Food and Agriculture Organization of the United Nations

Food Loss Analysis: Causes and Solutions

Case studies in the Small-scale Agriculture and Fisheries Subsectors

Methodology

May 2016

Strategic Objective 4, Output 2.2

Develop tools, methodologies and indicators for assessment of the magnitude of food losses, in various subsectors

This document is unedited and made available as presented by the FAO Global Initiative on Food Loss and Waste Reduction (Save Food) Working Group.

Contents

0. Introduction

The objective of this methodology for case studies of selected food supply chains is:

- *identification and quantification of the main causes of food losses;*
- *analysis of the impact and solutions to reduce food losses on their technical and economic feasibility, food quality and safety requirements, social acceptability and environmental sustainability;*
- *concrete proposals to formulate a food loss reduction programme.*

0-1 Concept

Food losses refer to the decrease in edible food mass throughout the different segments of the food supply chains – production, postharvest handling, agro-processing, distribution (wholesale and retail), consumption. Food losses and their prevention have an impact on the environment and climate change, food security and livelihoods for poor people, 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 the 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 national level, and based on literature review, statistical data, and stakeholder interviews.

The analysis of 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 what losses are the most important for specific supply chains, what is the impact of eventual solutions and which solutions are economically, environmentally and socially feasible. It is clear that food loss reduction will be of great benefit to all actors in the food production and supply chains, to food security for poor people, improve climate resilience and make more efficient use of natural resources. However, the solution to food loss should not be more expensive than the food loss itself, should not cause any negative impact or risk on consumer's health, should not place a higher burden on the environment and greenhouse gas (GHG) emissions, should make more food available to the people that need it most, and should be socially and culturally acceptable.

Understanding the impacts of food losses and as well as the solutions is important from an environmental and climate change perspective. Food production systems rely on a limited natural resource base along with the goods and services provided by natural ecosystems. Food losses are a waste of resources and inputs and contribute to the degradation of terrestrial and aquatic ecosystem. Reducing food losses will therefore help to improve efficiency and sustainability of food supply chains (FSC) whilst simultaneously reducing GHG emissions embedded in the losses. Furthermore, reducing losses will be key to increase the adaptive capacity to climate change.

However, the role of energy also has to be considered when assessing causes of, and solutions to food losses. Insufficient access to modern energy[1] and technologies may have a significant influence on post-harvest losses. It is therefore important to identify the different technologies and sources of energy utilized along the supply chain in order to assess the options for climate smart technologies to reduce food losses.

[1] A reliable (and ideally sustainable) source of energy.

Gender analysis of the value chain allows to better understand the underlying causes of food losses from a wider perspective. The different productive and social roles of men and women affect their access to productive resources, technologies and services, as well as their social status due to imbalanced power relations. This affects the efficiency in the FSC, often resulting in an increase in food losses.

National and subsector-wide statistical surveys have as disadvantage that they don't zoom in to specific situations, and that the information obtained cannot be verified by real measurements. Therefore the Save Food Initiative has designed the 'food supply chain' case studies, for the most important food subsectors in developing countries. In these case studies primary and empirical data will be generated for the different causes of food losses, and solutions for food losses will be analysed for their feasibility.

A case study is just a one-moment recording 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 at using the results of the case studies to target opportunities for investment programmes and interventions, during which formulation a wider geographical scope and the seasonality will be analysed.

0-2. Main types of food losses

The Definitional Framework of Food Loss is provided in Annex 2.

Quantitative (or physical) food losses refer to the decrease in edible food mass available for human consumption throughout the different segments of the supply chain. In practical terms this is food that, after harvest (crops), capture (fish), taking to slaughter (meat) or milking (dairy) is not consumed. It is either left to deterioration and discarded accidentally/voluntarily or as required by regulations due to non-compliance with food safety standards and regulations. Quantitative loss can be caused by pests eating or spoiling the food, rotting, and contamination and spilling.

In addition to quantitative losses, food products can also face a deterioration of quality, leading to a loss of economic and nutritional value. This food has undergone changes owing to spoilage or physical damage, and such the food products are sold for a lower price than would have been achieved if they were considered of 'best quality'. Apart from the economic loss, in most cases the quality deterioration goes along with a significant loss of nutritional value, and as such affects health and nutrition security of the population.

Several factors influence the spoilage of food products:

- Pre-harvest climatic conditions (e.g. excess water during the days before harvest).
- Harvest index used ('physiological' timing at which food is harvested).
- Time between harvest/ slaughter/ capture/ milking and final use or consumption.
- Temperature and moisture content of the products.
- Handling, packaging and storage practices and hygiene.
- Presence of (natural or foreign) hazards/ contaminants in the food.
- Market access and marketing strategies.
- Quality standards and regulations.

Food safety is the most critical dimension of food quality. If the quality has deteriorated to a level that the food is not safe anymore for human health, the food will be removed from the FSC, resulting in a *quantitative* food loss. Assuring food safety and quality is a clear element to reduce (e.g. applying GHP for perishable products) food loss. However sometimes lack of compliance with food safety regulations and standards leading to food withdrawal from the FSC which could lead to an increase of losses. Effective food safety controls can vary from one geographical area to another and also depends on the selected value chain, infrastructure and national capacity, none of which could be over looked while identifying the causes for food loss.

0-3. Methods for food loss assessment and solution finding

This is the methodology of a case study of one or two selected FSCs, rather than a national subsector study.

An effective supply chain food loss assessment involves the collection of data and their analysis. Assessments are carried out using qualitative and quantitative field methods. Subsequently, solutions to food losses will be formulated from the results and conclusions of the assessment. The core of the assessment of FL in a food supply chain is the acquisition of data. For this the methodology integrates four tools (referred in this document as the '4S' approach) based on an FAO publication[2] and diverse lessons learned by FAO's Rural Infrastructure & Agro-Industries Division, with different food operations. While it is suggested to use to certain degree all four methods, the feasibility of doing so can only be determined by the researcher leading the loss assessment activity.

The methods includes:

I. **Preliminary Screening of Food Losses ('*Screening*').** Based on secondary data, documentation and reports, and expert consultations (by phone, e-mail, in person) without travel to the field.

II. **Survey Food Loss Assessment ('*Survey*').** A questionnaire exercise differentiated for either producers, processors or handlers/sellers (i.e. warehouse manager, distributor, wholesaler, retailer) and other knowledgeable persons of the supply chain being assessed, complemented with ample and accurate observations and measurements.

III. **Load Tracking and Sampling Assessment ('*Sampling*').** For quantitative and qualitative analyses at any step in the supply chain.

IV. **Solution Finding ('*Synthesis*')**. Used to develop an intervention programme for food losses, based on the previous assessment methods.

As illustrated in diagram 1 the sequence in the 4-S approach for food loss assessment should be: 1) Screening, 2) Sampling and Survey, 3) Synthesis, and concluding with the elaboration of a Final Report.

[2] Diei-Ouadi and Mgawe: Post-harvest fish loss assessment in small-scale fisheries (2011)

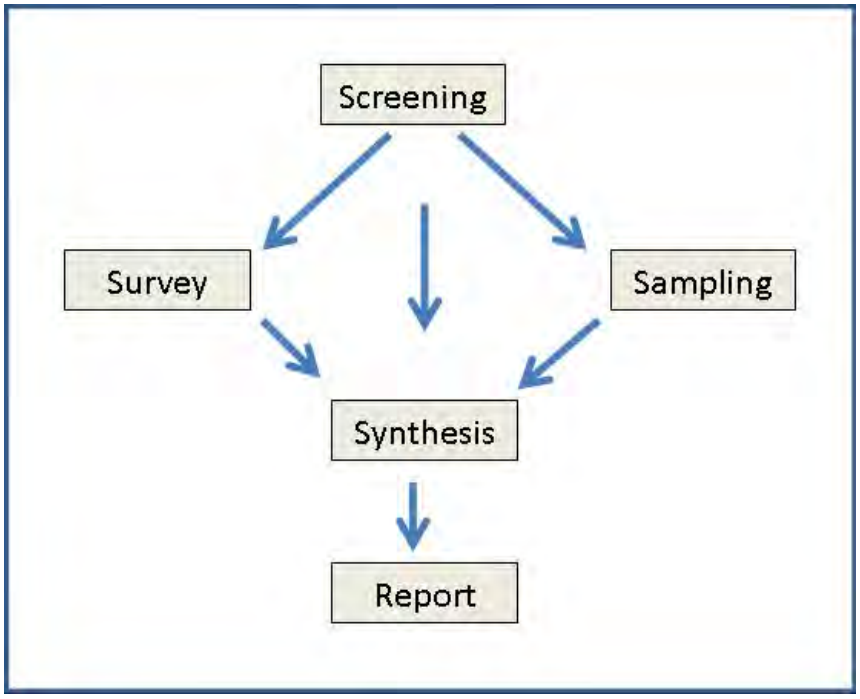


Diagram 1

The *Screening* method is used to have a rough idea of the range of losses and some main causes for those. Notably, the *Screening* can provide the baseline in a particular area, zone or country (depending on the availability of data) and should be instrumental to provide a background for the planning and implementation of the *Survey* and *Sampling* methods. The *Synthesis* method is the step in which all results and conclusions are merged towards developing an intervention programme for food loss reduction. While all methods have the potential of providing qualitative and quantitative information, the qualitative analysis can only be accurate if the assessment is done in-situ (*Sampling*) and/or provided by highly knowledgeable actors in the FSC (*Screening*). Quantitative data can be sourced from all methods, but the ability to reflect the reality of each will depend on 1) the accuracy of the source, being actors (*Survey*), data from government or other institutions (*Screening*), or both; and 2) the representativeness of the sample evaluated within the production operation and within the production/ handling community (*Sampling*).

Whether you use the Screen, Survey or Sampling method, gender analysis must be included. While all methods can provide some information for gender analysis, it is important to collect sex disaggregated data. More specifically, the following aspects must be analyzed:

- The different access to resources and services of men and women. This information helps to understand if men and women use and control strategic resources such as land, water, technologies, services, training, markets and information, which may allow them to reduce and prevent food losses.
- Cultural practices which include believes, norms and values about men and women as economic actors, can represent social barriers that may block the performance of the chain.
- Social position of men and women to identify their different ability to have a voice and influence decision-making in the food supply chain.

This is equally important for the environmental and climate change assessment. Food losses along the supply chain are expected to have both direct and indirect impact on the environment and climate change, which has to be taken into consideration. More specifically, the following aspects must be analyzed:

- What are the current constraints and impacts of food production of the selected supply chain to the environment and supporting ecosystems? For instance, are there issues with land degradation, water scarcity, erosion or deforestation in the area?
- What are the main issues related to climate change? Is climatic variability affecting food production and what are the adaptive capabilities of the communities? Is food production/ land-use sector in the country a major contributor to climate change? How would food loss reduction contribute to national climate change mitigation and adaptation objectives?
- What role does energy and energy access play in food losses? What technology measures are available to reduce food losses and to increase the use of sustainable energy in the supply chain?

For finding solutions and a successful intervention programme to reduce food losses, ***it is absolutely essential that the researchers at all times try to identify the cause of each food loss that they are told about or observe*** during the Screening, Survey and Sampling methods, and record the causes accordingly with due attention to their level of importance, as this determines where priority should be set within given loss reduction options.

Diagrams 2 and 3 show hypothetical information that serves as an illustrative introduction of what the main tasks are before the assessment, and what the expected output is, along with an outline of recommended interventions. Since it is probably not feasible to assess all points of the supply chain, the work must emphasize on selected points, and using the methods explained below. In order to better understand the social and gender related causes of food losses, particular attention should be given to the points where women are mainly involved, depending on the specific chain. It is important to determine how losses vary in those points, and distinguish the variation in types of losses along the chain.

While the case studies addressed with the 4S approach would not provide statistical valid results to determine exact levels of losses in the area/ region/ subsector, the case study needs to provide: 1) as accurate as possible the levels of losses in the different steps within the selected FSC so that the most important losses can be identified; 2) useful information for statisticians developing predictive models.

The combination of quantitative data with qualitative data (as shown in Diagram 3) is of particular interest as in developing countries qualitative losses are often the most abundant, and the reason for low profit margins for producers and other actors in the FSC. While it may be true that in developing countries most of the qualitative losses do not result in loss of mass, it is also true that most consumers improve economically and are conscious about quality standards. This will lead to more qualitative losses ending up in quantitative losses. The Sampling (below) requires specific identification of causes for the qualitative deterioration of food.

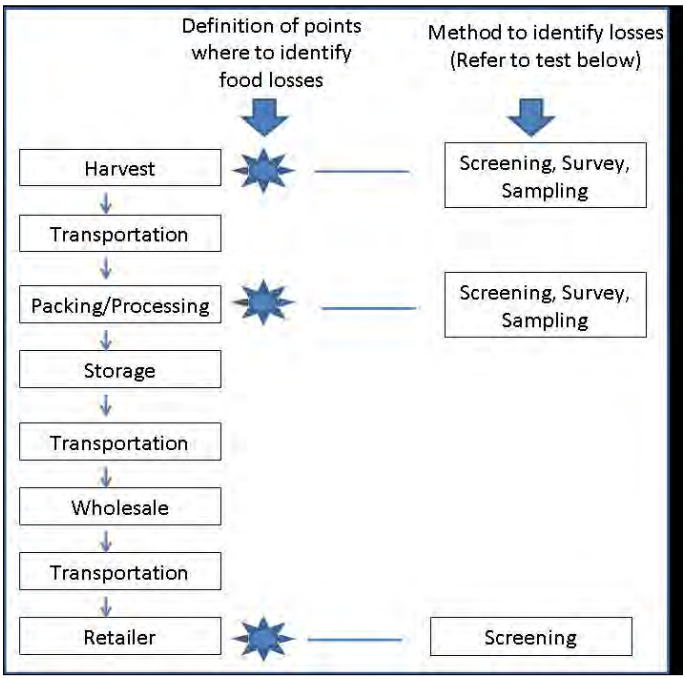


Diagram 2

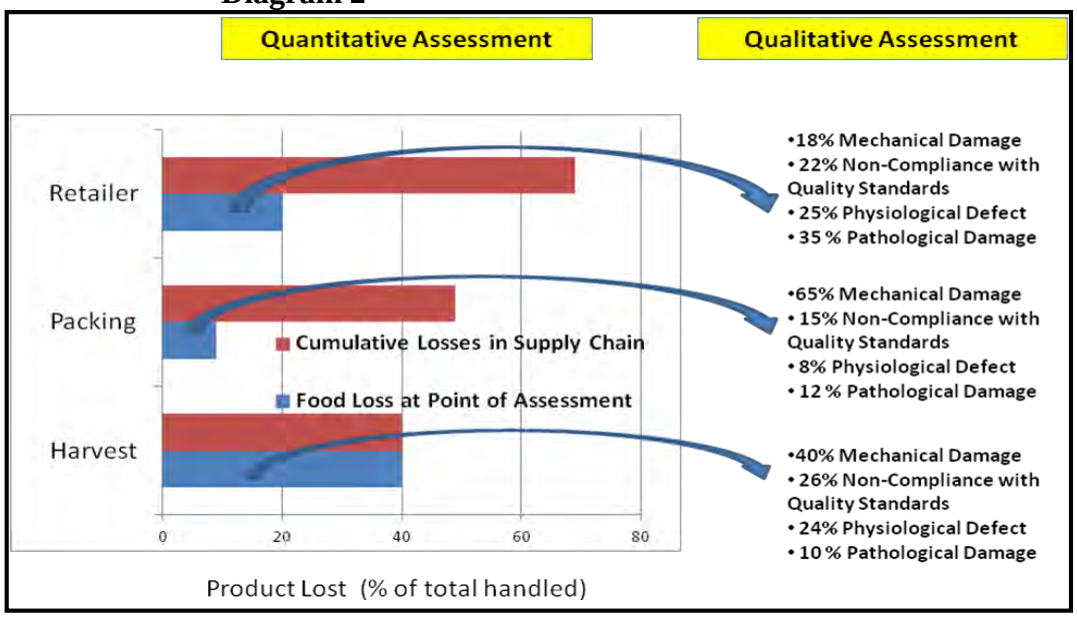


Diagram 3

The four methods will provide users and decision makers with different ways of understanding food losses. Details of each method are provided below with some guidance and examples.

The mode of operation in this case study approach, including the various technical disciplines of the researchers/ team composition have been provided in Annex 5.

A number of detailed tables have been provided for reporting of the results. The researchers at all times are free to insert new rows or columns in the tables, or design *additional* (not to replace the existing) tables and diagrams if it will present their results well.

All tables and diagrams have examples in Annex 2.

