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A globally recognised regulator of a sustainable, agile and innovative agronomy and horticulture sector

AGRONOMY AND HORTICULTURE DEVELOPMENT DIVISION

RESEARCH AND DEVELOPMENT SUBDIVISION

AN ANALYSIS OF FOOD LOSSES IN THE CONTEXT OF THE CROP INDUSTRY IN NAMIBIA



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EXECUTIVE SUMMARY

Food loss has the potential to raise the price of food, and this has a detrimental effect on food availability and security. Reducing food loss can boost food availability, support food security, foster resilience, and transform the agrifood system. Namibia currently does not have official statistics or clear information regarding the extent of food losses from fruits, vegetables, and cereal crops. Hence, this study's overall objective was to quantify food losses in Namibia, specifically in the horticulture (fruits and vegetables) and agronomy (grains/cereals) sectors, primarily at the production level. Additionally, the study provides policy recommendations and strategies to mitigate food loss at the farm level.

A survey approach was utilised, incorporating face-to-face interviews using a structured questionnaire. Data were collected from 148 respondents across seven agronomy and horticulture production zones, including 126 producers, 7 processors, and 15 wholesalers/distributors. Secondary sources from online literature were also reviewed to supplement the findings. The key findings are that out of a total of 261,090 tons of agronomy and horticulture production in 2022/23, 58,475 tons (valued at N\$723 million) were lost, representing a 22% food loss rate. Horticulture accounted for 92% (53,851 tons, valued at N\$691 million) of the total losses, while agronomy contributed 8% (4,634 tons, valued at N\$30 million).

In terms of stages of food loss in Namibia, production/harvesting accounts for 74% (43,093 tons, N\$610 million); transport accounts for 10% (6,026 tons, N\$43 million); and storage accounts for 16% (9,357 tons, N\$69 million). The main contributing factors are pests and diseases, whereby infestation by insects and crop diseases significantly impacts food loss, particularly in horticulture; whereas weather conditions in the form of extreme climate events such as droughts, floods, frost, and excessive heat cause major losses at the production stage; and lack of market access whereby farmers struggle to sell their produce due to oversupply, inadequate transportation, and limited storage infrastructure.

The study recommends that farmers adopt effective pest and disease control programmes and collaborate with neighbours to combat invasive and migratory pests like tuta absoluta; government investments in affordable transportation, road improvements, and central storage facilities at village/constituency levels should take centre stage to reduce spoilage and to improve market access; promote climate resilient crops, improve irrigation and water harvesting systems, and enhance climate forecasting services to reduce climate-related losses.

1. INTRODUCTION AND BACKGROUND

According to the Food and Agriculture Organisation of the United Nations (FAO, 2011), about 1/3 of the world's food production is lost or wasted globally every year. This represents 1.3 billion tons of wasted food at a cost of approximately US\$1 trillion, which is equivalent to over N\$16 trillion. Of this food waste, fruits and vegetables make up 45% and cereals 30% (Figure 1). On the other hand, the majority of staple crop production losses in developing nations (approximately between 50% and 80%) occur at the farm level, according to the International Food Policy Research Institute (IFPRI, 2022) study, whereas average losses at the middle-man and processor levels were approximately 7% and 19%, respectively. However, the root reasons extend far beyond the farm gate (Delgado et al., 2017).

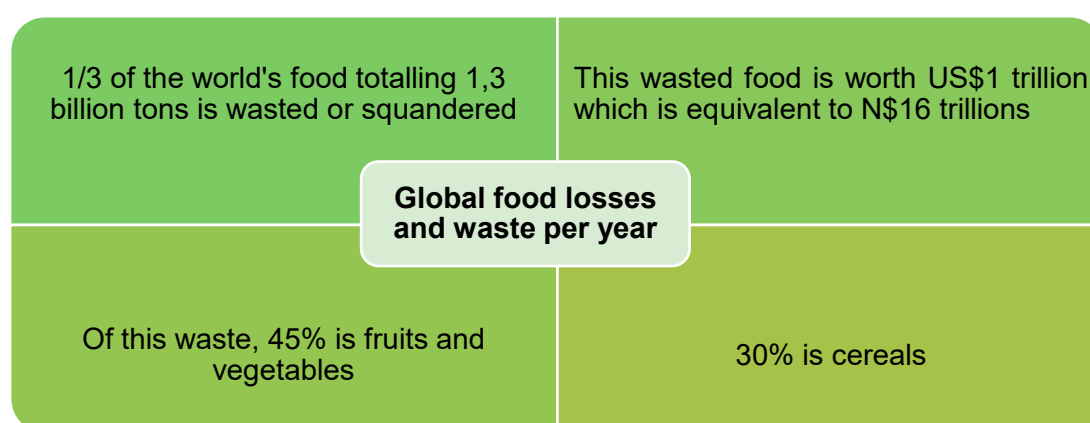


Figure 1: Global food losses and waste. FAO (2011)

Similarly, about 1.4 billion hectares of land, which is 28% of the world's agricultural area, is used annually to produce food that is lost or wasted (Food and Agriculture Organisation (FAO), 2013). FAO further states that developing countries suffer more food losses during production, whereas in middle- and high-income countries, food waste happens more at the retail and consumer levels. Food loss and waste undermine the sustainability of the global food systems. When food is lost or wasted, all the resources that were used to produce this food, including water, land, energy, labour, and capital, go to waste.

In addition, the disposal of food loss and waste in landfills leads to greenhouse gas emissions, thereby contributing to climate change (Buzby, 2022). Food loss and waste can also negatively impact food security and food availability, and contribute to increasing the cost of food. Each country's food system cannot be resilient if it is not sustainable, hence the need to focus on the adoption of integrated

approaches designed to reduce food loss and waste. As such, actions are required globally and locally to maximise the use of the food we produce.

FAO (2013) defines **food loss** as the decrease in edible food mass at the production, post-harvest, and processing stages of the food chain, whilst **food waste** refers to the discard of edible food at the retail and consumer levels.

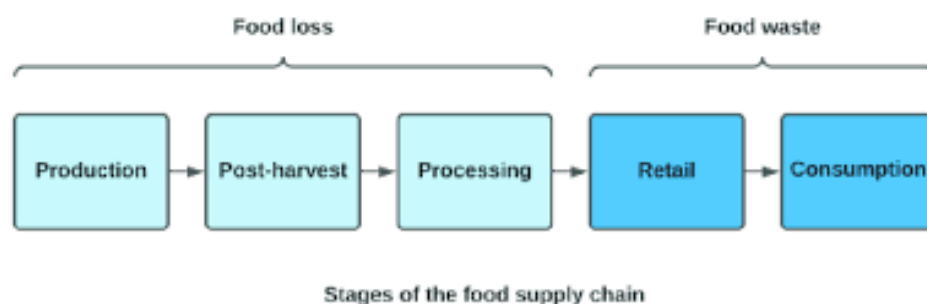


Figure 2: Food loss and food waste stages in the food supply chain. Brennan and Browne (2021)

As per the definitions and also Figure 2 above, it is evident that food loss can happen due to problems in the value chain stages, which can be due to problems in the markets, institutions, or policy frameworks. Food waste, on the other hand, is more of a behavioural problem that comes as a result of human habits, customs, traditions, and behaviour (Ghamrawy, 2019). Therefore, the targeted respondents for this research were limited to those involved in the production and harvest, post-harvest (loading, packing, etc), transportation, wholesale, and/or processing handling stages of agronomy and horticulture crop products in larger volumes/quantities, whereby there is a possibility for policy interventions.

Currently, Namibia does not have official statistics regarding the extent of food losses and wastage, from both horticulture (fruits and vegetables) and agronomic (grain/cereals) crops perspectives. Hence, this study aimed to quantify food losses in Namibia, focusing on both fruits and vegetables and grains, mostly at the production level. The study, thus, suggests some necessary policy recommendations that can improve the situation in terms of food loss from production to the wholesaling/ distribution level.

2. PROBLEM STATEMENT

An estimated 13% of the world's food is lost from production to processing, and an additional 17% is wasted in homes, food services, and retail settings, all while hunger and food security persist (State of

Food Security and Nutrition Report, 2023). Moreover, food loss and waste can also raise the price of food and have a detrimental effect on food availability and security. Therefore, reducing food loss and waste can boost food availability, support food security, promote healthy diets, and foster resilience, all of which are important factors in the transformation of agrifood systems. Reducing food loss and waste contributes significantly to climate change by lowering greenhouse gas emissions (GHGs). Because food security depends on the preservation and protection of our natural resources and ecosystems, it can assist nations and corporations in increasing their ambitions regarding climate change.

Despite the above important aspects, incidents of food loss at the production level have been coming out in Namibia, especially from the small-scale horticulture farmers, and mostly due to limited access to markets (Mwengo, 2022). Beyond reports such as these, Namibia has no specific data or estimation of the extent of food losses to use for policy interventions or any mitigating strategies. The country continues to experience challenges relating to food losses in fruits, vegetables, and grains; however, no reliable statistics are available for use, and the level of losses is not quantified nationally.

3. SIGNIFICANCE OF THE STUDY

According to the Namibia Zero Hunger Strategic Review Report (2016/2017), it is estimated that about 24% of all food calories grown per year are lost or wasted along the food value chain of smallholder producers in the country. Additionally, for commercial smallholder farmers, losses are estimated at 14%, while for communal farmers, the losses are more than 40% for perishable products and 20% for grain such as maize, sorghum, and wheat (Namibia Zero Hunger Strategic Review Report, 2016/2017). This is, thus, a clear opportunity to develop policies or strategies that will identify approaches relating to the production, handling and storage, and processing stages of the value chain for reducing food loss in Namibia. Although there is evidence of food losses in Namibia, there are currently no comprehensive records about their extent, especially for each crop group (i.e., agronomy and/or horticulture crops).

This study gathered data, although limited, that quantified the extent of food loss at certain levels of the food value chain, i.e., at the production, post-harvest, and processing stages in Namibia. These statistics also provide an idea of not only how much food is lost at each stage, but also at which stage food is lost the most, so that appropriate and targeted interventions are formulated from a policy point of view. Additionally, these statistics give a clear indication to stakeholders, be it farmers, traders, and processors, on the level of food loss and how much of that is in their control to mitigate further loss in the future.

4. RESEARCH OBJECTIVES

The specific objectives of this research are:

- ✓ To quantify the level of losses of the key horticultural (fruits and vegetables) and grain (white maize, wheat, and pearl millet) crops in Namibia;
- ✓ To investigate and establish the factors contributing to crop-related food losses in Namibia; and
- ✓ To suggest recommendations on what should be done to reduce food losses in Namibia's crop industry.

5. RESEARCH METHODOLOGY

5.1 Study design and location

The study used both qualitative and quantitative methods to collect primary and secondary data. Primary data were collected through a survey approach whereby face-to-face interviews were conducted using a structured questionnaire, with both closed and open-ended questions. In addition, a review of secondary sources of information on the internet was used to substantiate the primary data obtained from the field survey.

The study was conducted in Namibia, where respondent farmers/producers, formal wholesalers/traders, and processors were sampled from all 7 agronomy and horticulture production zones in the country, namely: Zambezi, Kavango, North Central, Karst, Central, South, and Orange River (Figure 3).

