeholders along the supply chain are smallholder farmers, traders, assemblers, transporters, processors, and consumers. Table 1.8 presents a summary of the number of stakeholders, and an estimate of their revenue along the supply chain based on the interviews during the field survey.

Social structures in the supply chain

The different activities along the supply chain take place in specific social contexts and under varying conditions. The social structures determine the differentiated gender roles, including the roles of girl and boy children. In general, women usually participate in activities requiring more intensive labour, and have different (often less) access to resources and services than men. Women tend to be less involved in rural organizations and decision-making, which limits their access to facilities, information and markets.

A sample size of 86 respondents was used for the groundnut study. The distribution of the sample was 50/50 for men and women. The age distribution is shown below; 50 percent of the

[8] Total population for the three selected villages
[9] Selected households from the three villages
[10] Total population for the whole Extension Planning Area
[11] Number of trucks ranging from 1 to 4
[12] For the five transporters interviewed, employing a driver and an assistant
[13] Capacity ranging from 500 to >2 000 tonnes

TABLE 1.9
Age distribution of the respondents

Age distribution (N=86)	
Percentiles	***Age range***
First quartile	21 – 31
Second quartile	31 – 38
Third quartile	39 – 54
Fourth quartile	55 – 72

Source: Field survey

TABLE 1.10
Crops grown

Crop	Crops grown last season		Household main crops	
	Respondents	Percentage of cases	Respondents	Percentage of cases
Maize	86	100	78	92
Groundnuts	82	95	48	56
Soya	56	65	32	38
Tobacco	6	7	2	2
Beans	8	9	1	1
Total	238	277	161	189

Source: Field survey

sample respondents are 38 years old or younger, meaning the population is relatively young.

Approximately 73 percent of the respondents were married and 27 percent were single. In terms of household composition, 73 percent identified themselves as heads of household; 91 percent of the male respondents are heads of household, compared to 56 percent of the female respondents. Membership to clubs is low at 43 percent of the respondents. In the study area, NASFAM has been promoting commercial production of groundnuts for many years. It is surprising that only 43 percent of farmers are members of a club; 49 percent of women said they were members of a club, compared to 65 percent of the men.

As stated earlier in this report, groundnut is a major cash crop in the Mchinji area. Respondents were asked to mention the crops they grew last season and indicate the ones they considered to be the main crops. Table 1.10 shows the results of the analysis.

All 86 respondents said they grew maize last season. Groundnut is ranked second, with 95 percent of the respondents saying they cultivated this crop last season. The main crops are maize, groundnuts and soya. Contrary to common thinking in Malawi, tobacco is not the main crop in this area and is grown by a mere 7 percent of the respondents.

Husbands and wives appear to be growing crops together. Hence, there is no significant difference between men and women regarding the crops cultivated during the previous season. Even when cross-tabulating for the main crops, the results are the same.

Groundnut harvesting

The questionnaire included a question on *who is involved in the harvesting of groundnuts*. Table 1.11 shows the division of labour and that 48 percent of harvesting is by women. Very few men are involved in harvesting groundnuts, which is probably because the crop has traditionally been cultivated by women. Harvesting groundnuts is also very tedious. Both the processes of lifting the groundnut haulm from the ground and plucking the nuts from the haulms involve hard work. Lifting is done using a hand-held hoe and this is the only tool farmers use to lift nuts. Nuts are plucked by hand by women, children and casual labourers, as there is no special equipment.

TABLE 1.11
Actors involved in groundnut harvesting

Group	Respondents	Percent
Women	41	47.7
Casual workers	16	18.6
Men, women and children together	14	16.3
Men	5	5.8
Men and women together	7	8.1
Women and children together	3	3.5
Total	86	100

Source: Field survey

TABLE 1.12
Responsibility, containers and transport used by men and women in harvesting groundnuts

	Activity	Percent contribution	
		Male	Female
Ensuring all groundnuts are harvested in the garden	Lifting and plucking	47.4	52.6
	Monitoring the field before going home	36.4	63.6
	Carefully harvesting groundnuts	22.2	77.8
Containers used to carry groundnuts from the garden by men and women	Baskets	41.9	58.1
	Polythene bags	23.8	76.2
	Buckets	0	100
Transport used to carry groundnuts from the garden by men and women	Head-loading	10.0	30.0
	Ox-cart	10.0	5.0
	Bicycle	80.0	65.0

Source: Field survey

Transport

Baskets are used almost equally between men and women, although more women than men use polythene bags to carry groundnuts. Buckets are mentioned 100 percent by women only. It was also noted that women and girls carry groundnuts from the field to homesteads. This is the custom and 30 percent of women carry the load on their head, compared to 10 percent of the men.

In the focus group discussions, people were asked to explain why they carried groundnut on their heads. Their response was that it is because their production is low and there is no need to hire an ox-cart. It was indicated, however, that a few farmers who harvest many groundnuts use bicycles and ox-carts, which are driven by young men. Only 5 percent of women said they used ox-carts against 10 percent of men. However, it is predominately women who load the crop into the ox-cart. During groundnut harvesting men predominantly use bicycles. All this shows that women are overburdened with a lot of work at harvest time.

Shelling

It was reported that shelling is a family activity, and all family members participate, including children. This is an activity where child labour is used significantly.

Table 1.13 shows the FSC steps and the key actors where groundnut losses occur. It was not useful to differentiate the conditions of participants' involvement, based on an evaluation of how well those identified were equipped, the sanitary conditions and their access to extension services and training. This is because everyone works under similar conditions during this stage of the FSC. None of the actors in the supply chain have received training or extension services in this area.