I. Screening Method ('*Screening*')

The *Screening* method consists of a review of secondary information and key-informant (expert) interviews. This method helps to develop a qualitative understanding of losses and provides indicative quantitative data for the entire loss assessment. It will provide an overview of the FSCs in the subsector, and subsequently enable to make a selection of (one or more) FSCs for Surveying and Sampling. In this phase it is important to collect sex- and age group-disaggregated data and information related to women's, men's youth's and vulnerable groups' involvement in the FSC to gain insight into social and gender constraints and strategies within the chain. National climate change strategies and action plans must be reviewed and food losses should be considered in this context. Finally the *Screening* method should pre-identify the Critical Loss Points in the FSC, where to focus the Surveying and Sampling. In this way, when resources are limited and distances are vast, the researchers could prioritize their visit to the most critical stages of the FSC. This is important to narrow down the costly field work and optimize its output efficiency.

Secondary data are low cost, and are available from diverse sources. A secondary data review, while it depends on the quality of the available data and information provided, can be a useful way of generating background information for the entire assessment.

I-1. Review of secondary data and key-informant (expert) interviews

The sources of data and other information from documentation and experts include local institutions (food science department, ministry of agriculture, ministry of environment, climate change focal points, ministry of health, national statistics, research institutions); libraries (to acquire research done in the past); non-governmental organizations (NGOs); International donor organizations; private sector; on-going projects; media sources, the internet. This should include experts in all relevant disciplines (climate change experts, sociologists, technologists, food safety experts, natural resource experts, economists), preferably in the specific subsector. In this phase travel should be limited, and experts should be interviewed by phone or e-mail if they are not around.

OUTPUT I-0: LIST OF LITERATURE AND EXPERTS CONSULTED

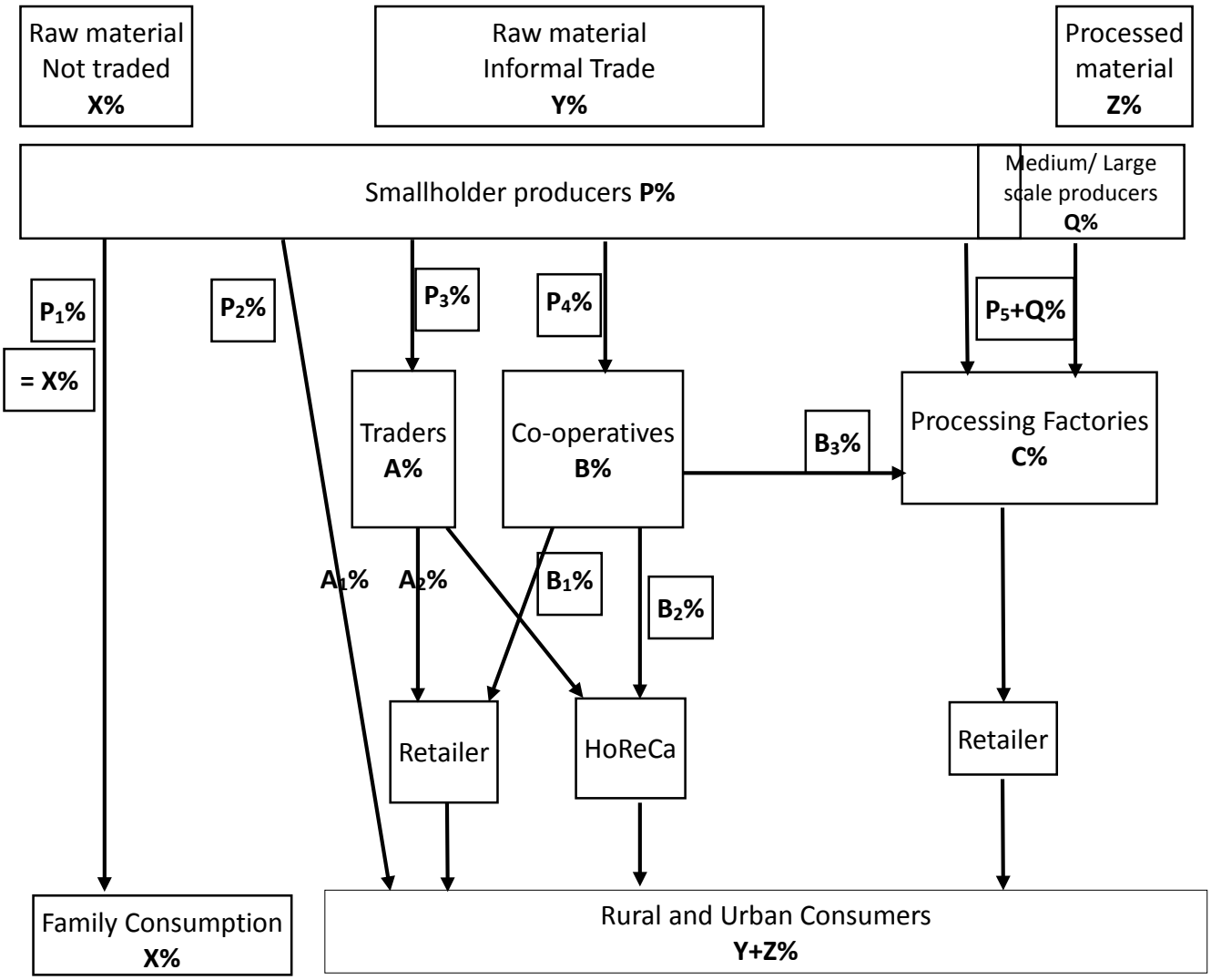
Document title	Author(s)	Institution, year
Expert name	Title/ position	Institution

The information collected here should describe the status and importance of the subsector, the developments over the last 15 years, an inventory of activities and lessons learnt from past and on-going interventions in food losses, the process of policy making and current policy framework or national strategy (if any) on losses in the subsector, and a brief description/ assessment of the level and extent of current implementation. Special attention should be given to existing legislation and standards (if any) - including the context of national climate change policy

frameworks - which contribute either by decreasing or increasing food loss throughout the FSC. See Annex 4 for a brief guidance on food safety considerations for FL assessment. It should list relevant institutions and their role in terms of policy, organisational structure, mandate and activities in the small and medium subsector industry sector.

The information sought through the *Screening* method should allow for the study leader to construct a thorough scheme showing the diverse paths in the food supply chains of the selected food product, highlighting the role of the actors rather than the activities. Output I-1a shows the amount of product (in %) moved from each actor to the different subsequent actors or utilization points. This exercise may serve to better understand the different steps in the supply chains. This can facilitate to identify later the critical loss points. The scheme can also provide a view for what are the accumulated costs associated with the food loss along the FSC.

OUTPUT I-1a: NATIONAL PRODUCTION INFORMATION OF THE SUBSECTOR - Actors and product flow



$X+Y+Z = 100$. $P+Q = 100$. $P_1+P_2+P_3+P_4+P_5 = P$. $P_1 = X$. $B_1+B_2+B_3 = B$. $A_1+A_2 = A$.

$A+B+C = P_3+ P_4+P_5+Q$. $C = B_3+P_5+Q$.

OUTPUT I-1b: NATIONAL PRODUCTION INFORMATION OF THE SUBSECTOR

					Annual production (t/yr)		Cultivated area (ha)	Average yield (ton / ha)
Raw material								
Average annual growth over the last 10 years (%)								
Average cost of production (USD / ton)								
					on-farm consumption		**marketed**	
Percentage of production								
					volume (ton/year)		**value (USD/year)**	
Market product #1,								
Market product #2,								
Market product #3,								
Number, sex, age of	**female**				**male**			**Total**
	15-30	**30-45**	**45+**	**total**	**15-30**	**30-45**	**45+**	**total**
Producers								
Traders								
Processors #1								
Processors #2								
Processors #3								
Retailers #1								
Retailers #2								
Retailers #3								
					Small		**Medium**	**Large**[3]
Level of processing operations								
Level of trading/ wholesale operations								
Level of retail operations								

In order to help the research team to better consider food safety-related causes for losses throughout the FSC, the table below should be filled with available information on the national *food safety management mechanisms*, as well as the level of food safety control in the selected FSC. This includes gathering information on the required/ applied regulations and knowledge

[3] Number of employees/ workers: Small: < 10. Medium: 10-50. Large: > 50

of potential food safety issues (most likely or significant hazards) in the selected chain based on the product type, through a desk study or interview with the actors. Any other available information on food losses due to food safety hazards which is not considered in this table should be indicated at the bottom of the table.

OUTPUT I-1c: FOOD SAFETY MANAGEMENT MECHANISMS

Controller	**Control**	**Actual Situation in the FSC**		**Responsible agent**
Government regulation and require-ments	National food safety/ quality standards	Exists and applies to the whole FSC		
		Exists but not rigorous		
		Doesn't exist		
	Frequency of checking (None, Low, Medium, High)	Harvest		
		Transport		
		Storage		
		Process		
		Market		
	Obligatory registration of the food processing/ preparation unit	Exists		
		Doesn't exist		
FSC actors - food safety management system	GHP/ GAP/ HACCP/ voluntary standards			
	Identification of poten-tial hazards			

I-2. Selection of Food Supply Chains

A food supply chain (FSC) is a connected series of activities to produce, process and distribute food. A FSC is in principle determined by its final product. For example, a cheese FSC is different from a fresh milk FSC, although they may have a large part in common. In this study each FSC will be selected based on its final product, the area (district, community/ies) where the raw materials are being produced, and all the intermediate segments of the chain (storage, processing, sales) that are active on the same product from the production area.

Based on the information obtained as outputs I-1a and I-1b, one or two FSCs in the subsector will be selected for in-depth survey and sampling.

Ranking FSCs by their importance in terms of economic impact and food security is paramount, as well as the contribution the particular FSC makes to national development objectives such as employment, poverty reduction and the generation of foreign exchange. Describing the profile of the FSC operations is important to determine where to apply the *Survey* method and/or the *Sampling* method.

Economic importance can be derived from the total value of the products from the FSC. Employment provision is reflected by the number of people that receive an income, directly or

indirectly, from activities by the FSC. Generation of foreign exchange is the value of export of products from the FSC. Contribution to income generation for actors is the fraction of total income of the main actors in the chain (producers, processors, traders, retailers) due to their activity in the same chain. For example, one could say that the production and/or sales of cassava account for 50-80% of the producers' income. The contribution to food security should be expressed in figures of national consumption of the FSC products.

The basic criteria for selection of FSCs are:
- based on smallholder producers;
- significant scale of food production;
- preferably including agro-processing and urban market;
- if possible, included in an on-going support programme for the subsector.

OUTPUT I-2a: FOOD SUPPLY CHAINS IN THE SUBSECTOR

FSC #	Geographical area of production	Final product	Volume of final product (ton/year)	Number, age and sex of smallholder producers[4]	Market of final product, location, buyers[4]	Project support
1						
2						
3						
4						
5						

Table I-2a identifies and lists the main FSCs in the subsector by the geographical location, final product and market for the final product. Tables I-2b and I-2c will be completed by assigning a score of **1 (low), 2 (medium) or 3 (high)** to the factors in the columns for each FSC in the rows. The total scores will be used as a guide to select the FSC for the study.

OUTPUT I-2b: IMPORTANCE OF FOOD SUPPLY CHAINS (from I-2a) AT NATIONAL LEVEL

FSC #	Economic Importance	Generation of foreign exchange	Contribution to national food consumption	Contribution to national nutrition	Impacts on environment and climate change
1					
2					
3					
4					
5					

[4] Create more columns as required

OUTPUT I-2c: ECONOMIC IMPORTANCE OF FOOD SUPPLY CHAINS (from I-2a) FOR SMALLHOLDER ACTORS

FSC #	Sex	Percentage of produce by		Contribution to income generation (% share of total annual income)				
		smallholders	Other	Farmers	Middle men	Processors	Wholesalers	Retailers
1	Female							
	Male							
2	Female							
	Male							
3	Female							
	Male							
4	Female							
	Male							
5	Female							
	Male							

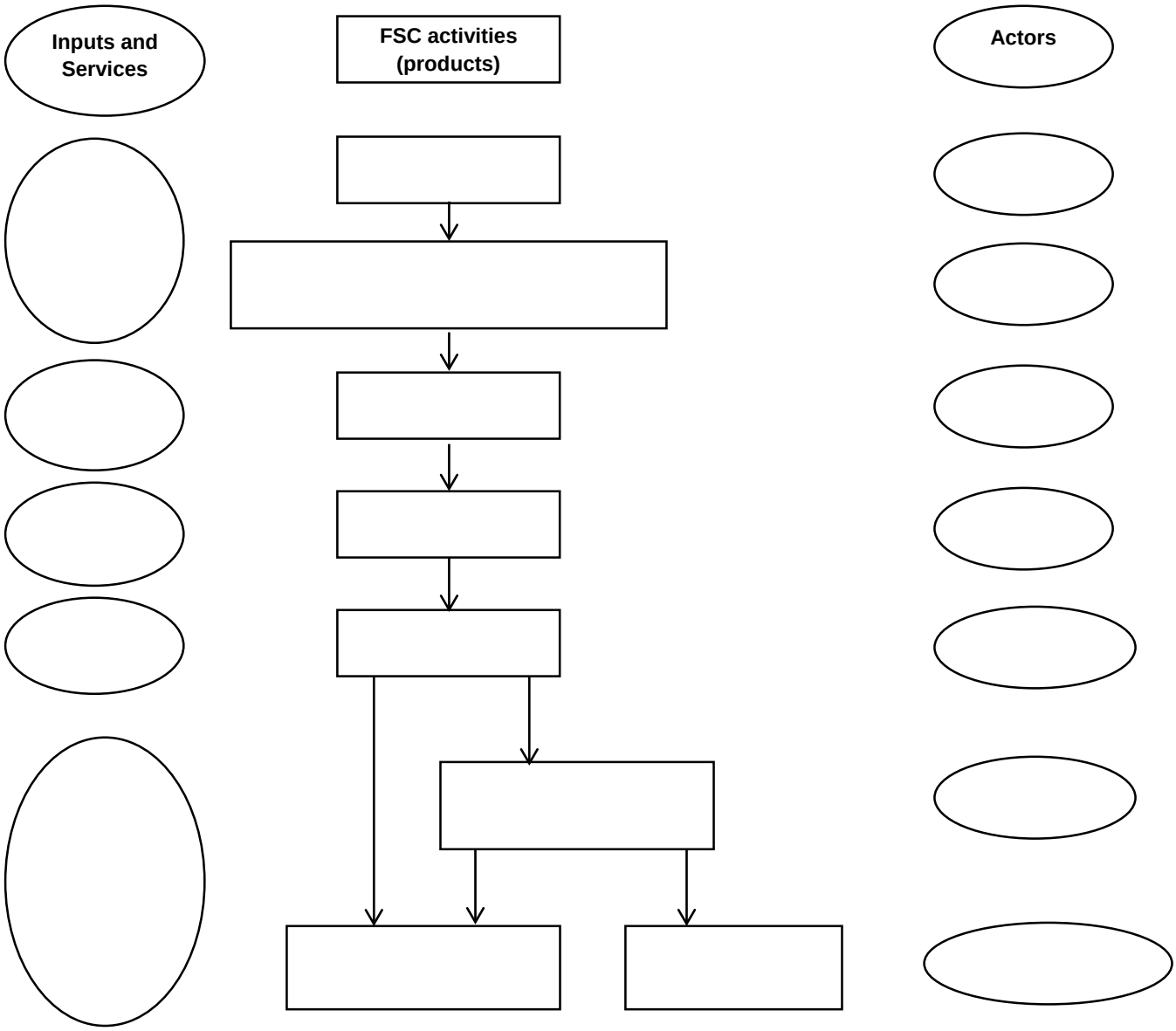
I–3. Characterization of food losses in selected FSC – Critical Loss Points

The points in the FSC where food losses have the highest magnitude, the highest impact on food security, and the highest effect on the economic result of the FSC, are called the Critical Loss Points (CLP). The study will focus on those CLPs provided there is also the feasibility of conducting a good assessment. With this approach the impact of successful solutions are the highest.

For the selected FSC a flow diagram has to be drawn as in Output I-3a. This diagram includes the production inputs, for the sake of documenting eventual waste or impact on environment. For example: use of water, or of wood where smoking or traditional heating is done to deliver end-products.

Details of the (intermediary) products that are being produced in the FSC are being recorded in the *Survey* method, Output II-3a.

OUTPUT I-3a: FLOW DIAGRAM OF THE SELECTED FSC



For the selected FSC the information to be listed in Output I-3b should be collected from the secondary data and expert interviews as much as possible.

As much as possible estimates of the quantitative losses at each step in the FSC will be made, as well as estimates of the qualitative losses at the different steps of the FSC. In this method a practical way to 'estimate' qualitative losses is by understanding the amount of product that is re-directed to lower-quality markets. Some causes (e.g. crown rot in bananas) are so well known that it can be recorded within the *Screening*.

OUTPUT I-3b: PRELIMINARY SCREENING OF FOOD LOSSES IN THE SELECTED FSC

FSC # ___ , <geographical area>, <market product>			
Step in the FSC	**Expected Critical Loss Points**		**Comments Remarks**
	Quantitative	Qualitative	

I-4. Planning the implementation of the *Survey*, *Sampling and Synthesis* methods

Based on the findings of the *Screening*, a plan can be made to visit the FSC and its actors where they are operating. The visits to apply the *Survey* and *Sampling* methods should focus on the identified Critical Loss Points of the FSC. Taking into account the seasonality of production and harvest is very important, to visit the FSC actors when the activities to observe are actually taking place. Preparing a "crop calendar" or an equivalent for non-crop products would be advisable.

