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Food losses in international trade of agricultural commodities: A case study in Sri Lanka

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Food losses in international trade of agricultural commodities: a case study in Sri Lanka



Jeevika Weerahewa
Thushara Wickramaarchchi

ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

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ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

WORKING PAPER

Food losses in international trade of agricultural commodities: a case study in Sri Lanka

Jeevika Weerahewa,¹ Thushara Wickramaarachchi²

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Abstract

Sri Lanka's development strategy has long emphasized enhancing trade competitiveness, with agriculture playing a significant role in its economy. This study addresses the critical yet often overlooked issue of food losses at the country's borders, which undermine its trade competitiveness. From 2016 to 2020, agricultural exports comprised about a quarter of Sri Lanka's total exports, while food imports accounted for around 13% of total imports. The research investigates the magnitude and causes of these border food losses and proposes strategies to mitigate them. Analysis using the Standard Compliance Analytics of UNIDO identified considerable rejections at entry and exit points. Stakeholder consultations indicated that these rejections primarily result from trading firms' inability to comply with complex regulatory and certification requirements. A lack of awareness among exporters about stringent standards in certain markets also contributes to these rejections. Stakeholders suggest strategies such as digitization, improved coordination between government agencies, and capacity building for government officials. The study recommends enhancing awareness among private agents about domestic and international regulations, improving the capacity of government officials, and developing infrastructure in the agricultural value chain, especially during grace periods following the introduction of new regulations, as well as prioritizing investments based on a cost-benefit analysis, considering both direct and indirect benefits of various options.

Keywords: *Stakeholder consultations, Food losses, Food security, GTAP*

JEL Codes: *Q17, F13, Q18, M48*

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List of abbreviations

ARR	Aggregate Rejection Rate
CDA	Coconut Development Authority
CPLs	Certificates, Permits, Licenses
CR	Coverage Ratio
CUSDEC	Customs Declaration
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FCAU	Food Control Administrative Unit
FDA	Food and Drug Administration
FI	Frequency Index
FLI	Food Loss Index
FSIS	Food Safety and Inspection Service
GMOs	Genetically Modified Organisms
GTAP	Global Trade Analysis Project
HACCP	Hazard Analysis and Critical Control Points
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
LMO	Living Modified Organism
MRL	Maximum Residue Limit
NGO	Non-governmental Organization
NPPO	National Plant Protection Organization

NPQS	National Plant Quarantine Service
NTB	Non-tariff Barriers
NTM	Non-tariff Measures
OIE	World Organization for Animal Health
PQS	Plant Quarantine Station
PS	Prevalence Score
PSC	Phytosanitary Certificate
RASFF	Rapid Alert System for Food and Feed
RI	Regulatory Intensity
RNQP	Regulated Non-quarantine Pests
RRRI	Relative Rejection Rate Indicator
SLTIP	Sri Lanka Trade Information Portal
SPS	Sanitary and Phytosanitary
TBT	Technical Barriers to Trade
TFA	Trade Facilitation Agreement
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
URR	Unit Rejection Rate
USDA	United States Department of Agriculture

1. Introduction

Reduction of food losses and waste along value chains has drawn the attention of researchers, policymakers and the general public over the past decade.³ Consequently, it has become a target and a goal in a number of policy documents in the national and international arena. Complete avoidance of food losses and waste, however, is neither feasible nor required. The marginal costs of food losses and waste reductions should be compared with social benefits when designing public interventions to ascertain optimal food losses and waste at different points in value chains.

The objective of this study is to examine the extent and causes of the food losses at the border of Sri Lanka and potential strategies to mitigate them by focusing on the food losses and waste associated with fruits and vegetables. The product choice was made because food losses and waste associated with perishables is much higher than those of non-perishables. It also is a growing export sector of Sri Lanka. A study covering Sri Lanka gives useful evidence for policymaking owing to two reasons. First, enhancement of export competitiveness, in general, and promotion of fruits and vegetables, in particular, is listed as a policy priority. Second, Sri Lanka ranks as one of the worst performing countries in terms of the trading food score (a score of 25.4 which is the penultimate score among countries listed) and the cost to obtain specific export documents (\$233) which is the fourth last country) of enabling the business of agriculture of the World Bank. Moreover, estimates on food losses and waste at the export point are scarce, however, some anecdotal evidence for the presence in Sri Lanka of fruits and vegetables does exist primarily owing to cumbersome export and import procedures (De Mel and others, 2011).