TABLE 1.13
Detailed description of the food supply chain – social structures

Supply Chain Steps	Involvement of Women		Involvement of Men		Who is mainly involved: women, men, children	Organization level of FSC actors	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult women	Boys	Adult men			
	Qualifier	*Qualifier*	*Qualifier*	*Qualifier*			
Harvesting	1	1	1	1	Women	Individual	- Lifting: Everyone uses the hand held hoe to lift the nuts. Hence there is no difference in equipment or sanitary conditions. With regard to extension services, none have received training or extension services in this area. - Plucking: Again mostly women are engaged in plucking along with children and casual labourers. There is no special equipment for plucking nuts; everyone involved uses their own hands. When assessing the accessibility of equipment, extension services and training, as well as the sanitary conditions, the results revealed they were not accessible or bad (qualifier '1').
Transportation	1	1	1	3	Women	Individual	Women and girls carry the groundnuts from the field to homesteads. When bicycles and ox-carts are involved, the activities are almost certainly carried out by men (ox-carts are driven by young men). However, women loading the crop into the ox-cart. At this stage, the rating is 'moderately good' to 'good'.
Shelling	1	1	1	1	Women	Family and neighbours	It was reported that shelling is a family process, i.e. all family members participate as well as children. This is an activity where child labour is used significantly. Shelling among the smallholder farmers is 100 % done by hand. Shelling is time consuming and causes blisters on the thumbs.
Transport to market	2	2	2	2	Men/Women	Individual	Transport to markets is mostly by bicycle. Even women hire bicycles to go to the markets.

Source: Field survey
Legend:
1. Bad equipment and sanitary conditions; extension services and training are not accessible.
2. Satisfactory equipment and sanitary conditions; extension services and training are somewhat accessible.
3. Good equipment and sanitary conditions; extension services and training are accessible.
4. Excellent equipment and sanitary conditions; extension services and training are easily accessible.

Chapter 3

Food losses – study findings and results

DESCRIPTION OF THE GROUNDNUT SUPPLY CHAIN RISK FACTORS

Preharvest conditions and actions in the field can indirectly lead to losses at later stages in the chain, as production and agronomic practices influence quality at harvest, suitability for transport and shipping, storage stability and shelf-life after harvest (HLPE, 2014). The risk factors that are likely to contribute to food losses are summarized in Table 1.14:

TABLE 1.14
Food Loss Risk Factors

Variable	Unit	Relation to food losses: contributing to low losses	Value (observed in the case study)
Crop variety/Fish/ Animal race	***Groundnuts***	***Resistant variety / race***	
Good Agricultural Practices (GAP)	Y/N	Yes	Y
Rainfall during production	mm	Optimum range	23
Production supply/demand ratio	Ratio	< 1	1.3
Rainfall during post-harvest phase	mm	Low rainfall	This mostly contributes during growth and harvesting, causing aflatoxin contamination.
Post-harvest technology	L/M/H	High	Lack of improved technologies.
POs / Cooperatives	Y/N	Yes	
Processing technology	L/M/H	High	Some are too expensive to be owned by smallholder farmers.
Good Manufacturing Practices (GMP)	Y/N	Yes	Badly applied, products are contaminated.
Packaging materials and facilities	L/M/H	High	Packaging materials not providing enough protection to the grain.
Cold chains	Y/N	Yes	Not commonly applied.
Transport duration	Hour	Low duration	Some grains get lost on the way from the field or from the factory to the distribution points.
Market information	L/M/H	High	Lack of marketing information results in selling the products at low prices, leading to losses.
Price incentive for quality	Y/N	Yes	Most farmers do not get better prices for better quality grains because vendors cheat.
Knowledge of FSC actors	L/M/H	High	Most farmers do not have information about how the FSC operates.
Consumer access to food product	L/M/H	High	

Legend: Y/N = yes / no; L/M/H = low / medium / high.
Source: Field survey

CRITICAL LOSS POINTS

The selected groundnut supply chain studied has four critical loss points: drying, stripping, shelling and storage. All four CLPs mainly occur at the farmer level although shelling also takes place at the trader level. A brief description of each loss point is presented below.

Drying

After the lifting stage, smallholder farmer's dry groundnut in the field, placing groundnut haulms in small rounds or upside down on ridges. Pest infestation from weevils, rodents and birds causes damage to the pods. The presence of weeds in the field sometimes creates an environment that is conducive to rodents breeding, which further damage the groundnut during drying. Some groundnut pods are damaged by livestock, wild animals, and eaten by passers-by such as school children. Here the problem is the lack of proper and affordable drying facilities in the farming communities.

Stripping

Hand stripping of groundnut is common among smallholder farmers using family or hired labour. Both adults and children participate. The process involves moving several small drying rounds of haulms to one point, and this results in some haulms being missed in the process. Apart from pods being left on the haulms, as they have not been stripped, some haulms are lost when spilled during transfer from the drying points to where they are stripped and the spillage is never collected. Weeds may also cause haulms to be left behind during haulm collection and stripping when some pods are left in the soil.

Shelling

Most smallholder farmers hand shell when harvesting groundnut, a practice commonly conducted by people of different ages and with the majority being children. This results, especially with the children, in lack of attention during shelling and some pods or nuts end up being mixed with the shells, thereby causing losses. Some farmers sprinkle water on the pods before shelling to soften the pods and make shelling easier. This action usually results in increasing the moisture content of the nuts thereby causing the development of aflatoxin. Sometimes, the farmers sprinkle water on shelled groundnuts a day prior to selling to increase the weight. As a counter-measure, by those who buy the groundnuts, they tamper with the weighing equipment resulting in a transaction that is not based on trust.

In addition, some small traders, who after buying groundnuts from the market in Kamwendo area, use shelling machines in Lilongwe town before selling the groundnut. The machine shellers are commonly associated with a high percentage of broken grains, causing losses in the process.

