Baseline Study of Postharvest Loss of Selected Crops in Two Districts of the Morogoro Region of Tanzania

Project Report

February 2023

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This project was funded by the Institute for Sustainable Food, the University of Sheffield.

Executive Summary

In this report we present the results of a baseline study investigating the reasons for postharvest loss (PHL) for three perishable/semi-perishable crops (onion, tomato and sweet potato) produced in the Morogoro region of Tanzania, one of the leading perishable crop production regions in the country.

The aim of the baseline study was to assess post-harvest loss at various stages of the food production cycle (harvesting, transportation, storage, processing and handling), its causes, the available technology, information and knowledge sources applied, and to envisage solutions to mitigate these losses.

The study was conducted in three villages, Malolo and Dumila in Kilosa district, and Ihenje in Gairo district, all located in Morogoro, Tanzania. The study used both qualitative and quantitative approaches to collect data. Data were collected in September - October 2021 by using a combination of different methods, concurrently: a structured questionnaire, observations and interviews.

A brief summary of the results of the study is given here:

Main Findings Related to the Farmers

- Most farmers were from Kilosa, were male and evenly distributed between the ages of 20 to 59, with between 1 to 5 dependents.
- They had mostly been educated only to primary school level.
- In general, farmers had very small amounts of land (between half an acre to 2.4 acres), but mostly owned the land they farmed.

Main Findings Related to the Crops Grown

- All the crops were grown primarily for income rather than for consumption.
- Yields for onion and sweet potato crops varied in proportion to the size of the farm.
- Tomato crop yields in Kilosa varied regardless of farm land acreage.
- Nearly all crops were sold at the farm rather than at a market.

Main Findings Related to Postharvest Loss

- The perceived reasons for loss differed depending on the crop.
- For all crops, loss was mainly reported during harvesting and transportation, caused by various reasons, but for onions loss occurred mainly during storage due to poor storage facilities.
- Crops were primarily harvested by hand, except for sweet potatoes for which the hand hoe was commonly used.
- Transportation was mainly through head-carrying and by motorcycle. A small amount of loss during transportation was common across the crops.
- Storage spaces were hardly used for tomato and sweet potato crops, but commonly used for onions.
- Onions were stored in traditional huts which are known as “Vihenge” for a long period of time (mostly between 2 to 3 months).
- Thus, for onions, wastage/food loss also commonly occurred during storage.

- Poor storage facilities and spoilage were the top reasons reported for loss, which were statistically associated.
- Food processing was rarely used for any type of crop.

Knowledge of crop production and ICT use:

- Participants were only moderately confident about their harvesting and handling techniques and lacked confidence in storage techniques.
- The current ICTs in use were mainly for point-to-point communication and information, such as text-based use of mobile phones and radio. The participants appeared to have a low level of ICT use for farm business.
- No Internet use was reported, yet some have adopted smartphones.
- Participants reported low levels of confidence in ICT skills, yet were willing to adopt them.
- Participants reported learning farming techniques mostly from observing others.

Overall assessment of the postharvest loss situation:

- Farmers are caught in a vicious cycle of continuous harvest/postharvest loss leading to poor profits and the inability to invest in innovations or improved techniques or farming inputs.
- The issue is complicated by lack of bargaining power caused by lack of knowledge of the market, poor storage, transportation and handling facilities caused by lack of investment and dependence on middlemen who themselves are trying to make a profit out of goods that have a short shelf life and are seasonal.
- Their need to engage in a market economy for the production and sale of their produce places them in a supply chain which is hampered by lack of control over a key part of that chain: controlled storage of the product.
- The farmers are engaging with this market economy using tools and techniques more suitable for subsistence farming, but which are not scalable.
- Ideally, to be successful, farmers would have access to relevant information and knowledge sources and technological solutions that would support their engagement in this kind of market, but these kinds of solutions are alien to the culture and existing practices of the farmers.

