- SAVE FOOD -

GLOBAL INITIATIVE

ON FOOD LOSS AND WASTE REDUCTION

Food Loss Analysis: Causes and Solutions
Case studies in the Small-scale Agriculture and Fisheries Subsectors

Methodology

August 2014

Strategic Objective 4, Output 2.2, Activity 1.2

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

0. Introduction

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, food 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.

During the recent decades numerous studies have been undertaken to assess the quantities of food losses and food waste 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 research revealed the knowledge gap: we have quantitative estimations of food losses, we know the causes of food losses, and we know 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, and to the environment. However, we don't know yet which causes of food losses are the most important, what is the impact of solutions and which solutions are viable and cost-effective, in economic, environmental and food security terms. Meaning: the solution to food loss should not be more expensive than the food loss itself, should not place a higher burden on the environment and greenhouse gas emission, should make more food available to the people that need it most, and should be socially and culturally acceptable.

A gender analysis of the value chain allows to identify causes of food losses from a wider point of view. Food loss can be increased because the differences in the productive and social roles of men and women determine: i. differential access to productive resources and services; ii. cultural practices, that include beliefs, norms and values about men and women as economic actors; and iii. social position, that places women and men in different power conditions. All of these can lead to raise the losses in the food supply chain.

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 provide 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.

The objective of this study is the identification and quantification of the main causes of food losses in the selected food supply chains, and the analysis of the measures to reduce food losses on their technical and economic feasibility, social acceptability and environment-friendliness, leading to concrete proposals to implement a food loss reduction programme.

0-2. Main types of food losses

Quantitative 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 thrown away accidentally, voluntarily or as authorized. Quantitative loss can be caused by pests eating or spoiling the food, rotting, 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 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:

- 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.
- Market access and market strategies.

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

The present investigation is 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. We suggest a methodology integrating four methods, based on an FAO publication[1] 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 consultant leading the loss assessment activity.

The methods:

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), complemented with ample and accurate observations.

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.

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

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.

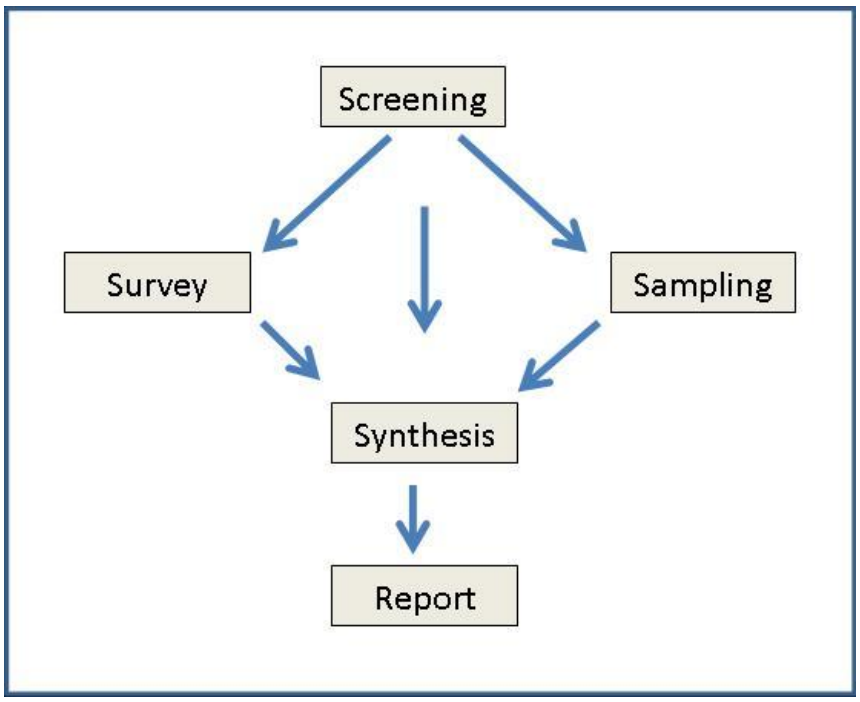


Diagram 1

The *Screening* method is used to have a rough idea of the range of losses and some main causes for those. Notably in this project the *Screening* method should be used to give some background for the implementation of the *Survey* and *Sampling* methods. The *Synthesis* method will put all results and conclusions together and develop 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*), government data (*Screening*) or both; and 2) the representativeness of the sample evaluated within the production operation and within the production/ handling community (*Sampling*).