Farm-level storage

Among the storage facilities used are polypropylene bags, traditional granaries and metal drums

TABLE 1.15
Summary of quality scoring for groundnut

Quality score	Description of the quality	Percentage reduction of market value
0	Unfit for human consumption but fed to animals	100
1	Grains with 85 % damaged grains and 50 % aflatoxin contamination	85
2	Grains with 70 % damaged grains and 40 % aflatoxin contamination	70
3	Grains with 65 % damaged grains and 35 % aflatoxin contamination	65
4	Grains with 50 % damaged grains and 10 % aflatoxin contamination	50
5	Grains with 30 % damaged grains and 15 % aflatoxin contamination	30
6	Grains with 20 % damaged grains	20
7	Grains with 15 % damaged grains	15
8	Grains with 10 % damaged grains	10
9	Grains with 5 % damaged grains	5
10	No damage to the grains and no aflatoxin contamination	0

Source: Load tracking and sampling data

TABLE 1.16

Quality analysis of sampled groundnut units

Unit evaluated	Overall quality score	Type of damage (deterioration) if any	Potential cause and symptoms
1	9	Mechanical damage	Presence of cuts on pods and grains from hand hoes
2	6	Pathological damage	Aflatoxins because of fungus
3	7	Entomological damage	Weevils
4	7	Mammal damage	Rodents infestation
REPORT: Average score: 7.25			

Source: Load tracking and sampling data

TABLE 1.17

Presentation of Load tracking and sampling results

A	Product	Groundnut			
B	Event	Storage			
C	Duration of the event	1 month			
D	Location	Kamwendo			
	Before the event	**Experimental Unit**	**Weight of unit**	**No. of units**	**Total weight**
E	Load <total harvest>	Bag	45 kg	31	1 395 kg
F	First-stage sample	Bag	45 kg	7	315 kg
G	Second-stage sample	5 Litre bucket	1.5 kg	2x7	21 kg
		Value (score / percentage)	Observations / Causes		
H	Sample size Second-stage	21 kg	Grains mixed together with shells and thrown away, some pods eaten by livestock		
I	Average quality score (0 – 10)	8			
J	Percentage unfit (< 2)	10 %			
K	Percentage low quality (2-6)	5 %			
	After the event		**Weight of unit**	**N. of units**	**Total weight**
L	Load <describe>	Bag	44.2 kg	31	1 370.2 kg
M	First-stage sample	Bag	44.2kg	7	309.4 kg
N	Second-stage sample	Scoop	1.5 kg	2x7	21 kg
		Value (score / %)	Observations / Causes		
O	Sample size Second-stage	21 kg	Pods damaged by rodents		
P	Average quality score (0 – 10)	7			
Q	Percentage unfit	15 %			
R	Percentage low quality	8 %			
	Quantity loss	**Value (%)**	**Observations / Causes**		
S	Percentage lost (E-L)/E	1.8 %	Rodents		
	Quality loss	**Value (%)**	**Observations / Causes**		
T	Percentage lost (Q-J)	5 %			
U	Percentage quality reduction (R-K)	3%			

Source: Load tracking and sampling data

(temporary storage). Most farmers store unshelled nuts, which will be shelled at the time of marketing or will be sold unshelled. Rodent and weevil infestation normally occur if the storage structures are not properly protected from pests. The type of storage facilities (warehouse and open space) and factors such as moisture, heat, livestock and other contaminants cause losses when the grain is stored in open spaces incurring high losses.

Quality analysis

Table 1.15 shows the results of observations made along the FSC on how groundnut was scored in terms of market value.

As explained under *Methodology*, at the beginning of this report, there were four sampled units. There were some holes on the nuts or pods, an indication of rodent damage. Aflatoxin contamination was detected with spore colonies spotted on the pods. In addition, some pods had cuts from hand hoes used during lifting and some nuts had holes as a result of weevil infestation (Table 1.15). Pods are more resistant to weevil infestation; hence farmers store unshelled groundnuts.

Table 1.16 indicates the quality score of the samples collected based on pathological, entomological, mechanical and damage by animals. On average, a score of 7.25 was recorded for the samples.

LOAD TRACKING: QUANTITATIVE ANALYSIS

Tracking of the load was conducted at the farm storage stage. The product was monitored over a period of one month. The load weighed 1.4 tonnes and was made up of 31 polypropylene bags each having a 45 kg capacity. Samples were collected using a bag sampler just before storage and after completion of the activity. A bag was regarded as the sampling unit. On average, the quantity loss was an estimated 1.8 percent and the quality loss was 5 percent. Some direct causes were storage pests and aflatoxin (Table 1.17).

Table 1.18 presents both low loss points and critical loss points observed in the groundnut supply chain. The losses captured are both qualitative and quantitative and occur during lifting, drying, stripping, transportation and storage. Levels of losses are presented, including the symptoms, causes, impacts and suggested solutions to the problems recorded.

IMPACT OF FOOD LOSSES IN THE GROUNDNUT SUPPLY CHAIN

Social impact of food losses in the FSC

The study identified the following social impact resulting from food losses in the groundnut supply chain:

- Loss of income from the quantities lost along the groundnut supply chain, resulting in households losing purchasing power, failing to buy basic items for families, and thus increasing food insecurity in the community.
- Loss of the European Union market because of high aflatoxin levels (above the allowable limits), which has resulted in reduced foreign exchange.
- Farmers obtain low prices for their groundnuts because of the low quality of the crop. Buyers take advantage of this situation.
- Because of losses at the various FSC levels, farmers have reduced the amount of groundnuts they market. As a result, farmers lose income and fail to provide for their families. This contributes to food insecurity among farmers.
- Some studies showed that groundnut products have high levels of aflatoxins, which is believed to contribute to health problems (liver cancer) in the population.
- Lack of raw materials for the processing of plants, including peanut butter, roasted nuts and cooking oil.