Recommendations of the Baseline Study

1. The innovations needed for technological solutions to the issues identified in the baseline study need to be quite localised and to have buy-in from the farmers.
2. There need to be efforts to provide the farmers with support to transition from traditional subsistence methods to more commercialised ones.
3. There needs to be a plan to provide supporting institutions and infrastructures around the food production system.
4. There is also the need to address structural inequalities that keep farmers in a persistent state of poverty.
5. There should be a movement towards balancing indigenous and ”improved” practices in the farming community.

Introduction

The baseline study investigated the reasons for postharvest loss (PHL) for three perishable/semi-perishable crops (tomato, sweet potato and onion) produced in the Morogoro region of Tanzania, one of the leading perishable crop production regions in the country.

The aim of the baseline study was to assess post-harvest loss at various stages of the food production cycle (harvesting, transportation, storage, processing and handling), its causes, the available technology applied and to envisage technological solutions to mitigate the loss.

The study was undertaken by a collaborative team of researchers from the Department of Geography and Environmental Studies at The University of Dodoma in Tanzania, and the Information School and the Institute of Sustainable Food at the University of Sheffield in the United Kingdom.

The study was conducted in three villages, Malolo and Dumila in Kilosa district, and Ihenje in Gairo district, all located in Morogoro, Tanzania. These three villages were selected in consultation with the Morogoro region agricultural officer. There was a regional difference/focus in the type of crop grown per district, with an emphasis on onion and tomato in Kilosa and sweet potato in Gairo. Malolo village (Kilosa) is famous for onion production, mainly as a cash crop supplying 80% of onion farmers' income. Dumila (Kilosa) produces many types of vegetables including tomatoes, onions, spinach, okras and others. Tomatoes are also mainly produced as a cash crop in Dumila. Sweet potatoes are a main cash crop in Ihenje village (Gairo).

A survey was conducted with a total of 114 respondents, which is 11% of the total households in that area. In addition to the survey, 7 face to face key informant interviews were conducted with ward executive officers and agricultural extension officers. Twenty middlemen, i.e., individuals whose task is to connect farmers to markets, were interviewed using mobile phones. Three field observations were made. The data collection took place between September and October 2021.

Socio-demographic details:

- Farming activity in the surveyed districts is dominated by males (>=63%) in all three villages compared to females, the percentage of which ranges from 23% to 37%.
- Male farmers can hire farm plots, more often than women. 4% more male than female farmers hired the farm used for farming activities.
- In all 3 villages, the majority of the farmers (90%) own farm sizes ranging from half an acre to 2.4 acres (Table 2), reflecting the level of poverty existing among farmers in the study area.
- Only a few farmers own farm size between 2- 4.5 acres and only 3% of farmers in Dumila village own above 5 acres, while in all villages few farmers own above five plots.

Table 1: Basic demographic data in percentage

Demographic Data		Kilosa		Gairo
		Malolo (%)	Dumila (%)	Ihenje (%)
Age	18-28	9	11	23
	29-39	38	35	30
	40-50	24	35	26
	51+	29	20	31
Education	Informal	12	24	21
	Primary	71	57	63
	Secondary	18	19	14
	Tertiary	-	-	2
Sex	Male	77	70	63
	Female	23	30	37
Farm size in acres	0.5-2.4	100	92	93
	2.5-4.5	-	5	7
	5+	-	3	-
Number of dependants	1	9	8	7
	2-5	71	70	70
	6+	21	22	23
Number of plots in acres	1-2.5	73	89	81
	3-4.5	21	8	14
	5+	6	3	5
Farm ownership	Head of household	54	50	88
	Respondents Landlord	43	47	9
	Both	3	3	3

Baseline Study Results

Postharvest Loss - Onion

Summary of Findings

- All respondents growing onions (n=33) were growing the crop for sale, while just under half (16) were also growing it for consumption.
- All onion farmers were located in Kilosa district.
- **Harvesting:**
    - Onions were mainly harvested by hand (100%), with knives also used as tools on occasion (17%)
    - ‘Damage by harvesting’ was reported as the main cause of food loss for onions.
- **Transportation:**
    - During transportation, a small quantity of crop loss was experienced by half of the respondents.
    - The main reasons for crop loss during transportation were poor skills in packing and poor material for packing.

