Food and Agriculture Organization of the United Nations

# Food loss analysis: causes and solutions

## Case study on the maize value chain in the Democratic Republic of Timor-Leste

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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# Foreword

Widescale global food losses and waste affect the sustainability and efficacy of food and nutrition systems, especially in the developing world. While food loss measurements are often limited by a dearth of data, high loss estimates in developing countries result from food supply chain failures. In 2011, the Food and Agriculture Organization of the United Nations (FAO) and the Swedish Institute for Food and Biotechnology published its Global Food Losses and Waste study which estimated that approximately one third of the total food produced for human consumption is either lost or wasted. While numerous studies have been undertaken to quantify food losses at the national level, information regarding the critical loss points, or areas where food loss in a specific food supply chain is most prevalent, is often unclear. Compounding the challenge, the underlying reasons for loss-inducing food supply chain failures also require further examination.

In order to improve global, regional and local knowledge about the underlying reasons for food loss, as well as to assess where critical loss points occur, FAO undertook a series of case studies involving numerous food supply chains in developing countries. Utilizing a defined food loss and waste analysis framework, the Organization and its partners identified nationally-important food products, and commissioned local-level studies of the losses in these chains. The findings of the study will be used to develop technically, economically, environmentally and socially feasible solutions to reduce food losses. These solutions will be developed both in the chains examined, as well as in similar chains in other countries, with due considerations for economic parity, agro-ecology and social conditions.

Maize is one of the most consumed food products in the Democratic Republic of Timor-Leste, and given that the majority of residents rely on subsistence farming, the crop is the most critical for food and nutrition security. Resultantly, supply chain inefficiencies in the maize subsector have rippling economic and social impacts throughout the country. These impacts are further exacerbated by an absence of large-scale maize industries or producers in the country. A critical examination of food losses in formal and informal maize supply chains is required in order to develop worthwhile solutions for farming communities across the island state.

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# Abbreviations and acronyms

| | |
|---|---|
| ACELDA | Agribusiness firm working in partnership with MDF |
| ACIAR | Australian Centre for International Agricultural Research |
| ARP | Agriculture Rehabilitation Project |
| BNCTL | Banco Nacional Comercio de Timor-Leste |
| CLP | Critical Loss Point |
| DNS | Directorate of National Statistic |
| FAO | Food and Agriculture Organization of the United Nations |
| FGD | Focus Group Discussion |
| FSC | Food Supply Chain |
| GAP | Good Agriculture Practices |
| GHP | Good Hygiene Practices |
| GIZ | German Agency for International Cooperation |
| Ha | Hectare |
| HACCP | Hazard Analysis and Critical Control Points |
| Hoka | Local storage facilities for storing paddy rice |
| IFAD | International Fund for Agricultural Development |
| IMF | International Monetary Fund |
| JICA | Japan International Cooperation Agency |
| Kg | Kilogram |
| Kwh | Kilowatt |
| LLP | Low Loss Point |
| MAFF | Ministry of Agriculture, Forestry and Fisheries |
| MAP | Ministério Agricultura e Pescas |
| MCIE | Ministry of Commerce, Industry and Environment |
| MDF | Market Development Facility |
| MSME | Micro Small and Medium Enterprises |
| na | Not available |
| NGO | Non-Governmental Organization |
| NSD | National Statistics Directorate |
| NSSRV | National Seed System for Releases new maize Varieties |
| RDP IV | Rural Development Program (Phase Four) |
| RDTL | República Democrática de Timor-Leste (The Democratic Republic of Timor-Leste) |
| SDP | Strategic Development Plan |
| SoL | Seed of Life |
| SRI | System of Rice Intensification |

| | |
|---|---|
| TLHS | Timor-Leste Household Survey |
| TLMSP | Timor-Leste Maize Storage Project |
| UNFPA | United Nations Population Fund |
| UNTL | Universidade Nacional Timor Lorosa'e |
| USAID | United States Agency for International Development |
| UNJP | United Nations Joint Project |
| USD | United State Dollar |
| WFP | World Food Programme |

# Introduction to the case studies

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

In light of the above, FAO and its partners launched the Global Initiative on Food Losses and Waste, which is a global effort to reduce food losses and waste using various approaches including awareness-raising, and developing a methodology to research post-harvest losses among other initiatives. Multiple partners have been supporting efforts at the national and regional levels through various projects, including the Project 'Food loss reduction through partnerships and evidence-based interventions', also known as the United Nations Joint Project (UNJP). The UNJP, which is funded by the Government of Ireland, is a collaborative initiative on food loss reduction between the FAO and IFAD.

This joint project between IFAD and FAO aims to support the provision of technical support to assess food losses. The project has been linked with IFAD-led field based activities including: national loss assessments in Ethiopia, Malawi and Timor-Leste; a regional workshop on food losses; and the development of awareness and knowledge materials in support of IFAD project design and implementation.

Food losses refer to the decrease in edible food mass throughout the different segments of the food supply chain – production, post-harvest handling, agroprocessing, distribution (wholesale and retail), and consumption. Food losses and their prevention impact 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 recent decades numerous studies have been undertaken to assess the quantities of food losses in many countries around the world. Most of these studies were conducted at the national level, and based on literature reviews, statistical data and stakeholder interviews.

The analysis of literature and overall reports reveals a knowledge gap: while quantitative estimations of food losses have been produced, and there is certainty about the major causes of food losses, it is unclear which of the 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 greatly benefit all actors in the food production and supply chain, will improve food security for poor people, advance climate resilience and make more efficient use of natural resources. The solution to food loss, however, should not be more expensive than the food loss itself, should not cause any negative impact or risk to consumers' health, should not place a higher burden on the environment and greenhouse gas (GHG) emissions. Solutions to food looses should ensure more food is available for the people who need it most and should be socially and culturally acceptable.

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

A case study is just a one-moment recording of what is happening in a specific food supply chain in a specific season in a specific location; in another season or in a different location the situation can be very different again. It was therefore considered important that the Save Food Initiative should undertake many case studies in many different locations, so that the study results would provide significant trends and solutions. Further, the strategy aimed to use the results of the case studies to target opportunities for investment programmes and interventions, during which a wider geographical scope and seasonality would be analysed.

The assessment of post-harvest losses along maize supply chains in Timor-Leste used the methodology developed by FAO under the Save Food initiative and adapted it to the specific conditions and local context. The maize subsector has been identified by the Government of Timor-Leste as a priority for the reduction of post-harvest losses. The study involved smallholder farmers, cooperatives, transporters, traders, millers, warehouse managers of cooperatives, and daily labourers.

The main objective of this study was to obtain a clear view of the weak points in selected maize supply chains in order to identify where food losses occur, evaluate quantitative and qualitative losses, analyse their main causes, and identify key interventions to reduce food losses improve the efficiency of the food supply chain (FSC). These analyses will eventually lead to concrete proposals to implement a food loss reduction programme.

An effective supply chain food loss assessment involves the collection of data and its analysis. Assessments were carried out using qualitative and quantitative field methods. Subsequently, solutions and strategies for addressing food losses were formulated from the results and conclusions of the assessment. Through the formulation of food loss reduction strategies, the project adopts a holistic approach based on the entire supply chain, recognizing the strong role of multiple actors, including the role of institutional structures and policy environment.

Given the magnitude of food losses, making profitable investments in reducing losses and improving the efficiency of the food supply chain could help bring down the cost of food to the consumer, increase access to food, while at the same time improve economic returns to farmers and other actors in the value chains.

## METHODOLOGY

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

### Selection of countries and subsectors

Countries and subsectors that already have ongoing programmes are selected to provide the project partners to work and collaborate with in the field. Subsectors are chosen from the important food commodities in the country: cereals, roots and tubers, fruits and vegetables, oilseeds and pulses, fish and seafood, and animal products (meat, milk, eggs, etc.).

### Identification of consultants

The field work is conducted by a team of two or three national consultants: a subsector specialist (who might be an actor in the food supply chain), an agricultural economist and a rural sociologist.

### Selection of food supply chains

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

The basic criteria for selection of the FSCs are:

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

### Uniform methodology

The methodology of the case studies was designed to be uniform for all countries so that the results are comparable and extrapolation is made possible. The methodology was developed specifically for this purpose. It is comprised of four ('S') elements:

- *Preliminary screening of food losses ('Screening').* This is done based on secondary data, documentation and reports, and expert consultations without travel to the field.

- *Survey food loss sssessment ('Survey').* This is done using different questionnaires for producers, processors or handlers/sellers (i.e. warehouse managers, distributors, wholesalers, and retailers) and other knowledgeable persons in the supply chain being assessed, complemented by ample and accurate observations and measurements.
- *Load tracking and sampling assessment ('Sampling').* This is useful for quantitative and qualitative analyses at any step in the supply chain.
- *Monitoring and solution finding ('Synthesis').* This is used to develop an intervention programme for food losses, based on the previous assessment methods.

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

### Stakeholder validation

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

### Methodology adopted in this study

In this research, FAO's case study methodology as described above was followed along the maize supply chains in IFAD supported project areas.

Data was collected from direct observations and interviews with key actors in the supply chains. In addition, secondary data was collected from government and private institutions and through a review of the literature.

The case study was conducted with close consultation and coordination with the six heads of the villages, extension workers and leaders of farmer groups in order to obtain a clear picture of the activities being conducted by stakeholders in the supply chain.

This study was conducted from July to October 2015.

### Preliminary screening phase

Activities to select the FSC included:

- Assemble and review technical information or literature, as well as recent economic data. Policy and strategy documents were reviewed as well as technical reports, quality standards and regulatory frameworks and mandates of relevant institutions.
- Conduct consultations with experts from MAFF, FAO Timor-Leste, SoL/the Australian Centre for International Agricultural Research (ACIAR), IFAD Timor-Leste, Universidade Nacional Timor Lorosa'e (UNTL), local NGOs, the private sector and community leaders.
- Review the documentation and level of implementation of the Timor-Leste maize storage project, which is funded by IFAD, and of the silo project for seed storage, which is funded by Mercy Corps, and analyse the strength and bottlenecks of the projects and their programmes.
- Identify what additional and/or new information is required to obtain a clear understanding of maize losses in the selected supply chains in the study site.
- Identify indicators to assess or measure the impact of food losses on the local and national economy, and on local social systems.
- Based on the above information and knowledge of the supply chain, select the specific supply chain(s) and the geographical location for the maize study.

### Survey phase: collection of primary data

Thorough interviews with stakeholders of the selected FSC were conducted, including focus group discussions (FGD). The survey was complemented by observations of the FSC activities, systems and products.

The percentages of losses (kilogram/100 kg of grain) along the supply chain were computed from the data generated from the questionnaires. Corresponding monetary values were calculated taking into account the price of one kilogram of maize grain (USD 0.45).