The present paper is organized into five sections. Following the introduction, the second section presents the concepts and measurements related to food losses and wastes occurring in international trade. The third section contains a description of the trends and patterns of trade of major food items of Sri Lanka, focusing on fruits and vegetables, and provides an outline of export and import procedures of Sri Lanka for various agricultural export items and destinations. The fourth section shows a computation of the extent of food losses at the border using rejections and provides causes of rejections for food and vegetables. The fifth section presents views of the trading firms and government officials on the losses in international trade and potential solutions. The sixth section provides an assessment of economic implications of the enhancement of border efficiency. The seventh section provides a summary and conclusions.

³ For recent work on food losses and waste in Sri Lanka, see Aheeyar and others, 2023; Wasala and others, 2014.

2. Conceptualizing and measuring food loss at international trade

2.1.1 Distinguishing ‘food loss’ and ‘food waste’

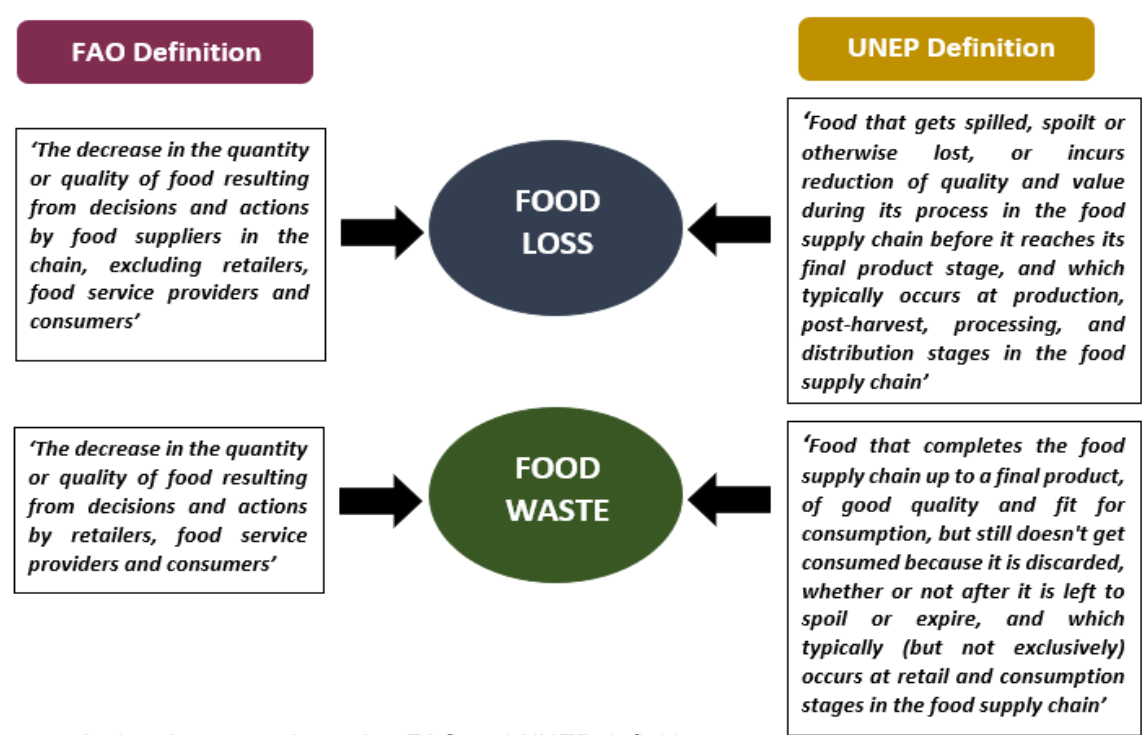
The Food and Agriculture Organization of the United Nations (FAO) estimates that in 2020, approximately 720.4 million to 811.0 million people around world were undernourished, and approximately 1.6 billion metric tonnes of food were lost or wasted globally. According to the FAO’s State of Food and Agriculture (2019) report, around 14 per cent of the world’s food (valued at \$400 billion per year) continues to be lost after it is harvested and before it reaches the shops; while UNEP’s Food Waste Index Report shows that a further 17 per cent of food ends up being wasted in retail and by consumers, particularly in households (UNEP, 2021). According to FAO estimates, the food that is lost and wasted could feed 1.26 billion people every year. The amount of food losses and waste was approximately one third of the food produced for human consumption (FAO, 2021). Recognizing and understanding food losses and waste has, therefore, become imperative. According to the United Nations Environment Programme (UNEP), food that was originally meant for human consumption but for various reasons is removed from the human food chain is considered as food loss or waste, even if it is then directed for non-food use (feed, bio-energy). However, knowing the exact distinction between food loss and food waste is important in formulating recommendations to reduce both of them.