- **Storage:**
    - Most respondents (~80%) used storage facilities for their onions but in varying amounts: 23% stored a small amount, 26% stored more, but less than half of their crop after transportation, 14% chose to store more than half, and 17% stored all their onions.
    - Onions were mostly stored for a period between 2 to 3 months.
    - Traditional huts “Vihenge” were the main storage facilities for onion storage.
    - Nearly half of the respondents lost close to half of their stored crop, while 30% lost a small amount.
    - The top 3 reasons for loss during storage include poor storage facilities (77%), spoilage (68%) and low technology (55%).
    - There is a statistically significant relationship between spoilage and poor storage facilities, i.e., spoilage is likely to be occurring due to poor storage.
- **Processing and Handling:**
    - There were no notable findings related to processing and handling of onions from respondents

Postharvest Loss - Sweet Potato

Summary of Findings

- All respondents growing sweet potatoes (n=51) were growing the crop for sale, while just over four-fifths (44) were also growing them for consumption.
- **Harvesting:**
    - Sweet potatoes were mainly harvested by hand hoe (85%) and by hand (33%), with some farmers also using both techniques.
    - Nearly all the respondents reported some amount of loss during harvesting with the main reasons being ‘damage when harvesting’ (76%), ‘delay in harvesting’ (45%) and ‘weather’ (29%).
- **Transportation:**
    - A small amount of crop loss was reported by around two-fifths of the respondents during this stage.
    - The top three reasons for crop loss during transportation were poor transportation (mainly motorcycles and head-carrying), poor packing and packing material (mainly sacks).
- **Storage:**
    - Only a few respondents (8%) used storage for a small amount of sweet potatoes after transportation.
    - The main storage method used was a pit
    - Other respondents (16%) stated a preference for delaying harvesting as an alternative to storage.
    - The quality of sweet potatoes stored in this way was judged to be inferior with poor appearance and change in colour being noted as poor quality attributes.
    - Crop loss was not significant during this stage.
    - Where loss did occur, the top reasons were attributed to insects/pests, spoilage, poor storage facilities and low technology.

- **Processing and Handling**
    - A few respondents (n=5) reported processing a small amount of sweet potatoes after storage.
    - Any loss during this stage was attributed mainly to ‘insufficient skills’, lack of appropriate processing technologies and inadequate facilities.
    - There were no notable findings related to handling of sweet potatoes from the respondents
- **Market**
    - The majority of the respondents sold their crop at the farm (86%) while the rest were at the market (14%)

Postharvest Loss - Tomato

Summary of Findings

- All respondents growing tomatoes (n=40) were growing the crop for sale, while just a little over a third (14) were also growing them for consumption.
- Tomato farmers were primarily located in Kilosa
- **Harvesting:**
    - Tomatoes were only harvested by hand (100%), with no one reporting using other tools during the harvesting
    - Over 90% of the respondents reported some loss during harvesting with the main reason being ‘weather’ (77.27%), ‘delay in harvesting’ (56.82%), and ‘damage when harvesting’ (55.27%).
- **Transportation:**
    - During transportation, small quantities of crop loss were experienced by more than half of the respondents.
    - The top three reasons for crop loss during transportation were poor transportation, poor packing and weather.
- **Storage:**
    - Only one respondent used storage facilities for their tomatoes after transportation
    - Spoilage and poor storage facilities were reported as a top reason for crop loss during storage
- **Processing and Handling:**
    - Only one respondent reported processing tomatoes after storage
    - Any loss during this stage was attributed mainly to ‘insufficient skills’ and ‘lack of appropriate processing technologies’
    - There were no notable findings related to handling of tomatoes from respondents

Comparisons across crops

- While onion and sweet potato yields are comparable to the size of the farms, tomato yields tend to vary considerably from farm to farm for reasons unknown.

- The figures below illustrate the differences in loss at the harvesting and transportation stages for the 3 crops. There is some variation across crops depending on the stage.