## Maize study

There were 145 respondents in this study, comprising 100 maize producers, 20 traders, 10 retailers, and 15 collectors of maize in each subdistrict of the district of Lautem.

Characteristics of the respondents are shown in Table A below:

The survey was conducted in the district of Lautem, in the subdistricts of Lospalos Villa, Lautem and Tutuala and in several villages including Fuiloro, Bauro and Muapitine. In addition, a number of subvillages are also included in this study, namely Central, Laivai, Nakroma, Leleto and Wailuro.

## Policy framework or national strategy

Timor-Leste's Strategic Development Plan (SDP 2011-2030) clearly defines the goals of the agriculture sector, which include the improvement of national food security, the reduction of rural poverty, supporting the transition from subsistence to commercial farming, and promoting sustainability and the conservation of Timor-Leste's natural resources (RDTL, 2011).

As a key area for rural development, increased agricultural productivity (including the maize subsector) will lead to increased demand for other goods and services in rural areas. To achieve this, the Government has developed and implemented policies and regulations in support of agricultural production, post-harvest loss reduction and marketing, thereby enabling the sector to serve as a driving force for economic growth and social progress in the medium and long term.

Some of the key areas of these policies and regulations include:

- technological investment in agricultural mechanisation;
- optimisation of crop production (rice, maize, coffee, coconut, vegetables, etc.) and post-harvest loss reduction;
- promotion of farming seed centres and their distribution at regional and district level;
- reinforcement of technical training for farmers and extension workers; and the
- promotion of agricultural research and information.

The implementation of the above policies included the distribution of improved high-yield varieties of maize, tractors, shelling and milling equipment, and storage facilities , government purchasing of maize and the allocation of extension workers at village level.

The National Seed System for Releases for Released Varieties (NSSRV) and Timor-Leste Maize Storage Project (TLMSP) are considered as a priority and need to be strengthened in order to increase agricultural growth. As most of the losses in maize occurred at the stage of storage, it is important to concentrate on how to reduce losses at this stage.

## Relevant institutions and their roles

There are a number of institutions involved in the development of the maize sector in Timor-Leste. These institutions include the Ministry of Agriculture and Fisheries, the Ministry of Commerce, Industry and

TABLE A
**Respondent characteristics**

| | Farmer | Trader | Retailer | Collectors |
|---|---|---|---|---|
| Total respondent | 100 | 20 | 10 | 15 |
| Gender: Male (%) | 70 | 90 | 40 | 100 |
| Female (%) | 30 | 10 | 60 | - |
| · Education (%) | | | | |
| · Completed Primary School | 21 | 40 | 50 | 20 |
| · Completed Secondary School | 39 | 30 | 25 | 15 |
| · Completed Tertiary education | 1 | - | - | - |
| · No school/Illiteracy | 39 | 30 | 25 | 65 |
| Average age (year) | 47 | 40 | 38 | 40 |

*Source*: authors' research (field survey)

Environment, the National Bank of Commerce of Timor-Leste (BNCTL) and national and international agencies. In addition, the institution responsible for setting up food standards is the Ministry of Commerce, Industry and Environment (MCIE). So far, however, no specific food safety standards and quality criteria have been applied to maize in Timor-Leste.

TABLE B
**Relevant institutions and their roles in the maize subsector**

| Institution | Role in terms of policy | Mandate and activities |
|---|---|---|
| MAFF | Policy development and drafting of regulations to support actitivies under MAFF. | Foster and oversee food production; and promote industry in the agriculture sector; create technical assistance centre for farmers. |
| MCIE | Design, execute and assess the policies for commerce, industry and environment. | Promote the development of the cooperative sector, especially in rural areas and agriculture; promote micro and small enterprises; purchase local products such as maize and rice. |
| BNCTL | Commercial bank that caters to Timorese individuals, micro, small and medium enterprises interests in urban and rural areas. | Provide financial access to poor Timorese (e.g. offer loans to farmers in rural areas). |
| SoL/ RDP IV | Focus on increasing yields by selecting and distributing improved varieties of superior genetic quality. | Improve agronomic practices, reduce post-harvest storage losses, and improve input supply arrangement for seeds. |
| IFAD | Guarantee food self-sufficiency and empower rural women and men to achieve higher incomes and improved food security. | Distribute maize storage facilities to farmers and facilitate policy development on food security issues. |
| FAO | Support the improvement of institution and coordination mechanisms for policies, laws, regulations and programmes. | Supported the development of the post-harvest management strategic framework in 2013. |
| IFAD, SoL, USAID | Ensure sustainable post-harvest protection of seeds and grain stocks and improve crop production in rural areas. | Address seed system security issues to mitigate post-harvest storage losses for maize and rice and to maintain better quality seeds. |
| UNDP | Address local climate impacts, through strengthened local administrative capacity, accountability, and public participation to ensure that climate risks are properly weighted in local decision-making. | Provide technical advice and assistance to build strong and capable public institutions at national and subnational levels in justice, parliament, human rights, anti-corruption, police, economic development, environmental management and disaster risk management |

# Executive Summary

Maize is the most widely consumed commodity in the Democratic Republic of Timor-Leste. Most farming households in the country can be characterized as subsistence farmers, and maize is a key determinant of household food security. Because of the lack of market opportunities and low production, most maize produced (85 %) is for own consumption. There are no large-scale maize industries or producers in Timor-Leste. Most maize is produced by smallholder farmers and there is only a small percentage of medium-scale producers.

The average annual production of maize in Timor-Leste is around 87 000 tonnes; and productivity is and 2.1 tonnes per hectare. Of this, 20 percent of maize is marketed, generating a market value of USD 11.6 million.

In the past ten years, the Government of Timor-Leste and various key stakeholders have invested much effort in increasing maize production, particularly in high potential areas such as Maliana, Baucau, Viqueque, Manatuto and Suai. The stakeholders involved in the maize subsector include the Ministry of Agriculture, Forestry and Fisheries (MAFF), the German Agency for International Cooperation (GIZ), the Ministry of Commerce, Industry and Environment (MCIE), the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD), Seed of Life (SoL), the the United Nations Development Programme (UNDP), the World Bank, the Japan International Cooperation Agency (JICA), and local and international non-governmental organizations (NGOs).

Some examples of the interventions implemented include:

- providing training and technical assistance to farmers;
- promoting the use and distribution of improved seeds, storage facilities, agricultural machines and equipment;
- allocating extension workers in all villages around the country;
- improving linkages between products and markets; and
- rehabilitating irrigation schemes. Even if these programmes do not focus on food loss reduction, their interventions are key components for reducing post-harvest losses in maize supply chains.

There are two types of supply chains in the maize subsector, the formal and informal. In the informal chain, farmers sell their maize directly to the consumers at the farmgate, to their neighbours, friends and at the local market and village level. Most farmers in Timor-Leste are involved in this chain. In the maize subsector, farmers sell their maize to the traders; the traders to the retailers, and the retailers to the consumers. Only a small number of maize producers sell their products directly to the consumers at the local or district market.

In this study, the formal and informal maize supply chains were selected for an in-depth field survey in the districts of Lautem, following the methodology of the 'food supply chain' case studies.

It was found that losses occurred at all stages of the selected maize supply chains. In the maize supply chain, the critical loss points identified were harvesting, drying and farm storage, with average estimated losses after each process of 5.5 percent, 2.5 and 2.5 respectively.

The total estimated losses for maize are 21.7 tonnes or 15.4 percent of the total annual production of 140.8 tonnes in the study area, which represents an economic loss of USD 9 800 for the studied supply chain or USD 98 per farmer (selling price: USD 0.45 per kg).

The causes of losses are multiple: lack of labour, lack of equipment, rain during harvesting, inadequate and inefficient harvesting or production practices, lack of drying and storage facilities, poor management of these facilities, lack of transport equipment and poor road conditions. Quantitative and qualitative losses are mainly because of moulds, damage by rodents and chickens, spillage and germination.

To address these challenges, and reduce post-harvest losses (PHL) in maize supply chains, the study recommends that the government and institutional partners introduce and promote proven post-harvest technologies, and provide training and extension services to raise awareness of post-harvest losses, their impact, value and how to address them.

# Chapter 1
# Introduction and background

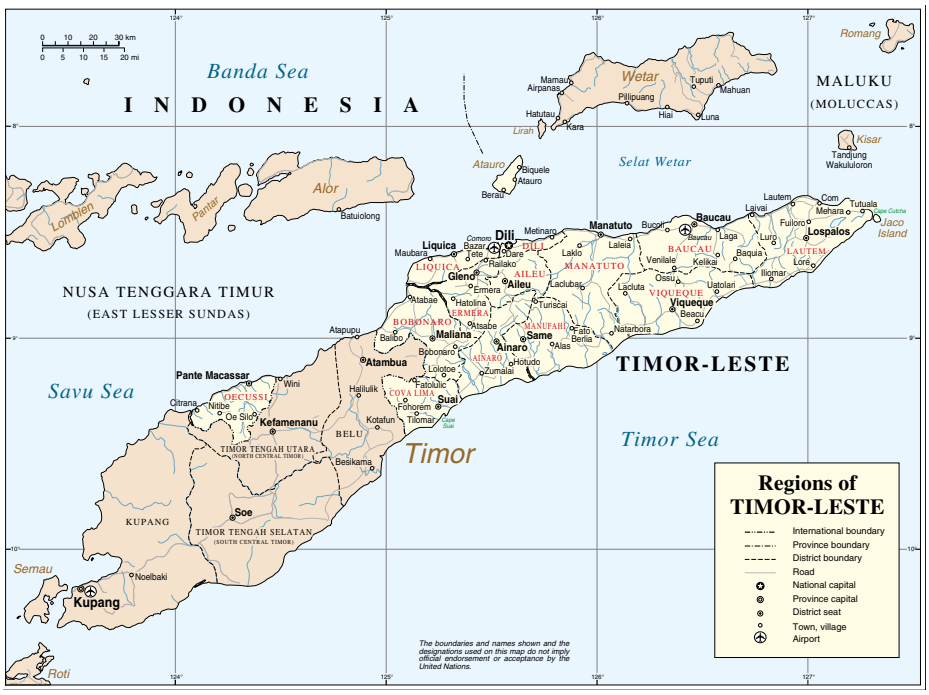
## STATUS, IMPORTANCE OF THE MAIZE SUBSECTOR

Maize (*Zea mays* L.) is the main staple crop in the Democratic Republic of Timor-Leste and the main staple food crop for 80 percent of the population in rural areas, where it is also a major source of income and employment. Farming the crop absorbs more than 70 percent of the total labour force in the agriculture sector. According to the National Statistics Directorate (NSD) and the United Nations Population Fund (UNFPA, 2010), it is estimated there are around 102 300 households involved in maize production, which is 55 percent of all households in Timor-Leste. The average maize cultivation area is 1.0 to 1.5 ha per farm (Care International, 2004) and the average yield is 1.0 to 2.0 tonne/ha (SoL, 2014). Moreover, with the use of high-yield varieties and fertilizers, and the continued support farmers receive with free land preparation, maize production has increased by about 46 percent from 2012 to 2013 (Young, 2013).