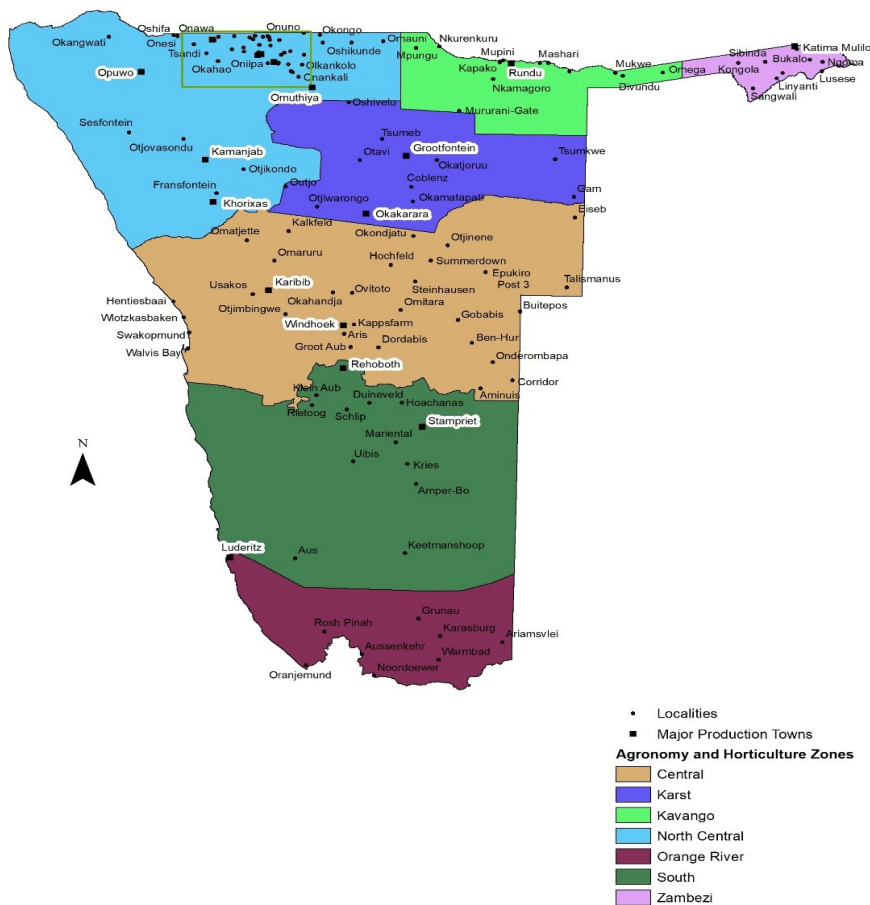


Figure 3: Study area as per the agronomic and horticulture zones

5.2 Population and sampling plan

The study population comprised 447 registered agronomy (wheat, white maize, and pearl millet) producers/farmers, 886 horticulture (fruits & vegetables) producers/farmers, and 24 agronomy processors (millers) in Namibia. Unfortunately, the number of horticulture processors is unknown, and thus, the study consulted the stakeholders at random and through referrals. With a total population size of 1,371 respondents (including an addition of an estimated 14 horticulture processors and wholesalers/distributors), the research targeted 172 stakeholders as respondents, which translated to 13% of the population.

The study, therefore, sampled and targeted a total of 172 respondents as a sample size, representing 13% of the population. Upon the data collection process, at least 148 respondents were interviewed

successfully. These comprised 126 producers (both horticulture and agronomy), 7 processors, and 15 wholesalers/distributors (Table 1).

Table 1: Target population and sample size

Respondent category	Population	Targeted sample	Actual number of respondents interviewed
Producers	1,333	150	126
Processors	24	15	7
Wholesalers/distributors	Unknown	7	15
TOTAL	1,357	172	148

5.3 Data collection and analysis

The data for this study were collected through the use of structured questionnaires for the oral interviews of the sampled respondents. A descriptive analysis method using Microsoft Excel was employed to analyse and provide summarised data in the form of graphs, tables, and figures presented herein.

6. RESULTS AND DISCUSSIONS

This section presents and discusses the survey findings, including possible suggestions to reduce food losses across the crop value chain in Namibia. The analysis was made based on different food value stages, i.e., production and harvest, post-harvest (loading, packing, etc.), transportation, wholesale, and/or processing and handling stages.

6.1. Demographic characteristics

The geographical and gender distribution of the interviewed respondents is illustrated in Figure 4. The figure indicates that 76% of the respondents are male and 24% are female. Out of this, the highest number of male respondents are from the Karst production zone (22), followed by Kavango with 17 respondents respectively. The highest number of female producers is in the Kavango production zone with 14 respondents (Figure 4).

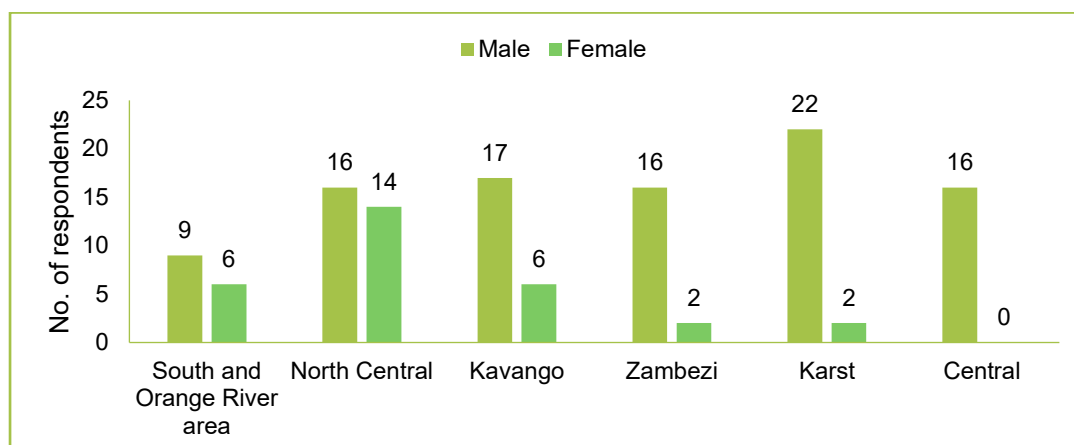


Figure 4: Producers' geographical and gender distribution

As indicated in Figure 5, the combination of South and Orange River production, as well as the Central production zones, recorded the highest number (5 each) of wholesalers that were interviewed for this study.

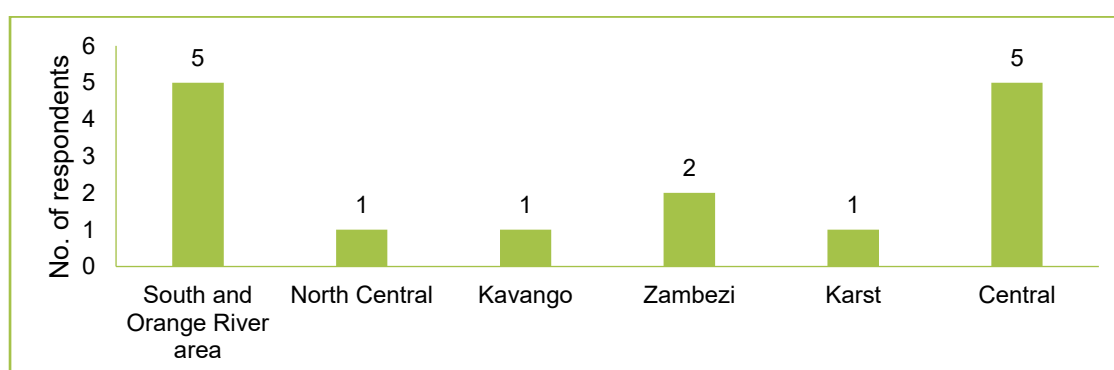


Figure 5: Wholesaler's geographical distribution

This study also interviewed 7 processors, who mainly consisted of agronomists or grain millers across the country. Two (2) of these are from North Central, Karst, and Central each, and only one (1) is from the Kavango production zone (Figure 6).

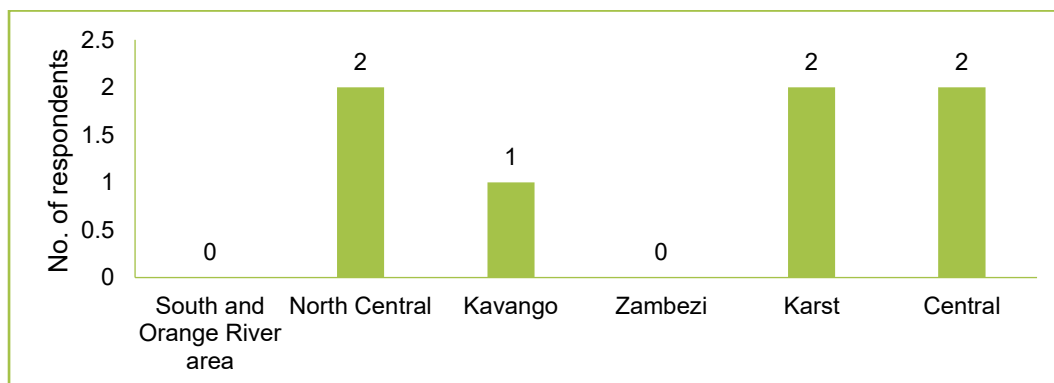


Figure 6: Processor's geographical distribution

6.2. Food loss at various value chain stages in Namibia

The subsections below summarise the factors and level of food losses at various food supply chain stages as per the feedback of the stakeholders engaged in this study.

6.2.1. Production and harvesting stage

As indicated in Figure 7, at least 94% of the consulted producers/farmers admitted to experiencing crop loss during the production stage of either horticulture or agronomy crops. Similarly, the results further indicate that most farmers lost less than a hectare of crops during the production stage alone (before harvest), followed by those who indicated losing about 1-5 ha of crops at the production stage, with a few farmers indicating losing between 5 and 10 ha and more than 10 ha, respectively.

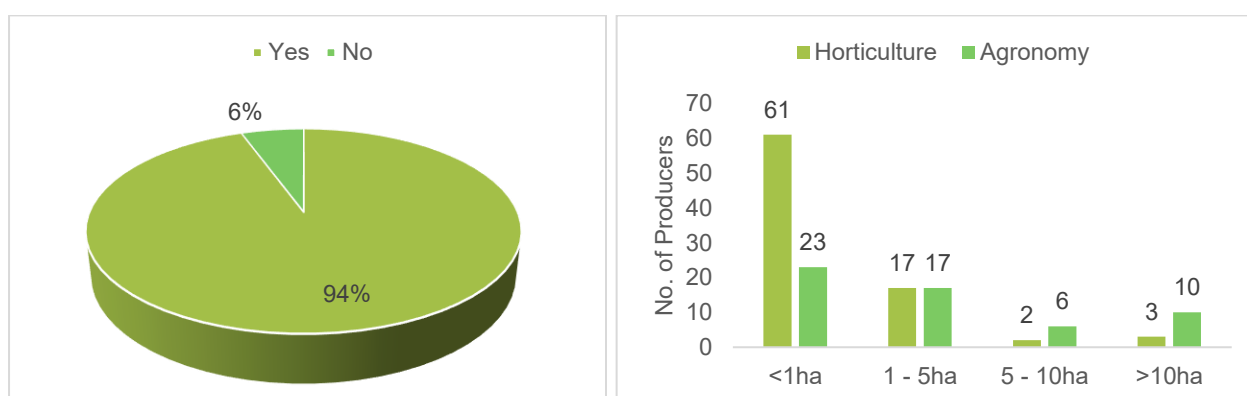


Figure 7: Proportion of farmers experiencing crop loss during production (left) and the level of crop loss during production (right)

Harvesting methods are also one of the most important factors that contribute to food losses. Lack of machines (such as harvesting machines) may lead to manual harvesting practices, which are more likely to cause some damage that will result in crop loss.