Before conducting fieldwork it is important to make initial contacts with a community through key individuals, such as local officials, community leaders or chiefs, staff of projects that are operational in the area, among others taking into account special arrangements required for interactions and interviews with women. Establishing links like this will make it easier to identify operators for interviews. It is important to identify culturally sensible issues to address them correctly.

Logistics (car, driver, accommodation) have to be arranged well, as well as some money for communication, interpretation, hospitality, sampling or buying samples, service fees and allowances, etc.

Tools to bring along: measuring tape; weighing scales; rope, knife, scissors; sampling bags, baskets and/or buckets; digital camera; mobile phone; stationery.

The implementation plan should be recorded for each FSC in Output I-4.

OUTPUT I-4a: Field Case Study implementation plan

FSC: _____

Date	**Location**	**Activities**	**Team members**	**Remarks**

II. Survey Method (‘*Survey*’)

The *Survey* implies making observations of the FSC right in the field, and interviews to be conducted with the FSC actors. The *Survey* is a tool that relies heavily on the internal assessment of the actors in the chain. In some cases this may be seen as private or sensitive information. Thus, it is important to provide a background to the producer/ handler about the on-going work, and to highlight that this survey will help them and the industry with the identification of solutions to food losses issues, and that no names will be associated to the information provided. In the cases that the producers are women, identify if it is necessary to be accompanied by an authority or other people from the community. The survey should be sensitive and detailed enough to identify more clearly quantitative and qualitative information than that provided in the *Screening* method. **Very important is –with permission– to look around and make observations and photos of the FSC operations as much as possible.**

In a community or at an FSC site at first a general orientation and familiarization is required. It consists of the following activities:

- Walk through the location and/or community to observe FSC activities and stakeholders; take photographs if allowed/ possible.
- Conduct a group interview with a cross-section of stakeholders from the location and/or community, during which the objectives of the work and the team are introduced and a flow diagram is developed to identify key activities and stakeholders. A semi-structured interview (SSI, § II-2 and Annex 3) is conducted to understand losses in general and who are affected. Be sure to include women’s representation, different age groups and capture the viewpoints of the most vulnerable if they are part of the stakeholders.
- Using information from the general group interview (above), undertake SSIs with groups of different stakeholders at the location to understand food losses more in detail, and obtain views on possible solutions to food losses. A separate meeting with a group of women could be important as in the general group women have often less opportunities to express themselves.
- Carry out interviews with key informants – including those who are not FSC actors – to generate a detailed understanding of losses, including the economic value, impacts on the environment and climate change and impact on the community. Validate, cross-check and build on information from group interviews and provide case studies describing examples of the causes and effects of losses.
- **In the cases that the interviewees are women, identify if it is necessary to be accompanied by an authority or other people from the community. Also be aware of cultural rules with respect to interviewing senior members and leaders of the community.**
- **Ensure that the total of people interviewed are representative of the community, if necessary by attending to specific ‘less visible’ people separately.**
- Before leaving the location or community, hold a validation meeting at which the key findings are presented to a cross-section of stakeholders. The meeting should aim to cross-check that the team’s findings are accurate, reflect the real situation and provide an opportunity for the team to discuss the data and address any knowledge gaps.
- Prepare daily reports based on the information collected, and prepare a final loss assessment study report. Data analysis should ideally be completed in the location while memories are still fresh. Daily team meetings held at the end of a data collection day, to analyze and validate the assessment findings, are recommended.

II-1. Observations and food loss factors

One of the ways to understand activities, food losses and the causes of losses in a location is simply to observe what goes on and learn from what you see. Information from observations can be cross-checked or validated during subsequent SSIs. This exercise should identify a number of environmental, economical, habitual or other type of factors which have an effect on food loss – see also II-7. It is important during this process to appraise the existing infrastructure and basic amenities. Checklists such as presented in Annex 2 can be used to guide the observation process.

II-2. Semi-structured interviews, Key-informant interview

How to conduct a semi-structured interview (SSI) as well as a few important things to remember when using SSIs are presented in Annex 3.

A key-informant interview (KII) is conducted with an individual or select group of people who are especially knowledgeable or experienced about FSC practices of the area, have adequate local knowledge and are conversant on food losses. Such key informants can be identified with the help of community leaders and other operators. The main purpose of a KII is to generate detailed data on losses (especially causes, economic, environmental and social impact, potential solutions), validate, crosscheck and build on information from group interviews and observation, and provide case studies describing examples of the causes and effects of losses. It is important that the KII gives a better understanding of the gender implications on the food losses. Further, the key-informants may have well developed views on measures to reduce food losses. The aim should be to have different views and experiences represented.

The information retrieved from the SSI, the KII and the observations should be recorded in output matrices II-3 to II-6, which as such also provide the checklists for conducting the interviews and observations.

II-3. Basic information about the FSC **– Output II-3b**

Product transformation and conversion factors. In the postharvest handling and agro-processing stages of the FSC the products often undergo a transformation. For each intermediate and final product the *processing conversion factor* has to be determined, preferably by direct measurements in the process, that calculates the quantity of primary product/ raw material required to produce the intermediate or final product. Results to be presented in Output II-3a.

OUTPUT II-3a:

(INTERMEDIARY) PRODUCTS AND CONVERSION FACTORS IN THE FSC

Activity in the process	Duration[5]	Product out	Weight from 100	Cumulative error (± %)	Conversion Factor

[5] Only applicable for processes that are determined by a length of time independent of the quantity of product and the amount of labour, such as drying, fermenting, ripening, storage, transportation.

By-products. Most FSCs produce – in addition to the main product – also one or more by-products, which have a potential value. This could be non-food products, such as potato peels that are being used as animal feed. It can also be products that are or can be in principle food, for example the kernels of oilpalm fruits containing an edible oil. A by-product that is not consumable or meant for consumption (by culture, or preferences in the countries) is not a food loss. It is food loss only if people would eat it, but can't because the FSC is not equipped for making it available for human consumption. This could happen when for example the processing technology is not available, or the process is not efficient resulting in a higher quantity of by-product than it should have. The final destination of the by-products should be identified and reported.

Services. A short listing and – if meaningful – description of services that the owner of the product in each stage of the FSC engages/ hires/ receives to facilitate the product and process flow. These services could be specific processing, packaging, transportation, storage, cleaning, marketing, casual labour, consultation. This means that in some cases the step in the FSC could be a service at the same time, e.g. milling.

Product quality and safety. Food safety could be a potential cause for losses throughout the food chain. Food safety related causes are sometimes visible (insects, mold, filth) but could be also invisible (excess pesticide residues, mycotoxins). The extent (contribution) of food safety and quality on food losses can vary from one geographical area to another and also depending on the selected value chain, infrastructure and national capacity in government and value chain, none of which should be over looked while identifying the causes for food loss.

Furthermore, since the food loss assessment team is a multi-disciplinary team (expertise involved in the work such as food safety, technology, gender and social, economy, etc.) before starting the implementation of the methodology, the team should be briefed and have a common understanding of the different aspects that are reflected in this work. This would maximize the performance and increase the synergy among the people involved.

See Annex 4 for a brief on the food safety and quality dimension of the food loss methodology.

II-4. Social structures in the FSC **– OUTPUT II-4**

The different activities along the FSC are taking place in specific social contexts and under varying conditions. The social structures determine the differentiated gender roles; women usually participate in more intensive labor activities, have different, often less, access to resources and services than men, boosting their outputs; and are less involved in rural organizations and decision making limiting their access to facilities, information and markets.

To address these gender differentials that might influence FL, it is necessary to understand the social structures of the FSC, to look at the division of labour at each FSC step and identify the gender and age of the main group of actors involved. While understanding if the activity is dominated by men or women, it is possible to identify who to target. If an activity is identified as a loss point, and if this activity is mainly managed by women, there could be some gender related causes and thus, gender related solutions should be applied.

In the table, use the collected data and observations to indicate the main actors involved in the FSC step (girls, women, boys, men) and then assess the conditions of this involvement by qualifying the FSC actors' participation with a value from 1 to 4, based on an evaluation of how well the identified participants are equipped, how sanitary conditions are, if they have access to extension services and training etc. required to minimize FL.

Rating Score	Description
4 – Excellent	Excellent equipment and sanitary conditions; extension services and training are easily accessible.
3 – Good	Good equipment and sanitary conditions; extension services and training are accessible.
2 – Moderately good	Satisfactory equipment and sanitary conditions; extension services and training are somewhat accessible.
1 – Bad	Bad equipment and sanitary conditions; extension services and training are not accessible.

Also, indicate if the activity is done individually, in the household together with other family members and/or as part of a rural organization/cooperation. Finally, provide some explanation on the chosen qualifier and/or additional observations, examples etc.

II-5. Economics of the FSC - **OUTPUT II-5**

This section provides the information of the FSC as a *Value Chain*, indicating the costs of all operations in the FSC, and the value of the products reflected as farm-gate, wholesale and/or retail prices, resulting in the value-added of the final product. Apart from Table II-5, the researchers are at liberty to provide more detailed information – if necessary in self-created tables – on the for example the costs of various inputs (labour, materials, services, energy, etc.) and the revenue from various by-products. Any other economic considerations relevant to the selected FSC are equally welcome.

II-6. Environment-related inputs and factors in the FSC

The researchers should record and describe the *inputs* and *parameters* related to the *environmental, climate change and energy* dimension of agricultural or fisheries production, processing and distribution and the potential impacts of these practices, with information covering the aspects relating to natural resources – water, land, ecosystems, energy and potential sources of GHG emissions. An example of inputs and a checklist of parameters has been provided in Annex 2. This is not an exhaustive list of all parameters but rather a guidance.

Inputs - OUTPUT II-6a.

Production. Record all the inputs that are used on farm or on board, and the quantities used. At farm level it is important to note the use of synthetic fertilizers or chemicals as this has impacts on soils and the capacity to retain moisture and nutrients as well as contributes to GHG emissions. All tools and equipment should also be noted along with both energy and water inputs at production level. *Storage.* Record the storage technology as well as the source of energy used to regulate temperature and moisture, if any. In case sheds are used where no energy is being used, describe the construction of the shed. This would include the physical characteristic of the storage infrastructure and the material used for building, for instance lack/ presence of walls, shed made of stems and leaves. A picture of the storage infrastructure would be desirable. *Processing and packaging.* The technology used for the processing of food, the capacity of processing plant and the source of energy should be documented. This would include processing such as drying, smoking, baking, canning etc. This should also include water consumption for the different processes. The corresponding energy source and how much energy is used for processing should also be noted. *Transportation.* The mode of transport should be noted. The details that would need to be noted for instance include how food is transported e.g. vans, trucks

bullock carts etc. In case trucks and vans are used, it should we noted if they are air conditioned or cold trucks as well as their fuel mileage (liters of diesel consumed/km). *Retail*. Energy use at retail level would focus on storage and ripening facilities for wholesalers and retailers in markets. Normally this would be cooling (freezing, refrigeration, air conditioning) powered by electricity. However, if remote areas lack electricity, then it should be noted how the food is being chilled and stored. Pictures of the facilities would be desirable.

Factors – OUTPUT II-6b.

Provide detailed information on the farming/fishing practices where the commodity is being produced. Unsustainable land and fishing practices have negative impacts on environment and increases vulnerability, particularly when food is then lost later along the supply chain. It is therefore important to note practices such as tillage, cutting down trees, slash-and-burn, flood irrigation, etc. as these methods contribute to forest and ecosystem degradation, soil infertility and erosion. Any issues with land degradation and soil quality due to agricultural practices related to land preparation for cultivation should therefore be noted. It is also important to record if cultivation and agricultural expansion has been a driver of deforestation and degradation of other ecosystems. What are the main sources of GHG emissions that are non-energy related? This would include emissions from degraded soils, deforestation, methane from paddy rice and livestock as well as biomass burning in the field. Is the production rainfed or irrigated? Describe the state of water quality and availability and note if changes have been observed related to rainfall patterns, drought, etc. For fisheries, the main focus should be on fishing practices and impacts to ecosystem diversity and functioning. Additionally, it is important to identify and understand any potential impact that climatic change may have on losses at production level as well as to identify how solutions can contribute to climate resilience and adaptation.

Whenever food losses are identified along all stages of the supply chain it is important to note any alternative use of the losses or if they are re-introduced as biofuels, animal feed or for composting, etc.

OUTPUT II-3b: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – BASICS

FSC stage[6]	Geographical[7] Location	Months of the year[8]		Main Prod-ucts[9]	Quantity (ton)	By-products	Quantity (ton)	Duration/ Distance[10]	Services	Food safety and quality controls applied by that part of the chain
		from	to							
Primary production										
Harvest										
Post-harvest handling										
Storage										
Transportation										
Market sales										
Agro-pro-cessing										
Storage										
Transportation										
Wholesale										
Retail										

[6] If one stage in the FSC has two different features, another row should be inserted. E.g. if in the same FSC both crib storage and warehouse storage exist.
[7] Village/town where the FSC stage is located.
[8] Timing of the stage of the FSC.
[9] "final" product produced by stage of the FSC.
[10] How long does the process in the FSC stage take / what is the distance (and duration) of transportation.

OUTPUT II-4: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – SOCIAL STRUCTURES

FSC STEPS	Involvement of Women		Involvement of Men		Who is mainly involved: women, men, children	Organization level of FSC actors[11]	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult women	Boys	Adult men			
	Qualifier[12]	Qualifier	Qualifier	Qualifier			
Primary production							
Harvest							
Post-harvest, handling							
Storage							
Transportation							
Market sales							
Agro-processing							
Storage							
Transportation							
Wholesale							
Retail							

[11] f.i. Individual/Household level/Cooperative

[12] Qualify the equipment, conditions, access to services and training, 4: excellent, 3: good, 2: moderately good, 1: bad.

OUTPUT II-5: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – ECONOMICS

FSC stage	Main Products	Cost of operation USD/kg	Cost USD/kg final product	Cumulative Cost USD/kg	Value USD/kg final product	Value-added / Margins USD/kg	Remarks
Primary production							
Harvest							
Post-harvest handling							
Storage							
Transporta-tion							
Market sales							
Agro-pro-cessing							
Storage							
Transporta-tion							
Wholesale							
Retail							

It could be required to calculate the cost and price for each intermediary product per kg equivalent to the final product, using the conversion factors of OUTPUT II-3a.

OUTPUT II-6a: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – ENVIRONMENT

PRODUCTION		Quantity	Unit
Tools, Equipment, Facilities			
Materials, Chemicals			
Energy			
Water			
Land			
STORAGE		Quantity	Unit
Tools, Equipment, Facilities			
Materials, Chemicals			
Energy			
TRANSPORTATION		Quantity	Unit
Tools, Equipment, Facilities			
Energy			
PROCESSING		Quantity	Unit
Tools, Equipment, Facilities			
Materials, Chemicals			
Energy			
Water			
WHOLESALE, RETAIL		Quantity	Unit
Tools, Equipment, Facilities			
Energy			

OUTPUT II-6b: FACTORS FOR THE ENVIRONMENTAL ASSESSMENT

Factors	Description	Details
Type of production system		
Land preparation practices		
Fishing grounds		
Soil quality and land degradation		
Water regime		
Ecosystem impacts		
Sources of GHG emissions		
Climatic factors		
Utilization of residues in the supply chain		
Re-use of food losses		

II-7. Food loss risk factors (parameters and variables)

Based on gained insights and understanding of food losses, where and why they occur, it could be possible to develop a calculator-based model for the estimation and prediction of food losses at different locations and for coming seasons. The model could be based on variables that have a relation - the parameter - to (the causes of) food losses. Clearly, in one season and one FSC a general cause-effect relation between variable and food losses cannot be established, and certainly not quantified. However, the researchers should identify potential factors, and record the 'value' of the variables (quantitative or qualitative) in Output II-7. Mathematically this *could* look like: FL = parameter × variable.

OUTPUT II-7: FOOD LOSS RISK FACTORS

Variable	Unit	Parameter - relation to food losses	Value of variable (observed in the case study)

II-8. Validation of results and reporting

At the end of the *Survey* a validation meeting will be held with key representatives of the community. The inclusion of (local) government staff is an effective way of raising awareness about food losses. It also provides an opportunity for discussing loss reduction interventions and encourages support to follow up actions on the findings.

At the validation meeting it is important to obtain a reliable impression of the FSC actors' perception of the food losses, how important these are to them, and to collect suggestions for applicable solutions.

The validation meeting is also an opportunity to analyze and raise social and gender dimensions and highlight the social patterns that affect men's and women's jobs, tasks and position in the value chains, as well as the efficiency and competitiveness levels that can lead to food losses caused by gender inequalities.

The results of the Survey are to be summarized in Output matrices II-3 to II-6. In addition, the report should describe in detail how all figures have been obtained.