Despite the increase in the production of maize, post-harvest losses remain an important threat to the country's food security. Maize losses amount to 13 percent, as reported in a recent baseline survey, and up to 30 to 45 percent annually as reported by Guterres and Williams in 2006 and by Guterres *et al.*, in 2014. These losses occur because of inadequate and ineffective post-harvest handling.

The population of Timor-Leste in 2015 was approximately 1.3 million people. With an annual maize consumption of 105 kg/pp/year, the annual

FIGURE 1.1
**Map indicating areas visited during the maize case study**




*Source:* https://goo.gl/images/x21HXT

TABLE 1.1
**Maize production, consumption and maize import in Timor-Leste from 2010 to 2015**

| Year | Cultivated area (ha) | Total maize production (tonne) | Productivity (tonne/ha) | Maize consumption (TLHS 105 kg/cap/yr) | Maize import (tonne) |
|---|---|---|---|---|---|
| 2010 | 75 803 | 148 890 | 2.12 | 63 030 | |
| 2011 | 24 928 | 30 666 | 1.41 | 64 035 | 84 746 |
| 2012 | 35 411 | 62 839 | 1.78 | 65 038 | 58 573 |
| 2013 | 49 514 | 118 069 | 2.41 | 65 050 | 9 343 |
| 2014 | 36 961 | 102 513 | 2.81 | 66 080 | 32 899 |
| 2015 | 30 163 | 64 795 | 2.08 | 67 500 | 71 617 |

*Source:* RDTL, 2011; IMF, 2011; MAFF, 2015

FIGURE 1.2
**National production information for the maize sector – actors and product flow**

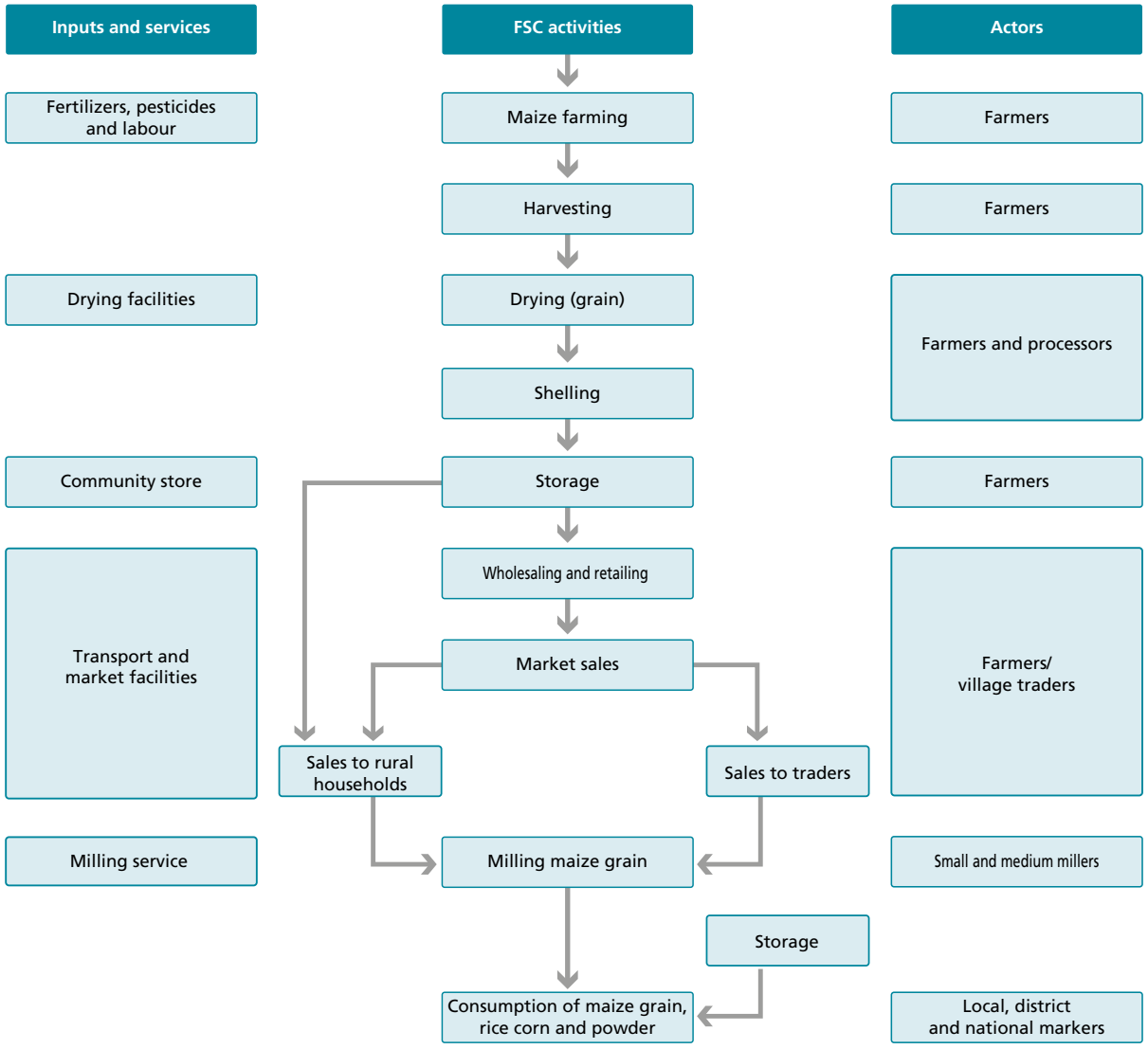


TABLE 1.2
**National production information for the maize subsector**

| | Annual production (tonne/year) | Cultivated area (ha) | Average yield (tonne/ha) |
|---|---|---|---|
| Raw material | 87 960 | 42 130 | 2.1 |
| Average annual growth over the last 10 years (%) | 2.0 | | |
| Average cost of production (USD/tonne) | 140 | | |
| | **On-farm consumption** | **Marketed** | |
| Percentage of production (%) | 80 | 20 | |
| Volume (tonne/year) | **Value (USD/year)** | | |
| Market product #1 Maize grain | 17 500 | 11.6 million | |
| Small | **Medium** | **Large** | |
| Level of processing operation | • | | |
| Level of trading/wholesale operation | • | | |
| Level of retail operation | • | | |

*Source*: Janes *et al.*, 2010; Lopes and Nesbitt, 2012

TABLE 1.3
**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 | | MCIE |
| | | Exists but not rigorous | • | |
| | | Doesn't exist | | |
| | Frequency of checking (None, Low, Medium, High) | Harvest | None | MCIE |
| | | Transport | Low | |
| | | Storage | None | |
| | | Process | None | |
| | | Market | Low | |
| | Obligatory registration of the food processing/ preparation unit | Exists | • | MCIE |
| | | Doesn't exist | | |
| FSC actors - food safety management system | GHP/ GAP/ HACCP/ voluntary standards | | None | |
| | Identification of potential hazards | | None | |

*Source*: authors' research (preliminary screening phase)

demand for maize has reached an estimated 136 500 tonnes per year. However, Timor-Leste only produces 88 000 tonnes of maize every year (Young, 2013). The country therefore needs to subsidize and import approximately 137 000 tonnes of maize every year in order to meet demand.

Further, most of the maize produced (80 percent) is for the farmers' own consumption and only about 15 to 20 percent is marketed. There are no large-scale maize industries or processors, 90 percent is processed by smallholder processors.

## Description of the food safety management mechanisms

So far there are no food safety standards regulating food sold to consumers. The Ministry of

Commerce, Industry and Environment (MCIE) is mostly engaged in checking the expiration date of imported foods.

No specific food safety and quality criteria or standards are applied to maize, while mycotoxins have been identified as a critical food safety problem. Guterres *et al*., in 2014 found that farmers are not aware of the food safety issues associated with mycotoxins. They are also unaware of the harvest, drying and storage techniques necessary to prevent their growth. Therefore, there is a need for capacity-development and training for those involved in farming and the post-harvest chain. Further, the Government, through the MCIE, needs to establish a new laboratory that is capable of undertaking the analysis and monitoring of aflatoxin trends.

## INVENTORY OF ACTIVITIES AND LESSONS LEARNED FROM PAST AND ONGOING INTERVENTIONS IN MAIZE LOSSES

Stakeholders involved in the maize subsector include the MAFF, MCIE, GIZ, JICA, Care International, USAID, FAO, IFAD and the private sector. The objective of their interventions is to improve maize production in Timor-Leste, as most households depend on this subsector for their livelihoods.

- The Government of Timor-Leste, through MAFF, and with the support of the international institutions mentioned above, has been investing in programmes to enhance the production of maize, particularly in the areas where there is a high potential for growing maize. Success in increasing maize production depends upon effective extension programmes, timely supply of inputs, and access to credit and support for mechanization programmes. The Government's interventions in the past decade include free land preparation; distribution of drums for maize storage, and tractors. The Government also established centres for maize seed production and multiplication, developed certification mechanisms, supported the use and distribution of inorganic and organic fertilizers, trained farmers and deployed extension workers to all villages in Timor-Leste.
- Under the Agriculture Rehabilitation Project (ARP, 2002-2007), MAFF distributed 2 906 tractors to the farmers in all territories of Timor-Leste to facilitate free land preparation (ploughing) for maize cultivation. This intervention aimed to improve the production and productivity of maize, thereby enabling the sector to serve as the driving force for economic growth and social progress in the medium to long term.
- Since 2004, Seed of Life has introduced improved high-yield varieties of maize such as *Kalinga*, Swam 5, *Sele* and *Noi Mutin* from overseas. The objective of this programme is to improve food security through increasing the productivity of staple crops. The Government of Timor-Leste, under the MAFF-Seed of Life programme, released new maize varieties that have already been proven to produce 25 to 30 percent more than local varieties of the same crop grown under normal farm practices.
- Between 2005 and 2010, FAO advocated silos for maize storage in rural areas. From 2011 to 2015, IFAD's Timor-Leste maize storage project (TLMSP) distributed 42 000 drums (200 litres) to maize farmers throughout Timor-Leste. The main objectives of this intervention was to reduce post-harvest losses of maize, increase food availability and agricultural value-addition, contribute to the balance of trade, by earning export revenue and by substituting imports, and by increasing incomes and employment in rural areas.
- Through the MAFF, the Government of Timor-Leste has been supporting programmes in the maize sector that include the distribution of tractors to farmers, free land preparation (ploughing), distribution of new high-yield varieties of maize, distribution of fertilizers and chemicals, introduction of Good Agriculture Practices (GAP) for maize, and provision of training to farmers through extension workers (RDTL, 2011; National Commission for Research and Development, 2008; MAFF, 2008a; MAFF, 2008b; RDTL, 2007).