FAO (2019) defines food *loss* as “the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers.” This refers to food that is discarded, incinerated or otherwise disposed along the food supply chain from harvest/slaughter/catch up to, but excluding the retail level, and does not re-enter into any other productive utilization, such as feed or seed. UNEP (2021) similarly defines food loss as “food that gets spilled, spoilt or otherwise lost, or incurs reduction of quality and value during its process in the food supply chain before it reaches its final product stage, and which typically occurs at production, post-harvest, processing, and distribution stages in the food supply chain”.

Food *waste*, on the other hand, refers to “the decrease in the quantity or quality of food resulting from the decisions and actions of retailers, food service providers and consumers” (FAO, 2019). UNEP (2021) further elaborates the definition of food waste as “food that completes the food supply chain up to a final product, of good quality and fit for consumption, but still doesn’t get consumed because it is discarded, whether or not after it is left to spoil or expire, and which typically (but not exclusively) occurs at retail and consumption stages in the food supply chain”. In other words, food is lost or wasted at every step of the supply chain, from the initial crop production in the field to final household consumption. Food losses occur from production to the retail level, whereas food waste occurs from the retail level to the consumption level. Fruits and vegetables are traded internationally over large distances involving several actors along the entire supply chain. The perishable nature of most fruits and vegetables, which results in shorter shelf life can, therefore, cause high food losses and waste. Losses of fruits and

vegetables during cross-border trade has received special attention due to the adverse impact on international trade. That said, this report focuses mainly on food losses of fruits and vegetables that occur during international trade with a specific reference to Sri Lanka.

Figure 1: Definitions of food loss and waste



Source: Authors' construction using FAO and UNEP definitions.

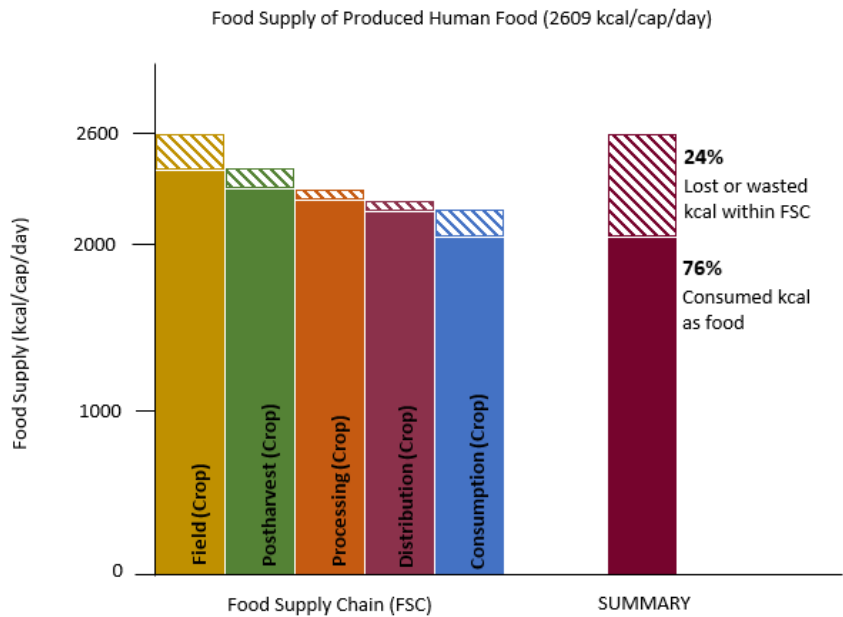
2.2 Food losses along the supply chain

A food supply chain consists of several segments. It begins with agricultural production and harvest, slaughter and catch, which refer to activities that take place when the produce is still on the farm or at the producer’s premises. It is followed by the post-harvest operations, which include cleaning, grading, sorting and treatments of produce. Consequently, food is moved to the storage and transportation stages, leading up to processing, which entails primary processing operations, such as drying, dehulling and deshelling. These stages often occur on the farm and involve secondary processing (product transformation). The wholesale and retail stages of the food supply chain follows the processing stage, and ultimately food is consumed by households or food services. The endpoint of the food supply chain is characterized by the consumption or removal of food from the supply chain.