A gender analysis must be considered regardless of the method, but mostly in the Survey, Sampling and Synthesis. While all methods have the potential of providing information for gender analysis, it will depend on the access to sex-disegregated data and the inclusion of gender categories, such as access to resources and services, cultural practices and social position.

For finding solutions and a successful intervention programme to reduce food losses, ***it is absolutely essential that the consultants 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.

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 suggested content for guidance.

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 recommendation on 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. It is important to determine how losses vary in those points, and distinguish the variation in types of losses along the chain.

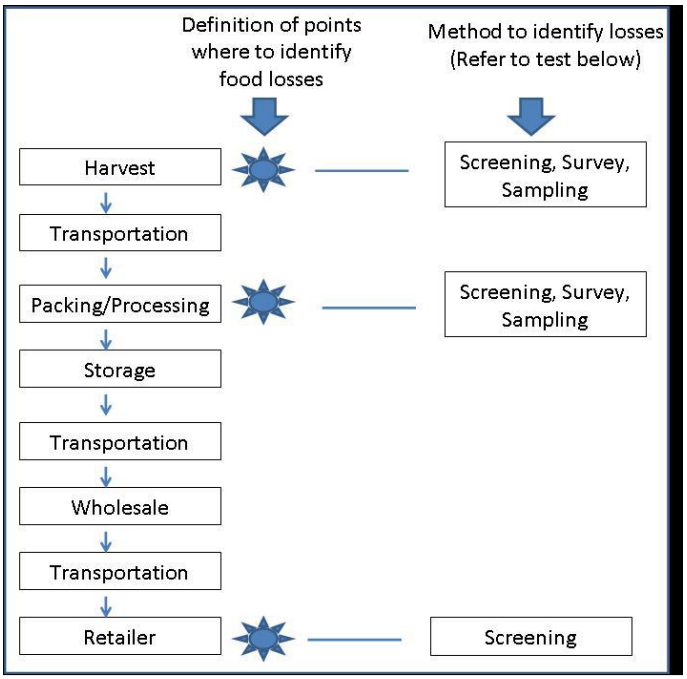


Diagram 2

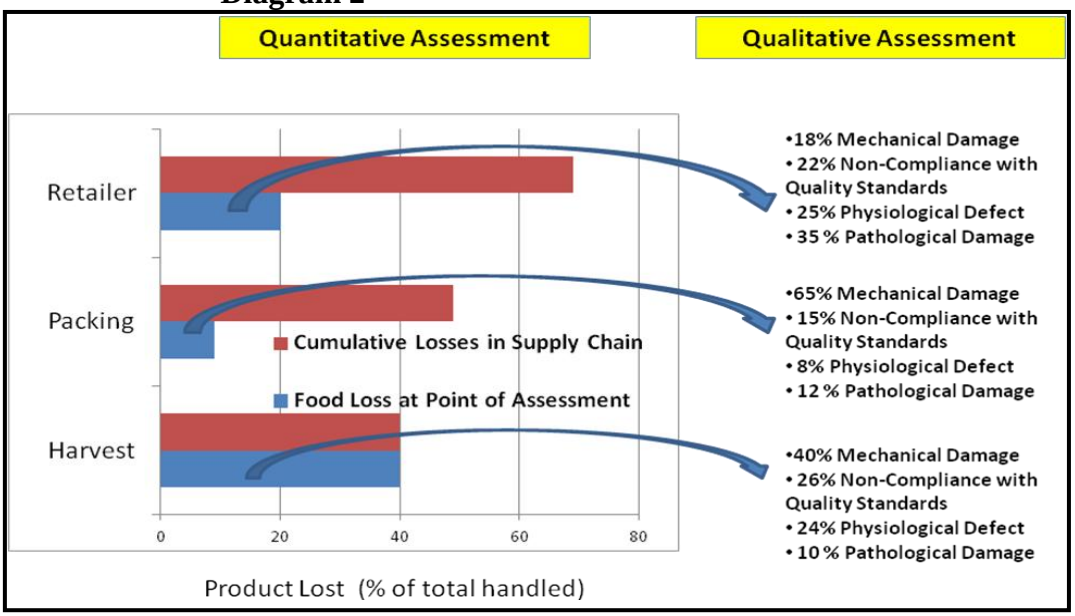


Diagram 3

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 identify sex-disaggregated data and gender analysis information. Finally the *Screening* method should pre-identify the Critical Loss Points in the FSC, where to focus the Surveying and Sampling.

