Food and Agriculture Organization of the United Nations

ETHIOPIAN STATISTICS SERVICE

REPORT ON OFF-FARM POST-HARVEST LOSS ASSESSMENT SURVEY IN ETHIOPIA

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Abstract

A study on post-harvest losses was conducted in Amhara, Oromiya and the Southern Nations, Nationalities and Peoples Region of Ethiopia to pilot a methodology to produce national statistics of off-farm losses. The study was conducted by Ethiopian Statistics Service (ESS), with technical and financial support from the Office of the Chief Statistician and the Statistics Division of the Food and Agriculture Organization of the United Nations (FAO). The study aimed at strengthening the capacity of ESS in generating reliable estimates on post-harvest losses. A questionnaire was developed for computer-assisted personal interviewing (CAPI) quantitative data collection. Data was collected withthe Census and Surveys Processing System (CSPro) software and tabulated using Statistical Package for Social Sciences (SPSS) and analysed using Microsoft Excel. Among the main findings, the study shows that a numberof the traders (retailers/assemblers, wholesalers, unions, cooperatives, processors) are involved in selling commodities like maize, wheat, horse beans, and haricot beans as important economic activities. Of paramount importance from the study is the finding that storage losses varied according regions, crops, types of traders and storage infrastructure. Due to relatively moderate sample size and some other statistical limitations, it was not confirmed whether those variations were due to chance or were statistically significant. From this pilot assessment of off-farm post-harvest losses, it is recommended that baseline data be established based on replication of the survey at a larger scale. It is also recommended that the survey be integrated to the extent possible into the existing national-wide data collection systems such as the agricultural production estimates survey to ensure low operational costs and sustainability.

Abbreviations and acronyms

CAPI	computer-assisted personal interviewing
CSA	Central Statistics Agency
CSPro	Census and Surveys Processing System
E.C	Ethiopian calendar
FAO	Food and Agriculture Organization of the United Nations
ESS	Ethiopian Statistics Service
PHL	post-harvest losses
SPSS	statistical package for social sciences

PART 1. INTRODUCTION

1.1 Background

The Ethiopian Statistics Service (ESS) of Ethiopia produces official statistics, which are paramount for the country policy monitoring and formulation. The Central Statistics Agency (CSA) has been producing agriculture related data in a multi- manner for about four decades, but still there is a data gap for pre- and post-harvest food losses. The national ten-year perspective development plan (July 2020 to 2030) urges to fill the data gap regarding food losses. This will enable it to line up with the Sustainable Development Goals. ESS had planned to conduct a post-harvest loss pilot survey which can be categorized in to two broad parts: i) the on-farm and ii) off-farm post-harvest loss. To do this a pilot survey work team was formed within the ESS to start the preparatory work. Ethiopia is one of the countries that benefitted from the technical support on post-harvest losses from the Office of the Chief Statistician and the Statistics Division of the Food and Agricultural Organization of the United Nations (FAO). Ethiopia requested the technical support to test a reliable methodological approach for estimating post-harvest losses. The technical support focused on improving capacity of the country in designing, compiling and analysing on-farm and off-farm post-harvest losses estimates based on a comprehensive and statistically sound methodology for generating reliable statistics on food losses. Ethiopia requires reliable statistics on post-harvest losses. The estimates are useful for monitoring the outcomes of the important investments aimed at reducing post-harvest losses in the country. The figures also help the government to come up with a discounting factor for crop production estimates. The statistics are therefore crucial in terms of providing net crop production figures for accuracy in the estimation of domestic food gap, gross domestic product and related official statistics. Ethiopia has been conducting annual agriculture surveys on regular basis for the last 30 years. However, previous studies never attempted to cover measuring food losses at national level covering the entire food supply chain. The reported loss figures thus far were based on small-scale research based studies. The new methodology focused on losses for various crops from harvesting to storage, and off-farm as well. The inclusion of physical measurements was also to provide results of better accuracy in quantifying post-harvest losses.

The technical support project on post-harvest losses (PHL) was provided to Ethiopia from April 2021 to March 2022 as part of strengthening collaboration at national level, the project was implemented jointly with the Central Statistics Service and Ministry of Agriculture, FAO-Ethiopia, the Office of the Chief Statistician and the Statistics Division of the FAO which also formed the technical team in charge of overseeing the effective implementation of the survey while at the same time ensuring that the results are reliable and accurate.

During the early stages of the pilot survey preparations, the well-organized FAO guideline on post-harvest loss assessment, was shared. Through the use of the guideline and completing with thorough discussions, the critical loss points and actors of the post-harvest loss processes were clarified for the Ethiopian context.

The decision was then made to conduct the pilot surveys for both the on-farm and off-farm post-harvest losses. Under the given arrangements, FAO would provide technical, logistical, and financial resources to carry out the off-farm component while the CSA would cater for the on-farm one and making use of FAO technical advice as well.

1.2 Objectives

The objectives of the assessment were to:

- Estimate the extent of post-harvest losses and some potential factors causing them at three PHL stages (storage, transaction, processing) on the four crops (maize, wheat, horse bean, haricot bean).
- Contrast subjective estimates of losses with objective methods.
- Map key supply chain actors (retailers/assemblers, wholesalers, unions, cooperatives, processors) of the PHL sector with indications of their respective roles; and
- Develop post-harvest loss measurement expertise to be used at larger scale in short, medium and long term.

1.3 Basic concepts/definitions

1. ***Crop:*** includes cereals, pulses, oilseeds, vegetables, root crops, fruits, coffee, inset, chat, hops, sugarcane, cotton, tobacco, produced for food, making drinks, stimulation, making fabrics or clothing, etc.

2. ***Crop production:*** the process of growing and harvesting of the above crops for own consumption and/or sale.

3. ***Direct (or quantitative) loss:*** The disappearance of food by spillage or consumption by rodents, birds, insects and other pests. It is measured as the loss in weight of commodities that would have been eaten if they had remained in the food chain. Losses can be the result of grain damage, which is characterized by superficial evidence of deterioration (for example, holed or broken grains). Weight losses are generally presented in two ways: (i) the actual weight of grain lost (an absolute loss, in kg or any other relevant physical unit); or (ii) as a percentage or proportion of a reference quantity, such as harvested quantities (relative loss). Finally, losses should be expressed for a given moisture content, which may vary depending on the crops. Indeed, weight reduction due to a decrease in moisture content, for example during drying, should not be accounted for as weight loss. These surveys focus on direct losses.

4. ***Economic losses:*** The monetary equivalent of direct or qualitative losses. For direct losses, the economic loss can be estimated by multiplying the lost quantities by the market price for the commodity. For qualitative losses, such as a stock of grain that contains a higher proportion of broken kernels, the loss corresponds to

the difference between the market price of first-quality grain (or the quality level that can usually be expectedby the farmer) and the price corresponding to the actual quality level, multiplied by the quantities produced.

5. ***Food loss:*** The measurable decrease in the quantity or quality of food produce. It is the result of any reduction in the availability of food or in the edibility, wholesomeness, or quality of food that reduces its value to humans. Food loss is considered as the unintended result of an agricultural process or technical limitation in storage, infrastructure, packaging or marketing (World Resource Institute, 2013). Food losses are often classified as direct or indirect.

6. ***Food waste:*** Term referring to food that is fit for human consumption but that is discarded either before or after it spoils. Hence, food waste is the result of negligence or a conscious decision to throw food away.

7. ***Harvest:*** The deliberate act of separating the food material from the site of immediate growth or production, for instance the reaping of cereals, the picking of fruits, the lifting of fish from water, etc.

8. ***Harvest losses:*** These occur during the harvesting process and may be due to shattering, mechanical damage and shedding of the grain from the ears to the ground.

9. ***Indirect (or qualitative or nutritional) losses:*** The loss caused by a lowering of quality leading to its rejection as food, of its nutritional value or of its economic value, these three aspects being interrelated. The quality of a food commodity can be assessed against criteria such as appearance, shape, size, and sometimes, smell and flavour. The assessment of nutritional losses (a type of qualitative loss) generally requires in-depth laboratory analysis. Nutrient losses may be due to selective feeding by pests, which targets the most nutritious parts of grains. Qualitative losses, although relevant, will not be treated in these surveys.

10. ***Meher (main) season crop:*** any temporary crop harvested between the months of Meskerm (September) and Yekatit (February) is considered as meher season crop, in most cases crops those planted during the major rainy season.

11. ***Pre-harvest:*** The period between the planting and the harvest of the crop.

12. ***Pre-harvest losses:*** Losses that occur before the beginning of the harvesting process and that may be due to attacks by insects, mites, rodents, birds, weeds, or diseases afflicting and damaging crops.

13. ***Post-harvest:*** The period beginning after separation from the site of immediate growth or production and ending when the food reaches its final use.

14. ***Post-harvest losses (PHL):*** Any losses occurring after the separation of the product from the site of immediate growth (harvest) to the moment it reaches the consumer.

15. ***Post-production losses:*** The combination of harvest losses and PHL.

16. ***Storage losses:*** Losses that occurred during the crop product is at a storage facility.

17. ***Transport losses:*** Losses that occurs during transporting the product from farm to storage.