Figure 8 indicates that 70% of the producers interviewed in this study harvest their crops manually, and only 9% use harvesting machines.

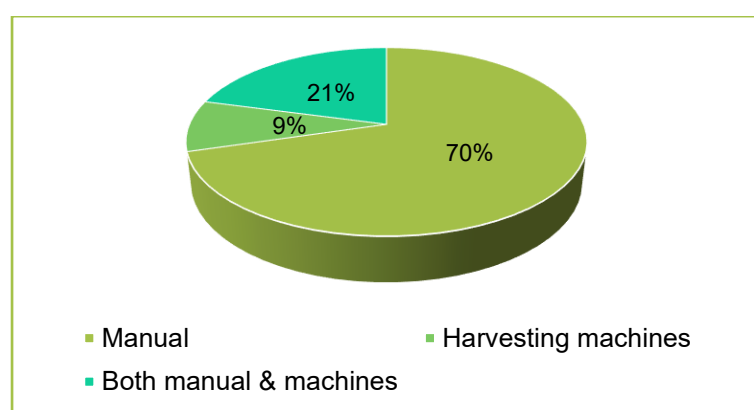


Figure 8: Harvesting methods

In terms of the containers used, the majority of horticulture farmers (76) use crates as containers to carry their crop products, whilst the majority of agronomy farmers (27) mostly use a combine harvester, which directly offloads either into the trucks transporting to the market or into the storage facility. There is also a high number of farmers who use sacks as containers to carry their crop products, both from horticulture (31) and agronomy (25) crops, respectively (Figure 9).

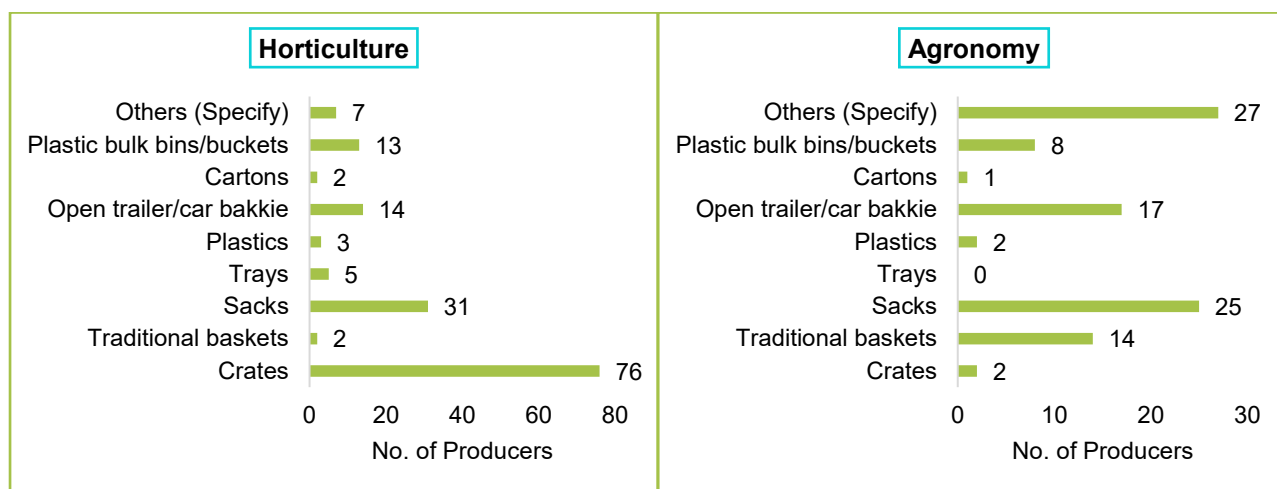


Figure 9: Types of harvesting containers (left: Horticulture crops, right: Agronomy crops)

Crop loss at the production stage can be affected by many factors, and most commonly, a combination of multiple factors can contribute to this loss. During this survey and as indicated in Figure 10, pests (including birds) were identified as the most contributing factors to crop loss during the production stage. This is followed by low rainfall, animals (of which farmers indicated wild animals as the main problem), theft, and then diseases, respectively.

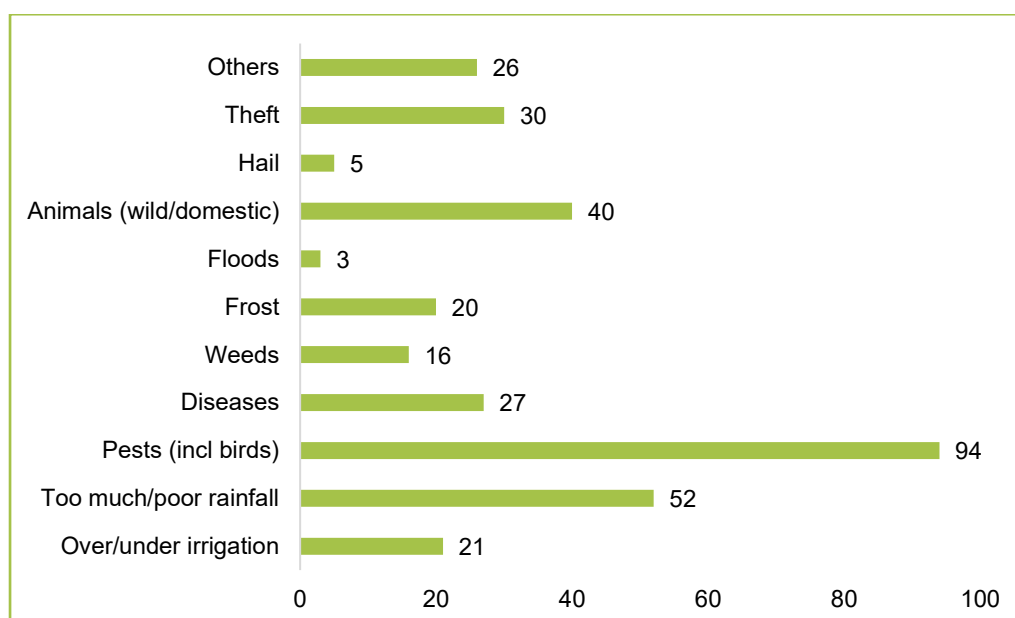


Figure 10: Common causes of crop loss during production

Methods and timing of harvesting (especially for grains) were indicated as two of the most essential aspects leading to food loss at the production stage. Some farmers also explained that due to the low

rate of mechanisation as well as an inadequate and inexperienced labour force, there can be delayed harvesting during the harvesting season, which leads to food loss.

Delayed harvesting, according to the farmers, can also be a key factor due to economic reasons such as low demand or high supply of the produce in the market, which would lead to lower returns because of low prices; therefore, to avoid financial loss, farmers decide to leave crops unharvested. In addition, poor resource availability and management, such as water, which leads to poor nutrients, leads to food loss during the grading and sorting stage (Ishangulyyev et al., 2019).

6.2.2. Post-harvest stage (sorting/grading and storage)

After harvesting, 99 producers/farmers indicated that they do sorting and grading of their products for market and pricing purposes. The majority of these farmers are from the North Central production zone (25), followed by the Karst production zone (22) (Figure 11).

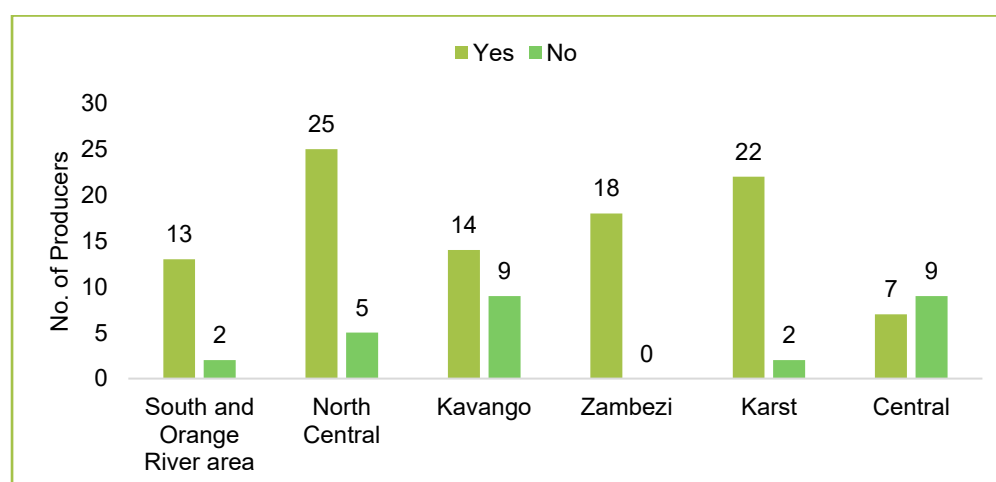


Figure 11: Indication of whether producers/farmers do sorting/grading of harvested produce

Figure 12 illustrates the results on how much of the farmers' harvest is lost during sorting and grading. For horticulture, 43% of the total respondents indicated that they lost more than 10 kg/ton of what was harvested, while about 31% indicated that they lost less than 1 kg/ton of the produce at this stage (Figure 12). For agronomy on the other hand, about 48% of the farmers indicated that they lost less than a kg/ton at this stage, with a considerable number of farmers (32%) facing a loss greater than 10 kg/ton

of grains and thereafter, about 13% and 6% of these farmers lose between 1.1 and 5 kg/ton and between 5.1 and 10 kg/ton of grains, respectively (Figure 12).

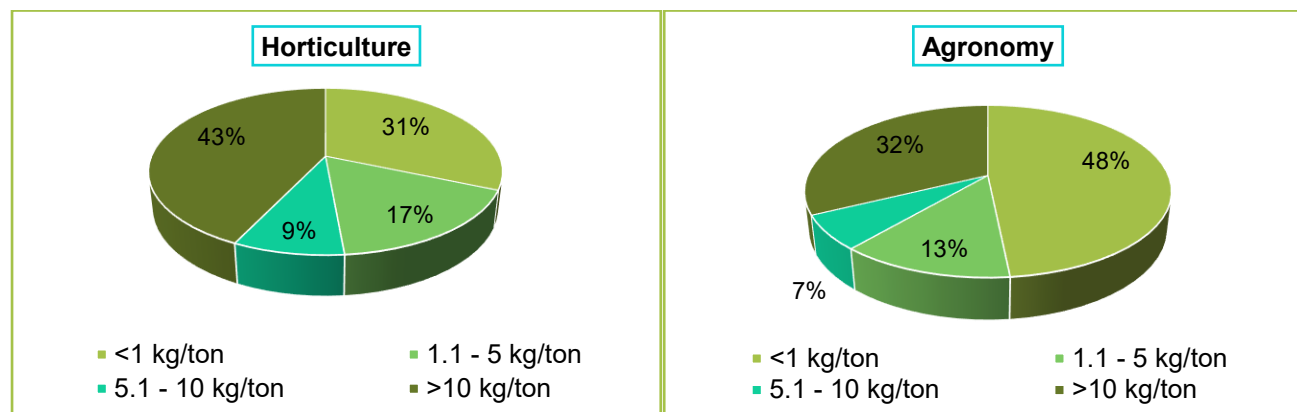


Figure 12: Level of crop produce loss during sorting/grading (Left: Horticulture, Right: Agronomy)

Farmers who store their products at the farm facility before transporting them to the market also experience produce loss due to one reason or another. Most farmers do not store their produce due to a lack of storage facilities; therefore, they harvest straight to the market or sometimes only harvest when they have secured a market. Martinez et al. (2014) state that a lack of storage and cold storage facilities, if highly perishable products are not sold on time, means that the farmers experience food loss. Therefore, good storage facilities help reduce food loss, particularly for perishable products.