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, national statistics, research institutions); libraries (to acquire research done in the past); non-governmental organizations (NGOs); International donor organizations; on-going projects; media sources, the internet. 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

I-2. Selection of Food Supply Chains

Based on the information obtained as outputs I-1 and I-2, 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.

OUTPUT I-1: PRODUCTION INFORMATION OF THE SUBSECTOR

NATIONAL	Volume ton/yr	Value USD/yr	Number, sex and level of producers, traders, processors, retailers
Raw materials			
Subsistence production			
Market product #1			
Market product #2			
Market product #3			

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

FSC #	Geographical area of production	Final product	Volume (ton/year)	Nr and sex of smallholder producers	Market of final product	Project support
1						
2						
3						
4						
5						

OUTPUT I-2b: IMPORTANCE OF FOOD SUPPLY CHAINS

FSC #	Economic importance	Employment provision	Generation of foreign exchange	Contribution to national food security
1				
2				
3				
4				
5				

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. 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.

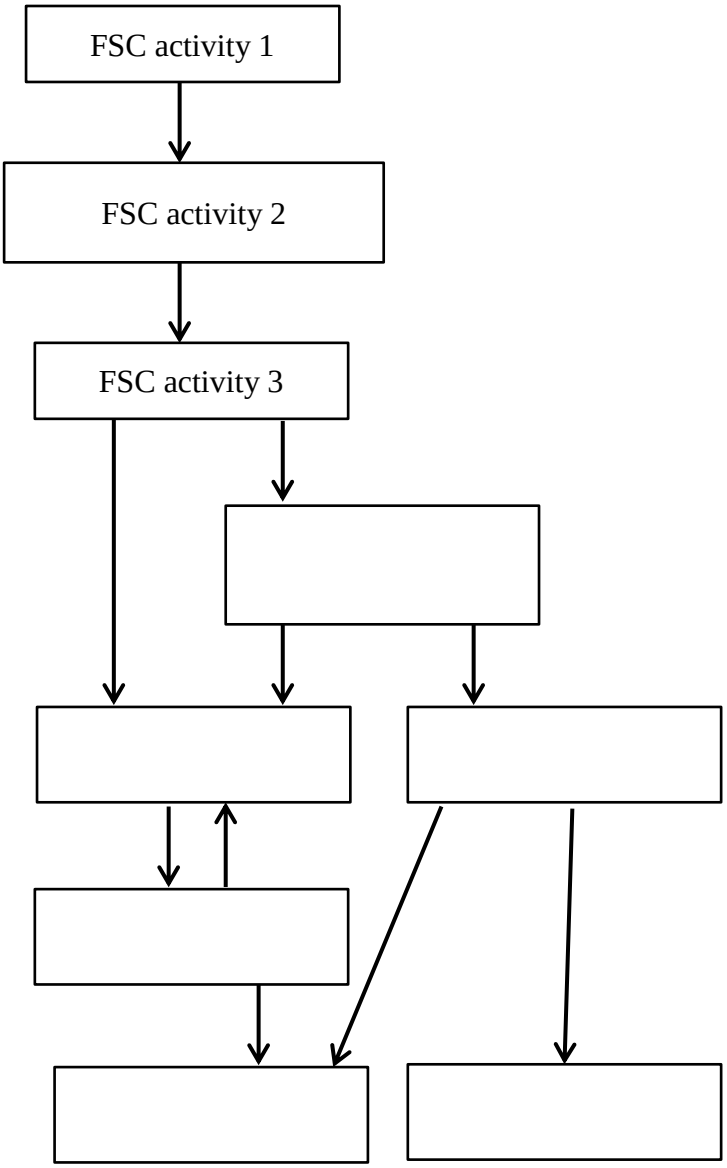
I–3. Characterization of food losses in selected FSC – Critical Loss Points

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 the example in Output I-3a.