18. Traditional storage:

Traditional type of storage facilities are the most commonly used facilities by smallholder farmers and there different types of this storage facilities mostly made of local inputs by the farmers. It can be any of the following:

- **Aerial storage:** Maize cobs, sorghum or millet panicles are sometimes tied in bundles, which are then suspended from tree branches, posts, or tight lines, on or inside the house
- **Underground storage:** are usually cylindrical, spherical or aspheric in shape; this method of storage is used in dry regions where the water table does not endanger the contents.
- **Jars:** These are large clay receptacles whose shape and capacity vary from place to place. The upper part is narrow and is closed with a flat stone or a clay lid: which is sealed in position with clay or other suitable material.
- **Calabashes, gourds, and earthenware pots:** These small capacity containers are most commonly used for storing seed and pulse grains, such as cowpeas. Having a small opening, they can be made hermetic, by sealing the walls inside and out with liquid clay and closing the mouth with stiff clay, cow dung, or a wooden (cork) dung reinforced with cloth.
- **Storage baskets (cribs) made exclusively of plant materials:** Basically similar to the outdoor type of platform described above, in all its variations, the traditional crib differs in always having a roof and wall(s). It may even be elevated at least one metre above ground level, with a fire maintained underneath to assist drying of the contents and, allegedly, to reduce insect infestation.
- **Open timber platforms:** A platform consists essentially of a number of relatively straight poles laid horizontally on a series of upright posts. They are usually rectangular in circular or polygonal platforms in shape.

19. **Modern storage facilities:** These storage types are mainly used by government, non-governmental organizations or private institutions, where a large amount of grains are stored and it is controlled for environmental factors like temperature, humidity moisture and so on. It is usually prepared with the help of subject matter experts.

1.4 Scope/coverage

Administratively, Ethiopia is divided into four levels: regions, zones, Woredas (districts) and Kebele (wards). The country comprises of 11 regions and two city administrations under these regions,plenty of Zones, Woredas and neighbourhood administration: Kebeles. In addition to the nine federal states within the country, there are two federal-level city administrations in Addis Ababa and Dire Dawa.

This pilot survey assessment covered the regions of Amhara, Oromia, and Southern Nations, Nationalities and Peoples Region. The aim was to produce enough data at the regional level for each of thosethree regions. The sample was based on available resources and just large enough to provide reasonable estimates ofa number of important characteristics.

Broadly speaking in terms of scope, the subject-matter content was defined as follows:

Losses during storage (by inquiry):

- type of trader
- crop/commodity handled
- type of storage
- amount stored
- quantity lost
- causes of losses

Losses during storage (by measurement):

- type of trader
- crop/commodity handled
- type of storage
- moisture content
- damaged grains characteristics
- undamaged grains characteristics
- storage duration
- causes of losses

Losses during transaction (by inquiry):

- type of trader
- crop/commodity handled
- type of storage
- amount of sales during transactions
- quantity lost during transactions
- causes of loss

1.5 Methodology and activities undertaken

Data was collected from 32 Woredas in 15 zones and three regions. Within the selected Woredas, 32 localities/towns/markets were selected and finally traders from those markets were listed and interviewed par especially trained enumerators. For this PHL assessment pilot survey, the sample consisted of the following structure:

	Category	Number
1	Regions	3
2	Zones	15
3	Woredas	32
4	Localities/markets (one per Woreda)	32
5	Retailers (8 per Market by inquiry)	256
6	Retailers (two per market by observation)	64
7	Wholesalers (four per market by osgry)	128
8	Wholesalers (two per market by observation)	64
9	Unions (one per Woreda by observation)	32
10	Cooperatives (one per Woreda by observation)	32
11	Processors (one per region by inquiry)	3
12	Number of field work days (two visits for two weeks)	18

The organization of fieldwork operation was coordinated between the head office and the eight (8) statistical branch offices found in the three regions in which the pilot survey was conducted. But due to the current security issues happening in the northern parts of the country two (2) branches could not be covered during this the pilot survey. To keep the sample size good enough the two-branch office sample were reallocated to Baherdar within the same region. All the eight branch offices took part in recruiting the enumerators and supervisors, preparing and sending field staff for training, assigning the field staff to their sites of enumeration, supervising the data collection, and the electronic data transfer.

The branch offices were also responsible for administering the financial and logistic aspects of the survey within their areas of operation. A total of 33 enumerators, 10 field supervisors and seven statisticians/experts were involved in the data collection and supervision in the branch offices. On average, one supervisor was assigned to three enumeration areas (Markets) for supervision of the data collection operations. All the enumerators were provided with the necessary survey equipment (data collection tablets, moisture meters, sampling spears, weighing scales, etc.) to ensure smooth operation of the pilot survey. To facilitate the data collection activities, a total of eleven (11) rented four-wheel drive vehicles were used.

The proper execution of a survey with a view to maintain good quality data , highly depends on the type of training given to the enumerators and supervisors and the consequent understanding of the tasks to be performed and the standard procedures to be followed by them during the survey operations. Quality and completeness of data are ensured when the training meets its objective of ending up with responsible and fervent enumerators and supervisors. In light of this point, the training was given to the field staff in two stages. The first stage is training of trainers, which took place at the head office for the head office staff (Training of trainers). The staff that took part in the first stage training was then assigned to conduct similar training for the enumerators and other field supervisors in seven (7) branch statistical offices. The survey could not be conducted in Debrebirhan branch office (branch office with two markets), even though training took place, due to the reasons explained above.

During the training sessions, the field staff was given detailed instructions on how to collect data, on the different methods of loss measurement, on moisture content measurement, on crop sample taking, on interviewing procedures, on quality checking methods, on manipulation of tablets, on the usage of data collection applications loaded on tablets, and on online data transfer.

The data was mainly collected from pre-selected cooperatives, unions, wholesale traders and retail traders (assemblers and collectors) selected from the most recent list of market traders in the selected market. The data collection mechanism was based on the subjective response taken from the selected respondents and the objective measurement

of the sample taken from the stored crops. Based on these two methods, the data has been collected in two visits for each trader or institution selected.

The data collection method was based on computer-assisted personal interviewing (CAPI) using Census and Surveys Processing System (CSPro) software. The data collected were transferred into tablets of the supervisors forfurther editing and quality checking through the mechanism prepared in CSPro application. At the end of any editingand quality assurance process, the supervisors also transferred the data using the same CSPro application in to CSA central computer servers.

The number of supply chain actors (planned and achieved), and broken down by region during the data collection exercise, is given in the following table.

Table 1: Supply chain actors

Region	Supply chain actors									
	Markets		Wholesalers		Retailers		Unions		Cooperatives	
	Planned	Covered	Planned	Covered	Planned	Covered	Planned	Covered	Planned	Covered
Oromia	12	12	72	68	120	120	12	5	12	5
Amhara	12	10	72	45	120	80	12	5	12	2
Southern Nations, Nationalities and Peoples Region	8	8	48	29	80	78	8	3	8	3
Total	32	30	192	142	320	278	32	13	32	10

Note: The planned part included all markets including the closed two markets in South Wello Zone, Desse branch office. The covered partdid not include the two markets in progress in Amhara region. The statistical package for social sciences (SPSS), and Microsoft Excel - were used for table production and analysis.
Source: Authors' own elaboration, 2023.

The proper supervision of the data collection process played a major role in the data quality. In order to assure this goal in the whole data collection process the supervision of the data collection was done by the branch office supervisors and statisticians as well as the experts from the head office teams. The branch office supervisors monitored on average three enumerators. The supervisor was responsible for the facilitation of administrative issues in addition to the technical supervision of the actual data collection. The statisticians assigned in each branch office also monitored the teams of enumerators and supervisors in their area. The head office teams received and gave the necessary solution for any technical and administrative issues raised from branch offices. In addition, the head office teams of experts were also deployed across the branch offices in which the pilot survey was being conducted in order to provide further technical support and monitoring of the data collection activities.

During the supervision process, the following usual activities of field supervision were conducted:

- spot checking during actual data collection (interviewing and measuring) and giving directions if there was anything that needed correction;
- doing re-interview, cross-checking the already collected information and accordingly making any necessary corrections;
- doing re-measurement; and
- revising and verifying the collected data and accordingly make any necessary corrections.

1.6 Limitations

Limitations due to sample selection/sample size and other statistical issues:

One of the main challenges that were encountered during the survey was the data collection period, especially concerning the Unions and the Cooperatives. In general, most of these institutions used to collect their products from the farmers after they harvest their crops. In other words, during the survey period these institutions did not have any sensible amount of grains in storage. Another challenge was to get the required sample number of traders especially for wholesale traders in some selected markets due to the size and characteristics of the market. In addition, the Market Lists that were used as a frame from which to select traders, were taken from some other market survey, in which the markets were selected based on expert opinion. In other words, the markets were not selected randomly, but purposively. A few market places were dropped because of the items (maize, wheat, haricot beans and horse beans) that were not available in the markets and also because of security reasons. These markets were replaced through a consulting process with the branch office managers.

The initial strategy for the statistical aspects of the assessment was to come up with weighted estimates of the variables under study; for that purpose it was enough to compute weights for each market, and then weights for retailers/assemblers and wholesalers.

However those weights could only be computed, assuming that the zones, Woredas, markets were selected using a random sampling scheme. Unfortunately, this was not the case for this pilot assessment survey. Therefore, the statistical results (mainly averages and percentages) are presented in this report as unweighted data.

The computation of these unweighted averages and percentages used the data provided by the traders who estimated levels of grain stored, transacted and losses at each stage of the PHL operations. These estimates, however, were subjective judgments of the traders whose memory precision could be affected with a passage of time. As a result, loss figures provided by the traders may not accurately reflect actual level of loss. Though the three regions, where the assessments conducted, were major producing areas of the four crops in the country, the 32 Woredas constituting the study samples, however, may not be fully representatives of the regions. Thus, the regional level estimation for the respective crop may not provide a highly accurate and objective picture of loss levels; this also means, that the deeper the level of breakdown within any given table, the less precise the information presented.

Limitations due to the "count and weigh method" used to compute losses by measurement (objective losses): The information regarding the moisture content of the sampled crops for the first visit could not be collected due to the lack of moisture meter for the fieldwork on time, and for four markets moisture content data was not collect at all.