As depicted in Figure 13, approximately 45 horticulture and 39 agronomy producers indicated losing some of their produce during storage. According to Figure 13, it can be deduced that most (61 farmers) lose either less than a kg/ton or above 10 kg/ton of their produce during storage, while a few indicated that they lose between 1.1 – 10 kg/ton during storage accordingly.

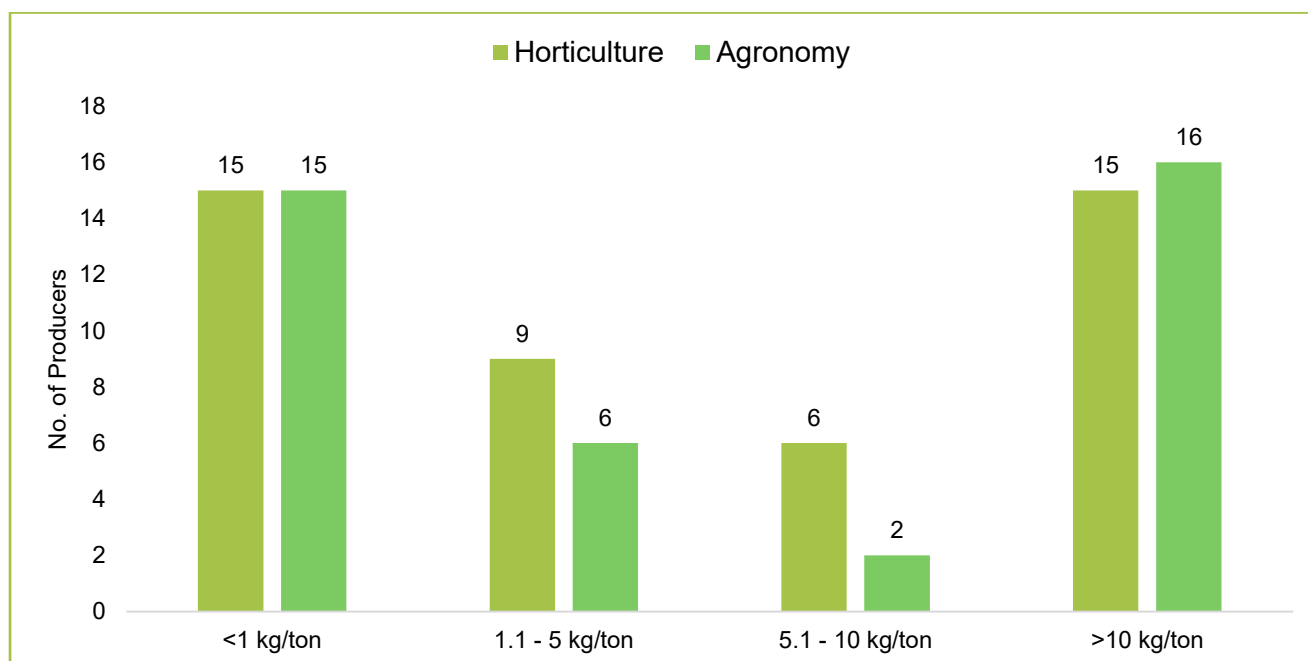


Figure 13: Level of produce loss during storage

The type of storage is also an important aspect of the food chain, as it contributes to the quality of the produce at the end of the day. As indicated in Figure 15, the majority of the horticulture producers (35%) interviewed store their fresh produce under the shade (tree/open shed – Figure 14). Although this can be ideal for crops such as onions, butternuts, and pumpkins, which may not require a cooling system, but may not be ideal storage for other perishable produce such as tomatoes, cabbage, and carrots.



Figure 14: Open shed (under a tree shade) as one of the storage options for low-perishable produce (NAB Survey, 2023)

At least 27% of the producers store their produce in cooled rooms, and at least 21% store their produce in uncooled rooms (Figure 15).

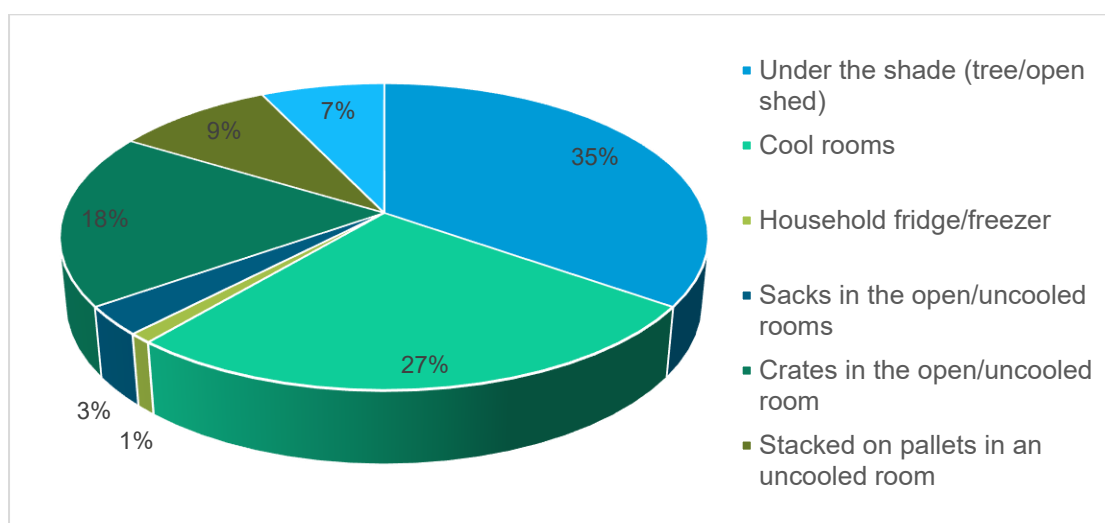


Figure 15: Type of storage – Horticulture

For agronomy farmers, 27% indicated that they store their grains in plastic dams under the sun, and 19% of the farmers indicated that they store their grains in silos (commercial) and sacks in open/uncooled rooms. There is also a 20% of producers who chose 'other' storage type, which was

mostly the traditional storage facility made from wood or the modernised plastic type (**Error! Reference source not found.**).

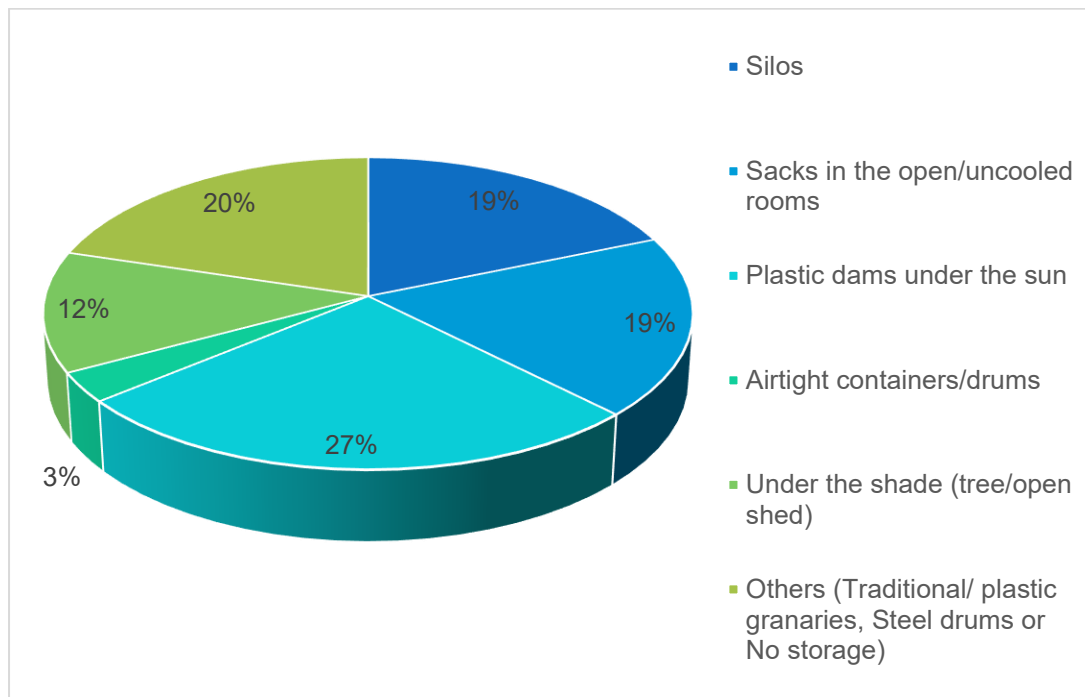


Figure 16: Type of storage - Agronomy

The storage duration/period of crop produce also has an impact on the level of loss experienced during the storage stage. Hence, the study also reviewed the storage duration for each category, which is summarised in Figure 17. About 32 horticulture producers only keep (store) their harvested produce for less than 6 hours at the farm, and at least 28 producers, mostly those with cool rooms, keep/store their produce for 18 hours or more. For the agronomy producers, 22 producers kept/stored their harvested grains for less than a month (mostly transported to the market immediately after harvest), and 22 producers (mostly those with storage facilities at the farm) stored their grains for 3 months or more.

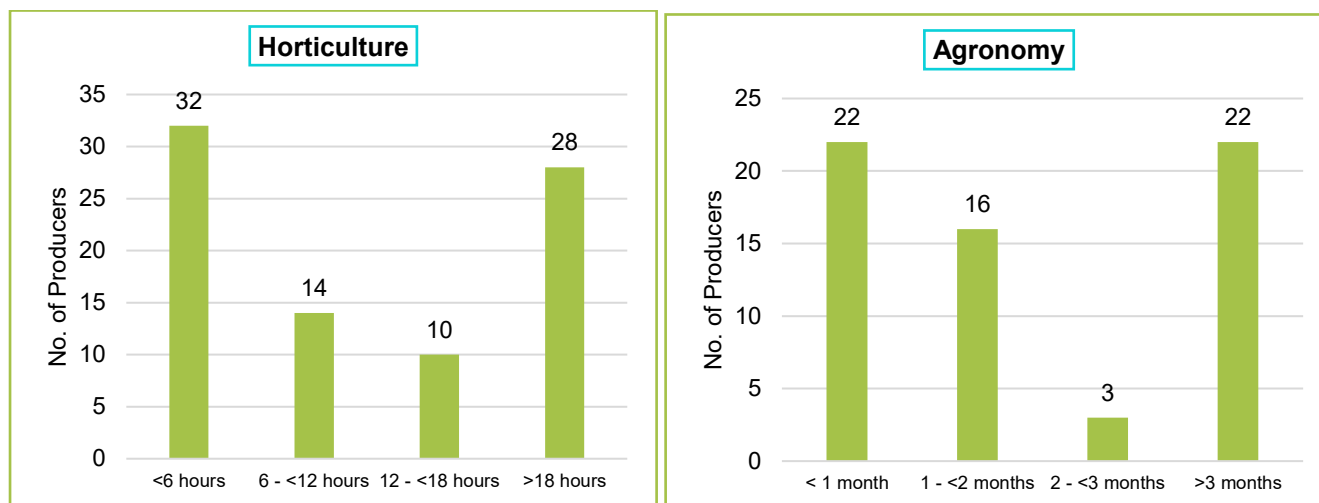


Figure 17: Storage duration: Left – Horticulture, Right - Agronomy

6.2.3. Transportation stage

In terms of transporting the produce to the market, only 35 horticulture and 28 agronomy farmers indicated that they lost their produce during transportation. About 23 horticulture farmers indicated that they lose about 1kg/ton or less, while for agronomy, about 21 farmers indicated that they lose less than a kg/ton of their produce during transportation. Only 7 horticulture and 2 agronomy farmers indicated that they lose more than 10 kg/ton of their produce during transportation (Figure 18).