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

Example in Annex 2



For each intermediate and final product the *processing conversion factor* has to be determined that calculates the quantity of primary product / raw material required to produce the intermediate or final product. Results will be presented in Output I-3b. Example in Annex 2.

OUTPUT I-3b: PRODUCTS IN THE FSC

Process	**Product**	**Weight from 100**	**Conversion Factor**

For the selected FSC the information as listed in Output I-4 should be collected from the secondary data and expert interviews as much as possible.

OUTPUT I-4: PRELIMINARY SCREENING OF FOOD LOSSES IN THE SELECTED FSC

FSC # ___ , <geographical area>, <market product>		
Step in the FSC	**Presumed losses**	
	Quantitative (%)	Qualitative

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

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. 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.

II. Survey Method ('*Survey*')

For the *Survey* observations of the FSC will be made in the field, and interviews will be conducted with the FSC actors. The *Survey* method 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. The survey should be sensitive and detailed enough to identify more clearly quantitative and qualitative information than was 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:

1. Walk through the location and/or community to observe FSC activities and stakeholders; take photographs if allowed/ possible.
2. 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 participation if they are part of the stakeholders.
3. 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 group of women can be pertinent since in the general group they have usually less opportunities to express themselves.
4. Carry out interviews with key informants to generate a detailed understanding of losses, including the economic value 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.
5. 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.
6. 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 variables.

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. A checklist such as the one presented below, can be used to guide the observation process:

- 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?
- 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?
- 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?
- What is the different role of men and women in the various operations?

II-2. Semi-structured interviews.

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.

The information retrieved from the SSI should be recorded in output matrices II-2 and II-3, which as such also provide the checklists for conducting the SSIs.

II-3. Key-informant interview.

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 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.

Also for the KII the information retrieved should be recorded in output matrices II-2 and II-3.

II-4. 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.

II-5. Food loss risk variables

Based on gained insights and understanding of food losses, where and why they occur, it could be possible to develop a model with calculator 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 to (the causes of) food losses. Obviously, in one season and one FSC the cause-effect relation between variable and food losses cannot be established, and certainly not quantified. However, during the study the consultants should identify potential variables, and record their 'value' (quantitative or qualitative) in Output II-1.

OUTPUT II-1: FOOD LOSS RISK VARIABLES

Variable	**unit**	**Relation to food losses: contributing to low losses**	**Result (observed in the case study)**
Crop variety/ Fish/ Animal race	name	Resistant variety / race	
Good Agricultural Practices (GAP)	Y/N	Yes	
Rainfall during production	mm	Optimum range	
Production supply/ demand ratio	ratio	< 1	
Rainfall during Postharvest phase	mm	Low rainfall	
Postharvest technology	L/M/H	High	
FBOs / 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	
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.

II-5. Validation of results and reporting

There is also a gender component, including sex-disaggregated data and gender categories, in order to identify social patterns that condition men's and women's jobs and tasks in the value chains, the efficiency and competitiveness levels that can lead to food losses because of gender inequalities. This approach may promote food loss reduction, higher productivity and enhance the economic potential of both women and men.

The inclusion at the final validation meeting 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.

A good way to summarize the results of an assessment is to use Output matrices II-2 and II-3:

OUTPUT II-2a: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN - BASICS

FSC stage	Location	Months of the year	Nr of actors		Products	Quantity (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services
			men	women					
Primary production									
Harvest									
Post-harvest handling									
Storage									
Transportation									
Market sales									
Agro-processing									
Storage									
Transportation									
Wholesale									
Retail									

OUTPUT II-2b: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN - IMPACTS

FSC stage	Cost of production	Value of products	Value-added / Margins	Land use (ha)	Water use (m^3)	Energy use (kWh)	Energy source	Gender / social pattern
Primary production								
Harvest								
Post-harvest handling								
Storage								
Transportation								
Market sales								
Agro-processing								
Storage								
Transportation								
Wholesale								
Retail								

OUTPUT II-3: SUMMARY RESULT MATRIX OF FOOD LOSSES

FSC stage/ process	Type of loss Qn./Ql.	%age lost in this process	%age incur-ring this process	%age loss in the FSC	Cause of loss/ Reason for low loss	Reduced market value	CLP / LLP	Impact/ Stake-holders affected (men / women)	Perception of Stakeholders (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.