Additional limitations inherent (to the "count and weigh method") as well as those encountered during data collection were that:

- Weight loss is underestimated when grains in the sample contain hidden infestation as damaged grains that have lost weight are included in the undamaged portion.
- Insects usually prefer to infest larger grains. Hence, under low infestation comparison of individual grain weight would lead to negative loss.
- At very high infestation, grains may be damaged to the extent that counting individual grains is difficult or even if countable, the weight of undamaged grains will be so small ultimately leading to negative estimates.

PART 2. STORAGE LOSSES BY INQUIRY

This section of the report provides some descriptive analysis of the off-farm PHL survey losses by inquiry data in order to understand some basic characteristics of the trading activities. The section, in particular, presents information on traders, their location, storage capacity, and the crops/commodities that they are trading. The results show that, among the traders interviewed, most of them were involved in selling at least one of the four (4) main crops under study. By region, comparing between the four crops under study the results show that majority of the traders are involved in maize, wheat, horse beans, and haricot beans in that descending order; this obviously varies between the regions.

The study used computation methods described in the guidelines on the measurement of harvest and post-harvest losses developed by the Global Strategy for Improving Agricultural and Rural Statistics. The losses, generally expressed in kilogram, were reported by the traders. Relative losses for all crops under study were calculated by dividing the average quantities lost by the average quantities stored and expressed as a percentage. For instance, percentage storage losses were calculated by dividing the average quantities of grain lost during storage by the average quantities brought to storage. This measure of relative losses indicates the relative amount lost.

2.1 Maize traders

2.1.1 Maize trader numbers and types

Table 2: Number and type of maize traders by region, visit and type of storage used

Number of traders	Type of trader				
Region, visit, type of storage	Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Amhara	**163**	**4**	**4**	**106**	**277**
First visit	**82**	**2**	**2**	**53**	**139**
Modern	7	1	2	13	23
Traditional	75	1	0	40	116
Second visit	**81**	**2**	**2**	**53**	**138**
Modern	6	1	2	13	22
Traditional	75	1	0	40	116
Oromiya	**209**	**4**	**4**	**118**	**335**
First visit	**107**	**2**	**2**	**60**	**171**
Modern	7	1	2	8	18
Traditional	100	1	0	52	153
Second visit	**102**	**2**	**2**	**58**	**164**
Modern	6	0	2	7	15
Traditional	96	2	0	51	149

Number of traders Region, visit, type of storage	Type of trader Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Southern Nations, Nationalities and Peoples Region	**94**	**4**	**4**	**29**	**131**
First visit	**48**	**2**	**2**	**15**	**67**
Modern	1	0	1	0	2
Traditional	47	2	1	15	65
Second visit	**46**	**2**	**2**	**14**	**64**
Modern	1	0	1	0	2
Traditional	45	2	1	14	62
Grand total	**466**	**12**	**12**	**253**	**743**

Source: Authors' own elaboration, 2023.

Table 3: Average quantities stored, lost and average relative loss by region and type of maize trader

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**1 539**	**12**	**0.77**
Retailer assembler	**715**	**4**	**0.53**
Cooperative	**5 160**	**33**	**0.63**
Union	**25 050**	**488**	**1.95**
Wholesaler	**1 783**	**6**	**0.31**
Oromiya	**1 280**	**12**	**0.94**
Retailer assembler	**521**	**7**	**1.30**
Cooperative	**6 150**	**150**	**2.44**
Union	**7 350**	**255**	**3.47**
Wholesaler	**2 254**	**8**	**0.37**
Southern Nations, Nationalities and Peoples Region	**5 943**	**31**	**0.51**
Retailer assembler	**1 730**	**6**	**0.33**
Cooperative	**4 425**	**115**	**2.59**
Union	**137 500**	**687**	**0.50**
Wholesaler	**1 662**	**9**	**0.53**
Grand total	**2 199**	**15**	**0.69**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of maize traders compared to the Southern Nations, Nationalities and Peoples Region. Most maize traders use the traditional methods of storage whether they are wholesalersor retailer/assembler. Unions (small sample) however seem to use modern storage type exclusively. The information is also consistent by visit.

Table 4: Average maize quantities stored, lost, and average relative loss by region and type of storage

	Average quantity stored (kg)	Average quantity lost (kg)	Average loss (%)
Amhara	**1 539**	**12**	**0.77**
Modern	4 139	47	1.13
Traditional	1 035	5	0.50
Oromiya	**1 280**	**12**	**0.94**
Modern	2 556	50	1.97
Traditional	1 141	8	0.69
Southern Nations, Nationalities and Peoples Region	**5 943**	**31**	**0.51**
Modern	33 163	475	1.43
Traditional	5 085	17	0.33
Grand total	**2 199**	**15**	**0.69**

Source: Authors' own elaboration, 2023.

Cooperatives and Unions store far more on average (and seem to suffer relatively more losses as well) than the wholesalers and the assemblers collectors.

Most maize grains are found in the modern type of storage on average. Maize grain losses seem to be higher for modern than for traditional storage (however, this might have been because of sample size fluctuations, and other factors uncontrollable factors to be investigated further).

Table 5: Number of traders by region, visit, trader type and causes of maize losses

	Causes of losses mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**16**	**19**	**232**	**10**	**277**
First visit	**3**	**10**	**120**	**6**	**139**
Retailer assembler	2	9	67	4	82
Cooperative	1	0	1	0	2
Union	0	0	2	0	2
Wholesaler	0	1	50	2	53
Second visit	**13**	**9**	**112**	**4**	**138**
Retailer assembler	5	4	69	3	81
Cooperative	0	0	2	0	2
Union	1	0	1	0	2
Wholesaler	7	5	40	1	53

	Causes of losses Mechanical damage/Spillage	Other	Pest infestation	Physiological process	Grand total
Oromiya	**23**	**41**	**249**	**22**	**335**
First visit	**15**	**20**	**125**	**11**	**171**
Retailer assembler	9	13	81	4	107
Cooperative	1	0	1	0	2
Union	1	0	1	0	2
Wholesaler	4	7	42	7	60
Second visit	**8**	**21**	**124**	**11**	**164**
Retailer assembler	3	11	82	6	102
Cooperative	1	0	1	0	2
Union	0	1	1	0	2
Wholesaler	4	9	40	5	58
Southern Nations, Nationalities and Peoples Region	**10**	**10**	**108**	**3**	**131**
First visit	**5**	**5**	**56**	**1**	**67**
Retailer assembler	4	3	40	1	48
Cooperative	0	0	2	0	2
Union	0	0	2	0	2
Wholesaler	1	2	12	0	15
Second visit	**5**	**5**	**52**	**2**	**64**
Retailer assembler	5	4	35	2	46
Cooperative	0	0	2	0	2
Union	0	0	2	0	2
Wholesaler	0	1	13	0	14
Grand total	**49**	**70**	**589**	**35**	**743**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for maize as declared by the traders is pest infestation, followed by other causes, and mechanical damage.

Table 6: Average maize quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**1 539**	**12**	**0.77**
Mechanical damage/spillage	2 513	15	0.58

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Other	966	5	0.48
Pest infestation	1 557	12	0.79
Physiological process	650	11	1.72
Oromiya	**1 280**	**12**	**0.94**
Mechanical damage/spillage	1 373	21	1.54
Other	1 128	2	0.14
Pest infestation	1 325	13	0.98
Physiological process	961	11	1.18
Southern Nations, Nationalities and Peoples Region	**5 943**	**31**	**0.51**
Mechanical damage/spillage	2 265	8	0.35
Other	1 519	23	1.48
Pest infestation	6 807	34	0.50
Physiological process	1 817	2	0.09
Grand total	**2 199**	**15**	**0.69**

Source: Authors' own elaboration, 2023.

Average relative losses have been relatively high in Amhara and Oromiya. In the Southern Nations, Nationalities and Peoples Region, other causes of losses have brought about high average relative losses compared to the other causes.

2.2 Wheat traders

2.2.1 Wheat trader numbers and types

Table 7: Number and type of wheat traders by region, visit and type of storage used

Number of traders	Type of trader				
Region, visit, type of storage	Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Amhara	**95**	**1**	**8**	**59**	**163**
First visit	**49**	**1**	**4**	**31**	**85**
Modern	6	1	3	9	19
Traditional	43		1	22	66
Second visit	**46**		**4**	**28**	**78**
Modern	4		3	9	16

Number of traders Region, visit, type of storage	Type of trader Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Traditional	42	0	1	19	62
Oromiya	**146**	**4**	**10**	**76**	**236**
First visit	**76**	**2**	**5**	**39**	**122**
Modern	0	2	5	3	10
Traditional	76	0		36	112
Second visit	**70**	**2**	**5**	**37**	**114**
Modern	0	1	4	2	7
Traditional	70	1	1	35	107
Southern Nations, Nationalities and Peoples Region	**73**	**6**	**4**	**51**	**134**
First visit	**39**	**3**	**2**	**25**	**69**
Modern	0	1	1		2
Traditional	39	2	1	25	67
Second visit	**34**	**3**	**2**	**26**	**65**
Modern	0	1	1	0	2
Traditional	34	2	1	26	63
Grand total	**314**	**11**	**22**	**186**	**533**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of wheat traders compared to Southern Nations, Nationalities and Peoples Region. Most wheat traders use the traditional methods of storage whether they are wholesalers orretailer/assembler. Cooperatives and unions (small sample) however seem to use modern storage type exclusively. The information is also consistent by visit.