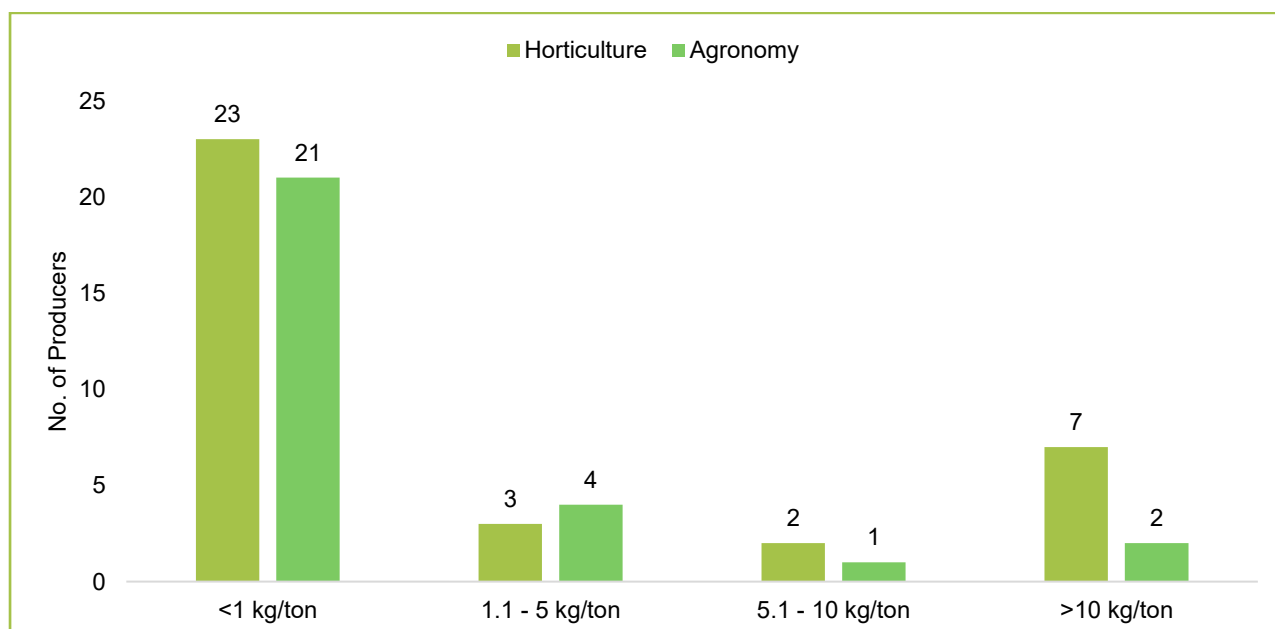


Figure 18: Level of loss of produce during transportation (to the market)

To give the results meaning, the total weighted frequency was calculated to determine the most common mode of transport used by the surveyed producers/farmers to get their produce to the market. In this case, and as depicted in Figure 19, the transport mode that carries the most weight is the type that farmers use the most to transport their produce to the market.

As illustrated in Figure 19, the majority of producers/farmers mostly use their own or rented un-refrigerated vehicles (score: 619 points) to transport their produce to the market. Alternatively, the next common method used is that the buyers also pick up the products themselves with their un-refrigerated transport (score: 278 points). The least used transport type is the animal-drawn cart with a score of 6 points.

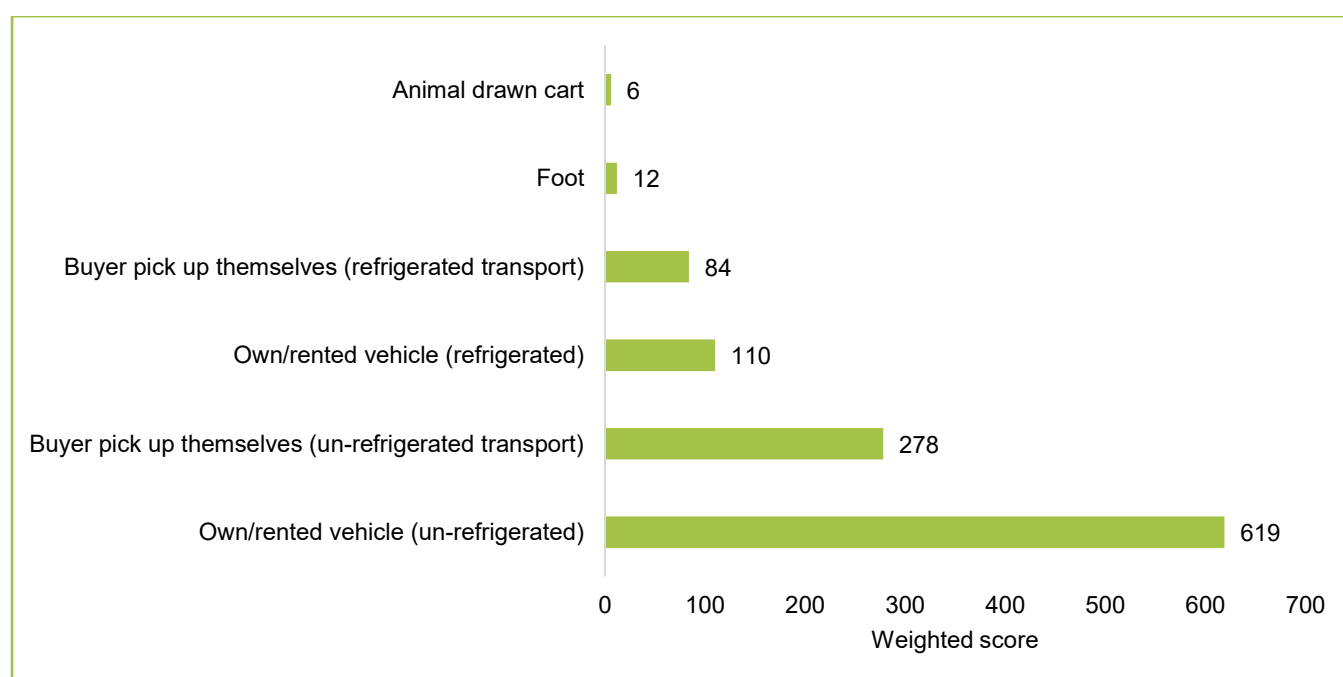


Figure 19: Type of transport to market



Figure 20: Own/rented un-refrigerated vehicle (open bakkie) transporting onions to the market (NAB Survey, 2023)

6.2.4. Value addition/ processing stage

The survey results indicate that there is a lack of value addition among the farmers. This is because about 57 horticulture producers (64%) and 55 agronomy producers (83%) indicated that they do not carry out value addition, respectively (Figure 21).

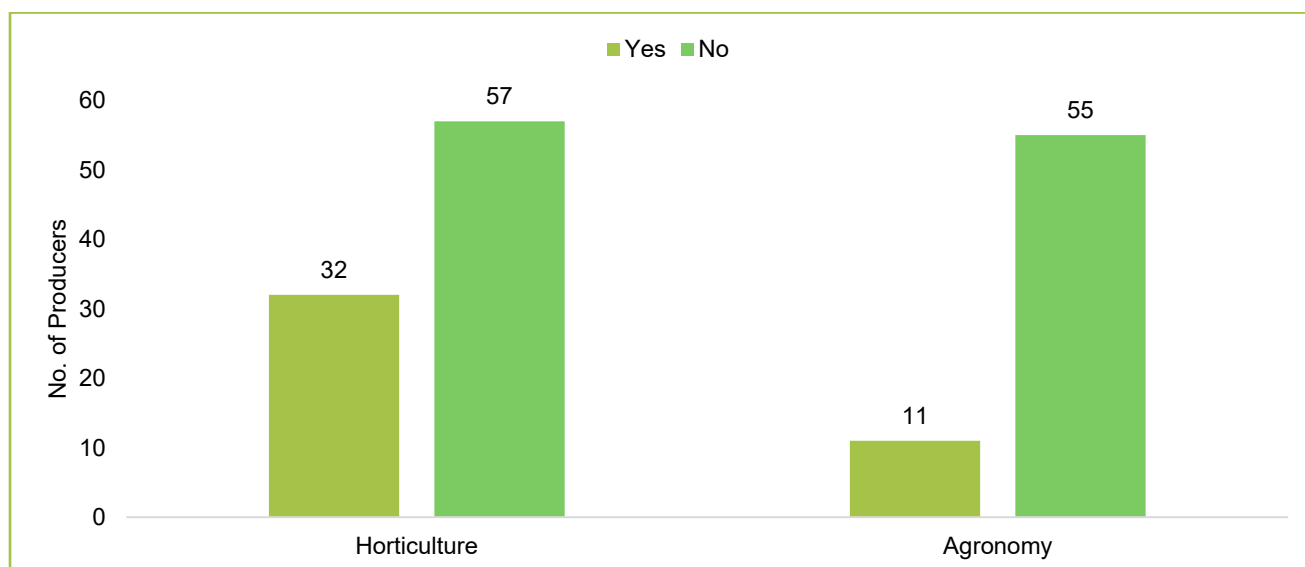


Figure 21: Proportion of farmers doing value addition

Figure 22 depicts the type of value addition done by the correspondents. A total of 36% (32) and 17% (11) of the surveyed horticulture correspondents indicated being involved in value addition (Figure 21), which is mostly doing packaging and drying, with very few doing freezing and processing (drying and canning) (Figure 22). As for agronomy, most farmers add value by milling, packaging, and in other ways, such as crushing their grains; however, only to make livestock feed (Figure 22).

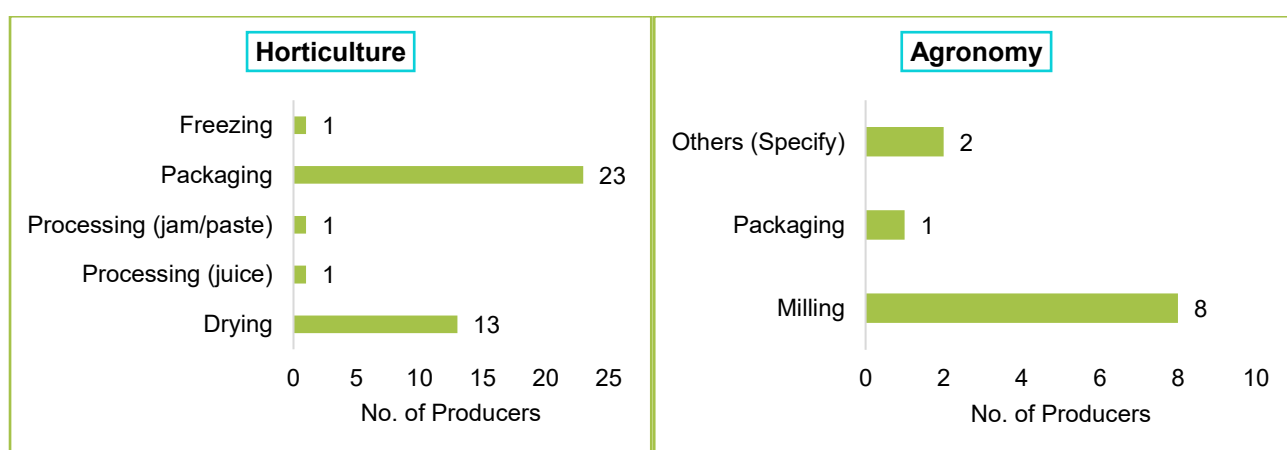


Figure 22: Type of value addition/ processing. Left: Horticulture, Right: Agronomy

As indicated in Figure 23, at least 46% of the horticulture producers/farmers and 50% of the agronomy producers/farmers indicated having lost 1 or less than 1 kg/ton of produce during the value addition or processing stage. The highest amount of loss during the value addition stage, of more than 10 kg/ton, is experienced by 23% of horticulture producers and 30% of agronomy producers, respectively.