III. Load Tracking and Sampling Method ('*Sampling*')

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 physical 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: *'Quantify the quantitative 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 from three parts of the bag (bottom, center, top); from a bunch of bananas (1^{st} stage sample) a

few bananas (2nd-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 1st-stage sample size should preferably be 30% of the load, however with a maximum of 20 samples. A 2nd-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.

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 consultants' judgment to decide whether this is feasible within the time frame of the study.

III-8. Quality 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.

Use 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.

OUTPUT III-1: QUALITY SCORING OF FOOD PRODUCTS

PRODUCT:	_____	
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) mechanical damage; 2) physiological damage; 3) pathological damage, 4) non-compliance with standards. The table in Output III-2 is an example to conduct this.

OUTPUT III-2: QUALITY ANALYSIS OF SAMPLED UNITS

Example in Annex 2

Unit evaluated	**Overall quality score**	**Type of damage (deterioration) if any**	**Potential cause and symptoms**
1			
2			
3			
4			
5			
6			
7			
8			
9			
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 physical loss, 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 food quality and then evaluate different qualities separately to determine changes. Determining quality can be subjective and is best done 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-3.

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-3: PRESENTATION OF LOAD TRACKING AND SAMPLING RESULTS

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

IV. Solution Finding (‘*Synthesis*’)

IV-1. The causes of food loss

While sometimes it is easy to determine the cause for the damage (see examples in the same table), there are often cases that the actual cause is not as clearly identified. In the latter cases 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.

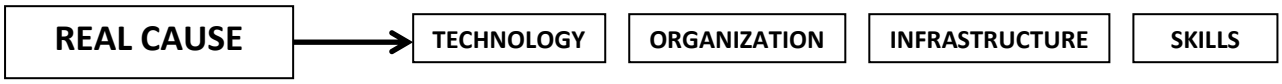
OUTPUT IV-1: CAUSE FINDING DIAGRAM

1. Food loss assessment methods have revealed a batch of food products being lost or of low quality.

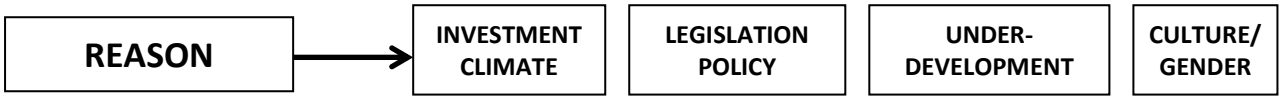
2. Identify and describe the *symptoms* that lead to this quantitative / quality loss.

3. Verify the alternative *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. 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-2b.

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 (infrastructure, 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	i = a × j
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 of the solution have to be assessed. These could include – in general or specifically related to men or women:
- the employment situation;
- 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.

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 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.

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-2b: 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 implications
	%age	weight	USD			%age	USD					