Table 8: Average wheat quantities stored, lost, and average relative loss by region and type of wheat trader

Region, trader	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**9 846**	**29**	**0.29**
Retailer assembler	**350**	**1**	**0.34**
Cooperative	**7 150**	**400**	**5.59**
Union	**183 843**	**510**	**0.28**
Wholesaler	**1 588**	**2**	**0.15**
Oromiya	**6 018**	**15**	**0.24**
Retailer assembler	**172**	**2**	**1.44**
Cooperative	**10 650**	**38**	**0.36**
Union	**123 934**	**248**	**0.20**
Wholesaler	**1 487**	**6**	**0.38**

Region, trader	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Southern Nations, Nationalities and Peoples Region	**4 867**	**34**	**0.70**
Retailer assembler	**2 528**	**12**	**0.47**
Cooperative	**8 000**	**114**	**1.42**
Union	**31 375**	**488**	**1.56**
Wholesaler	**5 767**	**21**	**0.36**
Grand total	**6 899**	**24**	**0.35**

Source: Authors' own elaboration, 2023.

Cooperatives and unions store far more wheat on average (and seem to suffer relatively more losses as well) than the wholesalers and the assemblers collectors, especially in the Southern Nations, Nationalities and Peoples Region and Amhara.

Table 9: Average wheat quantities stored, lost, and average relative loss by region and type of storage

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**9 846**	**29**	**0.29**
Modern	37 357	100	0.27
Traditional	2 323	10	0.41
Oromiya	**6 018**	**15**	**0.24**
Modern	65 355	99	0.15
Traditional	1 411	8	0.56
Southern Nations, Nationalities and Peoples Region	**4 867**	**34**	**0.70**
Modern	34 125	478	1.40
Traditional	3 967	20	0.52
Grand total	**6 899**	**24**	**0.35**

Source: Authors' own elaboration, 2023.

Most wheat grains are found in the modern type of storage on average. Losses seem to be higher for traditional storage compared to modern storage in both Amhara and Oromiya, while it is the opposite in the Southern Nations, Nationalities and Peoples Region.

Table 10: Number of wheat traders by region, visit, trader type and causes of wheat losses

Region, visit Region, visits, trader	Causes of losses Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**3**	**9**	**144**	**7**	**163**
First visit	**3**	**7**	**71**	**4**	**85**
Retailer assembler	3	5	38	3	49
Cooperative	0	0	1	0	1
Union	0	1	3	0	4
Wholesaler	0	1	29	1	31
Second visit	0	**2**	**73**	**3**	**78**
Retailer assembler	0	0	44	2	46
Union	0	1	3	0	4
Wholesaler	0	1	26	1	28
Oromiya	**12**	**51**	**165**	**8**	**236**
First visit	**9**	**23**	**87**	**3**	**122**
Retailer assembler	5	14	56	1	76
Cooperative	1	1	0	0	2
Union	1	1	3	0	5
Wholesaler	2	7	28	2	39
Second visit	**3**	**28**	**78**	**5**	**114**
Retailer assembler	1	18	48	3	70
Cooperative	0	1	1	0	2
Union	0	3	2	0	5
Wholesaler	2	6	27	2	37
Southern Nations, Nationalities and Peoples Region	**10**	**4**	**106**	**14**	**134**
First visit	**5**	0	**56**	**8**	**69**
Retailer assembler	3	0	34	2	39
Cooperative	0	0	3	0	3
Union	0	0	2	0	2
Wholesaler	2	0	17	6	25
Second visit	**5**	**4**	**50**	**6**	**65**
Retailer assembler	2	3	25	4	34
Cooperative	0	0	3	0	3
Union	0	0	2	0	2
Wholesaler	3	1	20	2	26
Grand total	**25**	**64**	**415**	**29**	**533**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for wheat as declared by the traders is pest infestation, followed by other causes, and mechanical damage physiological process.

Table 11: Average wheat quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity stored (kg)	Average relative loss (%)	Average quantity lost (kg)
Amhara	**9846**	**29**	**0.29**
Mechanical damage/spillage	90	0	0.43
Other	14 872	1	0.01
Pest infestation	10 206	33	0.32
Physiological process	156	1	0.38
Oromiya	**6 018**	**15**	**0.24**
Mechanical damage/spillage	22 442	4	0.02
Other	8 718	2	0.02
Pest infestation	4 243	20	0.46
Physiological process	763	3	0.44
Southern Nations, Nationalities and Peoples Region	**4 867**	**34**	**0.70**
Mechanical damage/spillage	2 580	8	0.32
Other	55	0	0.55
Pest infestation	5 355	41	0.77
Physiological process	4 179	8	0.20
Grand Total	**6 899**	**24**	**0.35**

Source: Authors' own elaboration, 2023.

In Amhara mechanical damage seems to be higher compared to the rest of causes, while pest infestation and physiological processes prevail in Oromiya. In the Southern Nations, Nationalities and Peoples Region, other causes of losses and pest infestation have brought about high average relative losses compared to the rest of causes.

2.3 Horse bean traders

2.3.1 Horse bean trader numbers and types

Table 12: Number and type of horse bean traders by region, visit and type of storage used

	Type of trader				
	Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Amhara	**92**	**2**		**29**	**123**
First visit	**47**	**1**		**17**	**65**
Modern	4	1		3	8
Traditional	43	0		14	57
Second visit	**45**	**1**		**12**	**58**
Modern	4	1	0	2	7
Traditional	41	0	0	10	51
Oromiya	**100**	0	**2**	**58**	**160**
First visit	**52**	0	**1**	**30**	**83**
Modern	0	0	1	1	2
Traditional	52	0	0	29	81
Second visit	**48**	0	**1**	**28**	**77**
Modern	0	0	1	1	2
Traditional	48	0	0	27	75
Southern Nations, Nationalities and Peoples Region	**52**	0	**2**	**18**	**72**
First visit	**25**	0	**1**	**9**	**35**
Modern	0	0	1		1
Traditional	25	0	0	9	34
Second visit	**27**	0	**1**	**9**	**37**
Modern	0	0	1		1
Traditional	27	0	0	9	36
Grand total	**244**	**2**	**4**	**105**	**355**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of horse bean traders compared to the Southern Nations, Nationalities and Peoples Region. Most horse bean traders use the traditional methods of storage whether they are wholesalers or retailer/assembler. Cooperatives and Unions (small sample) however seem to use modern storage type exclusively. The information is also consistent by visit.

Table 13: Average horse bean quantities stored, lost, and average relative loss by region and type of wheat trader

Region, trader	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**549**	**2**	**0.31**
Retailer assembler	**305**	**1**	**0.26**
Cooperative	**4 406**	**20**	**0.45**
Wholesaler	**1 057**	**3**	**0.31**
Oromiya	**754**	**6**	**0.82**
Retailer assembler	**169**	**2**	**1.29**
Union	**26 000**	**260**	**1.00**
Wholesaler	**891**	**4**	**0.48**
Southern Nations, Nationalities and Peoples Region	**1 842**	**21**	**1.12**
Retailer assembler	**840**	**3**	**0.36**
Union	**29 500**	**650**	**2.20**
Wholesaler	**1 661**	**2**	**0.10**
Grand total	**903**	**8**	**0.84**

Source: Authors' own elaboration, 2023.

Unions store far more horse beans on average (and seem to suffer relatively more losses as well) than the wholesalers and the assemblers collectors, especially in the Southern Nations, Nationalities and Peoples Region and Oromiya.

Table 14: Average horse bean quantities stored, lost, and average relative loss by region and type of storage

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**549**	**2**	**0.29**
Modern	1 225	3	0.27
Traditional	455	2	0.41
Oromiya	**754**	**6**	**0.24**
Modern	13 350	131	0.15
Traditional	431	3	0.56
Southern Nations, Nationalities and Peoples Region	**1 842**	**21**	**0.70**
Modern	29 500	650	1.40
Traditional	1 051	3	0.52
Grand total	**903**	**8**	**0.35**

Source: Authors' own elaboration, 2023.

Most horse bean grains are found in the modern type of storage on average. Losses seem to be higher for traditional storage compared to traditional storage except in the Southern Nations, Nationalities and Peoples Region.

Table 15: Number of horse bean traders by region, visit, trader type and causes of wheat losses

Region, visit Region, visits, trader	Causes of losses Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	0	**21**	**81**	**21**	**123**
First visit	0	**14**	**37**	**14**	**65**
Retailer assembler	0	11	26	10	47
Cooperative	0	0	1	0	1
Wholesaler	0	3	10	4	17
Second visit	0	**7**	**44**	**7**	**58**
Retailer assembler	0	4	35	6	45
Cooperative	0	1	0	0	1
Wholesaler	0	2	9	1	12
Oromiya	**5**	**11**	**138**	**6**	**160**
First visit	**4**	**7**	**68**	**4**	**83**
Retailer assembler	2	4	44	2	52
Union	0	0	1	0	1
Wholesaler	2	3	23	2	30
Second visit	**1**	**4**	**70**	**2**	**77**
Retailer assembler	1	2	44	1	48
Union	0	1	0	0	1
Wholesaler	0	1	26	1	28
Southern Nations, Nationalities and Peoples Region	**2**	**15**	**44**	**11**	**72**
First visit	**1**	**5**	**25**	**4**	**35**
Retailer assembler	0	4	18	3	25
Union	0		01	0	1
Wholesaler	1	1	6	1	9
Second visit	**1**	**10**	**19**	**7**	**37**
Retailer assembler	0	9	14	4	27
Union	0		01	0	1
Wholesaler	1	1	4	3	9
Grand total	**7**	**47**	**263**	**38**	**355**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for horse beans as declared by the traders is pest infestation, followed by other causes, and physiological process.

Table 16: Average horse bean quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**548.9**	**1.7**	**0.3**
Other	484.9	0.4	0.1
Pest infestation	581.1	2.2	0.4
Physiological process	489.0	1.0	0.2
Oromiya	**753.6**	**6.2**	**0.8**
Mechanical damage/spillage	505.0	4.0	0.8
Other	2580.6	23.6	0.9
Pest infestation	643.0	5.0	0.8
Physiological process	155.0	2.4	1.6
Southern Nations, Nationalities and Peoples Region	**1841.6**	**20.6**	**1.1**
Mechanical damage/spillage	900.0	2.0	0.2
Other	41.6	0.3	0.8
Pest infestation	2525.5	32.2	1.3
Physiological process	1731.8	5.5	0.3
Grand total	**903.3**	**7.6**	**0.8**

Source: Authors' own elaboration, 2023.