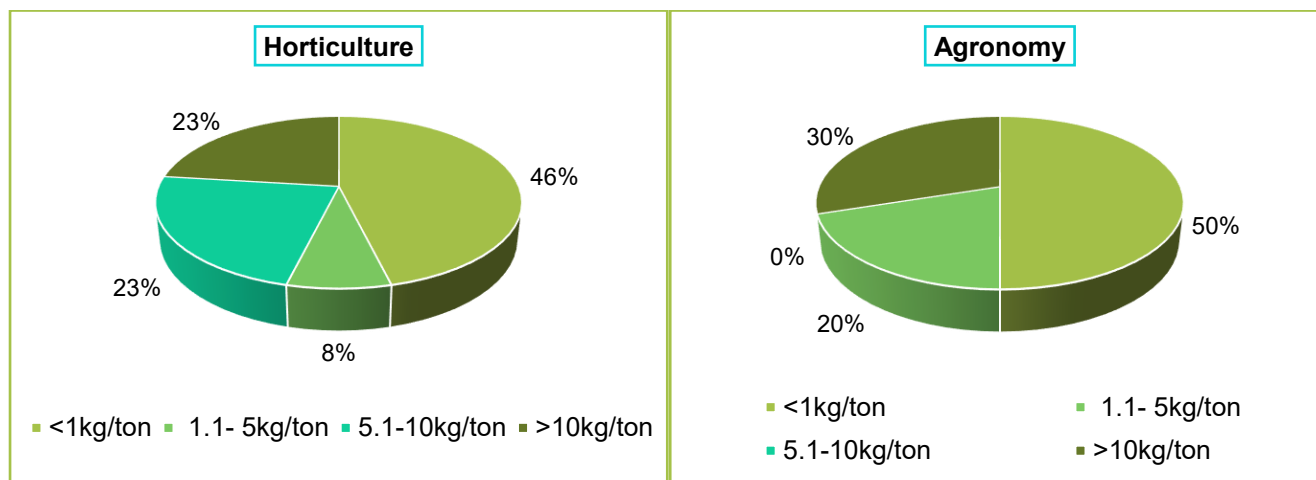


Figure 23: Level of loss during value addition/ processing. Left – Horticulture, Right - Agronomy



Figure 24: Drying/ canning of tomatoes and spinach, and packaging of cucumbers as a value addition/ processing practice (NAB Survey, 2023)

6.2 Overall crop loss at various handling stages

To reduce food loss or formulate appropriate measures to reduce food losses, it is imperative to understand the level of impact in terms of food losses at each stage in the food supply chain. Table 2 below highlights the level of losses over each of the controlled horticulture crops, as well as a few fruits, based on the surveyed producers/farmers for this study.

Table 2: Analysis of food loss at various handling stages at the farm level during 2022/23 – Horticulture (Source: NAB Survey, 2023)

Crop type	Area planted (Ha)	Total harvest (tons)	Quantity lost during production & harvest (tons)	Quantity lost during transportation from field to farm (tons)	Quantity lost during storage (tons)	% loss during production & harvest	% loss at transportation	% loss during storage	Total loss (%)
Tomatoes	122.3	8,390.0	369.2	0.3	13.8	4.4%	0.0%	0.2%	4.6%
Onions	107.8	4,535.5	250.5	0.01	65.9	5.5%	0.0%	1.5%	7.0%
Cabbages	55.1	127,128.1	16,612.3	6,000.0	9,004.1	13.1%	4.7%	7.1%	24.9%
Cabbages (units)		802,328.0	255,595.0	8,200.0	1,300.0	31.9%	1.0%	0.2%	33.0%
Sweet potatoes	15.4	113.4	22.7	-	0.5	20.0%	0.0%	0.4%	20.4%
Beetroots	60.8	1,935.7	114.3	-	9.8	5.9%	0.0%	0.5%	6.4%
Butternuts	97.4	2,947.4	159.8	-	30.9	5.4%	0.0%	1.0%	6.5%
Carrots	92.8	1,686.5	57.7	-	6.6	3.4%	0.0%	0.4%	3.8%
Peppers	27.1	1,373.5	103.0	0.5	0.6	7.5%	0.0%	0.0%	7.6%
Gem squash	15.2	211.5	8.6	-	0.8	4.1%	0.0%	0.4%	4.4%
Pumpkin	12.3	366.4	98.5	4.1	17.5	26.9%	1.1%	4.8%	32.8%
Pumpkin (units)		50.0	10.0	-	-	20.0%	0.0%	0.0%	20.0%
Spinach	4.7	38.2	0.7	0.0	-	1.8%	0.0%	0.0%	1.8%
Watermelons	27.1	416.2	68.3	10.8	38.3	16.4%	2.6%	9.2%	28.2%
Watermelons (units)		70,210.0	26,175.0	-	100.0	37.3%	0.0%	0.1%	37.4%
Potatoes	158.6	6,517.9	496.7	-	102.6	7.6%	0.0%	1.6%	9.2%
Sweet melons	13.2	466.0	44.5	-	1.3	9.5%	0.0%	0.3%	9.8%
Sweet melons (units)		27,000.0	950.0	-	-	3.5%	0.0%	0.0%	3.5%
Cucumbers	3.1	1,005.2	4.7	-	-	0.5%	0.0%	0.0%	0.5%
Cucumbers (units)		287.0	26.0	-	-	9.1%	0.0%	0.0%	9.1%
Lettuce	15.1	60,003.8	20,000.9	-	-	33.3%	0.0%	0.0%	33.3%
Lettuce (units)		207,160.0	42,160.0	-	-	20.4%	0.0%	0.0%	20.4%
Oranges	8.2	18.6	7.5	-	-	40.3%	0.0%	0.0%	40.3%
Mangoes	30.0	575.0	48.0	-	-	8.3%	0.0%	0.0%	8.3%
Lemons	0.5	6.0	3.0	-	-	50.0%	0.0%	0.0%	50.0%
Grapes	108.0	1,460.0	1.3	-	-	0.1%	0.0%	0.0%	0.1%
Dates	45.3	851.5	18.1	-	45.0	2.1%	0.0%	5.3%	7.4%
Totals (hectares & tonnages)	1,020.2	220,046.3	38,490	6,015.6	9,337.5	17.5%	2.7%	4.2%	24.5%
Totals (Units)		1,107,035.0	324,916.0	8,200.0	1,400.0	29.4%	0.7%	0.1%	30.2%

As depicted in Table 2, a high loss of more than 20% was recorded in horticulture crops such as cabbage, sweet potatoes, pumpkin, watermelons, and lettuce. Most of these losses are experienced

during the harvesting stage, which, overall, recorded a 17.5% loss. The main causes of the loss were improper harvesting practices (manual harvesting with casual workers with limited harvesting experience), poor transportation, inadequate packaging, and unsuitable storage conditions, resulting in physical damage, decay, and spoilage, significantly impacting the quality and quantity of the harvest. Similarly, oranges and lemons recorded a significant loss of 40.3% and 50% respectively, which were also experienced during the production/harvesting stages, primarily due to manual labour, pathogen attack, physiological disorders, and physical damage (such as bruising and peel injuries, causing pathogen growth and reducing quality and quantity).

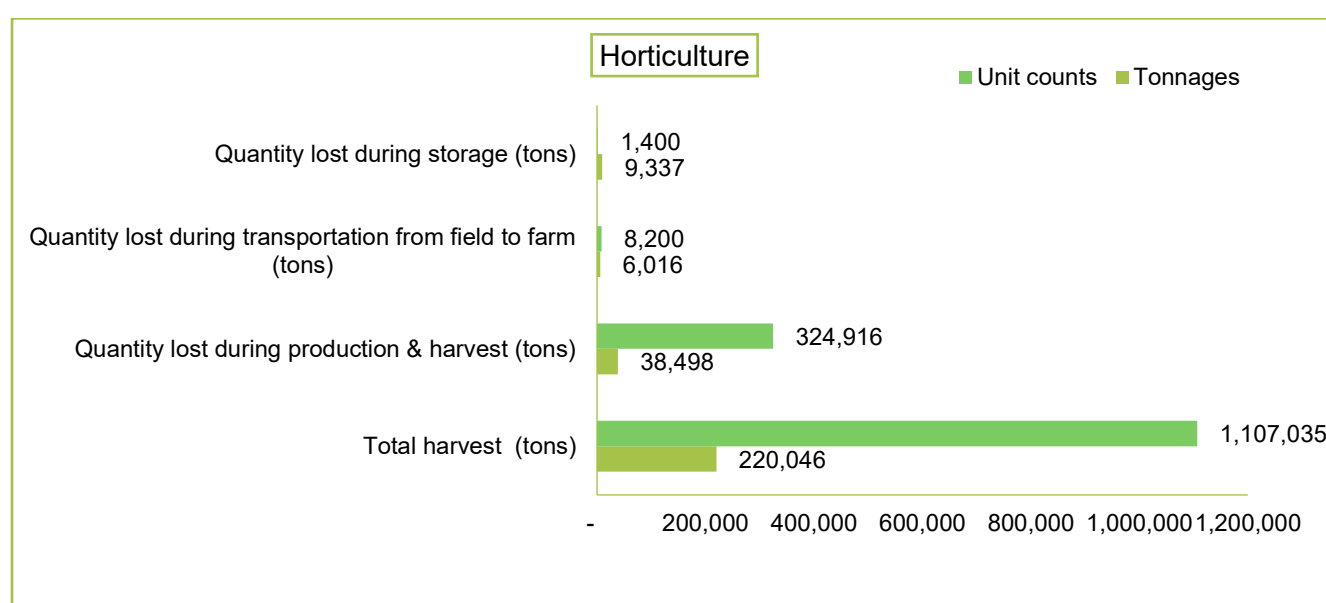


Figure 25: Overall analysis of loss per handling stage - Horticulture

As depicted in Figure 25 above, in terms of horticulture produce losses measured in tonnage, the largest loss was recorded at the production and harvesting stage (38,498 tons), therefore indicating that the majority of farmers lose most of their produce during harvesting and or production. The same is true for the horticulture products that were measured as single units, where a loss of 324,916 units out of a total of 1,107,035 units produced was incurred at the production and/or harvesting stage.

Table 3 illustrates the level of losses per agronomic crop at different stages based on the surveyed agronomy producers/farmers.