ANNEX 1

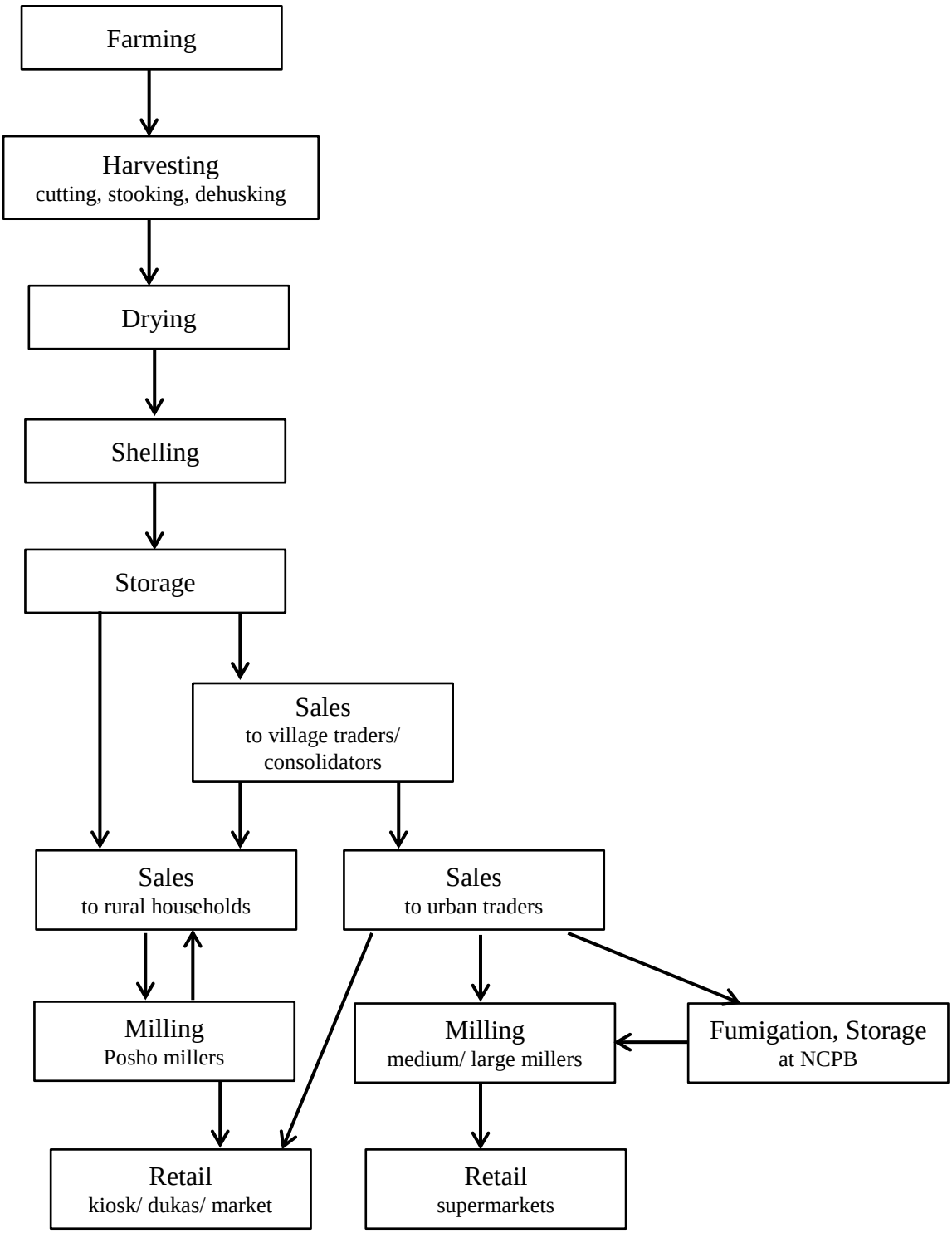
Terminology

Semi-structured Interview (SSI)
Subsector (SS)
Food Supply Chain (FSC)
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-3a: FLOW DIAGRAM OF THE MAIZE FSC



OUTPUT I-3b: PRODUCTS IN THE FSC – EXAMPLE OF GARI

Process	**Product**	**Weight from 100**	**Conversion Factor**
harvesting	cassava tubers	100	1.00
peeling	peeled cassava	80	1.25
grating	cassava pulp	80	1.25
fermenting	fermented pulp	58	1.72
sieving	sieved pulp	49	2.04
roasting	gari	26	3.85

OUTPUT III-2: QUALITY ANALYSIS OF SAMPLED UNITS - FRUIT

Unit evaluated	**Overall quality score**	**Type of damage (deterioration) if any**	**Potential cause and symptoms**
1	8	Mechanical	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	Pathological	Latent pathogen from field – With ripening the reproduction of the fungus has initiated
5	7	Physiological / Pathological	Excess heat during storage and latent pathogen from field
6	6	Mechanical	Mishandling, evident hit in one side of the product
7	9	N.A.	Excellent quality
8	5	Pathological	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. appeared the main factors of quality deterioration			

ANNEX 3

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 a favorable environment for women's participation, separately from men when pertinent
Reinforce discriminatory practices	Use an inclusive language, e.g. when referring to stakeholders, producers…
	Ask or approach women and men, they might have different points of views, experiences and challenges

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. 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.

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.

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 (see below).