MAFF, IFAD and SoL have also distributed 3 090 maize shellers and 500 milling machines to farmers to facilitate post-harvest processing.

Five thousand farmers benefited from the free land preparation programme. Jobs were created, such as for tractor drivers and mechanics. In addition, approximately 11 200 people participated in training through seminars and workshops. Finally, after the distribution of drums, farmers will be able to save 45 360 tonnes of maize over 20 years. This will generate around USD 13 608 000 income for farmers in the next 20 years.

TABLE 1.4
**Past and current government interventions in the maize subsector**

| Activities/Intervention | Institution/Project | Year |
|---|---|---|
| Improve food security (including maize) of selected poor households and increase agricultural production by using GAP and promote rural growth and the food security of rural families | ARP | 2002 – 2007 |
| Identification of maize varieties with good yield potential, tolerant to major abiotic and biotic stresses, resistant to weevils, with acceptable grain qualities for various maize ecosystems | SoL and MAFF | 2004 – 2016 |
| Training for Timorese engineers in making silos and drums for maize storage | FAO and IFAD | 2011 – 2016 |
| Training in Good Agriculture Practices for maize in order to increase production and reduce post-harvest losses of maize | GIZ-RDP | 2013 – 2015 |

*Source*: authors' research (preliminary screening phase)

TABLE 1.5
**Type of training and assistance given to maize farmers in Lautem**

| Topics of training and assistance | MAFF (%) | NGO (%) | Univ. (%) | Agency (%) | Agribus/ (%) | Coop. (%) | Other (%) |
|---|---|---|---|---|---|---|---|
| Maize production | 80 | 45.7 | - | - | 10.3 | 8.3 | - |
| Technical advice | 81.7 | 40.5 | - | - | 8.3 | 16.7 | - |
| Improving quality and quantity of maize | 66.7 | 40.5 | - | 8.3 | - | - | - |
| Value adding | 25 | 16.7 | - | 8.3 | - | 8.3 | - |
| Improving post-harvest handling up to storage | 80.5 | 16.7 | - | 8.3 | - | | - |
| Market Information | 10.5 | 16.7 | - | 8.3 | - | 7.7 | - |

*Source*: authors' research (field survey)

### Assistance and training

The results of the present study showed that 15 percent of the respondents in the study area received assistance and training in maize production. Training and capacity-building interventions were supported by MAFF. Diverse stakeholders, including cooperatives, international agencies and agribusiness companies contributed to their organization.

Respondents were asked to indicate the training they had attended, as they could have participated in several trainings delivered by different institutions.

Past interventions in the maize subsector focused on how to increase production and reduce storage losses. Intervention areas included development and promotion of improved maize varieties, production technology and storage facilities such as silos and drums. What has been learned from the past interventions is that not much attention is placed on the reduction of maize losses at the stages of harvesting, post-harvest handling, processing and marketing. However, reducing losses at these stages would contribute to increasing maize production and preservation.

## OVERVIEW OF THE MOST IMPORTANT FSCS IN THE MAIZE SUBSECTOR; SELECTION OF FSC

Maize production areas are the districts of Covalima, Oecusse, Baucau and Lautem. As shown in Table 1.6, the highest production of maize is in Covalima while the lowest is in Dili. The districts with the highest number of smallholder producers are Ermera, Baucau and Oecusse and the subdistrict of Maliana. In addition, most maize production areas are supported by international agencies including GIZ, SoL and IFAD.

Maize has been traded for many years through the barter and trust system (borrow something from someone and pay with maize after harvesting) between farmers and traders at the farmgate, at neighbours' houses, and at local, subdistrict and district markets. However, the lack of market for maize products has caused farmers to lose their

TABLE 1.6
**Food supply chains in the rice subsector categorized by geographical area of production**

| No. Food Supply Chain | Geographical area of production | Final product | Volume of final product 2014 (tonne/year) | Number, age, and sex of smallholder producers | Market of final product, Location, buyers | Project support |
|---|---|---|---|---|---|---|
| 1 | Covalima | Maize | 16 750 | 6 398 | Covalima | GIZ, SoL, IFAD |
| 2 | Oecusse | Maize | 12 584 | 11 294 | Oecusse | GIZ, SoL, IFAD |
| 3 | Baucau | Maize | 11 372 | 12 338 | Baucau/Dili | GIZ, SoL |
| 4 | Lautem | Maize | 11 129 | 5 909 | Lospalos/Baucau/Dili | GIZ, SoL, IFAD |
| 5 | Liquica | Maize | 7 033 | 7 244 | Liquica/Dili | GIZ, SoL, IFAD |
| 6 | Maliana | Maize | 5 624 | 11 176 | Maliana/Dili | GIZ, SoL |
| 7 | Ermera | Maize | 3 180 | 13 963 | Ermera | SoL |
| 8 | Manufahi | Maize | 2 582 | 4 984 | Manufahi | GIZ, SoL, IFAD |
| 9 | Aileu | Maize | 2 502 | 5 508 | Aileu | SoL |
| 10 | Manatuto | Maize | 1 956 | 3 578 | Mantuto/Dili | GIZ, SoL, IFAD |
| 11 | Viqueque | Maize | 1 690 | 6 789 | Viq/Baucau | GIZ, SoL |
| 12 | Ainaro | Maize | 519 | 7,166 | Ainaro | GIZ, SoL, IFAD |
| 13 | Dili | Maize | 454 | 439 | Dili | - |

*Source:* Ministry of Finance, 2011; MAFF, 2011; NSD and UNFPA, 2010

TABLE 1.7
**Importance of maize supply chains at the national level**

| No. Food Supply Chain | Economic Importance (USD) | Generation of foreign exchange | Contribution to national food consumption (%) | Contribution to national nutrition | Environmental impact |
|---|---|---|---|---|---|
| 1 | 7 537 500 | 1 | 25.7 | 2 | 1 |
| 2 | 5 662 800 | 1 | 19.3 | 2 | 1 |
| 3 | 5 117 400 | 1 | 17.5 | 2 | 1 |
| 4 | 5 008 050 | 1 | 17.1 | 2 | 1 |
| 5 | 3 164 850 | 1 | 10.8 | 2 | 1 |
| 6 | 2 530 800 | 1 | 8.6 | 2 | 1 |

NB: 1=low level; 2=medium level

*Source:* authors' research (preliminary screening phase)

TABLE 1.8
**Importance of maize supply chains for their actors**

| No. Food Supply Chain | Percentage of produce by smallholder | Income generation (USD/ smallholder producers/year) | Involvement of the poor (%) |
|---|---|---|---|
| 1 | 100 | 1 178 | 98 |
| 2 | 100 | 501 | 98 |
| 3 | 100 | 415 | 98 |
| 4 | 100 | 848 | 98 |
| 5 | 100 | 437 | 98 |
| 6 | 100 | 226 | 98 |

*Source:* authors' research (preliminary screening phase)

motivation to grow maize for sale, although some farmers continue to trade in maize to pay school fees for their children and other expenses.

The two types of value chains in the maize subsector are formal and informal.

- In the informal value chain, farmers sell their maize grain directly to the consumers at the farmgate, to neighbours and friends, as well as at village markets. Farmers fail to bring their products to the main markets at district and national levels on account of the following:
  - lack of processing facilities and skills to operate the processing equipment;
  - lack of knowledge of the marketing system and of information related to prices of inputs and outputs;
  - lack of capital;
  - low access to markets;
  - high transport costs; and
  - low prices.
- In formal value chains, farmers distribute their maize grains to the traders, who in turn sell to retailers and on to consumers. Some producers also process small quantities of maize into milled maize and sell it to consumers. Products sold in this chain are mostly maize grains but also milled products including rice, corn and maize powder produced by small-scale millers. Only a small percentage of farmers engage in the formal chains.

The FSC selected in this study is in Lospalos subdistrict. With an area of 635 km², Lospalos is the largest subdistrict in Timor-Leste, located in Lautem district. Both formal and informal value chains in the subdistrict were selected and analysed for the contribution they make to employment and food security.

The Lospalos subdistrict was selected based on the following criteria:

- Lospalos' high potential for maize production;
- the involvement and long-standing experience of its subsistence farmers with maize production;
- the importance of maize in the region in terms of food supply and income-generation as a source of food and income, farmers depend on this crop for their livelihoods;

TABLE 1.9
**Preliminary screening of maize losses in the selected FSC (Lautem district)**

| FSC Geographical area: Baucau Market product: Maize | | | |
|---|---|---|---|
| **Step in the FSC** | **Expected loss points** | | |
| | **Quantitative CLP or LLP** | **Qualitative CLP or LLP** | **Comments remarks** |
| Harvesting | CLP – wet grains, rats, spoilage, late harvesting, birds, germination and pests | CLP – Mould, weevils, dirt | |
| Farm storage | CLP – wet grains, rats, spoilage, germination, pests | LLP – Mould, weevils, dirt | |
| Homestead transfer | LLP – spillage | LLP – dirt, discoloration | |
| Drying | CLP – chicken/birds, rain, other animals | LLP – dirt | |
| Shelling | LLP – spillage | LLP – contamination, dirt | |
| Cleaning | LLP – spillage | LLP – dirt | |
| Milling | LLP – spoilage | LLP – spillage | |
| Packaging | LLP – broken grains, spillage | LLP – dirt | |
| Storage | LLP – mould | CLP – discoloration | |
| Loading | LLP – spillage | LLP – dirt, contamination | |
| Off-loading | LLP – spillage | LLP – dirt, contamination | |
| Transportation | LLP – poor roads, lack of material to cover the product, poor vehicles | LLP – discoloration | |

*Source:* authors' research (preliminary screening phase)

- IFAD's project in the area, which supports the promotion and distribution of household level storage facilities (drums); and
- the presence of trading activities related to this commodity.

In the study area, 95 percent of maize supply chains are informal. This report provides a synthesis and analysis of the data collected from both the formal and informal chains.

## PRESUMED FOOD LOSSES IN THE SELECTED FSC

The presumed food losses at critical loss points and low loss points are summarized in Table 1.9. The results of the literature study, consultations with experts, interviews with farmers and direct observations during field visits showed that maize losses occur at all stages of the supply chain, but three specific CLPs were identified: harvesting, drying and farm storage. CLPs are the points in the FSC where food losses are highest, and have the greatest impact on food security, and the affect the economic output of the FSC the most. In addition, the results revealed low loss points in the FSC (Table 1.9). At low loss points, it was found farmers were implementing good agriculture practices, including the use of drums for storage, and the use and good management of sacks for transporting maize, to facilitate loading and unloading.