Table 3: Analysis of food loss at various handling stages at the farm level during 2022/23 season

Crop type	Area planted (Ha)	Total harvest (tons)	Quantity lost during production & harvest (tons)	Quantity lost during transportation from field to farm (tons)	Quantity lost during storage (tons)	% loss during production & harvest	% loss at transportation	% loss during storage	Total loss (%)
White maize	2,529.1	39,436.3	4,438.1	10.10	16.50	11.25%	0.03%	0.04%	11.32%
Pearl millet	195.1	101.2	8.1	0.20	2.60	8.02%	0.15%	2.53%	10.69%
Wheat	292.8	1,505.9	148.9	-	-	9.89%	0.00%	0.00%	9.89%
Totals	3,017.0	41,043.3	4,595.1	10.30	19.10	29.16%	0.18%	2.56%	31.90%

Table 3 indicates that losses in white maize grain mostly happened at the production and/or harvesting stage, of which 11.25% loss was recorded during the last season (2022/2023 season). Wheat also recorded a 9.89% loss during production and/or harvesting, whilst pearl millet experienced a high loss of 8.02% also at production and/or harvesting stages, respectively. On average, at least each agronomy crop (white maize, wheat & pearl millet) records a loss of 9.72% during production and/or harvesting, 0.06% loss during transport from the field to the farm shed/ storage area and 0.86% loss during the storage stage.

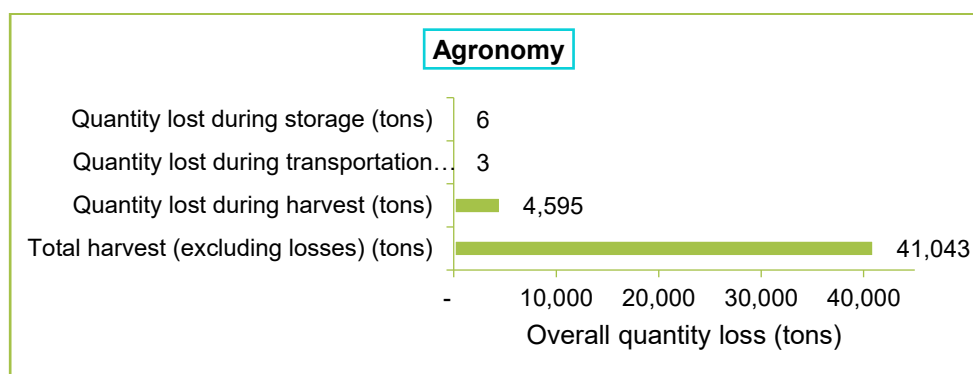


Figure 26: Overall analysis of loss per handling stage - Agronomy

Out of the overall crop loss experienced by the surveyed producers/farmers (2022/23), measured in tonnage (58,475 tons), horticulture loss accounts for 92% of the loss recorded, whilst agronomy crops only contributed an overall loss of 8%.

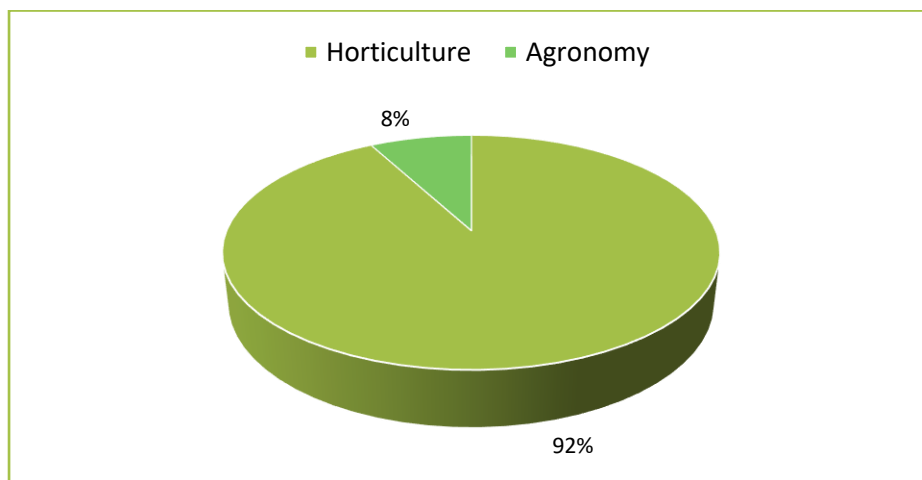


Figure 27: Food loss contributions: Horticulture vs Agronomy

In comparison to total production, out of 41,043 tons of agronomy crops produced, 4,624 tons (representing 11% agronomy loss) were lost at different handling stages. For horticulture, out of the total production of 220,046 tons, at least 53,851 tons (which represents 24%) were lost at different handling stages (Figure 28). Overall, across all crop types, the farmers interviewed for this study recorded a 22% loss against their total production for the period under review.

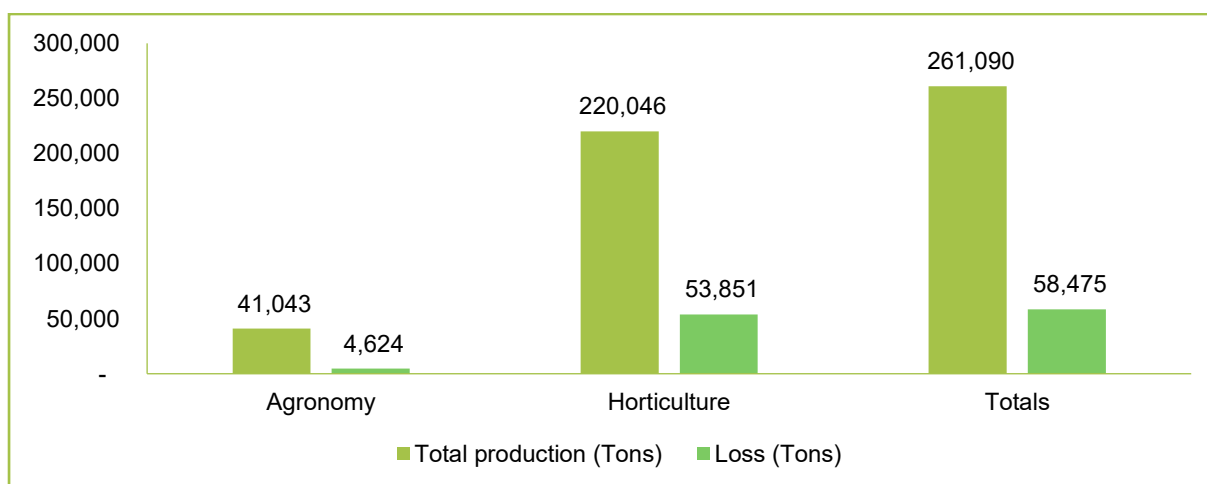


Figure 28: Total food loss vs production: Horticulture vs Agronomy

6.4 Ranking of handling stages where most food loss occurs in Namibia

For meaningful results, a total weighted score/frequency analysis was conducted to determine which of the handling stages farmers are likely to lose more of their crop produce, and hence to be considered

as food loss. This analysis will assist in identifying the handling stage that needs urgent interventions to eliminate or reduce food losses at the farm level. **Error! Reference source not found.** indicates the overall ranking of the handling stages in relation to the level of loss in Namibia.

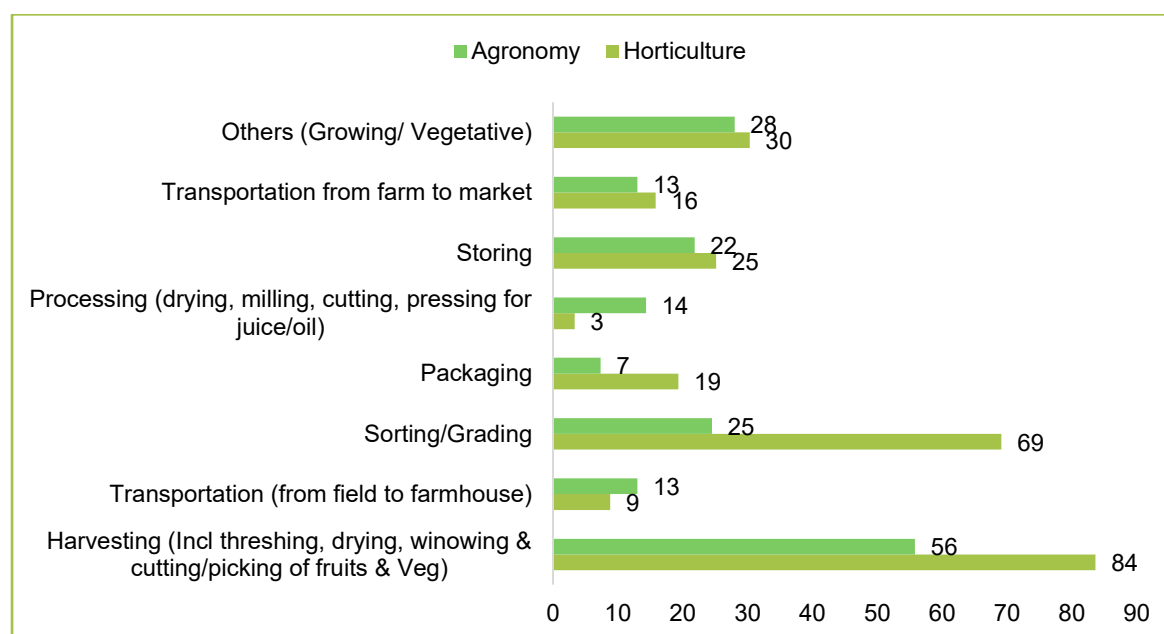


Figure 29: Ranking of handling stages in relation to the level of loss in Namibia

To interpret the results in **Error! Reference source not found.**, the handling stage with the highest weighted score is considered to be the one where farmers/producers are losing more of their produce, according to how they ranked the stages. Thus, as indicated in **Error! Reference source not found.**, the harvesting stage carries more weight for both horticulture and agronomy, followed by the sorting/grading stage for horticulture farmers only. These stages are, therefore, identified as the top two (2) stages where the majority of horticulture farmers are losing more of their harvested produce.

For agronomy, the farmers indicated that after the harvesting stage, it is the top stage where high loss is experienced. This top stage is recorded as 'other', identified or specified as the growing stage when plants are destroyed at the vegetative stage and never reach maturity due to many other reasons, followed by sorting and grading, and the rest of the stages follow subsequently.

The findings presented in **Error! Reference source not found.** indicate that food loss happens at every stage of the food supply chain activity at the farm; therefore, considering these results only represents a portion of the farmers surveyed, and it can be deduced that there is a possibility of more food loss

than what this report reveals. These findings are also partly in agreement with Gustavsson et al. (2011), who found that the highest food loss occurs at the production, handling, and storage stages.

6.4 Ranking of the most common causes/reasons for food losses in Namibia

To further understand the main reasons or causes of food losses in Namibia, Figure 30 presents the causes of crop loss or damage experienced by the farmers/producers during production, ranked in order of occurrence and also analysed by using the weighted score/frequency method.