In this food supply chain, approximately 25 per cent of the produced food (in terms of kcal) is lost (Kummu and others, 2012) (figure 2), and globally, approximately 14 per cent of food produced is lost during the post-harvest stage, up to, but excluding the retail stage (FAO, 2019). According to Kummu and others (2012), food losses in the value chain occur as agricultural, post-harvest losses or processing losses. Agricultural losses can

be the result of mechanical damage and/or spillage during, for example, harvesting or crop sorting, whereas losses resulting from storage and transportation between farm and distribution, and spillage and degradation during handling constitute post-harvest losses. Processing losses occur during industrial or domestic processing (Kummu and others, 2012).

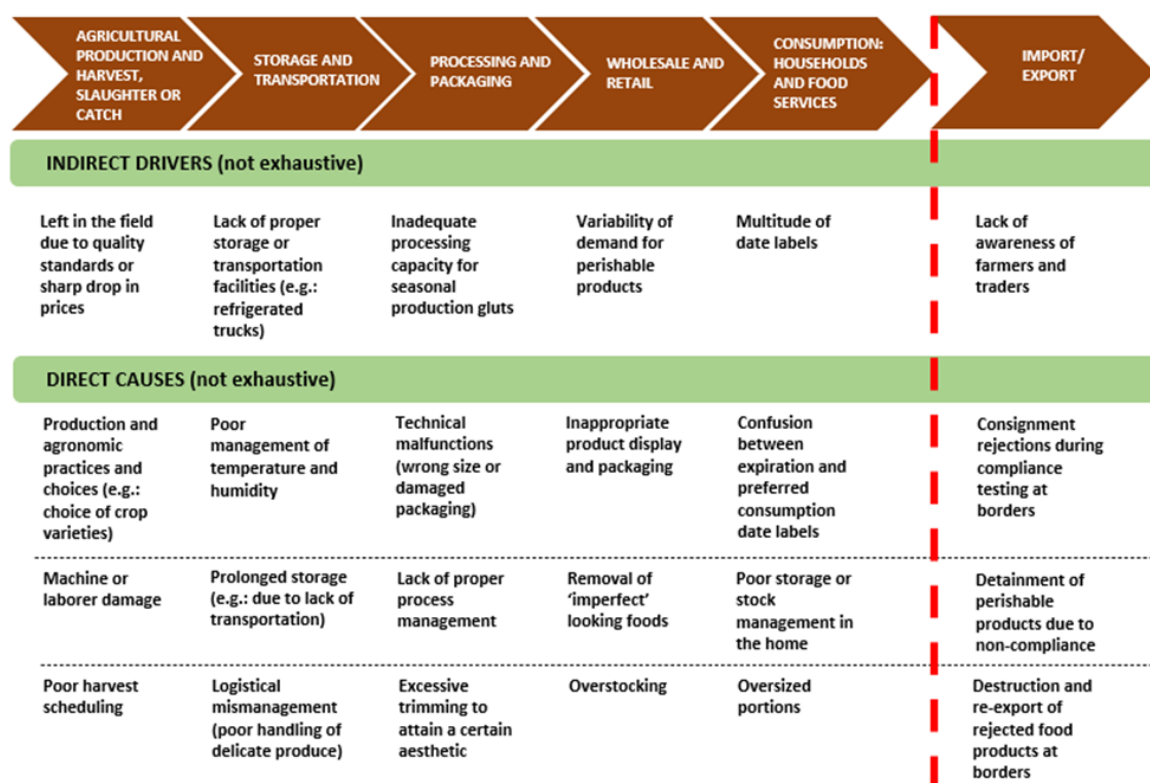
Figure 2: Food lost or wasted along the food supply chain



Source: Kummu and others (2012).