TABLE 1.18
Summary results matrix of food losses

Stage in Food Supply Chain	Type of loss Qn./Ql.	Percentage lost in this process Quantity	Percentage quality loss incurred in this process[14]	Percentage loss in the FSC Quantity	Symptoms	Cause of loss/ Reason for low loss	Reduced market value	CLP / LLP	Impact/ Stakeholders affected (men / women)	Perception of Stakeholders (men / women)	Suggested solutions
Lifting	QN	3 %		6 %	Presence of pods on ridges or in the soils	Method of lifting	10 %	CLP	▪ Low price resulting in reduced farmers' income ▪ When the groundnuts are contaminated with aflatoxins, stakeholders' health will be affected		Introduce new technologies for lifting
	QL		1 %	3 %	Presence of pods on ridges or in the soils	Method of lifting	21.4 %	LLP	Low price		Introduce new technologies for lifting
Drying	QN	2 %		5 %	Rodents, weevils, birds	Lack of proper drying facilities	15 %	CLP	Loss of market value	Need for introducing drying facilities	Introduce pest control technologies
	QL		2.6 %	13 %	Fungus	Lack of proper drying facilities	13.3 %	CLP	Loss of export market		Promote extension services
Stripping	QN	8 %		14 %		Use of underage labour	15 %	CLP	Reduced volume of harvest		New technologies
	QL		0 %	1 %			2 %	LLP			
Transport	QN	0.1 %		1.5 %	Spillage		0 %	LLP			
	QL		0 %	1 %				LLP			
Storage	QN	8 %		15 %	Fungus, Rodents, weevils	Poor storage structures, storage of untreated grain	25 %	CLP	Increased food insecurity	More efforts required to minimize losses with improved storage facilities	▪ Promote extension services ▪ Introduce pest control technologies
	QL		7 %	14 %	Discolouration	Lack of post-harvest management skills	20 %	CLP	Loss of export market		Promote extension services
Shelling (use of machines)	QN	6 %	3 %	11 %		Type of shelling machine	9 %	CLP	Loss of market value	Machines need to be modified so they easily separate pod shells and grains (such as shellers)	
	QL	3 %	1 %	6 %	Broken grains	Shelling of pods with very low moisture content	10 %	CLP	Low price		Introduction of improved machines that minimize breakages of grains

Source: Results of the study (the figures combine both the results of load tracking and those obtained during the other stages of the methodology). Qn: Quantitative; Ql: Qualitative

[14] This loss is in the form of reduced economic and nutritional value.

TABLE 1.19
Critical loss points – cause finding diagram

Loss point/stage and type	Symptoms	Causes	Real Causes	Reasons
Drying [Field and Homestead] Losses observed during drying include quantity and quality losses.	Presence of damaged grains resulting from infestation by weevils, rodents and birds, which takes place in the field as the haulms are placed upside down on ridges or in small rounds.	Long drying period of groundnuts in the field provides a chance to weevils, rodents and birds to cause damage to the drying pods.	▪ Presence of weeds in the field is creates environment for the breeding of the rodents, which further damage the groundnuts during drying. ▪ Long period of drying beyond the specified period results in the occurrence of these losses. ▪ Sometimes drying is conducted at the time when livestock are left without unattended. They end up in the field and eat the groundnuts left for drying.	▪ Lack of proper and affordable drying facilities in the farming communities, especially at the homestead. ▪ The presence of children and livestock at homestead deter farmers from drying the groundnut at the homestead because the nuts may be damaged by livestock and consumed by children or shared with friends without proper planning.
Stripping [Field] The losses that occur during the stripping process are quantitative and commonly occur in the field where most of the farmers carry out this activity.	Presence of pods on stripped haulms and on the ground results in reduced quantity.	▪ Common use of underage children, unreliable hired labour ▪ Presence of weeds is one of the causes. It has been observed that some pods are left on haulms unstripped, some pods are entangled in weeds and lost.	▪ Hand stripping is common among smallholder farmers using family or hired labour whereby both children and adults are involved. The process involves moving several small drying rounds of haulms to one point, and this results in some haulms being missed in the process. ▪ Apart from pods being left on the haulms as they have not been stripped, some haulms are lost from spillages during the transfer of the haulms from the drying points to where they are stripped. This spillage is never collected. ▪ The presence of weeds also causes haulms to be missed during haulm collection at the time of stripping where some pods are easily stripped off and left in the soil.	▪ This activity is among the high labour demanding activities and lack of machinery makes it difficult to carry out. Therefore, lack of affordable and reliable strippers is the major reason causing these losses. The use of machinery could minimize the use of underage children and of unreliable labourers, thereby minimising losses.

TABLE 1.19
(Continued)

Loss point/stage and type	Symptoms	Causes	Real Causes	Reasons
Shelling [Homestead/ Cottage Centre] The losses occurred during shelling are both qualitative and quantitative.	▪ Reduction in weight of the shelled nuts and broken groundnut grains after the shelling process resulting from hand shelling or machine shelling. After buying groundnuts from the market in Kamwendo, some small traders use machine shelling in Lilongwe town before selling. The machine sheller is commonly associated with a high percentage of grain breakage during shelling causing losses in the process.	▪ Most smallholder farmers practice hand shelling, which is commonly conducted by mixed ages, mostly children. This results in lack of concentration during the shelling process and some pods or nuts end up being mixed with the shells thereby causing losses. The manual winnowing after machine shelling contributes to quantity losses.	▪ Unavailability of winnowing machines after shelling and also lack of reliable shelling machines	▪ Unavailability of affordable machine shellers for use by smallholder farmers, which can ease the shelling process. The high cost of machine shelling is another real cause that many farmers do not use machine shelling. Furthermore, unavailability of such machines in the rural area such as Kamwendo force farmers to practice hand shelling.
Storage [Homestead]- During storage there are both quantity and quality losses.	▪ Most farmers store in-shell groundnuts (rather than shelled). Groundnuts will be shelled at the time of marketing or sold unshelled. Rodent and weevil infestations normally occur during the storage period leading to damaged grains.	▪ Among the storage facilities used are polypropylene bags, traditional granaries and metal drums (temporary storage). Commonly these storage structures are not guarded against rodents and weevils, resulting in losses.	▪ Real causes: if the storage structures are not properly guarded from these pests.	▪ Scarcity or availability of adulterated pesticides in the remote areas. This results from the lack of reliable agrodealers, suppliers of pesticides, as there is a low demand for farm inputs. Most farmers do not use pesticides to control biological agents on the stored groundnuts. Failure of the PCB to effectively control the importation and selling of chemicals in Malawi leaves farmers with no choice but to use unregulated pesticides. Most agrodealers, the suppliers of farm inputs, are located in the major cities of Malawi, leaving the rural farmers unable to access the farm inputs. If they do have access, the price of inputs becomes expensive because of transport costs.