Chapter 2

# The maize supply chain – situation analysis

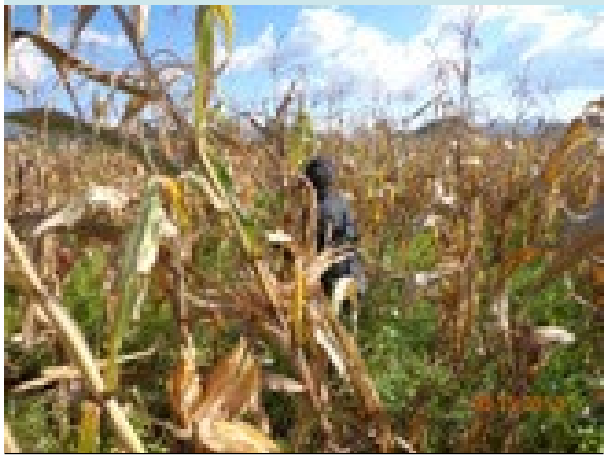
## DESCRIPTION OF THE SELECTED MAIZE SUPPLY CHAINS

As noted above, both maize supply chains in Lospalos, formal and informal, were selected for this study. In the informal chain, farmers do not have access to the district and Dili markets and they normally sell their maize grain directly to the consumers at the local market and to their neigbours at the village level.

In the formal chain, farmers deliver their maize grain to the traders at local and district markets. Then the traders sell the product to the retailers from Lospalos and Baucau, who in turn distribute it to consumers in Baucau and Dili. The products sold in this chain are maize grains and a small quantity of milled products. Most of the product sold is maize grain.

The site of this study are the subdistricts of Loaspalos Villa, Lautem and Tutuala and the villages of Fuiloru, Maupitine and Bauro in the district of Lospalos. The study was conducted from July to October 2015.

FIGURE 1.3
**Yellow leaves shows the maize is ready to harvest**



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The dominant maize system in these areas is rainfed lowlands and uplands. In 2014, with a potential of about 20 000 ha for maize cultivation, only 991 ha were planted. The total production of maize in Lospalos in 2014 was approximately 11 000 tonnes (MAP, 2014).

The FSC activities in Lospalos start with harvesting (manually, using a knife). Then the maize is transported to the farmhouse where it is dehusked. After, maize is transported to the warehouse using trucks or horses. The next activity is sun drying the maize using a tarpauline or *'biti'* spread on the ground, followed by shelling (manually and some use local equipment). Maize is then stored in drums and sacks before it is transported to the market or for milling.

**Harvesting** – takes place when the maize cobs are physiologically mature. Yellowing of leaves and husks may indicate the moisture content is between 30 to 35 percent (Guterres and Williams, 2006; Guterres and Da Costa, 2014a; Guterres *et al*., 2014b). Usually, farmers harvest their maize in March, but in 2015 farmers delayed harvesting until April and June because of the prolonged rainy season. Cobs are detached from the plant by hand, dehusked, placed in sacks, and transported directly to the homestead for further processing. Approximately 40 percent of harvested maize is left on the ground in the field for several days. The reason is a of lack of labour and harvesting equipment.

Maize is transported, on and off-farm, by truck or horses and is also carried manually, depending on the distance between the maize field and the farmers' homestead and the quantity of production.

**Dehusking** – of maize cobs after plucking from maize stalks is performed manually in the rural areas of the district of Lospalos. No hand-operated maize dehusker is available. Most farmers do not sort or grade the maize at this stage.

FIGURE 1.4
**Maize that has become mouldy due to rains**

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**Drying** – Most farmers in the study area rely on sun-drying before storage. Maize cobs are dried on tarpaulins or '*biti*' laid on the ground, some are hung from trees to dry. If it rains during drying and the grain is not protcted the grain develops mould and spoils.

**Shelling** – There are three traditional shelling/threshing methods currently practised by farmers in Lautem, Lospalos, Bauro, Fuiloru and Maupitine. Maize grains are removed from the cobs by hand, by beating them with a wooden stick or by using improved hand-held shellers. Grain is separated from the chaff and broken bits of cob at the winnowing and cleaning stages. According to some farmers, maize shelling is difficult when, as observed, the moisture contents is over 14 percent.
**Storage (community store)** – Around 95 percent of farmers in Lautem, Lospalos, Bauro, Fuiloru and Maupetine use airtight containers such as IFAD drums and silos to store maize. The maize grain is stored in the IFAD drums, either unshelled or in the form of grain, thus ensuring that the maize is safely protected from weevils, rats, chickens, insects and wild animals

The study also found that some farmers are still using traditional storage methods, including storing maize above a fireplace (5 percent), in an elevation house (3 percent), in bags inside the house (16 percent) and hanging maize from a tree (6 percent).

**Market sales** – Farmers in Lospalos normally sell their maize grain to traders at the local market and to their neighbours. In some cases farmers sell maize grain directly to retailers in Lospalos market. Farmers are unable to access the markets in Dili because of the cost of transport.

**Milling** – machines or locally available facilities such as a wooden mortar with a long wooden pestle and shatter stone are used to mill the maize. This equipment breaks the starch-filled endosperm into grit about the size of rice grains. The embryo and skin of the grain is milled into a fine powder. This fine material, the 'fine', is separated from the grit in a wide, shallow dish. The fine is fed to animals.

**Packaging** – *'Sacks' of different sizes (25 kg, 30 kg and 50 kg) are used to transport* the maize grain to the warehouse and to the market. This type of packaging is solid, easy to carry by hand, easy to load into and out of a vehicle.

FIGURE 1.5
**Different maize storage facilities at the study sites**

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FIGURE 1.6
**Traditional milling**

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FIGURE 1.7
**Machine milling (right)**

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TABLE 1.10
**Detailed description of the maize supply chain – basics**

| Stage in Food Supply Chain | Geographical location | Months of the year | | Main products | Quantity (tonne) | Duration/ distance | Services | Product quality & safety |
|---|---|---|---|---|---|---|---|---|
| | | from | to | | | | | |
| Primary production | Farm | Nov. | April | Maize | 140.76 | 5 m/1 km | | |
| Harvest | Farm | April | May | Maize | | 5 m/1 km | Labour | Mould and aflatoxin |
| Transportation | Farm to house | April | Aug. | Maize | 140.76 | 10 m/1.5 km | Trucks and horses | Poor |
| Post-harvest handling | In farm and houses | April | May | Maize | 140.76 | 5 m/1 km | Labour | Poor |
| Storage | In farm and houses | April | Aug. | Maize | | 5 m | Drums and community stores | Mould, weevils and aflatoxin |
| Market sales | Local market | April | Aug. | Maize | | 250 m | Market facilities | Mould and aflatoxin |
| Agroprocessing | Farm houses | April | Aug. | Grain and rice corn | | | Milling services | Mould and aflatoxin |
| Storage | In farm and houses | April | Aug. | Grain and rice corn | | 5 m | Drums | Good quality |
| Transportation | House to market | April | Aug. | | | 5 m/1 km | Trucks and horses | Poor |
| Wholesale | - | | | | | | | Insects |
| Retail | Lospalos, Baucau and Dili | April | Dec. | Maize and rice corn | | 300 m to 15 000 m | | Insects |

*Source:* authors' research (field survey)

## MARKETING SYSTEM IN THE MAIZE SUPPLY CHAIN

Today, there is no permanent buyer of maize because of past government interventions, which caused market distortion. The Government implemented the programme called *"Povu kuda Governu Sosa"* ("farmers grow and the Government buys") where it was the principal buyer. The Government also subsidized imported maize and rice.

Only a few producers set up their own small maize-milling and grading activities. The products are sold to local retailers and consumers in the district of Lautem. Traditionally, farmers sell their maize products to consumers, traders and retailers at the farmgate and at the local market. Then the traders and the retailers transport the maize products to the markets in Lospalos, Baucau and Dili. Only a small number of producers sell their maize directly to consumers at the Baucau and Dili markets.

The price of maize at the farmgate and at the local market is USD 0.25 for a 1.5 kg can, meaning that 1 kg of maize costs USD 0.45-0.50.

Most farmers sell their maize after harvest, from April to December, to earn money for daily needs such as school fees, health and traditional ceremonies. However, January to March is considered a lean month when farmers need to keep their maize for consumption and in preparation for the next growing season. The price of maize during this period is always very high compared to other months between April and December.

In terms of skills and technologies in post-harvest management, farmers learn from fellow farmers (75 %) and from traditional knowledge (53 %). The two main sources of information are extension workers (15 %) and radio programmes (2 %).

### Market profile

This study confirmed that most people continue to survive largely from subsistence farming, with very few selling their maize to markets. A number of factors, which include shortage of labour for greater production, low maize production because of lack of market incentives and high post-harvest losses account for this situation.

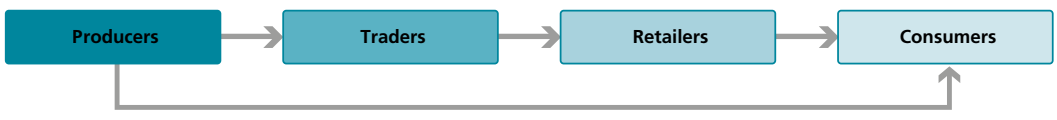
Marketing facilities and infrastructure in all territories, including the study areas, are very weak. Undeveloped markets discourage producers from going to there to sell their maize. Also distortions in the market deter private traders and rural enterprises from engaging in the grain trade. In the absence of functioning markets farmers will always produce for subsistence.

In the past, the Government, through the Ministry of Economy and Development and the MCIE, attempted to address market failure by establishing new markets and encouraging the purchase of local products (*Povu Kuda Governu Sosa*). Most of these interventions proved to be costly, often resulting in widespread corruption. The problems associated with weak markets still remain. There is the need for the Government to pursue policies and strategies that focus on value-addition through home-based industries and other off-farm businesses to trigger and sustain rural development.

This study also showed that most of the maize sold at the local market is not processed. Most maize is sold to local traders, or through district markets in Lospalos City or directly to local communities.

Most maize is sold fresh for roasting as a snack. Prices for fresh maize range from USD 0.5 to USD 1.00 for 5 to 6 cobs depending on supply. Dry maize on the cob is sold at USD 0.25 for three cobs. Shelled maize is sold at the market at USD 0.45 per kilogram. Since farmers earn higher prices locally than for exported (USD 250 per

FIGURE 1.8
**The actors in the maize supply chain in Lospalos**



tonne), there is no export potential for the maize produced.