Pest infestation and other causes are significant in the Southern Nations, Nationalities and Peoples Region. In Oromiya, physiological process is noticeable compared to the remaining causes. In Amhara, the three types of cause (other, pest infestation, physiological process), are less severe compared to Oromiya and the Southern Nations, Nationalities and Peoples Region.

2.4 Haricot bean traders

2.4.1 Haricot bean trader numbers and types

Table 17: Number and type of haricot bean traders by region, visit and type of storage used

	Type of trader Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Amhara	**29**	0	**4**	**4**	**37**
First visit	**15**	0	**2**	**2**	**19**
Modern	1	0	2	0	3
Traditional	14	0	0	2	16

	Type of trader Retailer assembler	Cooperative	Union	Wholesaler	Grand total
Second visit	**14**	0	**2**	**2**	**18**
Modern	1	0	2	0	3
Traditional	13	0	0	2	15
Oromiya	**24**	0	**2**	**17**	**43**
First visit	**11**	0	**1**	**10**	**22**
Modern	0	0	1	0	1
Traditional	11	0	0	10	21
Second visit	**13**	0	**1**	**7**	**21**
Modern	0	0	1	0	1
Traditional	13	0	0	7	20
Southern Nations, Nationalities and Peoples Region	**2**	**2**	**2**	0	**6**
First visit	**1**	**1**	**1**	0	**3**
Modern	0	1	1	0	2
Traditional	1	0	0	0	1
Second visit	**1**	**1**	**1**	0	**3**
Modern	0	1	1	0	2
Traditional	1	0	0	0	1
Grand total	**55**	**2**	**8**	**21**	**86**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of haricot bean traders compared to the Southern Nations, Nationalities and Peoples Region. Most haricot bean traders use the traditional methods of storage whether they are wholesalers or retailer/assembler. Cooperatives and Unions (small sample) on the other hand, however seem to use the modern storage type exclusively. The information is also consistent by visit.

Table 18: Average haricot bean quantities stored, lost, and average relative loss by region and type of haricot bean trader

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**14 471**	**55**	**0.38**
Retailer assembler	**242**	**0**	**0.10**
Union	**87 975**	**501**	**0.57**
Wholesaler	**44 125**	**2**	**0.01**
Oromiya	**10 090**	**3**	**0.03**
Retailer assembler	**145**	**1**	**1.01**
Union	**204 900**	**1**	**0.00**
Wholesaler	**1 212**	**6**	**0.50**

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Southern Nations, Nationalities and Peoples Region	**18 792**	**318**	**1.69**
Retailer assembler	**25**	**0**	**0.22**
Cooperative	**1 350**	**5**	**0.40**
Union	**55 000**	**950**	**1.73**
Grand total	**12 582**	**47**	**0.38**

Source: Authors' own elaboration, 2023.

Unions store far more haricot beans on average (and seem to suffer relatively more losses as well) than the wholesalers and the assemblers collectors, especially in the Southern Nations, Nationalities and Peoples Region and Amhara.

Table 19: Average haricot bean quantities stored, lost, and average relative loss by region and type of storage

Region, trader	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**14 471**	**55**	**0.38**
Modern	58 717	334	0.57
Traditional	5 907	1	0.01
Oromiya	**10 090**	**3**	**0.03**
Modern	204 900	1	0.00
Traditional	587	3	0.57
Southern Nations, Nationalities and Peoples Region	**18 792**	**318**	**1.69**
Modern	28 175	477	1.69
Traditional	25	0	0.22
Grand total	**12 582**	**47**	**0.38**

Source: Authors' own elaboration, 2023.

Most haricot bean grains are found in the modern type of storage on average. Losses seem to be higher for modern storage in the Southern Nations, Nationalities and Peoples Region and Amhara, compared to traditional storage. In Oromiya it is the opposite.

Table 20: Number of haricot bean traders by region, visit, trader type and causes of wheat losses

Region, visit Region, visits, trader	Causes of losses Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**5**	**23**	**6**	**3**	**37**
First visit	**4**	**10**	**2**	**3**	**19**
Assembler_collector	3	8	1	3	15
Union	1	1	0	0	2
Wholesaler	0	1	1	0	2
Second visit	**1**	**13**	**4**	0	**18**
Assembler_collector	0	12	2	0	14
Union	1	1	0	0	2
Wholesaler	0	0	2	0	2
Oromiya	**8**	**5**	**30**	0	**43**
First visit	**7**	**3**	**12**	0	**22**
Assembler_collector	1	2	8	0	11
Union	1	0	0	0	1
Wholesaler	5	1	4	0	10
Second visit	**1**	**2**	**18**	0	**21**
Assembler_collector	0	1	12	0	13
Union	0	1	0	0	1
Wholesaler	1	0	6	0	7
Southern Nations, Nationalities and Peoples Region	0	0	**06**	0	**6**
First visit	0	0	**03**	0	**3**
Assembler_collector	0	0	01	0	1
Cooperative	0	0	01	0	1
Union	0	0	01	0	1
Second visit	0	0	**03**	0	**3**
Assembler_collector	0	0	01	0	1
Cooperative	0	0	01	0	1
Union	0	0	01	0	1
Grand total	**13**	**28**	**42**	**3**	**86**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for haricot beans as declared by the traders is pest infestation, followed by other causes, and mechanical damage physiological process.

Table 21: Average haricot bean quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**14 471**	**55**	**0.38**
Mechanical damage/spillage	1662	1	0.07
Other	21 586	87	0.40
Pest infestation	4 587	1	0.02
Physiological process	1 033	1	0.13
Oromiya	**10 090**	**3**	**0.03**
Mechanical damage/spillage	26 450	5	0.02
Other	41 010	1	0.00
Pest infestation	574	3	0.56
Southern Nations, Nationalities and Peoples Region	**18 792**	**318**	**1.69**
Pest infestation	18 792	318	1.69
Grand total	**12 582**	**47**	**0.38**

Source: Authors' own elaboration, 2023.

Pest infestation is prevalent in both the Southern Nations, Nationalities and Peoples Region and Oromiya. In Amhara,other causes of losses can be noted.

PART 3. STORAGE LOSSES BY OBJECTIVE MEASUREMENT

3.1 Calculation of percentage losses

Calculation of percentage losses

The specificity of the calculation of storage losses for objective measurements is that percentage losses are directly calculated using the measurements done in laboratory. The count and weight method is used, based on the formula proposed by Harris and Lindblad (1978):

$$l_S^{(t)} = \frac{1}{W_u}\left[\frac{N_d}{N}.W_u - \frac{N_u}{N}W_d\right] \quad (1)$$

Where:

- $l_S^{(t)}$ is the percentage loss estimated for a given household visited in month t;
- N_u is the number of undamaged grain (W_u the corresponding weight);
- N_d is the number of damaged grain (W_d the corresponding weight); and
- $N = N_u + N_d$ is the total number of grains in the sample

A more intuitive version of this formula can be determined using the proportionality between the weight of each portion of the grain sample (damaged and undamaged) and its size in terms of number of grains: $W_u = \alpha_u N_u$ and $W_d = \alpha_d N_d$, with α_u (resp. α_d) the average weight of an undamaged grain (resp. damaged). The following inequalities should hold: $\alpha_u > 0$, $\alpha_d > 0$ and $\alpha_u > \alpha_d$ (on average, an undamaged grain should weigh more than a damaged grain). Using these notations, we show that:

$$l_S^{(t)} = \frac{N_d}{N}\left[\frac{\alpha_u - \alpha_d}{\alpha_d}\right]$$

The percentage storage loss is equal to the percentage difference between the average weight of undamaged and damaged grain, weighted by the share of damaged grains in the total number of grains of the sample. For example, if damaged grains weigh on average 25 percent less than undamaged grains and if damaged grains represent 50 percent of the sample, the percentage loss estimated for this sample will be 50% × 25% = 12.5%.

From (1) one can also derive another formula (the formula used in the guidelines):

$$\frac{1}{W_u}\left[\frac{N_d}{N}.W_u - \frac{N_u}{N}W_d\right] = \left[\frac{N_d}{N}.\frac{W_u}{W_u} - \frac{N_u}{N}.\frac{W_d}{W_u}\right]$$

Simplifying, one gets:

$$\frac{N_d}{N} - \frac{N_u}{N}\cdot\frac{W_d}{W_u} = \frac{1}{N}\left[N_d - \frac{N_u W_d}{W_u}\right]$$

This gives:

$$\frac{1}{N}\left[\frac{N_d W_u - N_u W_d}{W_u}\right]$$

Finally:

$$\left[\frac{N_d W_u - N_u W_d}{N W_u}\right] = \frac{W_u N_d - W_d N_u}{W_u N} = \frac{W_u N_d - W_d N_u}{W_u (N_d + N_u)}$$

3.2 Comparing objective and subjective loss

Table 22: Objective storage losses by region and crop

	Average of objective loss (%)
Amhara	**2.56**
Haricot beans	2.18
Horse beans	1.72
Maize	3.50
Wheat	1.54
Oromiya	**2.99**
Haricot beans	0.82
Horse beans	2.81
Maize	3.06
Wheat	3.23
Southern Nations, Nationalities and Peoples Region	**4.66**
Haricot beans	3.03
Horse beans	4.35
Maize	3.77
Wheat	5.67
Grand total	**3.15**

Source: Authors' own elaboration, 2023.