Source: Results of the study

FIGURE 1.13
Groundnuts contaminated because of poor handling

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Environmental impact of food losses in the groundnut supply chain

Although no Environmental Impact Assessment (EIA) was conducted as part of the case study, the potential environmental impact can be deduced from observations made within and outside the study site. For example, poor handling of groundnuts is bound to cause aflatoxin contamination, which poses a health risk to consumers (Figure 1.13)

In addition to possible aflatoxin contamination, there is also a potential health hazard during winnowing of the shelled groundnuts. Women who don't wear masks when winnowing inhale dust, thus exposing themselves to the risk of respiratory infections.

Furthermore, the cottage-processing centre does not have a proper disposal site for groundnut shells, which are often burned on-site. The large quantity of smoke generated is both an environmental and a health hazard.

There may also be an indirect environmental impact as loss of income forces farmers to become involved in other activities such as charcoal production, which has significantly contributed to deforestation and other environmental factors, including climate change. Other practices that affect the environment include the use of pesticides, which may affect non-target insects that are beneficial to the environment, thus disturbing biodiversity.

Low loss points

The researchers identified lifting and transportation of groundnuts from the field to the homestead as low loss points. During lifting, farmers use hand hoes, which make it easier to lift the haulms carefully leaving fewer pods in the soil, if the field is weed free.

During transportation, farmers use ox-carts, bicycles and carry the crop on their head. Farmers usually fill polypropylene bags (sacks) with groundnuts before loading them onto the ox-cart for transportation. This practice limits the number of pods lost during transport. Most farmers transport groundnuts after stripping. Polypropylene bags are used because farmers are aware that loading the pods directly in the ox-cart would result in heavy losses from spillage.

Chapter 4

Food loss reduction strategy – conclusions and recommendations

STRATEGIES FOR REDUCING GROUNDNUT LOSSES

Drying

Some post-harvest losses that occur are avoidable. Recommended strategies to reduce groundnut losses during the critical loss point of drying are:

- Provision of messages along the supply chain stressing good post-harvest management practices (extension services) including drying.
- Provision of covered drying facilities to protect against storage pests and livestock.
- Involvement of the Government in increasing the number of post-harvest specialists to provide technical support. This support would be achieved through research, and extension services to the farming community and private sector.

Stripping

Some groundnut post-harvest management activities such as stripping demand a lot of labour. The situation has deteriorated because of the absence of special equipment, either powered by animals or people, which would ease the pressure faced by smallholder farmers. The introduction of labour-saving stripping equipment would minimize the use of under-age labour. Rental or sale of equipment should be affordable to individuals living in the communities.

Shelling

To ensure farmers understand the connection between sprinkling water to soften pods before shelling and loss in quality, extension messages should be distributed and disseminated among farmers before and during shelling. Furthermore, credit facilities could introduce methods of payment that would ensure that smallholder farmers would be able to afford shelling machines or other equipment. Some of the contributing factors include prohibitive interest rates, which are over 35 percent of the base lending rate and financial institutions' stringent collateral requirements. There is therefore the need to establish affordable credit schemes so those in need can easily access credit.

The Malawi Bureau of Standards could ensure the proper calibration of weighing scales at selling points. This would build trust between farmers and buyers. Farmers should also be encouraged to stop sprinkling groundnuts with water as a counter-measure to their perception of manipulated scales. A policy should also be designed to address the importation of appropriate weighing scales that are in good working order.

Farm-level storage

Some farmers have no knowledge of the recommended moisture content for safe storage of groundnuts. Therefore, introduction of technologies to verify the moisture content could prevent and minimize aflatoxin contamination. The use of pesticides is recommended for use in the field against termites; rodenticides for the rodents; cats and rat guards would help protect the stored crop against rats and would minimize losses.

There is the need to accelerate the establishment of farmer organizations, as in most cases, smallholder farmers work alone. Farmers could be organized into groups, such as associations and cooperatives, to facilitate technology transfer as well as promote access to inputs and other services. This would also provide a way to pool farmers' products so they could achieve bargaining power when marketing their produce. The NASFAM model, which has proven to be successful over the years, could be replicated widely.

As the transport and storage infrastructure is in most cases poor, thus exacerbating food losses along the supply chain, there is a need for the Government to develop transportation infrastructure, in particular roads. The private sector could also participate in the development of appropriate

infrastructure, particularly storage and associated technologies, facilities and equipment.

Adequate technologies could be developed at various stages of the supply chain for example harvesting, packaging and storage. Technologies could be developed in collaboration with research institutions. In cases where technologies already exist, efforts should be made to raise the awareness of the concerned actors about their use and purchase of the technologies could be facilitated.