It is difficult to determine whether the producers make a profit from these transactions because the information is difficult to obtain, and the farm prices paid are variable and largely depend on bargaining at the point of transaction. Furthermore, there is no pricing structure based on the quality of the maize. Moreover, cost variations in maize production were difficult to determine at the time of the survey.

### Marketing constraints

As in the case of most other businesses, that of maize marketing also faces a number of challenges that affect business performance, and these apply equally to both men and women-run businesses. The main bottlenecks are the high-cost of inputs, price fluctuations and inconsistent supply of spare parts.

Other constraints include lack of skills in business management and technical expertise in key areas of the economy. These include weak property rights laws and lack of access to financial and banking services, failure to understand government regulations on issues that affect business operations.

Another group of constraints identified during the focus group discussions include limited access to technology, lack of opportunities for the bulk purchase of inputs and lack of working capital. Credit has to be obtained from informal sources such as friends or relatives or non-banking financial agencies with unfavorable terms.

Given the fact that most micro, small and medium enterprises lack capital, technology and skilled labour, it is hard for maize marketing businesses to achieve increasing returns to upscale their production processes.

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

As indicated earlier in this report, MAFF has, with the support of international institutions, implemented a number of programmes in support of farmers and maize production over the past decade. Some of the components of these interventions included free land preparation, distribution of drums to store maize, distribution of tractors, capacity-building activities and training, among others.

Farmers from all the regions have benefited from the distribution of 42 000 drums, 3 090 maize shellers and 500 milling machines to facilitate post-harvest handling and processing activities. Five thousand farmers benefited from the free land preparation programme. Jobs, such as drivers and tractor fleet managers, were created. In addition, approximately 11 200 people were trained through seminars and workshops.

Farmers will be able to save 45 360 tonnes of maize over 20 years through the distribution of drums. This will generate around USD 13 608 000 income for farmers over the next 20 years.

### Gender and socio-economic patterns

As shown in Table A at the beginning of this report (respondent characteristics), farmers involved in maize production are mostly men. This may be because of the traditional patriarchal and dowry system, and husbands' tendency to see their wives as property or subordinates. In agriculture, gender equality in Lospalos is very difficult to assess.

Men and women have different roles, but they all work in the fields. Dehusking and milling activities are generally carried out by women. Transport of maize to, within, and off the farm is by women and children who carry it manually. During discussions with farmers, some women indicated they did not have appropriate facilities for transporting their maize from the farm to the farmhouse store. The maize cobs used to be tied together, to be carried on the head to the farmhouse for temporary storage before transporting them to the main house.

Men have greater command over assets, particularly property. However, the authors' discussions with farmers indicated that the income accrued is regarded as income for the entire family, and that women have more control over its use.

As in most developing countries, men in Timor-Leste tend to work in the public domain and in businesses, as opposed to women who are traditionally obliged to do the domestic work. This traditional system restricts the economic activities of women and may act as a major constraint towards full use of their human potential.

However, this survey also clearly shows that the perception of women as wives and mothers tasked to stay in the home seems to have changed somewhat because of the increased demand for more income to sustain the family. Although real change, in how women are perceived, has yet to materialize, the survey shows there are signs of hope for a gradual change if women are given wider opportunities outside the domestic domain.

Push factors driving women out of the domestic domain are the increasing acceptance

TABLE 1.11
**Detailed description of the maize supply chain – social structures**

| FSC steps | Women | | | Men | | | Organizational level of FSC actors | Gender/ social patterns (additional obs & remarks) |
|---|---|---|---|---|---|---|---|---|
| | No. child | No. adult | Qualifier | No. child | No. adult | Qualifier | | |
| Primary production | na | na | na | na | 100 | 95 | Men | Oldest farmers |
| Harvest | 30 | 45 | 60 | na | 25 | 25 | Men and women | Oldest farmers |
| Post-harvest handling | 20 | 50 | 10 | 15 | 15 | 15 | Men and women | Oldest farmers |
| Farm Storage | 10 | 70 | 30 | 10 | 10 | 10 | Men and women | Oldest farmers |
| Transportation | 10 | 20 | na | 20 | 50 | 50 | Women including children | Women and young girls and young boys |
| Market sales | 30 | 70 | 30 | na | na | na | Women | Adult women |
| Agroprocessing | 40 | 60 | na | na | na | na | Women | Women |
| Storage | 30 | 70 | 30 | na | na | na | Men and women | Men and women |
| Transportation | na | 10 | na | na | na | na | Women | Adult women |
| Wholesale | na | na | na | na | na | na | Women | Adult women |
| Retail | na | na | na | na | na | na | Women | Adult women |

*Source:* authors' research (field survey)
na: not available

of women doing business, a more open market and family demands for more income. Women engage in productive activities, including doing small businesses as a means to generate income. One of the income-generation activities is selling surplus maize. The maize market profile by gender indicates that the role of women is on the rise.

This study has shown that maize ownership in the market is dominated by women (70 %), an indication that Timorese women are moving into the private sector, although this is only the beginning. The upward trend of women's engagement in business activities demonstrates there are more opportunities and they are being taken by women, although it was found that most women prefer to run their businesses from home because of pressures arising from their multiple tasks, in particular in care and household chores, which are traditionally seen as solely the women's responsibilities. The study revealed that those involved in maize production and agricultural activities at the farm level were mostly older than 40 years (the average age was 47 years), with young people moving into off-farm sectors including infrastructure, processing, hotels and restaurants in Dili and other places.

In this study, 97 percent of respondents said they owned their land (about 2.5 ha for their own agricultural production), 2 percent reported their land was customarily owned and the remaining 1 percent cultivate land they leased or under a sharecropping arrangement. All farmers grow maize as a main crop for food security.

TABLE 1.12
**Detailed description of the rice supply chain – Economics**

| FSC stage | Main products | Cost of production (USD/kg) | Value of products (USD/kg) | Value added/margins (USD/kg) | Remarks |
|---|---|---|---|---|---|
| Primary production | Maize | 0.12 | 0.45 | 0.33 | |
| Harvest | Maize | 0.025 | 0.40 | 0.375 | |
| Post-harvest handling | Maize | na | na | na | |
| Storage | Maize | na | na | na | |
| Transportation | Maize | 0.030 | 0.40 | 0.37 | |
| Market sales | Maize | na | na | na | |
| Agro-processing | Grain, rice corn and powder | 0.021 | 2.00 | 1.97 | |
| Storage | Grain, rice corn and powder | na | na | na | |
| Transportation | Grain, rice corn and powder | 0.020 | 2.00 | 1.98 | |
| Wholesale | - | na | na | na | |
| Retail | Grain, rice corn and powder | na | na | na | |

*Source:* authors' research (field survey)

TABLE 1.13
**Detailed description of the maize supply chain – Environment**

| FSC stage | Land use (ha/tonne) | Water use ($m^3$/tonne) | Equipment/ Infrastructure | Materials | Fuel/ energy sources | Energy use (kWh/ kg) | Remarks |
|---|---|---|---|---|---|---|---|
| Primary production | 1.5 tonne/ha | Need a lot of water | Hand tractor | Fuel | Fuel | - | |
| Harvest | 1.5 tonne/2m² | No need water | NA | Knife, sacks | - | - | |
| Post-harvest handling | 1.5 tonne/m² | No need water | NA | Sacks, tarpaulin | - | - | |
| Storage | 1 tonne/m² | No need water | NA | Drums | Firewood | - | |
| Transportation | Small area | 5 liters/day/car | NA | Fuel | Fuel | - | |
| Market sales | Small area | No need water | NA | Sacks | - | - | |
| Agroprocessing | Small area | No need water | NA | No agroprocessing | - | - | |
| Storage | 1 tonne/m² | No need water | NA | Sacks | - | - | |
| Transportation | Small area | 5 liters/day/car | NA | Fuel | Fuel | - | |
| Wholesale | Small area | No need water | NA | Sacks | Fuel | - | |
| Retail | Small area | No need water | NA | Sacks | - | - | |

*Source:* authors' research (field survey)

Chapter 3
# Study findings and analysis

## DESCRIPTION OF THE MAIZE SUPPLY CHAIN: RISK FACTORS

### Pre-production

The maize varieties planted by most farmers in Lospalos are *Kalinga* and *Sele*, which, farmers say, are good in terms of production results and are resistant to pests and disease.

As described by Guterres and Williams (2006), the percentage of fine material produced when the grains are pounded, and the amount of losses at milling, depend on maize varieties and milling facilities. It was shown that *Arjuna* and *Kalinga* varieties require more time and effort to pound and shatter than the local varieties (Local Mean and Local Mutin).

In addition, the constraints faced by maize farmers in Lospalos include the high cost of certified seed, lack of inputs, lack of rain during the production stage, and lack of equipment for land preparation (e.g. tractors).

### Poor agricultural practices

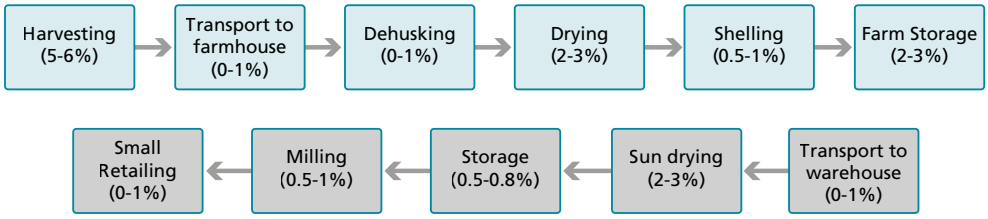
Most farmers still practice traditional methods of farming that contribute to food loss, practices such as leaving harvested maize to dry in the field for several days and storing the grain in tradi-

TABLE 1.14
**Food Loss Risk Factors**

| Variable | Unit | Parameter in relation to food losses | Value (observed in the case study) |
|---|---|---|---|
| ***Maize varieties*** | ***Name*** | ***Susceptible to weevils*** | ***Kalinga, Sele*** |
| GAP | Y/N | No | Traditional practices |
| Rainfall during production | mm | Mould | Rain at harvest |
| Production supply/demand ratio | Ratio | <1 | |
| Rainfall during post-harvest phase | mm | Low rainfall | Low rainfall |
| Post-harvest technology | L/M/H | Low | Low |
| POs/Coops | Y/N | Yes | No |
| Processing technologies | L/M/H | Low | Low |
| Good manufacturing Practices | Y/N | Yes | na |
| Packaging materials & facilities | L/M/H | High | Low |
| Cold chains | Y/N | Yes | No |
| Transport duration | Hour | Low duration | na |
| Market information | L/M/H | High | Low |
| Price incentive for quality | Y/N | Yes | No |
| Knowledge of FSC actors | L/M/H | High | Low |
| Consumer access to food product | L/M/H | High | Low |

*Source:* authors' research (field survey) - na: not available

FIGURE 1.9
**Estimated loss along the food supply chain in the study area**




tional storage that attracts moulds, insect pests and rodents.