Figure 1

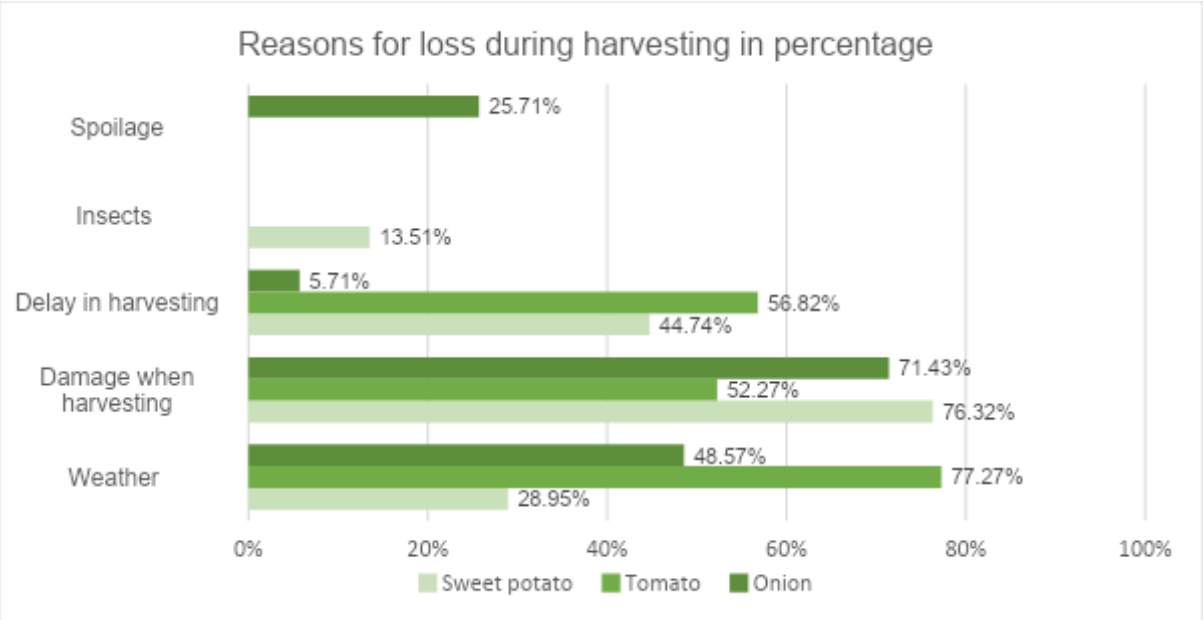
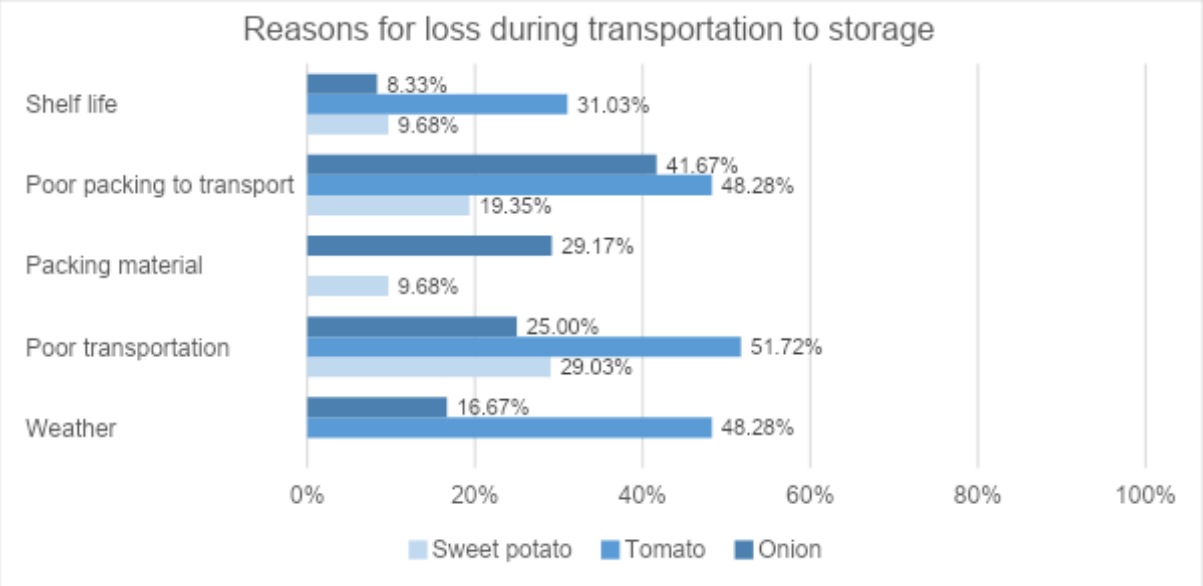