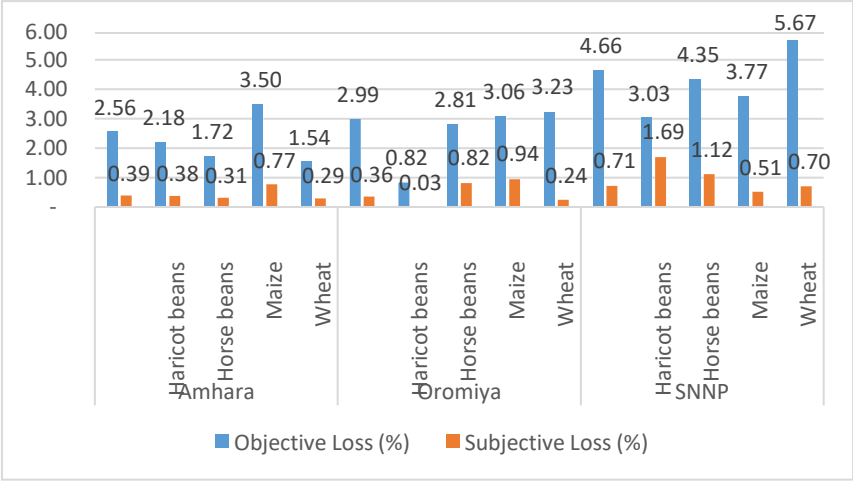
Table 23: Storage losses (inquiry) by region and crop

	Average quantity stored (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**4 390**	**17**	**0.39**
Haricot beans	14 471	55	0.38
Horse beans	549	2	0.31
Maize	1 539	12	0.77
Wheat	9 846	29	0.29
Oromiya	**3 105**	**11**	**0.36**
Haricot beans	10 090	3	0.03
Horse beans	754	6	0.82
Maize	1 280	12	0.94
Wheat	6 018	15	0.24
Southern Nations, Nationalities and Peoples Region	**4 886**	**35**	**0.71**
Haricot beans	18 792	318	1.69
Horse beans	1 842	21	1.12
Maize	5 943	31	0.51
Wheat	4 867	34	0.70
Grand total	**3 910**	**18**	**0.46**

Source: Authors' own elaboration, 2023.

By looking carefully at these two tables, one can see that the traders tend to underestimate their losses, or the objective measurement tends to overestimate the losses; this trend was also noted in both the Ghana and other studies on post-harvest losses. Figure 1 depicts it better.

Figure 1: Comparing objective and subjective losses (percentage)



Source: Authors' own elaboration, 2023.

PART 4. TRANSACTION LOSSES BY INQUIRY

4.1 Maize traders

4.1.1 Maize trader numbers and types

Table 24: Number and type of maize traders by region, visit and type of storage used

	Retailer assembler	Wholesaler	Grand total
Amhara	**166**	**104**	**270**
First visit	**82**	**53**	**135**
Modern	7	13	20
Traditional	75	40	115
Second visit	**84**	**51**	**135**
Modern	5	13	18
Traditional	79	38	117
Oromiya	**216**	**119**	**335**
First visit	**108**	**60**	**168**
Modern	6	8	14
Traditional	102	52	154
Second visit	**108**	**59**	**167**
Modern	7	7	14
Traditional	101	52	153
Southern Nations, Nationalities and Peoples Region	**97**	**28**	**125**
First visit	**48**	**15**	**63**
Traditional	48	15	63
Second visit	**49**	**13**	**62**
Modern	2		2
Traditional	47	13	60
Grand total	**479**	**251**	**730**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of maize traders compared to the Southern Nations, Nationalities and Peoples Region. Most maize traders use the traditional methods of storage whether they are wholesalersor retailer/assembler. The information is also consistent by visit.

Table 25: Average quantities sold, lost, and average relative loss by region and type of maize trader

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**119**	**0.67**	**0.56**
Retailer assembler	72	0.41	0.57
Wholesaler	195	1.08	0.55
Oromiya	**203**	**2.19**	**1.08**
Retailer assembler	77	1.69	2.19
Wholesaler	430	3.09	0.72
Southern Nations, Nationalities and Peoples Region	**120**	**0.70**	**0.59**
Retailer assembler	99	0.72	0.73
Wholesaler	192	0.64	0.33
Grand total	**157**	**1.37**	**0.87**

Source: Authors' own elaboration, 2023.

Wholesalers store far more on average (and seem to suffer relatively less losses as well) than the assemblers collectors.

Most transacted maize grains are found in the modern type of storage on average. Maize grain losses seem to be higher for modern than for traditional storage in Oromiya, while traditional is higher than modern in Amhara and the Southern Nations, Nationalities and Peoples Region.

Table 26: Average maize quantities sold, lost, and average relative loss by region and type of storage

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**119**	**0.67**	**0.56**
Modern	218	0.33	0.15
Traditional	103	0.72	0.70
Oromiya	**203**	**2.19**	**1.08**
Modern	169	2.65	1.57
Traditional	206	2.14	1.04
Southern Nations, Nationalities and Peoples Region	**120**	**0.70**	**0.59**
Modern	300	0.75	0.25
Traditional	117	0.70	0.60
Grand total	**157**	**1.37**	**0.87**

Source: Authors' own elaboration, 2023.

Table 27: Number of traders by region, visit, trader type and causes of maize losses

	Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**127**	**1**	**5**	**137**	**270**
First visit	**72**		**3**	**60**	**135**
Retailer assembler	47		1	34	82
Wholesaler	25		2	26	53
Second visit	**55**	**1**	**2**	**77**	**135**
Retailer assembler	35		1	48	84
Wholesaler	20	1	1	29	51
Oromiya	**217**	**8**	**6**	**104**	**335**
First visit	**107**	**6**	**1**	**54**	**168**
Retailer assembler	72	5		31	108
Wholesaler	35	1	1	23	60
Second visit	**110**	**2**	**5**	**50**	**167**
Retailer assembler	74	1	3	30	108
Wholesaler	36	1	2	20	59
Southern Nations, Nationalities and Peoples Region	**112**	**2**	**1**	**10**	**125**
First visit	**54**	**2**		**7**	**63**
Retailer assembler	39	2		7	48
Wholesaler	15				15
Second visit	**58**		**1**	**3**	**62**
Retailer assembler	45		1	3	49
Wholesaler	13				13
Grand total	**456**	**11**	**12**	**251**	**730**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for maize as declared by the traders is mechanical damage, followed by physiological process, and pest infestation, and other.

Table 28: Average maize quantities sold, lost, and average relative loss by region and cause of losses

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**119**	**0.67**	**0.56**
Mechanical damage/spillage	122	0.85	0.69
Other	100	2.00	2.00
Pest infestation	180	0.73	0.40
Physiological process	114	0.48	0.42
Oromiya	**203**	**2.19**	**1.08**

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Mechanical damage/spillage	138	2.44	1.77
Other	146	0.63	0.43
Pest infestation	38	0.68	1.77
Physiological process	351	1.85	0.53
Southern Nations, Nationalities and Peoples Region	**120**	**0.70**	**0.59**
Mechanical damage/spillage	125	0.65	0.52
Other	50	0.00	0.00
Pest infestation	7	0.50	7.14
Physiological process	84	1.41	1.68
Grand total	**157**	**1.37**	**0.87**

Source: Authors' own elaboration, 2023.

Mechanical damage and other category are prominent in Amhara, mechanical damage and pest infestation are prominent in Oromiya. Pest infestation and physiological process are prominent in the Southern Nations, Nationalities and Peoples Region.

4.2 Wheat traders

4.2.1 Wheat trader numbers and types

Table 29: Number and type of wheat traders by region, visit and type of storage used

	Retailer assembler	Wholesaler	Grand total
Amhara	**103**	**59**	**162**
First visit	**53**	**31**	**84**
Modern	6	9	15
Traditional	47	22	69
Second visit	**50**	**28**	**78**
Modern	5	8	13
Traditional	45	20	65
Oromiya	**152**	**77**	**229**
First visit	**76**	**38**	**114**
Modern		3	3
Traditional	76	35	111
Second visit	**76**	**39**	**115**
Modern		3	3
Traditional	76	36	112
Southern Nations, Nationalities	**76**	**51**	**127**

	Retailer assembler	Wholesaler	Grand total
and Peoples Region			
First visit	**39**	**25**	**64**
Traditional	39	25	64
Second visit	**37**	**26**	**63**
Traditional	37	26	63
Grand total	**331**	**187**	**518**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of wheat traders compared to the Southern Nations, Nationalities and Peoples Region. Most wheat traders use the traditional methods of storage whether they are wholesalersor retailer/assembler. The information is also consistent by visit.

Table 30: Average wheat quantities stored, lost, and average relative loss by region and type of wheat trader

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**63**	**0.47**	**0.74**
Retailer assembler	35	0.27	0.76
Wholesaler	113	0.81	0.72
Oromiya	**79**	**1.14**	**1.44**
Retailer assembler	32	0.69	2.15
Wholesaler	172	2.02	1.17
Southern Nations, Nationalities and Peoples Region	**169**	**1.10**	**0.65**
Retailer assembler	145	0.98	0.68
Wholesaler	203	1.26	0.62
Grand total	**96**	**0.92**	**0.95**

Source: Authors' own elaboration, 2023.

Wholesalers store far more wheat on average (and seem to suffer relatively less losses as well) than the assemblers collectors, in all three (3) regions.

Table 31: Average wheat quantities sold, lost, and average relative loss by region and type of storage

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**63**	**0.47**	**0.74**
Modern	109	0.34	0.31
Traditional	54	0.49	0.92
Oromiya	**79**	**1.14**	**1.44**
Modern	105	2.42	2.31
Traditional	79	1.11	1.41
Southern Nations, Nationalities and Peoples Region	**169**	**1.10**	**0.65**
Traditional	169	1.10	0.65
Grand total	**96**	**0.92**	**0.95**

Source: Authors' own elaboration, 2023.