Harvested maize should be stored in the sun or in the farmhouse, and shelling should be done immediately after the maize is dry. Storage should be in drums or silos.

In addition, most farmers do not sort or grade their maize at the stage of dehusking, which poses a danger of contaminating the good quality maize.

Traditional milling methods, as described earlier in this report, may cause grain spillage. Milling machines should be used.

Unless sufficiantly addressed, these inappropriate practices will contribute to increasing quality and quantity post-harvest losses.

### Climate change – rainfall during production and post-harvest phase

Excessive rain during harvesting causes high moisture in the physiologically mature maize cob, causing it to be susceptible to spoiling.

Should climate change lead to more unstable weather, including wet and cloudy conditions, post-harvest losses of maize may increase. Suboptimal drying practices and poor storage of grain can lead to mould growth. These in turn produce dangerous toxins known as aflatoxin and Zearlenone, which can render the grain unfit for human consumption (Hell *et al*., 2010). The Timor Global Company raised similar concerns when it stopped buying maize from Timor-Leste.

Climate is therefore a key determinant in grain losses, since climate change causes extreme weather events resulting in increased temperature and moisture levels. To complicate matters, most farmers do not have appropriate facilities to determine moisture content.

### Other risk factors

Some important aspects that are essential to the efficiency of a supply chain, and loss reduction efforts, were observed to be inadequate or rated to be of low value. These aspects included type and availabiltity of packaging material, access to market information, price incentives and cosumer demand for the commodity. The status of these components can determine the level of food loss risk. Table 1.14 shows the status of some of these elements and indicates the level of risk.

## CRITICAL LOSS POINTS

The data on quantitative and qualitative losses presented in this section was collected from field interviews, focus group discussions, and direct observations of the FSC activities and products. The average loss was then calculated for each activity along the supply chain.

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. Quality losses refer to the deterioration of quality in food products, leading to a loss of economic and nutritional value.

Most respondents in this study agreed that losses occur at all stages of the FSC (see Figure 1.9). Causal factors are the lack of labour and equipment, rain during harvesting, use of traditional methods for harvesting, lack of drying and storage facilities, poor management, lack of transportation facilities, poor packing and bad road conditions, among others.

The next section details the causes of losses for each step in the FSC. Critical loss points for maize are at the stages of harvesting, drying and farm storage.

**Harvesting** – The magnitude of losses at the stage of harvesting is the highest in the entire maize supply chain. Losses are caused by excessive rain during harvesting, which both delays harvesting and affects the subsequent storage and quality of the grain. The magnitude of losses in traditional methods of field harvesting is 5.5 percent

**Transfer to homestead** – Maize loss from spillage, breakage and leakage during grain transfer to the homestead is 0.5 percent. These losses are, however, seldom recorded and are likely to be variable.

**Dehusking** – This study found that losses from inappropriate dehusking of maize is 0.5 percent.

**Drying** – If unfavourable rain conditions occur, as in 2014, there is a risk that maize will not dry sufficiently, causing losses at a level of 2.5 percent (see Table 1.15).

**Shelling** – Total loss at the shelling stage is 0.75 percent. The cause of losses were identified as the use of manual methods and lack of shelling equipment.

**Storage** – In 2014, UNTL conducted a study on the 'Post-harvest losses of maize due to traditional methods in Timor-Leste'. In this report, it was noted that most farmers in Timor-Leste use traditional storage methods. It was estimated that the overall losses from traditional post-harvest systems, including traditional storage methods that do not protect maize from humidity and pest damage, are high (30 percent). Factors contributing to these losses are weevils (19 percent), rats (6 percent), mould (3 percent), chickens (1 percent) and germination (0.5 percent).

The present study revealed that overall the losses at the storage stage was 2.5 percent. The improvement is related to the fact that most farmers now use IFAD drums to store their maize, thus protecting it from weevils, rats, chickens, insects and wild animals.

**Milling** – The estimated loss from inappropriate milling is 0.75 percent. The cause of the losses is related to lack of adequate milling machines and use of inefficient milling machines.

## CAUSES OF LOSSES AND IDENTIFIED LOSS REDUCTION MEASURES

### Harvesting

**Lack of labour** – As most farmers harvest their maize manually, there is a high dependency on labour during the harvesting season. This has a strong impact on the timing and duration of harvesting. Because labour is in short supply, harvesting may be delayed or it takes longer than would be the case were adequate labour available. The duration of harvesting and transport to the farmhouse is several weeks or months, depending on the availability of labour.

Losses at this stage result from lack of labour and capital to hire labour, as well as lack of financial services in rural areas that would help farmers pay for additional labour for harvesting. In addition to these conditions, poor services are delivered by extension workers resulting in poor planning by farmers.

**Lack of equipment** – Most farmers harvest maize manually since they do not have the capacity to buy appropriate harvesting equipment. Harvesting is therefore time-consuming, unless more labour is hired or modern technology is used to save time and reduce the losses. A secondary cause is the lack of financial services in rural areas which would allow farmers to procure their own equipment or hire labour in time.

**Rain during harvesting** – In some areas, excessive rain often occurs in March and April, which is the time when maize is ready for harvesting. During these months, farmers mobilize others to harvest maize even if it is raining, otherwise it will germinate in the field. In some areas it rains continuously until May, which affects harvesting and subsequent activities.

**Dehusking** – As reported earlier, dehusking is done manually. In addition, most farmers do not sort or grade at this stage. Failure to grade or sort results in poor or bad maize being stored with and contaminating the good quality grain. These inappropriate practices are responsible for qualitative and quantitative losses.

**Transport to homestead** – Farmers use horses and trucks to transport maize around the homestead and to the market. Sometimes, they carry the grain on their backs or heads. Carrying on the head results in spillage through leaking containers.

**Drying** – The main purpose of drying is to prevent germination, development of bacteria and fungi and attack by mites and insects. One of the main problems faced by farmers in the district of Lospalos is frequent rains during harvesting time.

As a consequence, high humidity becomes a problem together with poor insulation levels and shortage of labour. Weather is therefore a key issue during and after harvest in the study sites.

**Shelling** – Most farmers in the study area use traditional shelling methods as they cannot afford to buy modern or improved equipment. Traditional hand-shelling requires a lot of labour and is time consuming. Farmers therefore wait for weeks to shell their maize as they do not have the capacity and resources to hire additional labour. Seed of Life, MAFF and IFAD have jointly distributed 3 202 maize shellers to maize farmers, but this is not sufficient to cover all the needs at national level.

Spillage breakage, and partial or total consumption by insects and birds cause losses during threshing and shelling.

**Lack of maize millers** – The use of traditional methods and equipment such as wooden mortars cause grain spillage and inefficient processing. Again, this is time consuming and requires labour. SoL, MAFF and IFAD have jointly distributed 500 maize millers to farmers. Although a useful gesture, the equipment is not enough to meet national needs level. More than 120 000 households require milling services.

**Lack of storage facilities** – The main constraints faced by farmers in relation to storage is the lack of adequate storage and poor storage management. This became evident in the storage drum project when farmers failed to understand the principle of hermetic closure, which requires the drum to stay sealed.

FIGURE 1.10
**Maize harvested manually**

©FAO/UNTL

The traditional methods used by farmers, and described earlier, do not protect maize from weevils, mould, chickens, rats and germination. IFAD has distributed 42 000 drums with 200 litre capacity to farmers. However, this quantity is not enough to address all needs.

## Low loss points

Discussions with stakeholders and observations have enabled the identification of low loss points as packing, loading, transporting, dehusking and shelling (Table 1.15).

IFAD drums have improved maize grain storage significantly, substantially reducing the normally high post-harvest losses. Use of the drums, however, is still far from being unanimously accepted by women, who complain of the weight they have to lift, and the time required to take the grains out of the drums.

TABLE 1.15
**Summary result matrix of maize losses**

| FSC stage/ Process | Type of loss (quantity/ quality) | Percentage lost (kg) | Percentage lost of the initial quantity | Average percentage of the product that incurred quality loss in this process | Cause of loss | Economic loss (USD) | CLP/LLP | Destination of food loss | Impact/FSC actors affected (men/women) |
|---|---|---|---|---|---|---|---|---|---|
| Harvesting | Quantity | 5.5 | 5.5 | na | Lack of labour, lack of equipment, rain during harvesting, manual method of harvesting | 3 500 | CLP | Animal feed or thrown away | Men and women |
| Transport to farmhouse | Quantity | 0.5 | 0.47 | na | Lack of transportation facilities and lack of packing | 300 | LLP | | Men |
| Dehusk | Quantity | 0.5 | 0.47 | na | Lack of dehusking facilities | 300 | LLP | | Men and women |
| Drying | Quantity | 2.5 | 2.34 | na | Lack of drying facilities and lack of labour | 1 480 | CLP | | Women |
| Shelling | Quantity | 0.75 | 0.68 | na | Manual method and lack of shelling equipment | 430 | LLP | | Men and women |
| Milling | Quantity and quality | 0.75 | 0.68 | 1.5 | Lack of milling equipment | 430 | CLP | | Women |
| Farm storage | Quantity and quality | 2.5 | 2.24 | 0.5 | Lack of storage facilities and poor management | 1 420 | CLP | | Women |
| Transport to warehouse | Quantity | 0.5 | 0.44 | na | Lack of transportation facilities, lack of packing and bad road conditions | 280 | LLP | | Men and women |
| Packaging | Quantity and quality | 0.75 | 0.65 | 0.2 | Lack of packing and manual method | 410 | LLP | | Women |
| Storage | Quantity and quality | 0.75 | 0.64 | 3.5 | Lack of storage facilities and lack of packing | 410 | LLP | | Women |
| Loading | Quantity | 0.5 | 0.425 | na | Lack of packing, lack of labour and lack of equipment | 270 | LLP | | Women |
| Off-loading | Quantity | 0.5 | 0.423 | na | Lack of packing, lack of labour and lack of equipment | 270 | LLP | | Women |
| Retailing | Quantity | 0.5 | 0.42 | na | Poor market structure and facilities | 270 | LLP | | Women |

*Source:* authors' research (field survey)

Chapter 4

# Food loss reduction strategy – conclusions and recommendations

## IMPACT OF FOOD LOSSES IN THE MAIZE SUPPLY CHAINS

Low production and high post-harvest losses negatively impact food consumption patterns as well as the food security and livelihoods of poor farmers in rural areas.

Maize losses along the supply chain in the study site are about 16 percent or 28 tonnes annually of the total annual production of 140.76 tonnes. This loss is equivalent to about USD 10 000 (USD 100 per farmer) if the maize grain is sold at the government price of USD 0.45 per kg.