The FAO (2019) has also elaborated on how losses occur along the food value chain during agricultural production and harvest, slaughter and catch, storage and transportation, and processing and packaging (figure 3). Leaving crops in the field, poor production and agronomic practices, machine/labour damage and poor harvest scheduling are factors behind food loss during agricultural production and harvesting. Lack of proper storage and transportation facilities, poor management of environmental conditions and logistical mismanagement cause food losses during storage and transportation, meanwhile, inadequate processing capacity, technical malfunctions, and poor process management result in food losses during processing and packaging (FAO, 2019). Food loss can be measured by the Food Loss Index (FLI). The global average is 13.8 per cent whereas the FLI value for Central and Southern Asia is approximately 20.4 per cent. Sustainable Development Goal 12 for ensuring sustainable consumption and production patterns includes the reduction of global food waste at the retail and consumer levels and the reduction of food loss along the production and supply chain by 2030. Sustainable Development Goal target 12.3 is to achieve reduced per capita food waste by 2030, at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

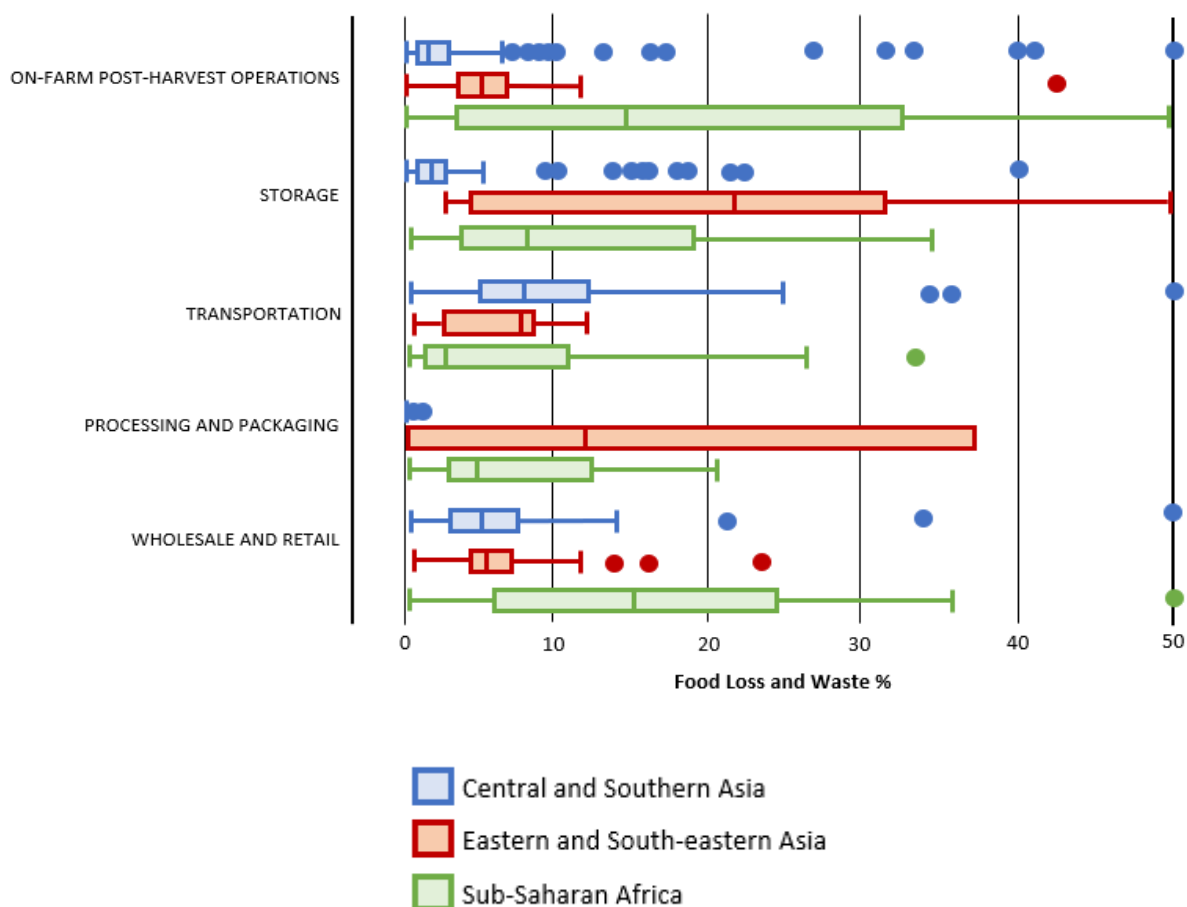
Figure 3: Potential direct causes and indirect drivers of food losses and waste



Source: FAO (2019).