Food loss reduction plan

- There is the need to lobby for the passing of the Draft National Agricultural Policy by Parliament and its enforcement by the relevant institutions. The Draft recognizes post-harvest losses as an issue and proposes measures for reducing them.
- Some post-harvest losses that occur are avoidable. It is therefore suggested that proper extension services be provided on groundnut post-harvest management along the chain. By doing so, smallholder crop losses can be minimized. It is suggested that the implementing institution be the Department of Agricultural Extension Services, in collaboration with the Department of Agricultural Research Services. Dissemination could be properly managed through training of trainers, followed by training of lead farmers and smallholders and through demonstrations.
- Some groundnut post-harvest management activities, including lifting and stripping, have proven to be highly demanding in labour. The situation has worsened because of the lack of requisite equipment, animal or labourers, which could ease the pressure faced by smallholder farmers. The introduction of tailored equipment could reduce the use of under-aged labourers. Improved and more appropriate equipment for lifting and stripping could contribute to solving the current problems.
- Moisture checking at the time of buying groundnut, as promoted by extension workers, is important in the prevention or reduction of aflatoxin contamination. Improved extension services will help farmers understand the implications of sprinkling water during shelling. The approach used in the implementation of this recommendation would include training of trainers and lead farmers and smallholders.
- It is also considered important to build farmers' trust on the veracity of weighing scales, which would involve the scales being properly calibrated by the Malawi Bureau of Standards at the selling points. Creation of a policy governing the importation of weighing scales would ensure they are in good condition and appropriate to local conditions.
- The study recommends the proper use and promotion of pesticides and rodenticides in the field, as well as the use of cats and rat guards to combat termites and rodents.
- There is a need to develop appropriate technologies at various stages of the supply chain: harvesting, packaging and storage. The development of such technologies should be in collaboration with research institutions. In cases where these technologies exist, but have not been adopted, efforts should be made to raise awareness among the actors concerned and the adoption of the appropriate technologies should be facilitated.
- There is the need to intensify the establishment of farmer organizations as in most cases smallholder farmers work alone. Farmers could be organized into groups, such as associations and cooperatives. This would facilitate technology transfer, as well as ease access to inputs and other services. This would also provide a way to pool farmers' produce to increase bargaining power when marketing. The NASFAM model, which has proven to be successful over the years, could be replicated in many areas. Institutions such as the Farmers Union of Malawi (FUM) and NASFAM, could take the lead in this effort in collaboration with the MoAIWD.
- Lack of access to credit for different operations along the supply chain is one of the major constraints faced by most actors in the groundnut supply chain. Contributing factors include prohibitive interest rates, which are above 35 percent of the base lending rate, and financial institutions' stringent requirements for collateral. There is therefore the need to establish affordable credit schemes to ease access to credit for those in need. This could be achieved through a review of the Acts and Roles of the Reserve Bank of Malawi (RBM), and other financial institutions, with regard to regulation of interest rates.
- In most cases, the transport and storage infrastructure is poor, thereby exacerbating food losses along the supply chain. There is the need for the Government to develop the transport infrastructure, especially the roads.

TABLE 1.20
Budget calculation for food loss reduction

	Item: drying	**Value**	**unit**
a	Product quantity	6.3	tonne/year
b	Product value	1 714.3	USD/tonne
c	Loss rate	4	Percentage
d	Anticipated loss reduction	50	Percentage
e	Cost of intervention **(Drying facilities)**	1 000	USD
f	Depreciation	5	years
g	Yearly costs of investment	200	USD/year
h	Yearly costs of operation	10	USD /year
i	Total yearly costs of solution	210	USD /year
j	Client costs per tonne product	33 333 333	USD /tonne
k	Food loss	0.252	tonne/year
l	Economic loss	432.0036	USD /year
m	Loss reduction	0.126	tonne/year
n	Loss reduction savings	216.0018	USD /year
o	Total Client costs	210	USD /year
p	Profitability of solution	6.0018	USD /year
	Item: stripping	**Value**	**unit**
a	Product quantity	6.3	tonne/year
b	Product value	1 714.3	USD /tonne
c	Loss rate	7	Percentage
d	Anticipated loss reduction	50	Percentage
e	Cost of intervention **(Stripping equipment)**	1 300	USD
f	Depreciation	5	years
g	Yearly costs of investment	260	Percentage /year
h	Yearly costs of operation	100	Percentage /year
i	Total yearly costs of solution	360	Percentage /year
j	Client costs per ton product	57.14286	Percentage /tonne
k	Food loss	0.441	tonne/year
l	Economic loss	756.0063	USD /year
m	Loss reduction	0.2205	tonne/year
n	Loss reduction savings	378.0032	USD /year
o	Total Client costs	360	USD /year
p	Profitability of solution	18.00315	USD /year
	Item: shelling	**Value**	**unit**
a	Product quantity	6.3	tonne/year
b	Product value	1 714.3	USD /tonne
c	Loss rate	9	Percentage

TABLE 1.20
(Continued)

d	Anticipated loss reduction	50	Percentage
e	Cost of intervention **(groundnut hand shellers)**	1 100	USD
f	Depreciation	5	years
g	Yearly costs of investment	220	USD/year
h	Yearly costs of operation	200	USD/year
i	Total yearly costs of solution	420	USD/year
j	Client costs per tonne product	66.66667	USD/tonne
k	Food loss	0.567	tonne/year
l	Economic loss	972.0081	USD/year
m	Loss reduction	0.2835	tonne/year
n	Loss reduction savings	486.0041	USD/year
o	Total Client costs	420	USD /year
p	Profitability of solution	66.00405	USD /year
	Item: Storage	**Value**	**unit**
a	Product quantity	6.3	tonne/year
b	Product value	1 714.3	USD /tonne
c	Loss rate	10	Percentage
d	Anticipated loss reduction	50	Percentage
e	Cost of intervention **(PICS bags)**	1 500	USD
f	Depreciation	5	years
g	Yearly costs of investment	300	USD /year
h	Yearly costs of operation	200	USD /year
i	Total yearly costs of solution	500	USD /year
j	Client costs per ton product	79.36508	USD /tonne
k	Food loss	0.63	tonne/year
l	Economic loss	1080.009	USD /year
m	Loss reduction	0.315	tonne/year
n	Loss reduction savings	540.0045	USD /year
o	Total Client costs	500	USD /year
p	Profitability of solution	40.0045	USD /year

Source: Results of the study

The private sector also has a role to play, particularly in the development of appropriate storage infrastructure and associated technologies, facilities and equipment.