III. Load Tracking and Sampling Method (‘*Sampling*’)

If there is an opportunity, it is encouraged to take actual measurements of food losses, for example by sampling a harvested area or a product batch, and take the weight of the lost product as percentage of the total product.

While *Screening* and *Survey* provide an understanding of food losses, load tracking (LT) is a method that is used to measure specific losses. It is typically used to measure losses during postharvest handling, storage, processing, transportation or marketing, relying on measuring quantity and quality losses before and after one or more events. The method relies on evaluating the quality and/or weight of (a sample of) a load of food product as it moves through a supply chain. Load tracking is a quantitative loss assessment that requires some skills in design of statistical experiments and data analysis. The method consists of the following key elements that need to be considered in design and implementation.

III-1. *Screening* and *Survey* report and data

With these findings prioritized losses will be identified to be investigated further by LT. The findings also have identified where these losses occur and who is affected by the particular loss and, therefore, who should be involved or contacted about participating in the LT activity.

III-2. Setting the objective

The objective of LT will be derived from *Screening* and *Survey* findings. The objective must be desirable and achievable. For example: *‘Measure the quantity and quality food losses of product X during packaging and transportation, and identify the causes of food losses’*.

III-3. Choosing the ‘load’

A load is a certain quantity of product, which can be followed (tracked) on its way through (part of) the FSC as one batch, and of which the changes in weight and quality can be measured. A load can be the harvest of one farmer or a group of farmers on one day, a truck load of maize cobs or banana bunches, the production of dried fish by a processor in one week, a production batch of yoghurt by a small dairy plant to be sold to the supermarket. It has to be determined how many loads are being produced in the FSC per year.

III-4. Unit of measurement or Experimental unit

These are units taken (sampled) from a load. The most practical is to make use of the units that are being generated and used in the FSC, for example a bucket of fish, a bag of maize grain, a container of milk or a bunch of bananas. It depends on the size of such a unit, whether the whole unit will be evaluated and measured, or whether again a representative smaller sample will be taken from the unit. This latter unit will normally be a weight or volume unit (kg or ltr).

III-5. Sampling

Often a two-stage sampling is required: 1) a systematic selection of units from the load, and 2) a random sample from the selected units, to be a measurable unit. For example: from a bag of maize grain (1^{st}-stage sample) with a scoop one kg of grains (2^{nd} stage sample) can be taken as measurable units from three parts of the bag (bottom, center, top); from a bunch of bananas (1^{st} stage sample) a few bananas (2^{nd}-stage sample) can be picked randomly. In all cases the weight or volume of the unit and the samples has to be measured.

Sample size: a 1^{st}-stage sample size should preferably be 30% of the load, however with a maximum of 20 samples. A 2^{nd}-stage sample size could normally be 1 kg or 1 litre.

Based on the samples, the total weight as well as the product quality of the load can be determined.

NB.: The weight loss as a result of regular intentional processes such as drying, fermentation, heating, etc. is not food loss. If such processes apply to a load, parallel samples of sound product have to be taken before and after the process to measure the intended weight loss.

III-6 Tracking

The sampling as described by point 5 above has to be applied twice for a load: one time when the load enters an event, and one time when it exits the event. In this way the food losses incurred during the event can be measured. Examples: sampling of a load of milk when it leaves the farm, and just before it enters the dairy factory; a load of fish or maize before and after the drying process; a load of bananas during three days in the retail market.

It is of critical importance that the Load does not get mixed or supplemented with new product during the load tracking process.

III-7. Replication

The load tracking and sampling as described by point 3 to 6 above provide a 'one moment shot' of what is happening on food losses in the FSC. However, along the season and geographical areas, with varying climatic conditions and varying human practices, results will be different with time and place. Pre-knowledge of the conditions that have effect on food losses (location, season, rainfall, cultural practices, product variety, distance to market, etc.) is required to design a statistical survey with meaningful replications. Therefore it is required to replicate the load tracking a number of times. As a general guide we could say that three replications at each of two or three different sites, times of the year, or rainfall conditions would be sufficient. However, it will be at the conditions in the FSC and the researchers' judgment to decide whether this is feasible within the time frame of the study.

III-8. Quality and safety analysis

Analysing quality can be subjective, thus, it is best if done with the guidance of a well-experienced person that can easily determine quality parameters and reasons for quality deterioration. To include in the analysis, consider quality factors that: 1) pose health risk to consumer; 2) pose consequences to the price of the product; 3) are easily determined, and deterioration can be forecasted given the handling system or the nature of the product.

The qualitative analysis can be done to the product that is 'lost' or has been rejected by determining the reason of rejection (or the main cause of the deterioration) or can be done to product that is still considered in the market, but with visible quality deterioration. In the latter case, the cause of quality degradation should be indicated. The first step is to determine the overall sensory (visual for most) quality of the product.

If a national grading system exists for the product, this should preferably be used. Otherwise, create a 10-point scale for assessing food quality, were: 0 = completely unfit for consumption, to be discarded, and 10 = in perfect shape. Then produce a table as below for each product being evaluated, and if possible add photos of the different quality stages of the product. Try to provide a realistic indication, based on observations, of the reduction of the market value of the product as a result of reduced quality. It is important for the team to consider whether there are causes of food loss due to the decision taken by regulatory authorities or by industry to remove food from the value chain due to safety concerns i.e. not all the quality related causes are visible. Depending on the context and findings (and resources available), the team may also need to decide whether there is benefit in sampling and analysis of product to better investigate the actual hazard or levels present.

OUTPUT III-8a: QUALITY SCORING OF FOOD PRODUCTS

PRODUCT:	**<product name>_____**	
Quality score	Description of the quality	%age reduction of market value
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

If at any point, the sample taken contains product that is ranked 7 or below, a description of the reasons/ cause for the lower-than-the-highest ranks should be added. The qualitative analysis should define the major reason for quality degradation between the main types of quality defect problems: 1) physical damage; 2) physiological damage; 3) biological damage, 4) non-compliance with regulatory or voluntary standards. The results should be presented in table Output III-8b.

OUTPUT III-8b: QUALITY ANALYSIS OF SAMPLED UNITS

Unit evaluated	**Overall quality score**	**Type of damage (deterioration) if any**	**Potential cause and symptoms**
1			
2			
3			
4			
5			
REPORT: Average score:			

III-9. Quantitative results

The quantitative results show what is actually measured in an LT activity. The most appropriate measurement is an objective measurement such as the weight. This gives a more accurate estimate of losses, although it is often necessary to convert this to a percentage and a monetary value in order to express the results in a form more easily recognized by decision-makers. For example, the result could be 'the weight of food discarded, or weight of food sold at lower price'.

To quantify loss of mass, one has to measure the weight of the units at the beginning and at the end of each stage or activity being assessed. This is more complicated when the stage by its nature induces a reduction of weight, like drying or sales. In those cases, one should from measuring the samples determine the percentage of the product that has become unfit or less fit for processing, sales or consumption and will be discarded (lost) or incur loss of economic and/or nutritional value.

When measuring quality loss one has to assess the quality of the product at the beginning and at the end of each stage or activity being assessed, to determine changes. Determining quality can be subjective and therefore a quality grading table has to be used, either from national quality standards if they exist, or designed by the researchers based on the operators' experience and understanding of quality.

With regard to the response on causes and solutions, it is extremely important in LT to observe the nature of the food losses that are being measured, and their direct causes. This will provide strong evidence-based cases for food loss reduction proposals.

There are some key ways in which the data from LT can be analysed and presented. Biometric or statistical knowledge and skills will ease the data analysis process. Software packages and computers are also helpful in data analysis.

Initial data analysis and *summary statistics* can be calculated by hand and do not necessarily require a computer. The most common summary statistics to use are the mean (average) and variance. The results can be presented in the table of Output III-9.

Graphical methods: the simplest method for visualizing the results of LT is to present the data in table form showing means and totals, and then using these data to draw bar and line graphs. Histograms are also useful for examining the distribution of a response.

OUTPUT III-9: PRESENTATION OF LOAD TRACKING AND SAMPLING RESULTS

A	Product				
B	Event				
C	Duration of the event				
D	Location				
	Before the event	Experimental Unit	Weight of unit	Nr of units	Total weight
E	Load				
F	1st-stage sample				
G	2nd-stage sample				
		Value (score / %)	Observations / Causes		
H	Sample size 2nd-stage				
I	Average quality score (0 – 10)				
J	%age unfit (< 2)				
K	%age low quality (2-6)				
	After the event	Experimental Unit	Weight of unit	Nr of units	Total weight
L	Load				
M	1st-stage sample				
N	2nd-stage sample				
		Value (score / %)	Observations / Causes		
O	Sample size 2nd-stage				
P	Average quality score (0 – 10)				
Q	%age unfit (< 2)				
R	%age low quality (2-6)				
	Quantity loss	Value (%)	Observations / Causes		
S	%age lost (E-L)/E				
	Quality loss	Value (%)	Observations / Causes		
T	%age lost (Q-J)				
U	%age quality reduction (R-K)				

III-10. Quantitative / Qualitative FL, Critical Loss Points (CLP), Low Loss Points (LLP)

Quantitative food loss refers to food that ultimately is not eaten by people. Qualitative food loss refers to food that has incurred a reduction in economic value or nutritional value, but not in weight and everything will be eaten by people. The *Survey* method should verify if the CLPs anticipated by the Screening method (par. I-3) indeed are Critical Loss Points.

Low Loss Points (LLP): The *Survey* and *Sampling* methods may reveal points in the FSC where the losses are actually unexpectedly low, which is < 1%. It is very important to record such observations and report on the reasons, as it may be the result of good practices and/or conditions which could serve as solutions to high losses in other FSCs.

For the environmental impact of food loss it is very important is to observe and record the *destination of food loss*: what happens with the food which is not going to be eaten by people. This food loss could be used as animal feed, as compost, put on agricultural land or dumped as garbage.

The results of *Survey* and *Sampling* methods will be summarized in Output III-10.

OUTPUT III-10: SUMMARY RESULT MATRIX OF FOOD LOSSES

FSC stage/ process	Type of loss Qn./Ql.	%age lost in this process Quant	%age of the product that incurred quality loss in this process	%age of product that goes through this stage	%age loss in the FSC	Cause of loss/ Reason for low loss	Re-duced market value	CLP / LLP	Destina-tion of food loss	Impacts on the environ-ment/climate change/natural resources	Impact/ FSC actors affected (men / women)	Loss percep-tion of FSC actors (men / women)	Suggested solutions

With regard to the economic impact of food losses, try to calculate or estimate the financial loss for the affected FSC actors as well as the overall economic loss of the food supply chain – in absolute figures and as percentage of the actor's income cq. total value generated in the FSC.

IV. Solution Finding (‘*Synthesis*’)

IV-1. The causes of food loss

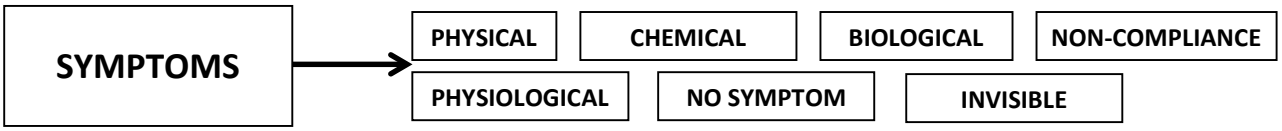
While sometimes it is easy to determine the cause for the damage, there are often cases that the actual cause is not as clearly identified. The origin of some causes could be located at the up-stream of the value chain, but the impact and actual loss happens further down in the value chain – or the other way around! We categorize the causes into micro (each stage of the FSC), meso (structural/secondary causes) and macro (impact of law and regulation) level. Accordingly the solutions could be developed at these three levels based on the identified causes and be supported by the actors and stakeholders that are operational and responsible at these respective levels.

A process of verification and identification of cause(s) of losses should be followed. The diagram below suggests such a process. The evaluator should first describe well the symptoms, determine the type of defect, consulting different sources what the main factor for quality degradation was and verify if there is more than one origin for the defects.

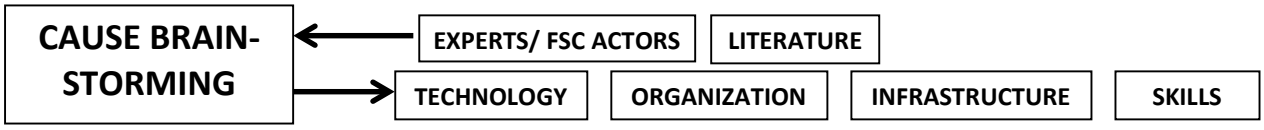
OUTPUT IV-1: CAUSE FINDING DIAGRAM

1. Food loss assessment methods have revealed a batch of food products containing *losses or product of low quality*.

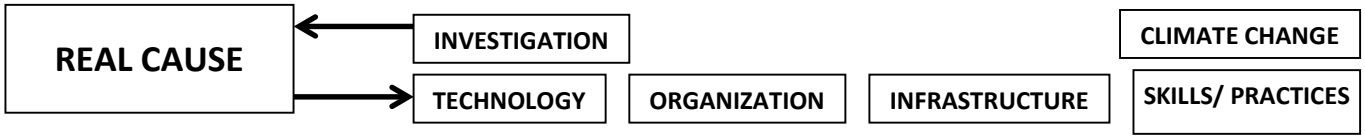
2. Identify and describe the *symptoms* that lead to this quantitative / quality loss.



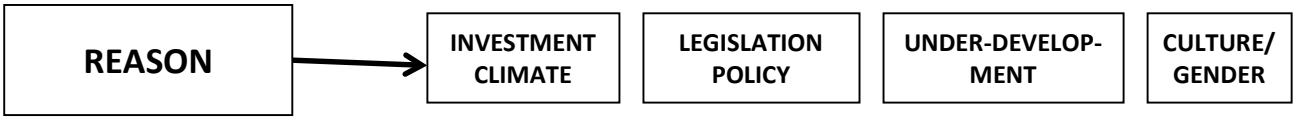
3. Verify the possible *causes* by consultation of experts and literature, and by on-site investigation.



4. Identify the *real cause* of the low quality and subsequent food loss.



5. Find the underlying *reason* for the cause, why the problem hasn’t been solved yet.



IV-2. The solutions to food losses

FSC actors will be the first source to suggest solutions for food losses, during the *Survey* method. Ensure women take part in solution finding. Provide a summary of the Critical Losses that have been identified, including the cause(s) and potential solution(s), as in the table of Output IV-3.

For each potential solution an intervention has to be proposed to implement it, and the technical and financial (economic, commercial) feasibility of the interventions have to be determined. The cost of the intervention could be private (equipment, training, packaging) or public (infra-structure, tax benefits, credit facilities), or both. The economic feasibility should be based on at least 10 years of operation of the proposed improvements. A table to calculate a quick budget for food loss reduction intervention is provided in Output IV-2a.

OUTPUT IV-2a: BUDGET CALCULATION FOR FOOD LOSS REDUCTION

	item	**value**	**unit**	**calculation**
a	Product quantity		ton/year	
b	Product value		$/ton	
c	Loss rate		%	
d	Anticipated loss reduction		%	
e	Cost of intervention		$	
f	Depreciation		years	
g	Yearly costs of investment		$/year	e / f
h	Yearly costs of operation		$/year	
i	Total yearly costs of solution		$/year	g + h
j	Client costs per ton product		$/ton	i / a
k	Food loss		ton/year	c × a
l	Economic loss		$/year	k × b
m	Loss reduction		ton/year	k × d
n	Loss reduction savings		$/year	m × b
o	Total Client costs		$/year	a × j = i
p	Profitability of solution		$/year	n - o

The economic implications of the solution have to be assessed. These could include:
- the price of the products;
- income generation;
- the response from the markets.
- GDP

The social implications - general or specifically related to men or women - of the solution have to be assessed. These could include:
- the employment situation;
- increasing/ reducing workload;
- the need for training to apply the solutions;
- who are going to benefit from the solutions, and who not;
- the required degree of organization of the beneficiaries;
- dynamics of power in the FSC - 'ownership' of the solutions, who is in charge;
- will the solutions cause people to be excluded from the value chain.

OUTPUT 1V-2b: Assessing social implications of specific food loss solution suggestions

(How) Does the suggested solution …	**Description of the potential impact**	**Gender dimension of the impact (how women and men may be affected differently)**	**Suggestions to mitigate negative impacts**

The food security implications of the solution have to be assessed. These could include:
- availability of food;
- access to food;
- safety of food;
- nutritional value of food.

The environmental implications of the solution have to be assessed. These could include:
- use of land and water;
- use of energy;
- type of energy required and what will be the source;
- waste products and waste water.

The climate change implications of the solution will have to be assessed. The solutions should therefore be in accordance with national mitigation and adaptation objectives. It must be clearly outlined how the proposed solutions is contributing to specific elements of climate change planning, such as:

- Nationally Determined Contributions (NDCs)
- National Adaptation Plans (NAPs)
- Nationally Appropriate Mitigation Actions (NAMAs)
- Other climate change strategies, green economies, National Communications, etc.