Most transacted wheat grains are found in the modern type of storage on average. Losses seem to be in Oromiya for both traditional and modern storage type. In Amhara, losses seem to be higher for the traditional storage type.

Table 32: Number of wheat traders by region, visit, trader type and causes of wheat losses

	Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**84**	**3**	**4**	**71**	**162**
First visit	**57**	**1**	**1**	**25**	**84**
Retailer assembler	37	1	1	14	53
Wholesaler	20	0	0	11	31
Second visit	**27**	**2**	**3**	**46**	**78**
Retailer assembler	19	2	0	29	50
Wholesaler	8	0	3	17	28
Oromiya	**143**	**10**	**13**	**63**	**229**
First visit	**76**	**2**	**3**	**33**	**114**
Retailer assembler	51	1	3	21	76
Wholesaler	25	1	0	12	38
Second visit	**67**	**8**	**10**	**30**	**115**
Retailer assembler	43	7	5	21	76
Wholesaler	24	1	5	9	39
Southern Nations, Nationalities and Peoples Region	**115**	**1**	0	**11**	**127**
First visit	**56**	**1**	0	**7**	**64**
Retailer assembler	34	1	0	4	39

	Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Wholesaler	22	0	0	3	25
Second visit	**59**	0	0	**4**	**63**
Retailer assembler	33			4	37
Wholesaler	26				26
Grand total	**342**	**14**	**17**	**145**	**518**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for wheat as declared by the traders is mechanical damage, followed by physiological process, and pest infestation.

In Amhara mechanical damage and physiological process are higher compared to the rest of causes, while almost all types of loss causes are at play in Oromiya. In Southern Nations, Nationalities and Peoples Region, physiological process and mechanical damage are noted.

Table 33: Average wheat quantities sold, lost, and average relative loss by region and cause of loss

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**63**	**0.47**	**0.74**
Mechanical damage/spillage	53	0.43	0.82
Other	10	0.00	0.00
Pest infestation	158	0.51	0.32
Physiological process	73	0.53	0.72
Oromiya	**79**	**1.14**	**1.44**
Mechanical damage/spillage	91	1.43	1.58
Other	42	1.05	2.53
Pest infestation	77	1.16	1.51
Physiological process	60	0.48	0.81
Southern Nations, Nationalities and Peoples Region	**169**	**1.10**	**0.65**
Mechanical damage/spillage	169	1.08	0.64
Other	50	0.00	0.00
Physiological process	175	1.32	0.75
Grand total	**96**	**0.92**	**0.95**

Source: Authors' own elaboration, 2023.

4.3 Horse bean traders

4.3.1 Horse bean trader numbers and types

Table 34: Number and type of horse bean traders by region, visit and type of storage used

	Retailer assembler	Wholesaler	Grand total
Amhara	**93**	**32**	**125**
First visit	**47**	**17**	**64**
Modern	4	3	7
Traditional	43	14	57
Second visit	**46**	**15**	**61**
Modern	5	2	7
Traditional	41	13	54
Oromiya	**100**	**60**	**160**
First visit	**51**	**30**	**81**
Modern		1	1
Traditional	51	29	80
Second visit	**49**	**30**	**79**
Modern		1	1
Traditional	49	29	78
Southern Nations, Nationalities and Peoples Region	**52**	**18**	**70**
First visit	**25**	**9**	**34**
Traditional	25	9	34
Second visit	**27**	**9**	**36**
Traditional	27	9	36
Grand total	**245**	**110**	**355**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of horse bean traders compared to the Southern Nations, Nationalities and Peoples Region. Most horse bean traders use the traditional methods of storage whether they are wholesalers or retailer/assembler. The information is also consistent by visit.

Table 35: Average horse bean quantities sold, lost, and average relative loss by region and type of wheat trader

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**42**	**0.08**	**0.19**
Retailer assembler	30	0.06	0.20
Wholesaler	77	0.14	0.18
Oromiya	**111**	**0.87**	**0.78**
Retailer assembler	32	0.41	1.27
Wholesaler	242	1.63	0.68
Southern Nations, Nationalities and Peoples Region	**55**	**0.29**	**0.52**
Retailer assembler	41	0.22	0.53
Wholesaler	95	0.50	0.52
Grand total	**76**	**0.48**	**0.63**

Source: Authors' own elaboration, 2023.

Wholesalers store far more horse beans on average (and seem to suffer relatively less losses as well) than the assemblers collectors, in all three (3) regions.

Table 36: Average horse bean quantities sold, lost, and average relative loss by region and type of storage

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**42**	**0.08**	**0.19**
Modern	57	0.13	0.23
Traditional	40	0.07	0.18
Oromiya	**111**	**0.87**	**0.78**
Modern	75	1.00	1.33
Traditional	111	0.87	0.78
Southern Nations, Nationalities and Peoples Region	**55**	**0.29**	**0.52**
Traditional	55	0.29	0.52
Grand total	**76**	**0.48**	**0.63**

Source: Authors' own elaboration, 2023.

Most transacted horse bean grains are found in the modern type of storage in Amhara. In Oromiya, higher amounts sold are stored are stored traditionally.

Table 37: Number of horse bean traders by region, visit, trader type and causes of wheat losses

	Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**55**	**1**	**6**	**63**	**125**
First visit	**34**	0	**2**	**28**	**64**
Retailer assembler	25	0	1	21	47
Wholesaler	9	0	1	7	17
Second visit	**21**	**1**	**4**	**35**	**61**
Retailer assembler	18	1	3	24	46
Wholesaler	3	0	1	11	15
Oromiya	**106**	**1**	**9**	**44**	**160**
First visit	**57**	**1**	**2**	**21**	**81**
Retailer assembler	34	1	2	14	51
Wholesaler	23	0		7	30
Second visit	**49**	0	**7**	**23**	**79**
Retailer assembler	29	0	5	15	49
Wholesaler	20	0	2	8	30
Southern Nations, Nationalities and Peoples Region	**64**	**5**	0	**1**	**70**
First visit	**32**	**2**	0	0	**34**
Retailer assembler	24	1	0	0	25
Wholesaler	8	1	0	0	9
Second visit	**32**	**3**	0	**1**	**36**
Retailer assembler	23	3	0	1	27
Wholesaler	9	0	0	0	9
Grand total	**225**	**7**	**15**	**108**	**355**

Source: Authors' own elaboration, 2023.

The most prevalent cause of losses for horse beans as declared by the traders is mechanical damage, followed by physiological process, and pest infestation.

Table 38: Average horse bean quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**42**	**0.08**	**0.19**
Mechanical damage/spillage	32	0.04	0.12
Other	5	0.00	0.00
Pest infestation	52	0.06	0.12
Physiological process	50	0.12	0.24
Oromiya	**111**	**0.87**	**0.78**
Mechanical damage/spillage	94	0.91	0.97
Other	10	0.00	0.00
Pest infestation	83	0.57	0.68
Physiological process	160	0.85	0.53
Southern Nations, Nationalities and Peoples Region	**55**	**0.29**	**0.52**
Mechanical damage/spillage	58	0.31	0.54
Other	8	0.00	0.00
Physiological process	100	0.25	0.25
Grand total	**76**	**0.48**	**0.63**

Source: Authors' own elaboration, 2023.

Mechanical damage is noted in the Southern Nations, Nationalities and Peoples Region. In Oromiya, mechanicaldamage, pest infestation are preponderant.

4.4 Haricot bean traders

4.4.1 Haricot bean trader numbers and types

Table 39: Number and type of haricot bean traders by region, visit and type of storage used

	Retailer assembler	Wholesaler	Grand total
Amhara	**30**	**4**	**34**
First visit	**15**	**2**	**17**
Modern	1	0	1
Traditional	14	2	16
Second visit	**15**	**2**	**17**
Modern	1	0	1
Traditional	14	2	16
Oromiya	**26**	**19**	**45**

	Retailer assembler	Wholesaler	Grand total
First visit	**13**	**10**	**23**
Traditional	13	10	23
Second visit	**13**	**9**	**22**
Traditional	13	9	22
Southern Nations, Nationalities and Peoples Region	**2**	0	**2**
First visit	**1**	0	**1**
Traditional	1	0	1
Second visit	**1**		**1**
Traditional	1		1
Grand total	**58**	**23**	**81**

Source: Authors' own elaboration, 2023.

As shown, Amhara and Oromiya have the highest numbers of haricot bean traders compared to the Southern Nations, Nationalities and Peoples Region. Most haricot bean traders use the traditional methods of storage whether they are wholesalers or retailer/assembler. The information is also consistent by visit.

Table 40: Average haricot bean quantities sold, lost, and average relative loss by region and type of haricot bean trader

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**294**	**0.20**	**0.07**
Retailer assembler	13	0.03	0.22
Wholesaler	2 400	1.45	0.06
Oromiya	**79**	**0.58**	**0.74**
Retailer assembler	24	0.34	1.41
Wholesaler	154	0.92	0.60
Southern Nations, Nationalities and Peoples Region	**3**	**0.00**	**0.15**
Retailer assembler	3	0.00	0.15
Grand total	**167**	**0.41**	**0.24**

Source: Authors' own elaboration, 2023.

Wholesalers store far more haricot beans on average (and seem to suffer relatively less losses as well) than the assemblers collectors, for all regions.

Table 41: Average haricot bean quantities sold, lost, and average relative loss by region and type of storage

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (%)
Amhara	**294**	**0.20**	**0.07**
Modern	10	0.25	2.50
Traditional	312	0.19	0.06
Oromiya	**79**	**0.58**	**0.74**
Traditional	79	0.58	0.74
Southern Nations, Nationalities and Peoples Region	**3**	**0.00**	**0.15**
Traditional	3	0.00	0.15
Grand total	**167**	**0.41**	**0.24**

Source: Authors' own elaboration, 2023.