Although food losses occur at every stage in the food value chain, the FAO (2019) has identified critical loss points along the chain where food losses and waste are most prominent and have the greatest impact on food security. The maximum values of losses and waste are higher for fruits and vegetables than for cereals and pulses at all stages in the food supply chain, except for on-farm losses and losses during transportation in Eastern and South-Eastern Asia. In Central and Southern Asia, the value of losses for cereals and pulses is limited at all stages in the food supply chain. The losses of fruits and vegetables are significantly high in sub-Saharan Africa and Eastern and South-Eastern Asia. These losses often occur during on-farm post-harvest operations, storage, and the processing and packaging stages in the food value chain (FAO, 2019). Food loss and waste occurs in developing countries, such as Sri Lanka, at the producer level, during the post-harvest handling and storage and during the early and middle stages of the food supply chain level due to managerial, financial, and technical limitations. Inherent uncertainties in agriculture, such as pests, adverse weather conditions and fluctuation of prices, contribute significantly to the amount of produce lost and wasted. Thirty per cent of all marketable produce is estimated to be left behind in harvest. However, information regarding food losses that occur during international trade is highly limited and, therefore, needs to be further explored. Figure 4 shows the losses of fruits and vegetables at every stage of the food value chain in three regions; Central and Southern Asia, Eastern and South-Eastern Asia and sub-Saharan Africa.

Figure 4: Range of reported food loss and waste percentages in supply chain stage (2000–2017)



Source: FAO (2019).

2.3 Food losses in international trade

Global trade, while providing livelihoods for farmers and people employed in the food supply chain, also plays a crucial role in improving the food and nutrition security of countries particularly those in Asia, Africa, and Latin America (Ge and others, 2021). Currently, agricultural trade exceeds \$1.1 trillion and is highly complex and interconnected (Benton, 2017). When considering the international trade of fruits and vegetables, only 7 to 8 per cent of the global production is exported. Global trade more than doubled between 2000 and 2018, with Latin America, the Caribbean and Asia becoming the largest exporters (FAO, 2020). In line with the increase in international food trade, the food supply chain is transcending international borders. Through international food trade, consumers benefit from year-round supplies, a greater variety of food and lower prices, but contrarily, it can also have implications on food safety.

International trade of agricultural produce could introduce new food safety risks, revive previously controlled risks, and spread contaminated food wider. Consequently, producers could also suffer from higher production costs, damaged reputations and

closed-off international markets. To handle these issues, trading countries practice regulatory approaches. For instance, in the United States of America, four agencies: Food Safety and Inspection Service (FSIS) in the Department of Agriculture (USDA); the Food and Drug Administration (FDA); the Environmental Protection Agency (EPA); and the National Marine Fisheries Service of the Department of Commerce have major regulatory roles. These four agencies actively monitor imports and sometimes they survey the safety of production abroad as well. The FDA oversees almost all import inspections, which include testing for pesticide residues and sanitary violations. FSIS handles meat and poultry products and conducts audits of foreign plants to ensure that sanitation meets United States standards. FSIS also re-inspects imports of these products using statistical sampling techniques to verify that exporting countries' inspection systems are working. The FDA has introduced voluntary guidelines for good agricultural practices that provide recommendations to growers - domestic and foreign - on how to reduce microbial hazards (FAO, 2016). Food safety concerns focus on pesticide residues, microbial and chemical contamination, and the effects of biotechnology (Buzby, 2003). Similarly, Asia-Pacific countries, such as Japan, also regulate the import of food and agricultural products. Japan does this through seven major laws that specify requirements related to, among others, food labelling, food additives, alcoholic beverages, animal products, nutrition claims, and organic food. Food importers submit notifications to the Food Sanitation Inspection Section of the Ministry of Health, Labour and Welfare Quarantine Stations in Japan, which determines if the imports are conforming to the Japanese Food Sanitation Act prior to being allowed entry into the country (USDA, 2018). In the European Union, fresh produce needs to comply with multiple safety and quality standards. Stringent European legislative requirements on safe food production provide emerging and developing countries with restricted and limited opportunities for export (Uyttendaele and others, 2014).