Outlining how the solutions can contribute to national climate change mitigation and adaptation priorities will be of significant importance for improving the financial attractiveness of food loss reduction measures and their action plans.

The above analysis of the solutions includes an assessment of prerequisites, risks and obstacles to implementation.

IV-3. Strategies for food loss reduction

In principle, there won't be the formulation of a stand-alone food loss reduction strategy, but rather strategic elements which should be integrated in existing national strategies for food security, agriculture/ fisheries, natural resources and/or economic development.

A national stakeholder workshop will be organized at the end of the field work, to discuss and validate the proposed solutions and define elements of a food loss reduction strategy. The workshop is important opportunity to raise awareness on the issue of food losses in the context of climate change and identify ways for integrating this with national and sub-national climate change priorities including adaptive capacities and technology needs.

During the workshop the basic concept will be prepared for an investment project to formulate the food loss reduction strategic elements in detail, apply them into the national strategies and implement solutions to effectively reduce food losses.

OUTPUT IV-3: SUMMARY TABLE OF FOOD LOSSES, CAUSES AND SOLUTIONS

Critical Loss Point	Magnitude of losses in the FSC			Cause of loss	Intervention to reduce losses	Loss reduction		Cost of intervention (USD)	Economic implications	Social implications	Food security implications	Environmental and climate change implications	Policy implications
	%age	weight	USD			%age	USD						

ANNEX 1

Terminology.

Semi-structured Interview (SSI)

Subsector (SS)

Food Supply Chain (FSC): The connected series of activities to produce, process and distribute food.

Value Chain (VC): The connected series of value-adding activities to produce, process and distribute food.

Food Losses (FL)

Critical Loss Point (CLP)

Low Loss Point (LLP)

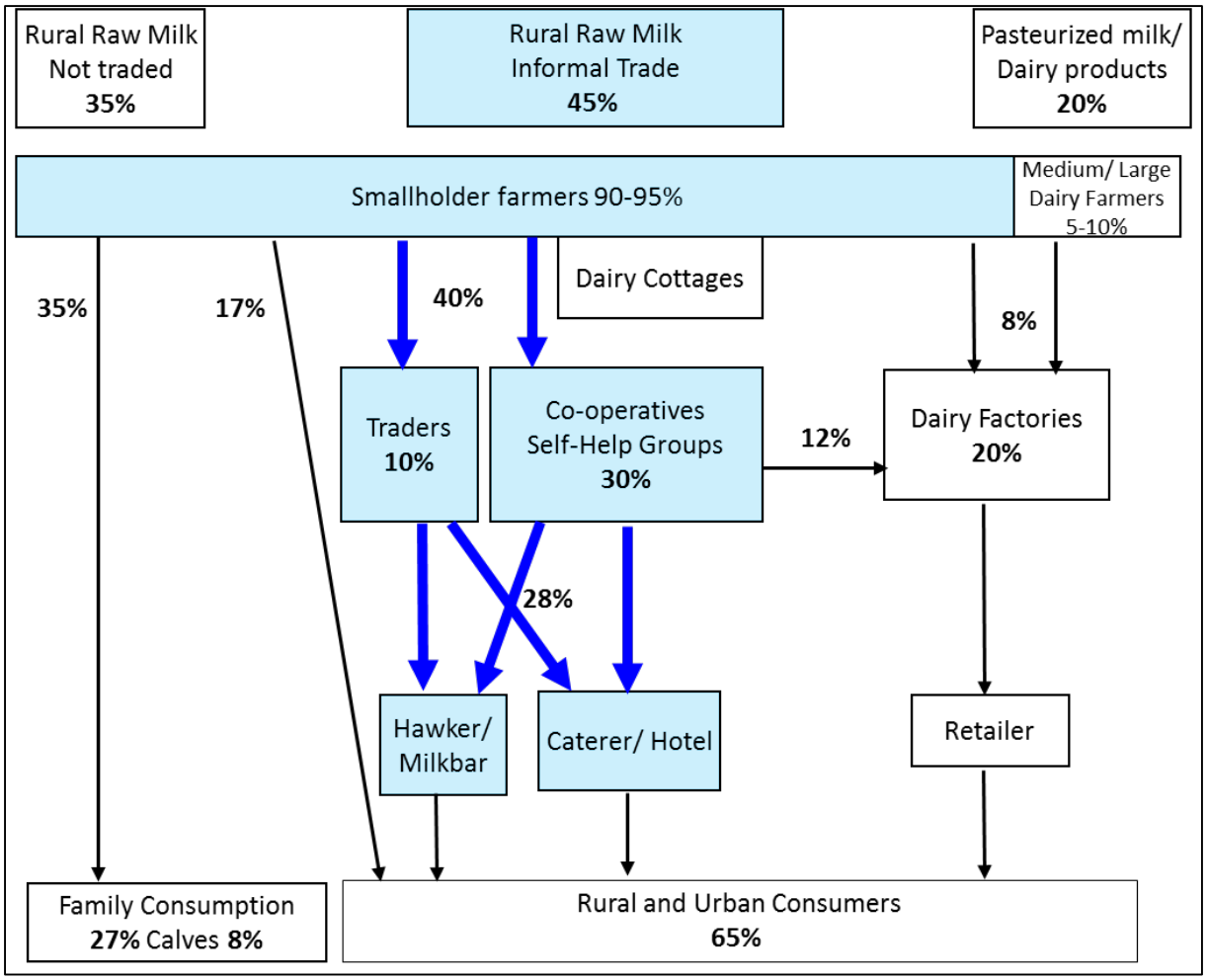
Smallholder Producer

Level of operators: **S**mall, **M**edium, **L**arge scale

ANNEX 2

EXAMPLES OF OUTPUTS

OUTPUT I-1a: Actors and product flow in the milk supply chain



The percentages indicate the fraction of milk that is produced by, or passed on to the actors. The thick blue arrows indicate the selected supply chains in the study.

OUTPUT I-1b: NATIONAL PRODUCTION INFORMATION OF THE SUBSECTOR

	Annual production (t/yr)	Cultivated area (ha)	Average yield (ton / ha)
Raw material	500,000	120,000	4.2
Average annual growth over the last 10 years (%)	3.3%	0.3%	3.0%
Average cost of production (USD / ton)			

	on-farm consumption	marketed	
Percentage of production	40%	60%	

	volume (ton/year)	value (USD/year)	
Market product #1, maize meal	150,000	40.5M	
Market product #2, stock feed	80,000	40M	
Market product #3, maize oil	20,000	20M	

Number, sex, age of	female				male				Total
	15-30	30-45	45+	total	15-30	30-45	45+	total	
Producers	5K	30K	25K	60K	5K	10K	25K	40K	100,000
Traders				0				120	120
Processors #1				300S				100S	400S + 10L
Processors #2									10L
Processors #3									3L
Retailers #1									200
Retailers #2									
Retailers #3									200

	Small	Medium	Large
Level of processing operations	X	X	
Level of trading/ wholesale operations		X	
Level of retail operations	X	X	X

K = thousand. M = million. L = large scale. S = small scale.

OUTPUT I-1c: 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		Food and drug administration
		Exists but not rigorous	X	
		Doesn't exist		
	Frequency of checking (None, Low, Medium, High)	Harvest	L	Food safety authority/ food inspection agency / food standards agency
		Transport	N	
		Storage	L	
		Process	M	
		Market	M	
	Obligatory registration of the food processing/ preparation unit	Exists		
		Doesn't exist	X	
FSC actors - food safety management system	GHP/ GAP/ HACCP/ voluntary standards	GAP / GMP		
	Identification of potential hazards	Mycotoxin, pesticide		

OUTPUT I-2a: FOOD SUPPLY CHAINS IN THE SUBSECTOR

FSC #	Geographical area of production	Final product	Volume of final product (ton/year)	Number, age and sex of smallholder producers	Market of final product, location, buyers	Project support
1	Munchinji	Maize	100 000	F-5000 M-4000	Lilongwe	IFAD
2	Kaware	Maize	120 000	F-5000 M-5000	Kaware, Lilongwe	CARE
3	Mponela	Maize	80 000	F-5000 M-3000	Blantyre	IREEP
4						
5						

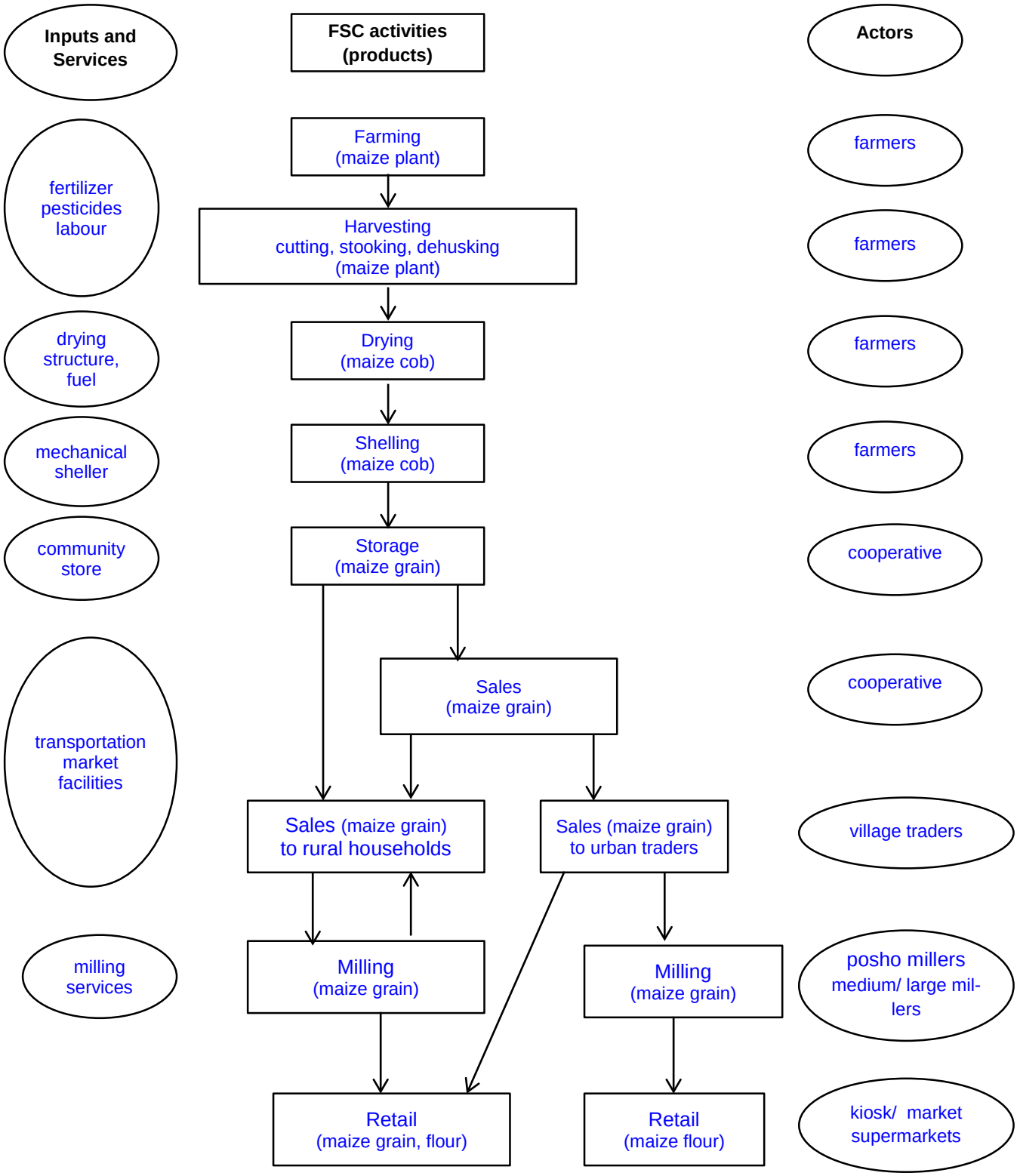
OUTPUT I-2b: IMPORTANCE OF FOOD SUPPLY CHAINS AT NATIONAL LEVEL

FSC #	Economic Importance	Generation of foreign exchange	Contribution to national food consumption	Contribution to national nutrition	Environmental and climate change impact	
1	3	1	3	2	2	
2	3	1	3	2	1	
3	1	1	2	2	1	
4						
5						

OUTPUT I-2c: ECONOMIC IMPORTANCE OF FOOD SUPPLY CHAINS (from I-2a) FOR SMALLHOLDER ACTORS

FSC #	Sex	Percentage of produce by		Contribution to income generation (% share of total annual income)				
		smallholders	Other	Farmers	Middle men	Processors	Wholesalers	Retailers
1	Female	50%	20%	80%	40%	30%	70%	20%
	Male	30%	0%	20%	60%	80%	50%	50%
2	Female							
	Male							
3	Female							
	Male							
4	Female							
	Male							
5	Female							
	Male							

OUTPUT I-3: FLOW DIAGRAM OF THE MAIZE FSC



OUTPUT I-3b: PRELIMINARY SCREENING OF FOOD LOSSES IN THE SELECTED FSC

FSC # _2_ , <geographical area>, <yoghurt>			
Step in the FSC	**Expected Critical Loss Points**		**Comments Remarks**
	Quantitative	Qualitative	
Transport to the collection center	10-12%	high	The containers are not clean and not made of appropriate materials, long distance, high temperature
Receiving point at the collection center	5%	n/a	Rejection due to adulteration

OUTPUT I-4a: Field Case Study implementation plan

FSC: MILK

Date	**Location**	**Activities**	**Team members**	**Remarks**
20–25 June	<capital>	Screening: Desk review and interview with the main stakeholders and VC actors		
1-14 July	<village name>	Survey: observations, ssi Sampling: FL measurements		
15-20 July	<village name>	Sampling: load tracking		

OUTPUT II-1: (INTERMEDIARY) PRODUCTS IN THE FSC – EXAMPLE OF GARI

Process	**Duration**	**Product out**	**Weight from 100**	**Cumulative error (± %)**	**Conversion Factor**
harvesting		cassava tubers	100	-	1.00
peeling		peeled cassava	80	5	1.25
grating		cassava pulp	80	6	1.25
fermenting	3 days	fermented pulp	58	8	1.72
sieving		sieved pulp	49	9	2.04
roasting		gari	25	11	4.00

PARAGRAPH II-3:

Checklist of **general parameters** for observations and interviews in *Survey*.

- Is there a form of inspection or control in place, either by the sector itself of by the authorities?
- Are sanitary conditions adequate?
- Are there animals wandering freely where food products are handled or processed, etc.?
- Is personal hygiene of producers, handlers and processors adequate?
- Are food products isolated from potential (sources of) contaminants (soil, insects, birds, chemicals, people, etc.), and how?
- Are food products protected from the sun and rain, and how?
- Are food products cooled or pre-cooled, adequately or not?
- Are food products packaged and stored adequately, and without delay?
- Are food products handled carefully to avoid damage?
- Is potable water used to wash food products or equipment?
- What are the different types of food products available or produced?
- What are the measurement and packaging units used, and how is it measured?
- How are food products transported and does this cause any damage or other loss?
- Are food products being processed adequately?
- Is there a practice of avoiding losses by re-using or re-working substandard product?
- Does the process produce (valuable) by-products?
- Are any quality standards being applied?
- What processing methods and equipment are used?
- What coping strategies are being used at the site to control losses?
- How effective are loss reduction measures?
- To what extent is the local infrastructure in place and adequate?

PARAGRAPH II-3:

Checklist of **food safety and quality parameters** for observations and interviews in *Survey*

All in yellow above in PARAGRAPH II-3 could be used as food safety and quality checklist and removed to here.

The following table shows in greater detail how the team should observe in practice food safety controls and handling of the product at different parts of the chain.

Stage of FSC	**Food Safety related inputs for observation**
Primary Production (farms, sea, etc.)	• Application of GAP (Good Agriculture Practice). This would cover the presence of pesticide, mycotoxin and veterinary drugs • Check the related records on above • Quality of the product
	• Animal health, GHP (Good Hygiene Practice) in farm such as in handling the product, cleaning and disinfection, clean equipment, cross contamination, etc. • Quality of the product
	• Quality of the fish after the catch • Condition of storage (for short period) on the spot before sending it to the market e. g exposure to sun, enough ice available, etc.
Storage	• Actual product quality • Condition of storage; Temperature, Humidity • Hygiene, pests • Packaging • Length of storage
Transportation	• Duration of the transport (proximity of the market/consumer) • Temperature • Handling by workers • Quality of the product before and after
Processing	• Application of HACCP and/or GMP (quality management, factory standards, contamination control, personal hygiene) • Any private standard/protocol in place to ensure food safety and quality • Quality of water for cleaning and for process
Retail	• Quality of the product when arriving • Storage and cool chambers • Stalls

OUTPUT II-3b: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – BASICS

FSC stage[13]	Geographical[14] Location	Months of the year[15]		Main Products[16]	Quantity (ton)	By-products	Quantity (ton)	Duration/ Distance[17]	Services	Food safety and quality controls applied by that part of the chain
		from	to							
Primary production	farm village <name>	Feb	May	maize				4 months	tractor	GAP
Harvest	farm village <name>	Jun	Aug	maize cobs	180	stalks		2 months		
Post-harvest handling	farm village <name>	Jun	Aug	maize grain	100	shelled cobs	80			Good hygienic practice / GHP
Storage	village <name>	Aug	Feb	maize grain	60			6 months	warehouse	GMP
Transportation		Jun	Aug	maize grain	40			30 km	truck	GMP
Market sales	city <name>	Jun	Aug	maize grain	40				market facility	
Agro-processing	city <name>	Feb	Mar	maize flour	60	grits	0.5	1 hr/ton	maize milling	GMP/HACCP
Storage										
Transportation										
Wholesale										
Retail	city <name>	Feb	May	maize flour	60			4 months		

[13] If one stage in the FSC has two different features, another row should be inserted. E.g. if in the same FSC both crib storage and warehouse storage exist.
[14] Village/town where the FSC stage is located.
[15] Timing of the stage of the FSC.
[16] "final" product produced by stage of the FSC.
[17] How long does the process in the FSC stage take / what is the distance (and duration) of transportation.