In addition, these losses impact not only food availability, nutrition, the economy and social issues, but they also represent a waste of resources used in maize production, for example for land, water, energy and other inputs.

For many farmers, therefore, maize losses directly impact their ability to feed a family, not to mention their ability to invest in technologies that will help them reduce such losses in the future.

## FOOD LOSS REDUCTION MEASURES

The measures that need to be taken into consideration, in order to reduce maize losses for each stage are:

- **Harvesting** – The introduction of *harvesting equipment* in high potential areas would minimize the time spent at these critical stages, as well as reduce the dependency on labour during harvesting. It is also important to improve farmers' harvesting and post-harvesting equipment.
- **Drying** – To avoid losses at this stage, one solution would be to *introduce new and adequate drying facilities*, such as solar driers and ovens (good insulation level, easy to manage, standing high off the floor, etc.), which allow good management of the drying process, even during the rainy season, thus significantly contributing to reducing losses.
- **Farm storage** – Finding new approaches and technologies to reduce the losses at the farm storage stage is crucial. To achieve this goal, *adequate storage facilities* should be introduced complemented by training for farmers on storage management.
- Providing appropiate *training and assistance* to improve farmers' skills and knowledge is crucial, in particular in the areas of harvesting, post-harvest handling, storage and processing. Most farmers in the study area lack the skills and knowledge to manage their maize all the way from harvesting through to processing.
- Raising awareness through the *dissemination of information* about losses of maize grain from the stage of harvesting to processing is needed as most farmers are unaware of the losses that occur every year. Not only would this measure improve production results, but it would also positively impact the use of resources (land, water, energy and other inputs) during production.

The costs and profitability of the harvesters recommended, to overcome the losses, have been calculated and are presented in Table 1.16. The calculations are based on 10 years of operation of the proposed improvements. The interventions suggested, however, need a thorough analysis of their economic feasibility, environmental impact as well as social acceptability, including the way they are going to be managed, before they can become actual recommendations.

## COST-BENEFIT ANALYSIS OF IDENTIFIED FOOD LOSS REDUCTION MEASURES

### Budget calculation to reduce maize losses

The technologies recommended in Table 1.16 are unavailable locally. There are no local manufacturers. However, they can be purchased and imported from Indonesia or Thailand.

TABLE 1.16
**Budget calculation for maize loss reduction – using harvesting machines**

| | Item: | Value | Unit | Calculation |
|---|---|---|---|---|
| a | Product quantity | 140.8 | tonne/year | |
| b | Product value | 450 | USD/tonne | |
| c | Loss rate | 5.5 | % | |
| d | Anticipated loss reduction | 94.5 | % | |
| e | **Cost of intervention** | 25 000 | USD | USD 5 000/harvester x 5 harvesters |
| f | Depreciation | 10 | Years | |
| g | Yearly costs of investment | 2 500 | USD/year | e / f |
| h | Yearly costs of operation | 750 | USD/year | USD150/year/harvester x 5 harvesters |
| i | Total yearly costs of solution | 3 250 | USD/year | g + h |
| j | Client costs per tonne product | 23.1 | USD/tonne | i / a |
| k | Food loss | 7.75 | tonne/year | c x a |
| l | Economic loss | 3 500 | USD/year | k x b |
| m | Loss reduction | 7.32 | tonne/year | k x d |
| n | Loss reduction savings | 3 300 | USD/year | m x b |
| o | Total Client costs | 3 250 | USD/year | i = a x j |
| p | Profitability of solution | 50 | USD/year | n – o |

*Source:* authors' research (field survey)

The intervention is feasible as the loss reduction savings after ten years would be USD 33 000, which is higher than the cost of intervention (USD 25 000). The detail of the intervention is as follows:

- The cost is around USD 5 000/harvester (5 harvesting machines are recommended).
- The machine can be imported from Indonesia or Thailand.
- The beneficiaries of this solution will be farmer communities with the total of five groups of farmers or 150 farmers.
- The financial resources will come from farmers, agencies and the Government of Timor-Leste. Farmers can afford the costs involved as the annual income from maize per farmer is around USD 850. A group of 25 farmers earns an annual income of USD 21 250 (150 farmers = USD 127 500).

The intervention is expected to reduce losses at the stage of harvesting, thus improving the value of the product and increasing the income of farmers in rural areas.

## CONCLUSIONS

One of the main global challenges is how to ensure food security and sustainable development for a growing world population. In this context, it has become important for the public and the private sectors to take into consideration interventions that aim to reduce post-harvest losses.

In Timor-Leste, the agriculture sector is one of the priority sectors named in the Strategic Development Plan 2011–2030. Since its independence, Timor-Leste has invested significantly in agricultural infrastructure, machinery and the provision of subsidd seeds and fertilizers. Policies and regulations regarding water and irrigation, the use of seeds and fertilizers, land use and management, and the use of pesticides, are being developed. In addition, from 2007 to 2009, a number of hand tractors, rice-milling equipment and storage facilities were introduced. Programmes included the rehabilitation of irrigation schemes. However, little attention was given to post-harvest losses, in particular in the maize subsectors.

Maize contributes significantly to the attainment of food and nutrition security in Timor-Leste. A large number of households depend on

TABLE 1.17
**Summary tables of maize losses, causes and solutions**

| Critical loss point | Magnitude of losses in the FSC | | | Cause of loss | Intervention to reduce loss | Loss reduction | | Cost of intervention (USD) per year |
|---|---|---|---|---|---|---|---|---|
| | Percentage | Weight (kg) | USD | | | Percentage | USD/year | |
| Harvesting | 5.5 | 7 750 | 3 500 | Lack of labour, lack of equipment, rain during harvest, harvesting of wet grain | Introduction of some harvesting equipment in combination with dehusking machines in the maize potential areas | 94.5 | 3 300 | 2 500 |
| Drying | 2.5 | 3 300 | 1 480 | Lack of drying equipment and rainfall during drying | Introduction of new and proper drying facilities | 60 | 890 | - |
| Farm Storage | 2.5 | 3 160 | 1 420 | Lack of storage facilities, use traditional methods, and lack of labour | Introduction of adequate storage facilities and more training of farmers on storage management | 75 | 1 065 | 2 000 |

*Source:* authors' research

the production of maize for household consumption and for a small income. However, poor quality and high post-harvest losses are a major challenge faced by farmers and other actors in the traditional maize chains. This study provides indicative quantitative data of food losses and examines the main causes of these losses, as well as analyses the causes in order to reduce them.

The study shows that losses in the maize supply chains in the study site occur at all stages in the chain. In the maize supply chain, CLPs are the stages of harvesting (5.5 percent), drying (2 percent) and farm storage (2.5 percent).

The main causes of losses identified in the maize supply chains include the shortage of labour, lack of equipment, waterlogged conditions, rain during harvesting, manual harvesting practices, lack of expertise in machinery set-up, lack of storage and drying facilities and poor management, among others.

To reduce these losses, a number of measures have been recommended:

- introduction of harvesting machines in the maize potential areas;
- increasing the number of threshers to reduce the long waiting period for threshing;
- improving storage facilities through the introduction of silos and drums to replace local storage facilities;
- provision of training and assistance to improve the skills and knowledge of operators of milling and threshing machines;
- provision of training to farmers in the areas of harvesting, post-harvesting, handling and storage;
- introduction of new and adequate drying facilities; and
- raising awareness through the dissemination of information about maize losses from harvesting to processing.

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# Factors contributing to losses in the maize supply chains in the district of Lospalos

| Form of loss at different stages | Percentage of respondents who say yes to each form of loss | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mould | Cracking | Broken | Pests/ weevils | Discoloration | Rats | Dirt | Spoilage | Birds | Germination |
| Harvesting | 63 | 7 | - | 29 | 9 | 75 | 10 | 19 | 45 | 19 |
| Homestead transfer | - | - | - | - | 3.8 | - | - | 96.2 | - | - |
| Dehusking | 4.5 | - | 36 | 6.7 | 10.1 | - | 3.4 | 41.6 | 1.1 | 2.2 |
| Shelling | 3.6 | 1.2 | 36 | 1.2 | 2.3 | - | 2.3 | 62.8 | - | - |
| Drying | - | 1 | - | - | - | - | - | 4.1 | 97.9 | - |
| Cleaning | - | - | - | - | - | - | - | - | - | - |
| Pounding/milling | - | 1 | 22.9 | - | 7.2 | - | 1.2 | 73.5 | - | - |
| Packaging | - | - | - | - | 5.9 | - | - | 70.6 | - | - |
| Storage | 12.9 | 3.2 | - | 29 | 9.7 | 9.7 | - | 45.2 | 25.8 | - |
| Loading | - | - | - | - | - | - | - | 100 | - | - |
| Off-loading | - | - | - | - | - | - | - | 100 | - | - |
| Transportation | - | 2.7 | - | - | 2.7 | - | 2.7 | 94.6 | - | - |

# Percentage of respondents who stated yes to the reasons for the maize damage/lost according to each supply chain

| Form of loss at different stages | Form of loss - percentage yes | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lack of labour | Water logged crop | Harvesting wet grain | Harvesting immature grain | Raining during harvesting | Use of traditional practices | Lack of equipment | Poor homestead transport | Lack of drying facilities | Poorly set machine | Lack of packaging | Lack of storage | Poor roads |
| Harvesting | 64 | 32 | 20 | 3 | 56 | 25 | 13 | - | - | - | 1 | - | - |
| Homestead Tranfer | 13 | - | - | - | - | 7.7 | 15 | 23.1 | - | - | 43.6 | - | 2.6 |
| Dehusking | 14 | 10 | 2.2 | 1.1 | 9 | 57 | 9 | 1.1 | - | - | - | 1.1 | - |
| Shelling | - | - | 2.3 | 3.5 | 1.2 | 72 | 20 | 1.2 | - | 1.2 | - | 1.2 | - |
| Drying | 72 | - | - | - | - | 1 | 4.1 | - | 56.7 | | - | - | - |
| Cleaning | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pounding/ milling | - | - | - | 1.2 | - | 15 | 17 | 1.2 | 1.2 | 69 | 1.2 | - | - |
| Packaging | - | - | - | - | - | - | - | - | - | - | 94.1 | - | - |
| Storage | 29 | - | - | - | - | 6.5 | 19 | - | - | - | 38.7 | - | - |
| Loading | - | - | - | - | - | - | - | 33.3 | - | 67 | - | - | 22.2 |
| Off-loading | 13 | - | - | - | - | - | - | 25 | - | - | 688 | - | 18.8 |
| Transportation | - | - | - | - | - | 2.7 | 8.1 | 29.7 | - | - | 16.2 | - | 48.6 |

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