- The capacities of the actors at different stages of the supply chain needs to be developed. The Government could be involved in increasing the number of post-harvest professionals to support the farming community and private sector. The Government could also consider including post-harvest related courses at various levels at learning institutions. Likewise, the private sector could build capacity among the workforce on issues related to reduction of post-harvest losses.

COST-BENEFIT ANALYSIS FOR THE RECOMMENDED FOOD LOSS REDUCTION MEASURES

The budget calculations are for the four critical loss points identified during the study, namely drying, stripping, shelling and storage. The different budgets cover a five-year period and are based on the quantity of 6.3 tonnes produced by the 60 households that participated in the study (Table 1.20). Budget expenditure items include purchase of equipment and delivery of related training activities.

Equipment budgeted in Table 1.20:

- Stripping: oil for motor-operated groundnut thresher, with a capacity of 2 000-2 500 kg of pods per day.
- Drying: raised platforms, with the capacity of drying 2 tonnes at once, and tarpaulins (40 m by 40 m).
- Storage: Purdue Improved Crop Storage (PICS) bags, budgeted for demonstrations and training activities.
- Shelling: groundnut hand shellers, with a shelling capacity of 400-500 kg per hour (two machines were budgeted).

Social implications of the food loss reduction measures

The use of pesticides on stored grain, if not applied properly by following the recommendations provided, may result in health risks for both the applicator and the consumer. Sometimes the misuse of pesticides, such as rodenticides, has killed people because most chemicals are highly toxic. There is a lack of extension services as there are many farmers and few extension staff. It is, therefore, crucial to improve extension services through the provision of the necessary knowledge about the post-harvest management of groundnuts. The greater involvement of women should be emphasized in training because they are most involved in pesticide application.

Moreover, some metal rodent traps are very dangerous to children, and if not properly handled, they may harm children. The use of rat guards could minimize the use of rodenticides, which, as has already been noted, are very toxic and harmful to people.

Drying of groundnuts in the field is a challenge because there is a risk of theft. As a consequence, the groundnuts are dried at the homestead. Women are extensively involved in this activity, which increases their workload. Introducing simple solar driers could reduce women's workload (Table 1.21).

FOLLOW-UP ACTION PLAN – CONCEPT NOTE FOR FUTURE INVESTMENT

Several critical loss points were identified along the groundnut supply chain. It is apparent that storage and shelling are the critical loss points with the highest losses in both quantity and quality. As such, these are the stages where interventions should focus on reducing losses.

Storage

Poor storage structures, storage of untreated grain and lack of management skills are some of the main causes of losses at the storage stage.

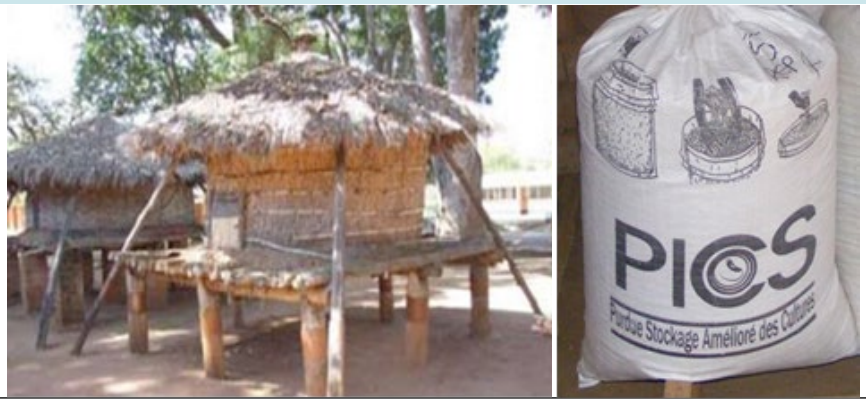
Consequently, the study recommends the introduction of better storage facilities such as

TABLE 1.21
Assessing social implications of specific food loss solution suggestions

Suggested solution	Social impact	Description of the potential impact	Gender dimension of the impact (how women and men may be affected differently)	Suggestions to mitigate negative impacts
Application of insecticides	1…increase health risk	Application of insecticides increases health risks	Women may not have proper training in application of insecticides	Proper extension services targeted at women
Proper drying	2. …increase the workload of women?	More time will be needed for the nuts to dry properly	Drying is done by women, thus increasing the time they work	Introduce simple solar driers such as black plastic shelves
Killing rats using indocid	3. …increase health risk	Indocid is a drug	Most people, men and women, are ignorant of the dangers of this drug	Promote granaries with rat guards
Putting rat traps	4. …danger to children	Traps can hurt people instead of rats	Rat traps are dangerous to people, especially children	Promote granaries with rat guards

Source: Results of the Study

FIGURE 1.14
Traditional storage (left) and a PICS bag (right)



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PICS bags as opposed to traditional granaries (Figure 1.14)

With respect to the storage of untreated grain and lack of post-harvest management skills, the study recommends capacity-building for farmers and other stakeholders involved in post-harvest management activities. Capacity-building should involve training of farmers in post-harvest management, including grain handling from harvesting up to consumption and grain treatment. Furthermore, field trips to places with good post-harvest facilities and practices, organized and coordinated by agriculture officers from the MoAIWD, are recommended.

The formation of farmer organizations is a useful intervention that could enhance the acquisition of skills at a relatively lower cost than would be the case if dealt with at the individual level. The NASFAM and the FUM, in collaboration with the MoAIWD and the LUANAR, are the institutions that could help form farmer associations or groups and train farmers in agribusiness focussing on supply chain management.