PARAGRAPH II-4:

Checklist of **social parameters** for observations and interviews in *Survey*.

- What are the specific roles of men and women in the various operations?
- Are there any differences in the conditions under which women and men participate in the observed activities?
- Are community services in place that supports people's domestic and care duties?

FSC - OUTPUT II-4 Checklist to address Gender Aspects

Try to find out as much as possible on the involvement of the FSC actors, both men and women, in their respective FSC activities. This information will be key to analyse social and gender related causes for food losses and identify socially acceptable solutions.

Division of labour	• Which activities along the FSC do women predominantly do, which ones do men do? • How these activities are related/affect women's and men's roles in other productive and domestic activities? • Consider/document/observe the involvement and role of men and women in: ____ production ____ harvesting ____ postharvest handling ____ storage ____ transport ____ processing ____ marketing (wholesale) ____ marketing (retail)
Types and control of assets	Consider/document/inquire about the ownership/control of men and women in: • How well are the FSC actors prepared and equipped to participate in the respective FSC activity? • Is the equipment appropriate and used adequately? • Under which conditions do the FSC actors pursue their respective activities? • Do women and men have equal access to assets: ➢ Natural resource capital: land, water, trees, livestock, genetic resources, soil fertility ➢ Physical capital: livestock, agricultural and business equipment, crop drying and storage structures, postharvest and food processing tools/supplies, labor saving technologies, houses, consumer durables, jewelry, vehicles and transportation, water supply and sanitation facilities, and communications equipment, mobile phones ➢ Human capital: education, skills, knowledge, information, health, nutrition; (these are embodied in the labor of individuals) ➢ Financial capital: money, savings, credit, and inflows (state transfers and remittances) ➢ Social capital: membership in organizations and groups, social and profession networks, mobility freedom ➢ Political capital: citizenship, enfranchisement, and effective participation in governance
Empowerment	Consider/document the ability and willingness of men and women to make decisions and changes regarding: • production activities (what to plant or produce, methods, tools, investments, work burden, etc.) • harvesting/postharvest activities (timing, tools, investments, etc.) • how to add value to foods (via processing, packaging, transformation, etc.) • how to transport produce from the farm to the market • how and where to sell (buyers, prices, locations, marketing options, etc.)

OUTPUT II-4: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – SOCIAL STRUCTURES

FSC STEPS	Involvement of Women		Involvement of Men		Who is mainly involved: women, men, children	Organization level of FSC actors[18]	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult women	Boys	Adult men			
	Qualifier[19]	Qualifier	Qualifier	Qualifier			
Primary production				3	Men	Individual	Men are in charge of land preparation, fertilizers and pesticides application. Limited technology available.
Harvest	2	2	2		Women	Household level	Women dominate weeding and harvesting. Children also participate. The qualifier is 2 due to the scarce inputs, labor intensive work, and additional work burden due to child care and domestic loads.
Post-harvest, handling		1		3	Women and men	Household level	Both women and men are involved. Women mainly involved in immediate processing as milling, done manually and with scarce technology. This leads to a significant loss risk. When technology is available, men are more often involved. Advisory services are scarce, and women are excluded.
Storage		2		2	Women and men	Household level	Both women and men are involved. Limited equipment and poor hygienic management. Women prefer hermetic bags that allow an easier access, while men prefer silos; these are more expensive and increases HH investment.
Transportation				3	Men	Individual	Male dominated stage because of the limited involvement of women in the manual work of loading/offloading
Market sales		2			Women	Individual	Traditionally dominated by women at local markets; they compete with each other and are not organized. Limited information on markets.

[18] f.i. Individual/Household level/Cooperative

[19] Qualify the equipment, conditions, access to services and training, 4: excellent, 3: good, 2: moderately good, 1: bad.

FSC STEPS	Involvement of Women		Involvement of Men		Who is mainly involved: women, men, children	Organization level of FSC actors[18]	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult women	Boys	Adult men			
	Qualifier[19]	Qualifier	Qualifier	Qualifier			
Agro-processing		2		3	Men	Cooperative	Male dominated since the plant for processing is outside the community and women have mobility restrictions. Yong women are involved in processing, in lower paid jobs, due to limited training opportunities.
Storage				3	Men	Cooperative	Dominated by men since this is done through producers organizations where women have a limited involvement.
Transportation				2	Men	Cooperative	Male dominated stage because of social exclusion of women from long distance driving of commercial vehicles. Men have limited access to adequate transports because of budget limitations.
Wholesale				3	Men	Cooperative	Dominated by men who deal with buyers at this level
Retail		2		2	Women and men	Individual	Traditionally dominated by women in local markets. Markets outside the community are lead by men. Women are also involved as employees

Recommendations to address social/gender issues in food loss reduction:

1. Focus where women are mainly involved
2. Identify social norms and traditions that limit women's participation
3. Identify men's roles that might increase women's opportunities
4. As mentioned in the table, identify training opportunities, equipment and infrastructure gaps, services and inputs that might reach women to reduce food losses.
5. Identify possibilities to reduce women's work burden, increase women's involvement in producers organizations to benefit from services and facilities, and increase women's voice and involvement in decision making.

OUTPUT II-5: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – ECONOMICS – **MAIZE FLOUR**

FSC stage	Main products	Cost of operation USD/kg	Cost USD/kg final product	Cumulative Cost USD/kg	Value USD/kg final product	Value-added / Margins USD/kg	Remarks
Primary production	Maize cobs	0.50	1.00	0.50			
Harvest	Maize cobs	0.10	0.20	1.20	1.50	0.30	
Post-harvest handling	Maize grain	0.20	0.36	1.56	1.80	0.24	
Storage	Maize grain	0.10	0.18	1.74			
Transportation	Maize grain	0.10	0.18	1.92			
Market sales	Maize grain	0.05	0.09	2.01	2.70	0.69	
Agro-pro-cessing	Maize flour	0.25	0.25	2.26			
Storage	Maize flour	0.10	0.10	2.36			
Transportation	Maize flour	0.10	0.10	2.46			
Wholesale	Maize flour	0.05	0.05	2.51	3.50	0.99	
Retail	Maize flour	0.05	0.05	2.56	3.80	1.24	

NB.: 100 kg maize cob = 55 kg maize grain = 50 kg maize flour

OUTPUT II-6a: DETAILED DESCRIPTION OF THE FSC – ENVIRONMENT

PRODUCTION		Quantity	Unit
Tools, Equipment, Facilities	Tractor, Tiller		
	Pen, Sty		
	Irrigation system		
	Vessel, Canoe		
	Fishing nets		
Materials, Chemicals	Nitrogen (N), Phosphorous (P_2O_5), Potassium (K_2O)		kg/ton
	Insecticides, Herbicides, Fungicides		kg/ton
	Farm manure, Crop residues		kg/ton
	Animal feed, Fish feed		kg/ton
Energy	Diesel, gas, electricity		l,m^3,kWh
	Animal traction		
Water	Irrigation per ton harvested product		m^3/ton
Land	Planted per ton harvested product		ha/ton
STORAGE		Quantity	Unit
	Shed, Silo, Warehouse		m^3
	Airconditioning, Refrigeration system		
Materials, Chemicals	Storage pesticides		kg/ton
	Packaging		
Energy	Electricity		kWh
	Solar energy		
TRANSPORTATION		Quantity	Unit
Tools, Equipment, Facilities	Truck, Van, Bike		
	Airconditioning, Refrigeration system		
Energy	Diesel, Petrol		ltr
PROCESSING		Quantity	Unit
Tools, Equipment, Facilities	Factory, shed		
	Dryer, Mill, Boiler, Mixer, Fermenter, Thresher, Press		
	Engine, Electromotor		
Materials, Chemicals	Preservatives, other additives		kg/ton
	Packaging		
Energy	Diesel, gas, electricity		l,m^3,kWh
	Solar energy		
	Fuel wood, biomass		kg/ton
Water	Cleaning water, Process water		m^3/ton
WHOLESALE, RETAIL		Quantity	Unit
Tools, Equipment, Facilities	Market stalls		m^2
	Store, Ripening chamber, Cold chamber		m^3
	Ice factory		
Energy	Electricity		kWh

OUTPUT II-6b: FACTORS FOR THE ENVIRONMENTAL ASSESSMENT

Factors	**Description**	**Details** (example of rice production)
Type of production system	flooded, perennial, agro-forestry, aquaculture	Flooded rice system
Land preparation practices	tillage, biomass burning	Burning of straws in the field, conventional tillage, manure from livestock
Fishing grounds	coastal, deep sea, pelagic, demersal, lake, river	
Soil quality and land degradation	nutrients, erosion	Issues with soil erosion
Water regime	quality, scarcity, contamination	Irrigated - intermittently flooded, water scarcity has been reported
Ecosystem impacts	deforestation, land degradation, over-exploitation, loss of biodiversity	Rice field after deforestation, crop diversification is not promoted
Sources of GHG emissions	non-energy related: methane, degraded soils; energy-related: chemical fertilizers, mechanical equipment	Methane from flooded period, and manure left in the field during dry season; energy emissions from irrigation system
Climatic factors	temperature, rainfall variability, drought	Dry seasons have been prolonged, increased extreme events
Utilization of residues in the supply chain	destination, purpose	Rice husks from the production is utilized as biofuel for the milling process
Re-use of food losses	destination, purpose	Rice losses are left in the field; some is utilized as animal feed

OUTPUT II-7: FOOD LOSS RISK FACTORS

FL = parameter **a** × variable **x.** FL transport (%loss) = **a** (%loss/hour) × **x** (hours of transport)

Variable	**Unit**	**Parameter: Relation to food losses - contributing to low losses**	**Value of variable (observed in the case study)**
Crop variety/ Fish/ Animal race	Name	Resistant variety / race	
Good Agricultural Practices (GAP)	Y/N	Yes	Y
Rainfall during Production	mm	Optimum range	23
Production supply/ demand ratio	Ratio	< 1	
Rainfall during Postharvest phase	mm	Low rainfall	
Postharvest technology	L/M/H	High	
POs / Coops	Y/N	Yes	
Processing technology	L/M/H	High	
Good Manufacturing Practices (GMP)	Y/N	Yes	
Packaging materials and facilities	L/M/H	High	
Cold chains	Y/N	Yes	
Transport duration	Hour	Low duration	2½
Market information	L/M/H	High	
Price incentive for quality	Y/N	Yes	
Knowledge of FSC actors	L/M/H	High	
Consumer access to food product	L/M/H	High	

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

OUTPUT III-8a: QUALITY SCORING OF FOOD PRODUCTS

PRODUCT:	**Mango**	
Quality score	Description of the quality	%age reduction of market value
0	completely rotten	100
1	skin break extended to the flesh, fungal decay, highly infested, putrid	100
2		
3	over-ripe, spongy, off-smell	60
4		
5	20% soft spots, 3+ spots skin damage	40
6		
7	1-2 spots of skin damage, 10% discoloured	15
8		
9	mature or ripe, homogeneity of colour, firm.	0
10		

OUTPUT III-8b: QUALITY ANALYSIS OF SAMPLED UNITS - FRUIT

Unit evaluated	**Overall quality score**	**Type of damage (deterioration) if any**	**Potential cause and symptoms**
1	8	Physical	Not appropriate pruning, some scratches are evident
2	9	N.A.	Excellent quality
3	7	Physiological	Low Relative Humidity in storage – Shriveling in some areas are starting to be observed
4	6	Biological	Latent pathogen from field – With ripening the repro-duction of the fungus has initiated
5	7	Physiological / Biological	Excess heat during storage and latent pathogen from field
6	6	Physical	Mishandling, evident hit in one side of the product
7	9	N.A.	Excellent quality
8	5	Biological	Latent pathogen from field – Evident fungus starting
9	8	Physiological	Water loss due to low R.H.
REPORT: Average 7.4. At this point of the handling chain a latent pathogen from the field and low R.H. ap-peared the main factors of quality deterioration			

OUTPUT III-9: PRESENTATION OF LOAD TRACKING AND SAMPLING RESULTS

A	Product	maize			
B	Event	storage			
C	Duration of the event	2 weeks			
D	Location	village			
	Before the event	Experimental Unit	Weight of unit	Nr of units	Total weight
E	Load	traditional store	1620 kg	1	1620 kg
F	1st-stage sample	bag	81 kg	5	405 kg
G	2nd-stage sample	scoop	1 kg	3x5	15 kg
		Value (score / %)	Observations / Causes		
H	Sample size 2nd-stage	15 kg			
I	Average quality score (0 – 10)	7.3			
J	%age unfit (< 2)	5%			
K	%age low quality (2-6)	7%			
	After the event	Experimental Unit	Weight of unit	Nr of units	Total weight
L	Load	traditional store	1580 kg	1	1580 kg
M	1st-stage sample	bag	79 kg	5	395 kg
N	2nd-stage sample	scoop	1 kg	3x5	15 kg
		Value (score / %)	Observations / Causes		
O	Sample size 2nd-stage	15 kg			
P	Average quality score (0 – 10)	6.8			
Q	%age unfit (< 2)	6%			
R	%age low quality (2-6)	9%			
	Quantity loss	Value (%)	Observations / Causes		
S	%age lost (E-L)/E	2.5%	Rodents, insects. Drying		
	Quality loss	Value (%)	Observations / Causes		
T	%age lost (Q-J)	1%			
U	%age quality reduction (R-K)	2%			

Paragraph III-9: Load tracking when the quantity of product is reducing

Load tracking at a wholesale market: 20 tons of bananas, during 7 days

a	b	c	d	e	f	g	h	i	j	k	l	m	n
day	Sales ton	Price $/kg	Remain ton	quality	b x e	weighed average quality f / d	quality reduction e - g	quality % < 2 (lost)	quantitative loss d x i ton	b – j ton	b x c $	Initial value $ c x d	economic loss $ m - l
0	0.0	**2.00**	**20.0**	**8.3**		**7.2**	**1.1**	1%	0.20			**40,000**	**8,868**
1	5.0	2.00	15.0	8.3	41.5			1%	0.15		10,000		
2	2.5	2.00	12.5	8.1	20.3			2%	0.25		5,000		
3	2.0	1.80	10.5	7.5	15.0			2%	0.21		3,600		
4	3.0	1.60	7.5	7.0	21.0			2%	0.15		4,800		
5	1.5	1.40	6.0	6.5	9.8			4%	0.24		2,100		
6	2.0	1.40	4.0	6.5	13.0			5%	0.20		2,800		
7	1.0	1.20	3.0	6.0	6.0			8%	0.24		1,200		
remain	3.0	1.20		6.0	18.0						1,632		
SUM	**20.0**				**144.5**				**1.64**		**31,132**		
							13% (1.1/8.3)		**8%** (1.64/20)	**1.36** (3.0-1.64)			**22%** (n/m)

NB.: This model doesn’t take into account price fluctuations independent of the quality.