Most haricot bean grains are found in the traditional type of storage on average. There is a relatively high loss for the modern type of storage in Amhara.

Table 42: Number of haricot bean traders by region, visit, trader type and causes of haricot bean losses

	Mechanical damage/spillage	Other	Pest infestation	Physiological process	Grand total
Amhara	**26**			**8**	**34**
First visit	**14**			**3**	**17**
Retailer assembler	13			2	15
Wholesaler	1			1	2
Second visit	**12**			**5**	**17**
Retailer assembler	11			4	15
Wholesaler	1			1	2
Oromiya	**12**	**3**	**9**	**21**	**45**
First visit	**8**	**1**	**2**	**12**	**23**
Retailer assembler	4	1		8	13
Wholesaler	4		2	4	10
Second visit	**4**	**2**	**7**	**9**	**22**
Retailer assembler	3	1	2	7	13
Wholesaler	1	1	5	2	9
Southern Nations, Nationalities and Peoples Region	**1**	**1**			**2**
First visit		**1**			**1**
Retailer assembler		1			1
Second visit	**1**				**1**
Retailer assembler	1				1
Grand total	**39**	**4**	**9**	**29**	**81**

Source: authors' own elaboration, 2023.

The most prevalent cause of losses for haricot beans as declared by the traders is mechanical damage, followed by physiological process.

Table 43: Average haricot bean quantities stored, lost, and average relative loss by region and cause of loss

	Average quantity sold (kg)	Average quantity lost (kg)	Average relative loss (kg)
Amhara	**294**	**0.20**	**0.07**
Mechanical damage/spillage	162	0.10	0.06
Physiological process	725	0.51	0.07
Oromiya	**79**	**0.58**	**0.74**
Mechanical damage/spillage	32	0.83	2.62
Other	5	0.00	0.00
Pest infestation	42	0.46	1.11
Physiological process	132	0.58	0.44
Southern Nations, Nationalities and Peoples Region	**3**	**0.00**	**0.15**
Mechanical damage/spillage	3	0.01	0.30
Other	3	0.00	0.00
Grand total	**167**	**0.41**	**0.24**

Source: Authors' own elaboration, 2023.

Mechanical damage/spillage and pest infestation are both prevalent in Oromiya.

PART 5. CONCLUSIONS

Among the main findings, the study shows that a number of the traders (retailers/assemblers, wholesalers, unions, cooperatives, processors) are involved in selling commodities like maize, wheat, horse beans, and haricot beans as important economic activities.

Of paramount importance from the study is the finding that storage losses varied according regions, crops, types of traders and storage infrastructure.

According to the traders, the average storage losses tended to small, across regions and crop type.

Objectively measured losses tended to be much higher than the losses declared by the traders.

Due to the relatively moderate sample size and some other statistical limitations as highlighted in the report, it was not confirmed whether those variations were due to chance or were statistically significant. Hence, larger scaleassessment surveys would need to be conducted with larger sample sizes to allow more rigorous hypothesis tests.

PART 6. RECOMMENDATIONS

Based on the challenges and lessons learnt from this pilot assessment, it recommended:

- To take into account the most appropriate survey period based on the harvest period of the required crops.
- To build a well-organized frame of supply chain actors, markets which indicates the markets characteristics from which traders can be sampled.
- To establish baseline data collection based on the replication of the survey at a larger scale.
- To ensure that the survey is integrated to the extent possible, into the existing national-wide data collection systems such as the Agricultural Production Estimates Survey to ensure low operational costs and sustainability.

ANNEX

Questionnaire

SECTION A: LISTING OF MARKET ACTORS/INSTITUTIONS

A1) Region: ..... Code |___| A2) Zone: ..... Code |___|

A3) Woreda: ..... Code |_____| A4) Market/Locality Name: ..... A5) Market/Locality |_____|

A6) Date of enumeration: ...../...../2021

Serial N°	Name of Trader/Processor/Institution	Address/locality	Type of Trader/Processor/Institution	Assembler-Collector Sequential Number	Wholesaler Sequential Number	Type of storage	Maize			Barley			Haricot Bean			Field Pea		
							Storage capacity (kgs)	Quantity stored (kgs)	Quantity stored last year (kgs)	Storage capacity (kgs)	Quantity stored (kg)	Quantity stored last year (kgs)	Storage capacity (kgs)	Quantity stored (kgs)	Quantity stored last year (kgs)	Storage capacity (kgs)	Quantity stored (kgs)	Quantity stored last year (kgs)
A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25

Code for A10: 1=Retailer-Assembler; 2= Wholesaler;

Codes for A11: 1= Traditional; 2= Modern

SECTION B: LOSSES DURING STORAGE (by inquiry)

B1) Region: ..... Code |___| B2) Zone: ..... Code |___|

B3) Woreda: ..... Code |_____| B4) Market/Locality Name: ..... Market/Locality N°|_____

B5) Date of visit: ...../...../2021 B6) Inquiry period: .....

Trader N°	Type of trader	Crops	Type of storage	Previous balance (kgs)	Additions during inquiry period (kgs)	Withdrawal during inquiry period (kgs)	Total amount stored (kgs)	Quantity lost (kgs)	Causes of loss
B7	B8	B9	B10	B11	B12	B13	B14	B15	B16

Code for B6: 1=First visit; 2=Second visit Codes for B9: 01=Maize; 02: Barley; 03= Haricot bean; 04= Field pea;

Code for B8: 1=Retailer-Assembler; 3= Wholesaler; 4= Cooperatives; 5= Unions; 6= Processing Unit

Codes for B10: 1= Traditional; 2= Modern

Codes for B11: 1= Mechanical Damage or Spillage; 2= Physiological process; 3= Pest infestation

SECTION C: LOSSES DURING STORAGE (for observation)

C1) Region: .... Code |___| C2) Zone: .... Code |___|

C3) Woreda:.......... Code |______| C4) Market/Locality Name: ....   C5) Market/Locality N° |______| C6) Date of visit: ....../......./2021

C7) Trader/Institution N°: |______| C8) Trader/Institution Type: |_____| C9) Inquity period: ....   C10) Storage duration (months): |_____|

Crop	Type of storage	Weight sample drawn (grams)	Moisture content (%)	Number of undamaged grains	Weight of undamaged grains	Number of damaged grains	Weight of damaged grains	Main cause of losses/damages	ID N° batch sample	Date sample drawn
C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21
|__||__|	|__||__|	|____|.|__|	|_____|	|_____|	|____|.|__|	|_____|	|____|.|__|	|_____|	|_____|	..../..../21

Code for C9: 1=First visit; 2=Second visit   Codes for C11: 01=Maize; 02: Barley; 03= Haricot bean; 04= Field pea;

Code for C8: 1=Retailer-Assembler; 3= Wholesaler; 4= Cooperatives; 5= Unions; 6= Processing Unit

Codes for C12: 1= Traditional; 2= Modern

Codes for C19: 1= Mechanical Damage or Spillage; 2= Physiological process; 3= Pest infestation

SECTION D: LOSSES DURING TRANSACTIONS (by inquiry)

D1) Region: ..... Code |___| D2) Zone: ..... Code |___|

D3) Woreda: ..... Code |_____| D4) Market/Locality Name: ... Market/Locality N°|_____|

D5) Date of visit: ...../...../2021 D6) Inquiry period: .....

Trader N°	Type of Trader/Institution	Crops	Type of storage	Quantity of Sales during transaction (kgs)	Quantity lost (kgs)	Causes of losses
D7	D8	D9	D10	D11	D12	D13

Code for D6: 1=First visit; 2=Second visit Codes for D9: 01=Maize; 02: Barley; 03= Haricot bean; 04= Field pea;
Code for D8: 1=Retailer-Assembler; 3= Wholesaler;
Codes for D10: 1= Traditional; 2= Modern; 3= No Storage
Codes for D13: 1=Grain scattering during measuring the quantity to be sold; 2= Grain scattering while bringing the commodity from the storage to measurment place ; 3= Grain scattering while loading the transacted quantity to the transport.

SECTION E1: LOSSES OF GRAINS BEFORE GRINDING (by inquiry)

E1) Region: _____ Code |___| E2) Zone: _____ Code |___|

E3) Woreda: _____. Code |___| E4) Market/Locality Name: _____. Market/Locality N°|_____|

E5) Date of visit: __/__/2021 E6) Inquiry period: _____.

Miller Serial N°	Name Milling Facility	Crops processed	Local grain standard	Quantity of grain received for processing during the reference period	Quantity of grain grinded (milled) during the reference period (kgs)	Quantity of grain lost before grinding (kgs)	Causes of grain losses
E7	E8	E9	E10	E11	E12	E13	E14

Code for E6: 1=First visit; 2=Second visit Codes for E9: 01=Maize; 02: Barley; 03= Haricot bean; 04= Field pea;

Code for E8: 1=Retailer-Assembler; 3= Wholesaler; 4= Cooperatives; 5= Unions; 6= Processing Unit (Milling Facility)

Codes for E10: 1= First Level; 2= Second Level 3= Third Level

Codes for E14: 1 = Grain spilled, broken, during cleaning; 2 = Grain spilled, broken, during sorting; 3 = Grain spilled, broken, during degerminating; 4 = Grain spread around machine 5 = Other

SECTION E2: LOSSES OF FLOUR AFTER GRINDING (by inquiry)

Quantity of flour obtained during the reference period (kgs)	Quantity of flour lost during the reference period (kgs)	Causes of flour losses
E15	E16	E17

Codes for E17: 1 =Milled flour left on the machine; 2 = Improper collection of flour; 4 = Spilling during packaging; 5 = Other.

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