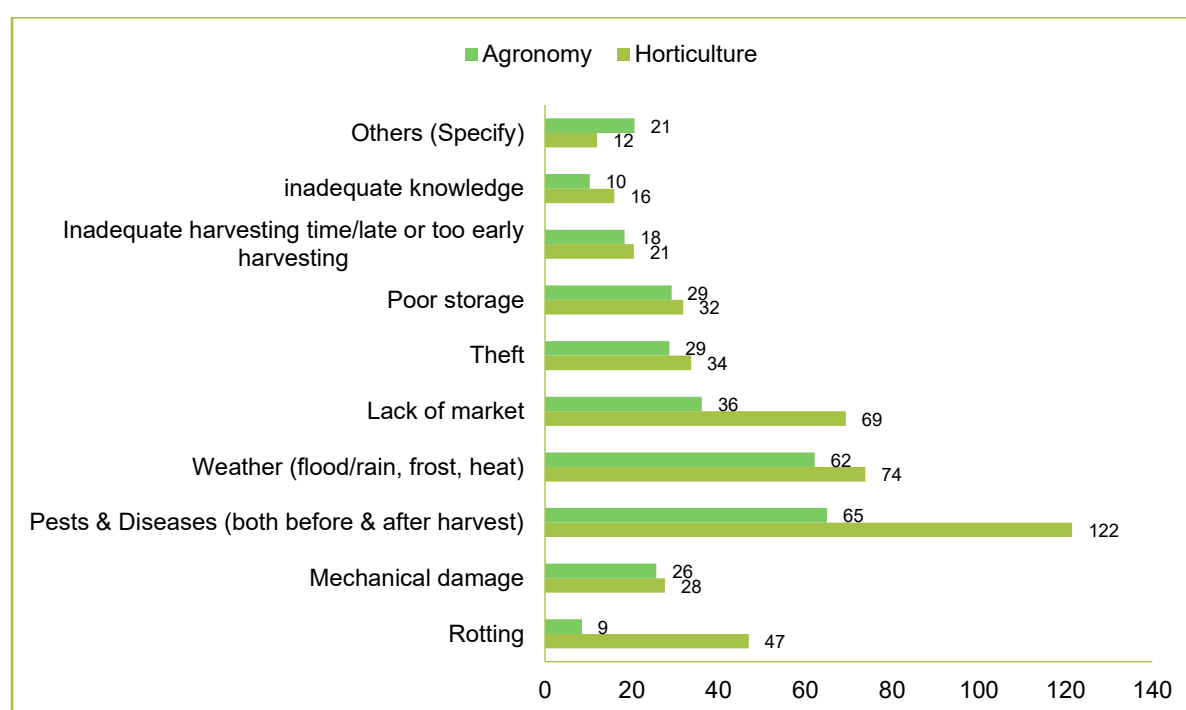


Figure 30: Ranking of common causes/reasons of food loss in Namibia

The major contributing factors to crop loss in Namibia, as indicated by the surveyed farmers, are pests and diseases for both horticulture (122 points) and agronomy (65 points). This is because many farmers also indicated that they lack access to chemicals to control these, and when such are available, it is mostly too expensive for them. This is then followed by weather (specifically low rainfall) (horticulture – 74 points and agronomy – 62 points). Subsequent to the factors mentioned above, farmers also identified a lack of market, theft, and poor storage as significant reasons why they experience food loss at the farm level (Figure 30).



Figure 31: A small-scale horticulture farmer spraying pesticides to control pests on his cabbage. (NAB Survey, 2023)

Methods and timing of harvesting (especially for grains) are said to be two of the most essential aspects leading to food loss at the production stage. Some farmers also explained that although not a common occurrence, a low rate of mechanisation, as well as an inadequate and inexperienced labour force, can delay harvesting during the harvesting season, which leads to food loss. Delayed harvesting, according to the farmers, can also be a decision due to economic reasons, such as low demand or high supply of the produce in the market, which would lead to lower returns because of low prices; therefore, to avoid financial loss, farmers deliberately leave the crop unharvested.

In addition, poor resource availability and management, such as water, which leads to poor nutrients, leads to food loss during the grading and sorting stage (Ishangulyyev et al., 2019). On the other hand, most farmers surveyed do not store their produce due to a lack of storage facilities; therefore, they harvest straight to the market. According to Martinez et al. (2014), a lack of storage and cold storage facilities leads to farmers experiencing food loss if highly perishable products are not sold on time. Therefore, good storage facilities help reduce food loss, particularly for perishable products.



Figure 32: Storage facility as a distribution point for organised farmers/cooperatives in the South Production zone in Namibia. (NAB Survey, 2023)

6.7 Possible suggestions to reduce food loss in the crop industry in Namibia

Based on the level of losses and causes for food losses experienced by producers/farmers at the farm level, farmers were asked to provide as many suggestions as possible for solutions to reduce food losses at the farm level and in Namibia's crop industry at large. These suggestions are summarised under Section 8 (Recommendations) according to different handling stages.

7. CONCLUSIONS

The objectives of this study was to quantify the level of losses of fruits, vegetables (major crops) and grains (white maize, wheat and pearl millet) in Namibia as well as to establish/investigate factors contributing to crop-related food losses in Namibia, the findings of this study revealed that a total of about 58,475 tons of food products (cereal, vegetables and a few fruits) were lost by the surveyed farmers in 2022/23. Out of this figure, horticulture contributed the biggest loss of 92% (53,851 tons), whilst agronomy contributed 8% (4,624 tons) respectively. The largest proportion of this loss was experienced at the harvesting stage, accounting for 74% of the loss, with transportation (from field to farm-shed) and storage accounting for 10% and 16% respectively (Figure 33). Figure 133 shows Namibia's rate of food loss on a national level.

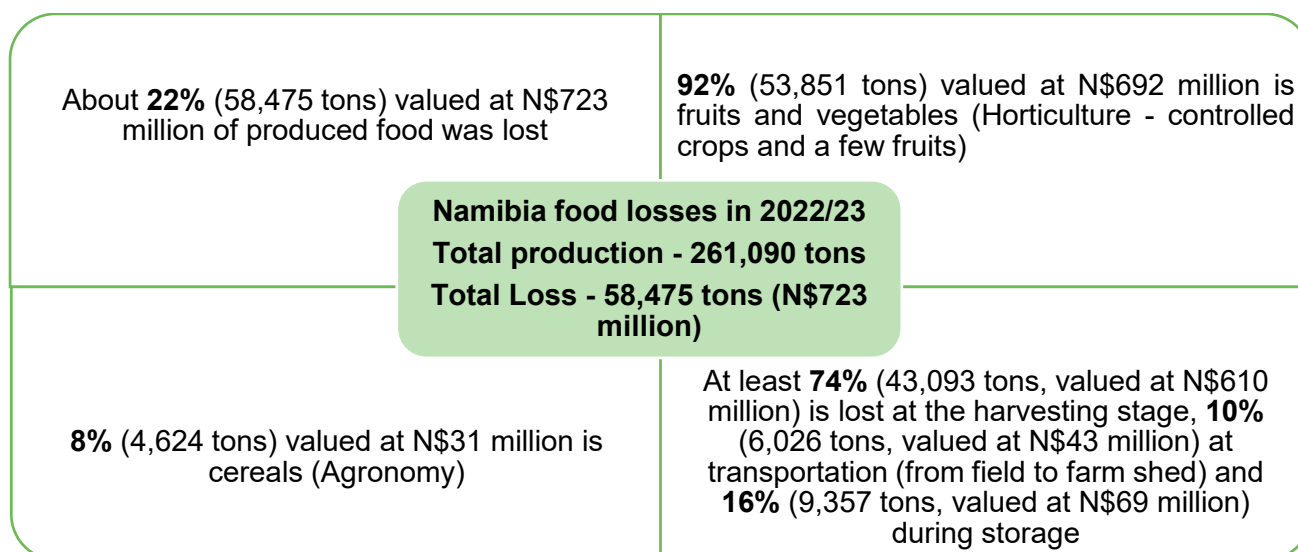


Figure 33: Namibia food losses (NAB, 2023)

According to the findings of this report, the main cause of food loss during the production stage for both agronomy and horticulture is mostly pests (including birds), followed by low rainfall, animals (wild animals), theft, and then diseases, respectively. At least 70% of producers interviewed in this study indicated that they harvest their produce manually, and only 9% use harvesting machines; thus lack of machines (such as harvesting machines) may lead to manual harvesting practices, which are more likely to cause some damage that will result in crop loss. No significant loss was reported by producers of both horticulture and agronomy crops during the transportation stage. However, substantial loss was reported as experienced during processing (which is mostly during the sorting stage) and storage stages due to some harvested produce being damaged, sub-standard, and or a lack of proper storage facilities for the produce.

Statistics presented in this report mostly rely on the food losses that happened at the farm level. Hence, this study has a limitation in terms of the availability of specific data for food loss on the processing level on a commercial basis, data that can be generalised to the processing industry in Namibia as a whole. This is because the only processors interviewed were all grain millers, and none for the horticulture processing industry. Whilst the agronomy processors (millers) are known to the NAB, there is very little information about horticulture processors involved in the large-scale commercial processing of horticulture products in Namibia.

Furthermore, due to limited resources and the unavailability of some of the wholesalers, the sample size for the interviewed wholesalers was quite small, and thus, no general conclusion could be made in terms of food losses at the wholesale handling/level in Namibia. These limitations, therefore, indicate room for further research to get a clear understanding of food loss across the entire food value chain.

8. RECOMMENDATIONS

From the results presented in Section 6, it is evident that food loss occurs in Namibia due to various reasons, as presented. It is, therefore, imperative that solutions or strategies are developed to help prevent or reduce food losses, especially at the farm level, as the main basis for this research. Based on the findings of this research, the following recommendations are made as categorised according to different handling stages.

Stage	Suggested strategy/solution
Production and harvesting stage	a) The government or any other institutions should provide continuous extension and mentorship services to farmers on production, crop management, value addition/processing, storage, marketing and market research, etc. b) The government or any other private entity should assist farmers in getting access to improved and/or new markets (especially export markets), especially for horticulture crops where large losses are experienced. c) Adopt new and improved harvesting techniques (e.g. proper tuber harvesting implements) that will not cause damage to produce while harvesting, especially for more sensitive horticulture crops. d) Agronomy crops tend to shatter more when harvested too late or mould easily when harvested too early. Farmers should ensure that produce is harvested at the right maturity time to guarantee quality while minimising crop damage. e) Horticulture crops are more perishable and have a short shelf-life. Farmers should enter into coordinated planting to ensure coordinated harvesting and delivery to buyers.

	f) Farmers should adopt effective pest and disease control programmes and coordinate with neighbours for migrant and resistant pests such as Tuta absoluta, which can cause extensive damage in horticulture crops, i.e. tomatoes.
Post-harvest stage (sorting/grading and storage)	a) Farmers should invest in improved and affordable technologies that will sort/grade harvested produce without causing any damage. b) The government should assist farmers by investing in storage facilities at the district/regional level, especially in areas where there are a lot of farmers. Farmers who can afford their own are also encouraged to invest in such appropriate storage infrastructures. c) Farmers should employ knowledgeable workers and train them in safe food handling practices.
Transportation stage	a) Encourage investment in affordable and appropriate transport facilities for farmers. b) The government should improve road infrastructure to ensure that farmers in remote areas also have access to affordable transport facilities and markets. c) Farmers should ensure that suitable drivers are employed or used to transport crops produced in various forms, i.e. perishables vs non-perishables. d) Ensure that a manageable tracking system is in place for easy monitoring of the status of the food products being transported.
Value addition/ processing stage	a) Farmers should invest in improved packaging to ensure and prolong the shelf life of fresh products. b) Ensure that workers are trained and can process the fresh produce, be it cutting, peeling, etc. c) Ensure that there are proper sanitary and cleaning inspections in place at the processing facility.

The study further recommends the following strategies that have some policy implications;

- a) Introduce incentive programmes to farmers or processors that have adopted strategies aimed at reducing food losses in terms of production and distribution (e.g., zero or reduced tax on agri-inputs for farmers/processors/wholesalers who make frequent donations to charity).
- b) Avail more funds to be used for extension services, mentorship, and food loss awareness campaigns to farmers and other key stakeholders in the food supply value chain alike.
- c) Formulate policies that will regulate contractual production agreements between farmers and sellers in case one of the parties fails to honour the agreement, especially after produce has been planted and harvested.
- d) The government should review the current market standards for crop products, with emphasis on Namibian farming conditions, so that the local farmers can meet and cope with them. Also, compel buyers to adhere to these standards when purchasing from local farmers/producers.

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