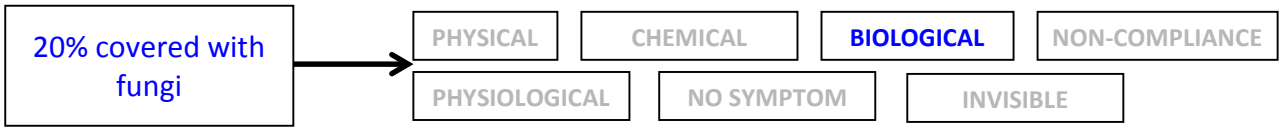
OUTPUT III-10: SUMMARY RESULT MATRIX OF FOOD LOSSES

FSC stage/ process	Type of loss Qn./Ql.	%age lost in this process Quant	%age of the product that incurred quality loss in this process	%age of product that goes through this stage	%age loss in the FSC	Cause of loss/ Reason for low loss	Reduced market value	CLP / LLP	Destination of food loss	Impact/ FSC actors affected (men / women)	Loss perception of FSC actors (men / women)	Suggested solutions
storage	QN	12%		75%	9%	Fungus		CLP	garbage	income	concerned	
	QL		40%	75%	30%	Discolouration	30%	CLP	consumed	income	don't care	
retail	QN	0.2%		100%	0.2%	Good and clean market facility	n/a	LLP	n/a	n/a	n/a	n/a

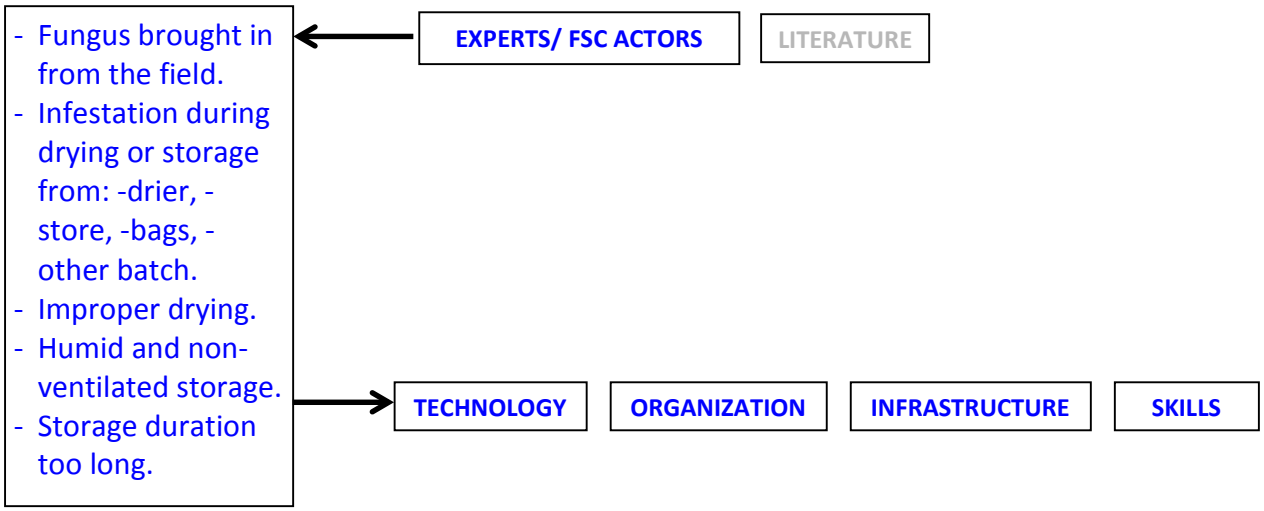
OUTPUT IV-1: CAUSE FINDING DIAGRAM

1. Food loss assessment methods have revealed a batch of food products containing *losses or product of low quality*.

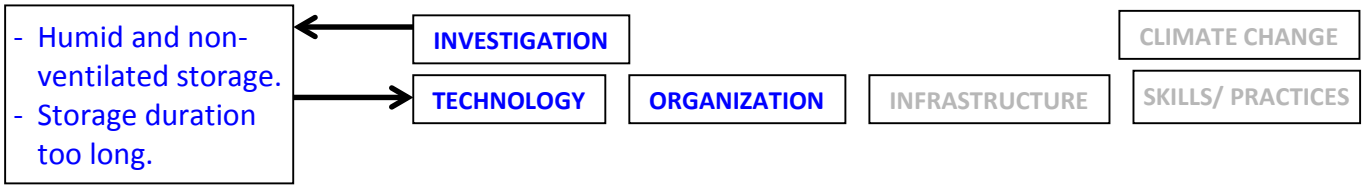
2. Identify and describe the *symptoms* that lead to this quantitative / quality loss.



3. Verify the possible *causes* by consultation of experts and literature, and by on-site investigation.



4. Identify the *real cause* of the low quality and subsequent food loss.



5. Find the underlying *reason* for the cause, why the problem hasn't been solved yet.

OUTPUT IV-2a: BUDGET CALCULATION FOR RIPENING CHAMBER TO REDUCE BANANA LOSSES AT THE WHOLESALE MARKET

	item	value	unit	calculation
a	Production of dessert banana	40,000	ton/year	
b	Value of banana	240	$/ton	
c	Loss rate	20	%	
d	Anticipated loss reduction	50	%	
e	Cost of 1 ripening chamber	80,000	$	
f	Depreciation	10	years	
g	Yearly costs of investment	8,000	$/year	e / f
h	Yearly costs of operation	30,000	$/year	
i	Total yearly costs of 1 chamber	38,000	$/year	g + h
ia	Capacity of 1 ripening chamber	20	ton	
ib	number of loads per year	72	/year	(5 days/load)
ic	Yearly throughput of 1 chamber	1440	ton/year	ia × ib
j	Client costs per ton product	26	$/ton	i / ic
k	Food loss	8,000	ton/year	c × a
l	Economic loss	1,920,000	$/year	k × b
m	Loss reduction	4,000	ton/year	k × d
n	Loss reduction savings	960,000	$/year	m × b
o	Total client costs	1,056,000	$/year	a × j
p	Profitability of solution	-96,000	$/year	n - o

In this example, the solution is NOT economically viable. It would break-even if the loss reduction was 55%.

OUTPUT 1V-2b: Assessing social implications of specific food loss solution suggestions

Example of a suggested solution: Dissemination of post-harvest technologies

(How) Does the suggested solution …	**Description of the potential impact**	**Gender dimension of the impact (how women and men may be affected differently)**	**Suggestions to mitigate (gender) negative impacts**
1. …impact the employment situation of FSC actors?	Technologies might replace labor forces, which could lead to lay-offs and lost income of FSC actors.	Women might be affected predominantly by lay-offs.	Make sure the potential benefits to post-harvest loss reduction are not overshadowed by lost income due to potential lay-offs.
2. … increase or reduce the workload of FSC actors?	Technologies have the potential to reduce work burden.	Reduced work burden could be of great benefit overall to women.	Identify the technologies that have the potential to reduce women's work burden and - if possible - favor these.
3. …raise or increase the need for training to apply solutions?	New technologies will most probably raise the need for training.	Women might be affected most, since they usually have less access to education and training.	Make sure the introduction of new technologies goes hand in hand with training offers. Make sure to include women in the trainings.
4. …distribute benefits to the FSC actors? (income access and control)	The introduction of new technologies might increase household incomes due to higher production quantities or reduced losses. Control over these higher incomes might not be distributed equally amongst the FSC actors and between women and men.	Women often have less control over household incomes.	Make sure, the benefits are distributed equally amongst the FSC actors. Make sure women get the opportunity to benefit from higher income possibilities and that control over earned income is with them.
5. …require a degree of organization of the FSC actors (membership in producer organizations/cooperatives etc.)?	Certain technologies might only be accessible through membership of an organization.	Women have less access to organization and cooperation memberships and therefore might not be able to access the improved technologies.	Make sure to cooperate with organizations that have female members. Support women's membership in cooperations and organizations, increase their participation at the decision-making-level.

(How) Does the suggested solution …	Description of the potential impact	Gender dimension of the impact (how women and men may be affected differently)	Suggestions to mitigate (gender) negative impacts
6. …impact dynamics of power in the FSC? (WHO has ownership of solutions?)	As practices improve and formerly manual activities become automatized, ownership might move from one group to another.	Often men take over activities that were formerly done manually and by women and now involve more advanced technological aspects. This might lead to transferred ownership from women to men, of both the work and the income generated from it.	Make sure women have equal access to newly introduced technologies and get appropriate training to use these. Make sure technologies are appropriate for the use by women.
7….take into consideration mobility restrictions of FSC actors?	It is possible that training necessary to implement/use the new technologies takes place outside the community. Transportation might be expensive/unsafe/not available.	Women might not be able to attend training that requires travelling, because of mobility restrictions due to financial or safety reasons, or because they might not be allowed to travel outside of their community.	Make sure training is accessible also for women, if it is not possible to have training inside the community, consider providing safe transportation.
8. …coincide with cultural and social norms and will be culturally and socially acceptable?	Some technologies or new practices might be considered as not suitable for some FSC actors, due to social and cultural norms.	Especially women might be excluded from certain technologies, because they might not be socially and culturally acceptable for them.	Be aware of social and cultural norms, be sure suggested solutions do not coincide with them, especially when they are resulting in an exclusion of women. Consider working with men in order to slowly alter social and cultural norms to become more gender equal.
9. …cause for some actors' exclusion from the FSC activities?	Due to the above mentioned reasons, actors might suffer from exclusion after the introduction of the new technologies.	Women might be affected disproportionately by exclusion from FSC activities.	Make sure proposed solutions are accessible for all FSC actors.

OUTPUT IV-3: SUMMARY TABLE OF FOOD LOSSES, CAUSES AND SOLUTIONS - **FISH**

Critical Loss Point	**Magnitude of losses in the FSC**			**Cause of loss**	**Intervention to reduce losses**	**Loss reduction**		**Cost of intervention (USD)**	**Economic implications**	**Social implications**	**Food security implications**	**Environmental and climate change implications**	**Policy implications**
	%age	Weight	USD			%age	USD						
Small town retail market	30	3,000 kg	10,000	Unprotected at high temperature	Cold chain: ice block machine and cooler boxes	80	8,000	2,000	Economic loss reduced from 10,000 to 4,000, or from 30% to 12%	20% of poorest fish mongers cannot buy the ice.	Higher income and more nutritious food available for x households	Reduced pollution from spoilt fish. Increased energy use to make ice blocks.	Need to provide subsidy or credit on ice block supply.

ANNEX 3

Semi-structured interviews

Semi-structured interviews (SSI) are conducted with a fairly open framework which allow for focused, conversational, two-way communication. They can be used both to give and receive information. Unlike the questionnaire framework, where detailed questions are formulating ahead of time, semi-structured interviewing starts with more general questions or topics. Relevant topics are initially identified and the possible relationship between these topics and the other issues become the basis for more specific questions which do not need to be prepared in advance. The majority of questions are created during the interview, allowing both the interviewer and the person being interviewed the flexibility to probe for details or discuss issues.

The interview or discussion is normally conducted with an individual or group of people who are knowledgeable about the topic of interest. The knowledgeable people are typically farmers/ fishers, processors, traders and community leaders, extension workers, etc. SSIs are particularly useful for interviewing those who incur losses in order to help understand causes and effects. Equally, interviewing those who do not incur losses helps understand how losses can be avoided or reduced. Usually, an SSI is guided by a checklist of key issues, different for different FSC actors being interviewed, and during the SSI someone in the team takes notes to record the information generated. It is essential that the team beforehand knows what information and results it would like to obtain from each SSI for each (group of) actor(s) in the FSC.

A few things to remember when using SSIs are:

Time value: The team should know the value of time. For example, the team should always be punctual for meetings and interviews and not keep people waiting or plan to have an interview when they are very busy with their day-to-day activities. An interview or meeting is best kept to less than two hours because people may grow tired or not be able to spend a long time away from their daily activities. Be aware that men and women may have different time availability.

Interview setting: An interview or meeting is best conducted somewhere convenient for the people concerned, and the location can be chosen in discussion with the local community. When meeting or interviewing women, be sure you do not compromise them, it may be necessary to invite a 'chaperon' from the community when the team members are only men.

Awareness of potential biases: There are many different biases to be aware of when conducting an assessment. People interviewed may have their own biases and may not necessarily cooperate fully. Therefore, cross-checking or triangulation of data is required. There can be a tendency for fieldwork to take place in locations that are easily accessible. Such locations may not be representative of the true picture. These may also be locations where people have experienced a lot of researchers, leading to what is called "research fatigue". There can also be a gender bias if only men or women are interviewed; again the true picture of losses may not emerge.

Note-taking techniques: Record the notes of interviews and meetings in a careful and discreet manner. Notes from interviews and meetings will help capture the key information and help the team to remember the important issues. Note-taking is not always easy as some people may be suspicious of you writing down everything that they say. Overcoming the suspicion may

require a level of trust that has not been established if the team is new to the community. If in doubt, always ask if it is okay for someone to take notes. If this is not possible, then the team should meet as soon as possible after the meeting and have a note-taking session to capture as much information as possible.

Politeness: Always be polite and friendly with the community in order to create a friendly atmosphere. This will greatly facilitate the assessment process and any follow-on work with the community.

Make a pleasant introduction: Let respondents know what the purpose of the PHFLA is. Provide as much information as possible about the loss assessment initiative. The team can narrate success stories, if any, of operators who were in similar situations but are now better-off. Let respondents know that the information they will provide will not be used against their interest, e.g. for revenue collection purposes.

Create a relaxed atmosphere and probe: Try to create a friendly and relaxed atmosphere for the interview or meeting. The PHFLA team has to make sure that they probe for detailed information.

Questions: Open-ended questions are useful, such as “Tell me about ...”, “Can you explain more about that?”, and some arise naturally during the interview “You said a moment ago ... can you tell me more?”. Participants should be allowed to ask their own questions to the team.

Thank respondents for their assistance: Do not forget to thank respondents for their time and cooperation. Failure to do so may be perceived as a lack of appreciation for their involvement.

Afterwards: The team should consult among themselves to identify others to interview and fix appointments for the interviews. As a useful guide to this process, an FD of activities at the site can be developed, one that shows the operations identified by the respondents and where losses are likely to occur.

Dos and don’ts of loss assessment fieldwork

Don’ts	Dos
Waste people’s time	Find about taboos and norms (e.g. be able to detect and avoid sensitive situations, which may undermine trust)
Act in a superior way to the community	Assure producers of the confidentiality of the information (not to be used against them, e.g. for tax collection)
Violate taboos and norms	Stimulate producers to talk
Demand appreciation	Speak clearly
Use language that community members may find hard to understand	Provide facts and information
Interrupt, blame	Be neutral and objective
Raise people’s expectations	Build up a dialogue
Side with opinion leaders or agitate	Assist producers to evaluate
Manipulate or create needs	Be patient
Be pompous	Be creative, adaptable and innovative
Discourage questions	Cross-check information
Make things too scientific	Listen and be interested
Speak too long	Respect producers, their perceptions and their knowledge
Display little enthusiasm in what people say and do	Create an enabling environment for women’s participation, separately from men when pertinent
Reinforce discriminatory practices	Use an inclusive language, differentiating between women and men when referring to stakeholders or producers.
	Contact and ask questions to both women and men, they might have different points of views, experiences and challenges

ANNEX 4

A brief on the food safety and quality dimension of the food loss methodology.

This brief provides an explanation for the assessment team, on consideration of food safety related reasons in the food supply chain that lead to loss of food product. It also intends to raise awareness among the team and ensure that food safety as a cause of food losses is not overlooked.

In summary the food safety team needs to understand:

- ✓ The food and likely hazards, reasons for spoilage, condemnation
- ✓ Government can make a decision based on a non-compliance and resulting in food being taken out of the chain (e.g.) – excess pesticide residue.
- ✓ Value chain operators running the production, processing of the food – may make a decision to remove food from a chain (spoiled incoming raw material, blown cans**)**

Survey and situation analysis:

A potential factor which can contribute to food losses throughout the value chain, either by reducing (e .g applying GHP for perishable products) or increasing food loss (e .g lack of compliance with food safety regulation leading to food withdrawal from the FSC) is applying effective food safety controls. These controls can be applied by either the value chain operators or government officials.

While evaluating the food safety and quality aspect of food losses, we need to recognize that countries are at different stages of development regarding the capacity of their food control system. Here are different scenarios:

i) The country has a well-functioning food control system and the quality and safety control measures are established among the value chain operators. In this case food losses are often **minimum.**

ii) The country's food supply chain is not developed to comply with the standards but strict food safety measures and inspections are in place that leads to **major food losses** due to non-compliance;

iii) The country has a basic food control system with non-existing or minimum inspection and the value chain actors don't comply with hygiene and safety requirements. This leads **to high amount of losses** at different points of the chain due to spoilage and contamination.

In summary, the decision made by the national government, industry or private sector to remove food from the value chain due to safety concerns or lack of compliance with standards (private and public, GHP, GAP) could lead to an increase of losses. It is important for the survey team to understand the scenarios and context of the value chain they are assessing.

Irrespective of the level of capacity and controls, it is recommended that in the "Survey phase", the team gather information (gain an understanding) on:

- ✓ level of controls and inspection, testing and any available information on food rejections by the government;
- ✓ existing official and voluntary legislation and standards which contribute either by, decreasing or increasing food loss throughout the FSC;

- ✓ where there is a non-compliance with the required / applied regulation there may be an increase in food losses (government information);
- ✓ potential food safety issues (most likely or significant hazards), in the selected chain based on the product type, most likely to lead to losses,
- ✓ what is known about the causes of food loss throughout the chain
- ✓ capacity by the value chain operators to apply effective controls (GHPs, HACCP) and therefore minimise food loss

In gathering information, team should also consider, where possible, the extent of non-official trade such as informal market[20] which plays a crucial role in developing countries in Asia and Africa where food loss is estimated the highest.

Assessing "actual" food losses

Another important aspect that should be highlighted for the team as the basis for the cause and solution finding is that ***food is lost when it goes out of the value chain***. Therefore when we are looking for causes, we should investigate the part of the food that ***is discarded*** for whatever reason including quality and safety. For instance in Kenya study and the case of the fish value chain, it is indicated that all the fish supply is consumed even those which are not safe for human consumption and there is no loss. This means that the part of food which remains in the food chain, even if contaminated with or without any visible sign, is not considered food loss.