Shelling

Some contributing factors to high losses at this stage include:

- inefficient shelling machines;
- shelling of pods with very low moisture content; and
- sprinkling water to soften the pods to facilitate manual shelling.

RLEEP, with funding from IFAD, is promoting groundnut production in the study area. A RLEEP official indicated that some farmers do not simply sprinkle water on the unshelled groundnuts but actually soak the unshelled nuts in water to soften the pods. This exacerbates the loss in quality as the soaked groundnuts absorb a lot of water, making them difficult to dry, promoting the growth of moulds and eventually resulting in aflatoxin contamination.

- A possible intervention at the shelling stage is the introduction of efficient shelling machines such as those fabricated by C-To-C Engineering at Kanengo industrial site in Lilongwe (Figure 1.15);

The study identified a cottage shelling industry at Mgona Township in the city of Lilongwe. It was noted that the shelling machines used in the cottage industry are locally made. The engineering specifications that could contribute to reducing losses had not been taken into consideration.

- A study to assess the efficiency of the shelling machines at the level of the cottage industry is therefore recommended. Among other activities, the study would establish the percentage of groundnut breakage caused by the current shellers, which could be redesigned if this percentage is considered high. There are several advantages to improving the locally-fabricated shellers, including easy access to back-up services, since the machines will be locally fabricated using locally available materials. In addition, the other advantages include job creation for those who build the improved shellers. Some of the institutions that are capable of undertaking the task of improving the locally made shellers are the agricultural engineering department of the LUANAR, the farm machinery department at Chitedze Research Station, the Malawi Industrial Research and Technology Development Centre (MIRTDC) and C-To-C Engineering.

FIGURE 1.15
Shelling Machine fabricated at C-To-C Enginnering

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The study also noted that the cottage industry is not properly organized, in the sense that the machine owners operate as individuals without coordinating or collaborating with others.

- Another intervention would be to organize the machine operators into a group or association, which would allow the group to be trained in post-harvest loss issues and would facilitate access to services such as loans.
- Another observation made at the level of the cottage industry regards the active participation of women who winnow the shelled groundnuts. The women operate in an unhygienic environment. The place is dusty because of the chaff from the groundnut shells. The women do not use any protective clothing such as work suits and masks, which can pose health risks that may result in respiratory infections. Masks would at least prevent the women from breathing in the dust.

In addition to the potential health risk from the dust, it was also noted that there is no proper way of disposing of the groundnut shells after they have been winnowed. Instead, the shells are burned generating a considerable amount of smoke. This is another health risk for people operating at the site. Heaping of unburned shells is also a potential environmental pollutant, which should be considered for any intervention to reduce environmental degradation.

Based on these observations, the following interventions are recommended:

- The introduction of briquette-making from the groundnut shells, as an additional enterprise for women, would have several advantages including:
- providing an additional source of income;
- reducing dependency on wood charcoal, which has significantly contributed to deforestation in most parts of the country; and
- reducing drudgery faced by women in collecting fuelwood for domestic use.

The study therefore recommends that briquette-making from groundnut shells be introduced and promoted among women as a way to furthering their economic empowerment.

- The study also recommends that in order to minimize environmental and health risks from some of the operations at the level of the cottage industry, awareness should be raised by training farmers in the field so they can learn how to supply clean grain.

[15] Efficiency of these shellers with respect to groundnut breakage is estimated at 98 percent implying that only 2 per cent of the groundnuts are broken.

TABLE 1.22
Recommended Interventions and Estimated Costs[16]

Critical Loss point	Type of Intervention	Beneficiaries	Estimated cost (USD[17])	Responsible Institutions	Remarks
Drying	Forming farmer groups[18] and Training of farmers	Smallholder farmers	15 000	NASFAM; FUM; MoAIWD; LUANAR; and Ministry of Trade and Industry	
	Training in post-harvest lost management	Farmers and extension staff	30 000	MoAIWD; LUANAR	Extension staff trained to keep on the assistance to the farmers. Training to include field trips to places of best practices
	Provision of drying facilities	Farmers	40 000	MoAIWD	To be procured through MoAIWD
Stripping	Introduction of labour-saving stripping equipment	Farmers	25 000.000	MoAIWD	To be procured through MoAIWD
Shelling	Training in aflatoxin management	Farmers and extension staff	20 000	MoAIWD, LUANAR	To cover all potential stages for aflotoxin contamination in the supply chain
	Provision of community-based hand shelling machines		25 000	MoAIWD	To be procured through MoAIWD
	Adaptive study to improve efficiency of shelling machines at the Mgona cottage industry	Groundnut sheller fabricators and traders and farmers	30 000	LUANAR; Chitedze Research Station; MIRTDC, C-To-C Engineering	
Storage	Provision of community and individual storage structures and facilities	Farmers and warehouse agents	100 000		Supplies such as hermetic bags
	Training in maintenance of storage structures	Farmers and warehouse agents	20 000.000		
Cross cutting	Training in environmental issues	Groundnut sheller operators; women entrepreneurs at the cottage industry	10 000	LUANAR, Ministry of Natural Resources, Energy and Mining	
	Machinery for groundnut shells, Briquette-making machine	Women entrepreneurs, individual households	50 000	LUANAR's Department of Agricultural Engineering	
	Training of women on briquette making	Women entrepreneurs, individual households	10 000	LUANAR's Department of Agricultural Engineering	

[16] Costs provided in this table are rough estimates. Time and financial resources during the case study did not allow for a detailed and more informative cost benefit analysis at the national level. It is therefore recommended that a detailed cost benefit analysis be conducted for the interventions recommended in this concept note.
[17] Exchange rate of USD 1 = MWK 682.3529 as at the time of developing the concept note. Estimated cost over a period of 5 years.
[18] Minimum of 10 members and maximum of 20.

Chapter 5
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