Figure 2



Postharvest Loss - Current Technology/Innovation Solutions

- Storage
  - Currently farmers' storage solutions consist of either a traditional or modified Kihenge for the storage of onions.

    - Issues connected with the use of the Kihenge include poor ventilation, lack of partitions to separate onions and tin roofs which cause overheating.
    - Innovations being considered are alternative roofing material, elevation of the Kihenge from the ground, ventilated partitions.
    - Alternatives to the Kihenge being considered are charcoal coolers or refrigeration. The former are being piloted but their installation is stalled, and the latter are thought to be too expensive to implement in current conditions.
    - Sweet potatoes were stored in a pit, but degradation of the potato is evident after some time.
    - No storage technology is in place for tomatoes.
    - No information technology solutions are currently available to address postharvest storage for any crop.
- Other parts of the food production cycle:
    - In general, as shown in Figures 1 and 2 loss also occurs at the harvesting and transportation stages.
    - In both cases fairly rudimentary means of handling, harvesting and transportation are used with packing material and conditions of transportation leading to losses
    - No information technology solutions are currently available to address these issues at these stages of the food production cycle.

Postharvest Loss - Current Information/Knowledge Sources

- Farmers rely on observations and word of mouth from each other to carry out their farming activities.
- The farmers do not benefit from knowledge disseminated by research institutions in the country.
- Farmers do not have access to market information, i.e., either prices of their products or buyer information.
- Farmers depend on intermediaries to provide them with needed information, e.g., information about improved seeds comes through the Ward office; information about buyers, the weight of their goods, the price of the products comes through middlemen
- Farmers also depend on practical experience gained from techniques that have been used over the years in farming, which they trust.
- There are no known technologies involved in the dissemination of information or knowledge related to farming activities.

Proposed Solutions and Evaluations

Technology & Information-based Solutions

- **Technology based solutions:**
    1. Improved storage technologies such as more efficient construction innovations to the existing traditional Kihenge
        - Advantages:

        - Since this is an incremental innovation, it would be fairly easy to implement.
        - More efficient storage would mean a longer shelf life for the onions and consequently better market value
    - Disadvantages:
        - Farmers may not be able to bear the cost of making these changes to the existing Kihenge
        - These changes may result in only incremental increases in the storage life of the onion

    2. Alternative storage technologies such as charcoal coolers or refrigeration can be considered as alternatives to the Kihenge or as solutions for those crops not already stored
    - Advantages:
        - Longer shelf-life for the products means better bargaining power for the farmer in negotiating prices for their products on a longer-term basis.
    - Disadvantages:
        - Sustainability problems:
            - Lack of capital or knowledge in resourcing the alternative storage facilities or in maintaining them may cause breakdowns.
            - Lack of reliable, sustainable or cost-efficient electricity supply to power refrigeration.

- **Information Technology based solutions**

    1. Use of sensor technologies and mobile phone networks to monitor and report on key indicators of storage efficiency in the traditional storage facilities, e.g., Kihenge or pits.
    - Advantages:
        - Monitoring of the efficiency of the storage facilities can be done in real time.
        - This information can be used as inputs into decision making about new technologies for storage.
        - The data can be used to compare across different sites to determine what works or doesn't work according to the specifics of that site.
    - Disadvantages:
        - Complex technological solution that may not be sustainable or scalable.
        - May be costly in terms of the materials and human resources needed to maintain it.
        - May need to address significant training needs in digital literacy.