In finding the causes for losses due to food safety reasons, the logical step after the desk study and literature review, is to try and understand from the managers, business actors and government, the reason why the product is out of chain. AND then ***if there is a capacity,*** we can try and trace the cause by testing in the laboratories, checking etc.

Understanding the loss is essential to identify the right solution. If the team identifies recurring losses with major impact on the livelihood of the poor– then there may be a need to investigate further to find a solution– and if resources allows – undertake lab – at the "load tracking" or solution finding stage. However, it is important to know that the aim is not building capacity in food safety at national level, but to identify the safety and quality related causes and finding solutions accordingly

Finally we should consider that a part of the challenge is that not all hazards are visible! We should remember that sometimes the factors that lead to losses in chain cannot easily determined but they could indirectly lead to losses. For example antimicrobial residue in milk affect the coagulation during the process and therefore the low quality yogurt and cheese is thrown out.

[20] By informal market we mean where many actors are not licensed and do not pay tax (e.g. street food markets and backyard poultry and pastoralist systems), markets where traditional processing, products and retail prices predominate (e.g. artisanal cheese production), markets which escape effective health and safety regulation (most domestic food markets in developing countries).

ANNEX 5

FAO DEFINITIONAL FRAMEWORK OF FOOD LOSS - February 2014

1. Food loss (FL)

The decrease in quantity or quality of food.

2. Quantitative food loss

The decrease in mass of food.

3. Qualitative food loss

The decrease of quality attributes of food.

4. Food

Any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs. (Codex Alimentarius Commission, Procedural Manual, 2013)

5. Food plants and animals (FPA)

Plants, animals and their derived products for food.

6. Non-food parts of food plants and animals

The parts of food plants and animals which are not intended to be consumed by humans.

7. Food supply chain (FSC)

The connected series of activities to produce, process, distribute and consume food.

Supplementary notes to the definitions

- **Food loss (FL)** in the production and distribution segments of the FSC is mainly caused by the functioning of the food production and supply system or its institutional and legal framework.
- An important part of food loss is called **food waste (FW)**, which refers to the removal from the FSC of food which is fit for consumption, by choice, or which has been left to spoil or expire as a result of negligence by the actor – predominantly, but not exclusively the final consumer at household level.
- Food waste is not sharply defined. However it is still recognized as a distinct part of food loss, because the underlying reasons, economic framework and motivation of the FSC actors for wasting food are very different from the unintended food loss, and subsequently the strategies on how to reduce food waste are conceived in a different, targeted manner. Although the term 'food loss' encompasses "food waste", the term **'food loss and waste' (FLW)** will continue to be used to emphasize the importance and uniqueness of the waste part of food loss.
- Quantitative food loss can also be referred to as physical food loss. It does not include the reduction of mass resulting from food processing operations such as drying, heating, ripening, fermentation. It does however include the removal of food for cosmetic or other market reasons by food processing operations such as grading and sorting.
- The decrease of quality attributes results in the reduction of nutritional value, economic value, food safety and/or consumers' appreciation:
    - Nutritional value refers to macro and micro nutrients such as proteins (including essential amino acids), fats (including essential fatty acids), carbohydrates (including dietary fibres), vitamins, and minerals and trace elements, as well as non-nutrient bioactive compounds found in plant-based foods such as phytochemicals (e.g. flavonoids, phytoestrogens, and tannins, etc.), in a way that it affects the nutritional status and health of the consumer.
    - Economic value refers to the price that any supplier in the FSC receives from its buyer, in a way that it affects the revenue of the supplier.
    - Food safety refers to the absence, or presence in acceptable levels, of microbiological, chemical or physical hazards in food to prevent risks to the health of the final consumer.
    - Consumers' appreciation refers to the perception of the food by the consumer, with regard to sensorial attributes such as appearance, texture, smell, taste.
- 'Consumption' refers to the ingestion of food by the final consumer.

- 'Intended' refers to the original purpose for the product in the food supply chain, even if certain actors in the FSC may intentionally discard a wholesome part of the product or divert it to a non-food supply chain. Example: the whole peeled potato is food, even if a french-fry manufacturer disposes of a fraction when slicing the product into uniform sizes.

  If at the early stages of the supply chain it is not determined, or not yet known, whether a product will be destined for food or not, absolute food losses can be assessed from percentage losses and statistical information on the fraction of that product which in a specific region and year finally enters a human food market.
- Whether plants, animals and their parts or products are intended for food depends on the FSC, the food system, and its geographical and cultural context.
- Fish[21] discards are the portion of total catch which is thrown away or slipped. It comprises the following components:
  - Species which are intended to be caught, but get spoilt and rendered unfit for consumption by the act of catching; these discards are food loss.
  - Species which are intended to be caught, but do not meet the regulatory or quality standards, such as size; these discards are food loss.
  - Species which are not intended to be caught, but which are fit for entering the FSC; these discards are food loss.
  - Species which are not intended to be caught, and which are not considered food; these discards are not food loss.
- Non-food parts of FPA are parts which are inedible, or could be edible but in the specific FSC are not destined to be consumed.
- The FSC starts from the moment that:
  - crops are harvest-mature or suitable for their purpose;
  - animals are ready for slaughter;
  - milk has been drawn from the udder;
  - eggs are laid by the bird;
  - aquaculture fish is mature in the pond;
  - wild fish have been caught by the fishing gear.

  The end point of the food supply chain is defined by when food is a) consumed; or b) removed from the food supply chain.

[21] Fish includes fish, shellfish and cephalopods

Scope of work in the Global Initiative on FLW Reduction

- FPA also include by-products intended for food, from plants and animals produced for non-food purposes. Example: cotton is grown for a non-food purpose, but the cottonseed is a by-product of which the oil can be used as food; sheep are reared for wool, but at the end of their wool-producing life the sheep are slaughtered for food.
- FLW includes:
  - By-products or secondary products that are in principle meant for human consumption, but that in specific supply chains cannot be transformed; for instance because of technical limitations, or because of lack of access to a market and therefore are discarded or redirected to non-food use.
  - Food that is fit to enter the FSC, but intentionally discarded or redirected to non-food use in the pre-harvest phase.
  - Food that is harvest-mature and unintentionally getting spoilt in the pre-harvest phase.
  - Food that is fit to proceed in the FSC, but redirected to non-food use or discarded in the post-harvest phase of sorting and grading (fruits, fish discards, etc.) without getting spoilt or spilled.
  - Food that is redirected to animal feed or compost; it is not re-entering a FSC as defined within the scope of work.
- FLW does not include:
  - Food that is consumed in excess of nutritional requirements.
  - Food that incurs a decrease of market value due to over-supply or other market forces, and not due to reduced quality.
- The scope of work includes:
  - Prevention (reduction) of FLW.
  - Utilization and management of FLW, with regard to redirection as animal feed, compost, biofuel.

  NB.: It is important to know the alternative use or destination of lost or wasted food, in order to assess the economic loss and the impact on the use of resources when producing this food. If food loss and waste are used for non-food consumption (as animal feed, as biomass), then the economic and environmental impact could be reduced.
- The scope of work does not include:
  - Utilization and management of non-food parts of FPA.
- The scope of work is based on major staple products for food security and includes the following subsectors, apart from derived products listed under 7.:
  a. cereals
  b. roots and tubers
  c. fruits and vegetables, plantains, bananas
  d. oilseeds, pulses, nuts
  e. meat
  f. milk and eggs
  g. fish, including shellfish and cephalopods
- The scope of work does not include the following subsectors or products:
  a. herbs, spices and condiments
  b. coffee, tea, cocoa
  c. sugar, honey
  d. alcoholic beverages
  e. confectionery products
  f. wild animals (apart from fish), insects, snails
  g. wild plants (fruits, vegetables, nuts, mushrooms)
  h. salt
  i. drinking water

ANNEX 6

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Terms of Reference for Institution / Company

Name			
Job Title	Case studies to food losses – extent, causes, solutions		
Division / Department	ESN		
Programme / Project Nr.	SO40202		
Location			
Expected Start Date of Assignment		**Duration:**	4 months
Reports to	**Name:**	**Title:**	

GENERAL DESCRIPTION OF TASK(S) AND OBJECTIVES TO BE ACHIEVED

Background and Justification.

Food losses refer to the decrease in edible food mass throughout the different segments of the supply chain that aims to provide food for human consumption. Food losses take place at production, postharvest, processing, distribution and retail stages in the food supply chain.

Food losses and their prevention have an impact on the environment and climate change, food and nutrition security for poor people, food quality and safety, 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. Currently, the magnitude of food losses have been assessed, and most of the causes of food losses have been identified. However, the assessments are extremely rough, and still unknown are the quantifications of food losses per cause, making it difficult to prioritise and decide on interventions, to have the maximum effect.

Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access, strengthen adapative capacities while ensuring greater post-harvest benefits to the farmers and processors. Given the magnitude of food losses, making profitable investments in reducing losses could be one way of reducing the cost of food and associated GHG emissions. However, that would require that financial gains from reduced losses do not outweigh their costs. If eventual cost reductions can be translated into price reductions, then the poor consumers stand to benefit in terms of nutrition, food security and livelihoods.

The main objective of this study is a clear view of the weak points of the food supply chains, and the identification of interventions to reduce food losses and improve the FSC efficiency.

The specific objective of this study is the identification of the main causes and indicative quantitative data of food losses in the food supply chain, and the analysis of the measures to reduce food losses on their technical and economic feasibility as well as social acceptability, leading to concrete proposals to implement a food loss reduction programme.

Implementation of the field study.

Being important food products in the country, the subsectors rice, lentils, dairy and fish have been selected of which one or two major supply chains each will be studied, in the state of Andhra Pradesh.

To each subsector, the consultancy company will assign national experts, being subsector specialist (SS), agricultural economist (AE), and rural sociologist (RS) who will work on the assignment together as a team. The consultancy company will work under the direct supervision of the Agro-industry Division (AGS) of FAO, with technical support from the Working Group on Food Losses, administrative and logistical support from the FAO Representative, and in collaboration with on-going field projects and activities in India from FAO, IFAD, WFP and others. The consultancy company will provide the national experts with means to travel, and to compensate for services from local stakeholders and government officials.

CRITERIA: The subsector supply chains to be studied will be selected based on the secondary data review findings and should start from small-scale operations to small and medium scale processors, will produce for human consumption, and have their final outlets in the communities/ villages, urban areas, the region or international markets. If possible, the selected chains are included in an ongoing support programme for the subsector.

The consultancy company will use the methodology developed for these studies by FAO.

Specific activities and main responsibilities.

Under the operational and technical supervision of the Agro-Industry Officer of AGS or the Products, Trade and Marketing Service (FIPM) of FAO, Rome, and in close collaboration with the FAO Country Representation, the consultancy company's experts will work as a team to undertake this assignment. Specific activities to be implemented are listed hereafter. Using the methodology provided by FAO, for each subsector the consultancy company's experts will:

A. SUPPLY CHAIN SELECTION AND STUDY IMPLEMENTATION PLAN.

1. Assemble and review technical information/ literature, as well as recent economic information.
2. Identify existing work in the area and review its completeness and gaps if any.
3. Identify what additional and/or new information the survey and analysis will provide on food losses.
4. Select the food products to include in the study and provide the reasons for this selection.
5. Select the specific supply chain and the geographical area where to undertake the study; provide the reasons for this selection.
6. Based on the above information and knowledge of the supply chain, identify 3-4 steps in the chain where food losses are likely to be high or have the highest impact.
7. Identify indicators to assess or measure the impact of food losses on the (local) economy, on the environment, and on (local) social systems.
8. Develop a detailed approach including a (semi)-structured tool for primary food loss data collection, identify how data will be collated and analysed; identify study scope and limitations, and any potential gaps.

   The study implementation plan will be submitted within one week of signature of contract for review and approval by AGS or FIP of FAO.

B. PRIMARY DATA AND INFORMATION COLLECTION.

9. Make logistical arrangements and the required contacts (with stakeholders, chain actors, authorities, rural sociologists, etc.) to undertake the study.
10. Visit the FSC activities and actors, especially the chain areas identified under 6 above, to make observations and have consultations and participatory field assessments to obtain the information as stipulated in the attached 'Outline of the Report on the Study to the Reduction of Food Losses'.
11. Determine the technical aspects of the various supply chain operations, assess the level of quantitative and qualitative food losses, the frequency of occurrence and identify their causes.
12. Determine the cost of the various supply chain operations, the prices and value-added of raw materials, intermediary and final products.
13. Assess the social aspects and environmental impact of the various supply chain operations.
14. Identify potential interventions to reduce these losses and estimate their cost.
15. Assess the social and environmental impact of the potential interventions to reduce food losses.

C. DATA ANALYSIS AND SYNTHESIS OF A FOOD LOSS REDUCTION STRATEGY.

16. Design the proposed interventions in detail, and prioritize them based on a cost benefit analysis.
17. Outline a food loss reduction strategy, including resources and means.
18. Prepare and submit the 'Report on the Study to the Reduction of <subsector> Food Losses' with all the findings and conclusions within five weeks after the end of the assignment;
19. Participate in a national seminar with other experts and stakeholders, to discuss the technical, economic, social, climate change and environmental, legal and food security implications, viability and acceptability of the food loss reduction measures for all food supply chains studied in the country, to endorse the final conclusions.

KEY PERFORMANCE INDICATORS

	Required Completion Date:
- Submission of implementation plan for field survey - Completion of field survey - Submission of the 4 Reports on the Study to the Reduction of <subsector> Food Losses - Participate in a national validation seminar	

REQUIRED COMPETENCIES

Academic Qualifications of the national experts.

Agricultural Economist: MSc in agricultural economics/ agri-business.

Subsector Specialist: MSc or BSc in agriculture, food science or marketing.

Rural Sociologist: MSc in Social Science, specialization in Gender, Farmer Cooperatives or related field.

Technical Competencies and Experience Requirements of the national experts.

Agricultural Economist: At least 5 years experience in agricultural research or support services to the agricultural sector.

Subsector Specialist: At least 10 years working experience in production, processing or trade in the subsector.

Rural Sociologist: At least 5 years experience in gender and community research or support services to the agricultural sector.

Outline of the Paper on Food Loss Reduction.

i. Table of Contents – *1 page*.

ii. Glossary, Country map – *1 page*.

1. THE SUBSECTOR - Introduction and Background.
   a Status and importance of the subsector; developments over the last 15 years. – *½ page*. DIAGRAM I-1a. TABLE I-1b, I-1c. – *2½ pages*.
   b Inventory of activities and lessons learnt from past and on-going interventions in subsector losses. – *½ page*
   c The process of policy making and current policy framework or national strategy on subsector losses (if any), and brief description/ assessment of the level and extent of current implementation. – *1 page*.
   d Relevant institutions and their role in terms of policy, organisational structure, mandate and activities in the small and medium subsector industry sector. – *1 page*.
   e Overview of the most important FSCs in the subsector, selection of FSC. TABLE I-2a. TABLE I-2b. TABLE I-2c. – *1½ page*. Presumed food losses in the selected FSC. TABLE I-3b. – *½ page.*
2. THE FOOD SUPPLY CHAIN - Situation analysis.
   a Description of the selected subsector supply chain, its location, an estimate of the quantities of products, and when the case study took place. TABLE II-3a. TABLE II-3b. – *2 pages*.
   b Description of the existing marketing systems of the selected subsector supply chain, for small-scale producers (formal and informal). – *½ page*. FLOW DIAGRAM I-3a. - *1 page*.
   c FSC actors' involvement and their benefit, including job creation and income generation; economic data of the FSC; environment-related inputs and factors of the FSC. TABLE II-4. TABLE II-5. TABLE II-6a and b. – *4 pages*.
3. THE FOOD LOSSES - Study findings and results.
   a Description of the FSC: risk factors. TABLE II-7. – *1 page*.
   b Critical Loss Points: type and level of food losses in the selected subsector chains, including both quantitative and qualitative losses. – *2 pages*. TABLE III-8a, 8b. TABLE III-9. – *2 pages*. TABLE III-10. – *1 page*.
   c The causes of these losses and identified (potential) loss reduction measures. DIAGRAM IV-1 – *2 pages*.
   d Low Loss Points, and good practices leading to low food losses. – *½ page*.
4. THE FOOD LOSS REDUCTION STRATEGY - Conclusions and recommendations.
   a Impact of food losses in the selected FSC. – *1½ page*.
   b Required inputs and cost-benefit analysis of the food loss reduction measures (for 10 year implementation) identified at the critical loss points; social implications. TABLE IV-2a. TABLE IV-2b. TABLE IV-3. – *3 pages*.
   c Food loss reduction plan and strategy, investment requirements. – *1 page*.
   d Follow-up action plan/ concept note. – *1 page*.

iii. Bibliography/ references.

TABLE I-0. – *1 page*.

Photos (in the text): – *2 pages*.

TOTAL: *35 PAGES*.