    2. Connecting farmers to buyers through online markets via mobile phones
    - Advantages:
        - Allows farmers to discover their market price more effectively

        - Farmers can build up buyer networks more efficiently
    - Disadvantages:
        - May need to address significant training needs in digital and information literacy.

3. Connecting farmers to farming information to improve their farming activities through mobile applications, e.g., text-based SMS services or interactive voice recognition (IVR).
    - Advantages:
        - Farmers can get first-hand information about improved technologies, techniques, farming inputs etc.
    - Disadvantages:
        - May suffer issues with uptake since farmers already use informal word-of-mount information sources
        - May need to address training needs in digital and information literacy.
        - Needs investment in resources to 'push' information out to the farming community.

Process-based Solutions

- Introducing farmers' cooperatives or supporting lead farmers in organising others to pool resources aimed at any of the issues identified above, e.g., to collectively invest in improved storage techniques or to collectively bargain with middlemen over access to markets and price information.
    - Opportunity: current collective irrigation techniques could provide a model of how this could work.
    - Challenge: since this is not currently part of the culture of how farmers work in this region, it may be difficult to introduce and implement such a solution.
- Strengthen formal and informal institutions around postharvest techniques and processes, e.g., regulating and formalising the middlemen role and providing transparency into the process by which they broker market relations for farmers, or providing resources for farmers to meet, observe and transfer knowledge about farming techniques that work.
    - Opportunity: current systems in place, although not very efficient, provide a scaffolding for more institutionalised processes, e.g., middlemen working on behalf of ward extension offices.
    - Challenge: managing the competing interests of farmers and middlemen in these kinds of processes would be difficult to achieve.

Recommendations

- **The innovations needed for technological solutions to the issues identified in the baseline study need to be quite localised and to have buy-in from the farmers.** The study reveals that farmers trust what they observe to be working in practice and have long-established traditions of information/knowledge sharing from generation to generation and from peer to peer. These current cultural practices around information and knowledge sharing need to be leveraged in order to ensure

sustainability. Since farmers already share practices by word of mouth, observations and so forth, they are more likely to trust solutions where they see evidence of them working and to trust the testimony of their peers as to the efficacy of solutions. Learning by observation and by doing are also inherent when considering this recommendation.

- **There need to be efforts to provide the farmers with support to transition from traditional subsistence methods to more commercialised ones.** All the crops covered in this baseline study are produced mainly for profit, however, the methods and techniques currently in use are not wholly aligned to a commercialised model of food production, hence farmers will need some support to make that transition from subsistence to commercialised farming. This support can take the form of capacity-building around markets and pricing to enable them to take control of the markets for their produce, for example. This recommendation comes with the expectation of new methods and technologies being introduced and learnt by the farmers as well, however, please note the caveats mentioned above about introducing technological solutions into this context.
- **There needs to be a plan to provide supporting institutions and infrastructures around the food production system.** The baseline study identified middlemen as one of these institutions, with both formal and informal elements. Ward offices and extension services as well as agricultural research institutions currently also provide formal services which could be strengthened. For example, it may be advisable to establish a system that will hold local authorities such as regional and or/district agricultural officers accountable for farmers' concerns i.e., access to information on inputs and new farming technologies.
- **There is also the need to address structural inequalities that keep farmers in a persistent state of poverty.** The baseline study revealed low levels of education, land ownership, capital, technical knowledge and gender disparities in distribution of resources. These structural inequalities help to maintain the vicious cycle of lack of investment in new technologies and knowledge which exacerbates the postharvest loss situation which leads to further loss of capital. It also suggests that transitioning from subsistence to commercialised farming would be further hampered by maintaining the status quo. Pathways to realising this recommendation mainly lie in developing policy interventions targeting issues such as land ownership, funding and other resourcing issues.
- **There should be a movement towards balancing indigenous and “improved” practices in the farming community.** Too often the language of the key informants suggests that traditional practices result from a lack of formal training/knowledge thus suggesting that these practices hold a lower status than those that might be introduced from external sources. Farmers in this baseline study tend to trust what works, hence the emphasis around learning from research and traditional practice should be to determine what works and why it works before incorporating any practice as an established way of working.