Failure to comply with minimum food safety standards can lead to food losses and, in extreme cases, affect the food security status of a country. In the fruits and vegetables industry, post-harvest losses occur in international markets due to non-compliance with trade regulations and buyers' demands (Kader, 2003). Compliance testing may result in at-the-border rejections of products imported from third countries (Uyttendaele and others, 2014). Such rejections and detentions are costly and lead to food losses and waste. In some instances, food may be reconditioned or relabelled and thus salvaged, however it is not always possible to do this with perishable food. Often, the food is rejected outright, and the exporter looks for a nearby buyer. Ultimately, the unacceptable food might be "dumped" on an unsuspecting third country. According to FSIS, agricultural produce is detained under authorities and later disposed of or condemned if found to be adulterated or misbranded. The loss of quality is an increasing concern as products showing qualitative loss often end up being rejected in destination markets, such as the United States and the European Union (Fonseca and Njie, 2009). Studies indicate that developing or transition countries account for more than 88 per cent of all the European Union food and feed rejections between 2002 and 2008 (Uyttendaele and others, 2014). Such rejections, detainments and seizures are critical food losses that occur further down

the food value chain during international trade that require great concern, as these losses have a higher economic value than losses that occur earlier in the supply chain (FAO, 2019).

The European Union Rapid Alert System for Food and Feed (RASFF) collects and disperses information on food safety problems that occur on the European Union market or with products entering the European Union and third countries rapidly so that corrective measures can be taken at the production end. According to calculations of losses of food by third countries as a result of the European Union border rejections, made by the United Nations Industrial Development Organization (UNIDO), the total value of the rejections between 2004 and 2008 for fruits and vegetables was calculated to be \$9 million, 0.01 per cent of the import value. According to UNIDO, the rejection data should be considered as indicators reflecting the challenges countries face to comply with the European Union food safety requirements and obtain market access (UNIDO, 2010).

2.4 Measuring food loss in international trade

To reduce the loss of food that occurs in international trade, it is necessary to first identify the extent of food losses through indicators and quantify them. The Food Loss and Waste Protocol, a multistakeholder effort of institutions, such as FAO, UNEP and the World Resources Institute, that addresses challenges in consistently measuring and credibly reporting on food loss and waste, has developed a global standard: “The Food Loss and Waste Accounting and Reporting Standard”. This standard provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food supply chain. The food loss can be quantified by obtaining data from multiple sources. In instances where direct access to food loss cannot be obtained, food loss records, databases, and surveys are used for measurement or approximation methods. RASFF, the Standard Compliance Analytics of UNIDO, and the National Plant Protection Organizations are sources that present indicators and data relevant to quantify food losses. However, in instances where direct access to food losses can be obtained, weighing, counting, assessing volume, or waste composition analysis can be conducted as quantification methods (Food Loss and Waste Protocol, 2016). Various methods of measuring food losses are displayed in table 1.

The Rapid Alert System for Food and Feed reports notifications on risks identified in food, feed, or food contact materials that are placed on the market in the notifying country or detained at an the European Union point of entry at the border with an the European Union neighbouring country. It displays notifications on consignment rejections, detainments, consumer complaints, releases and other information based on the notifying-country, hazard category and product category. UNIDO also provides information on border rejections in major global markets for different products from different exporting countries. It records rejections in such a way so as to identify the products and markets with the highest rates of non-compliance. UNIDO uses the

Rejection Analysis Tool to assess the overall impact of rejection on the export performance of countries of origin and estimates their compliance capacity by interpreting rejection trends together with additional key development, production and trade-related indicators. In addition, the Trade Standards Compliance Footprint of Sri Lanka records food trade patterns and performance and the number of food product import rejections, and displays rejection analysis based on the product group.

Table 1: Methods of quantifying food loss

	Methods	Definition
Measurement or approximation	Direct weighing	Using a measuring device to determine the weight
	Counting	Assessing the number of items that make up food loss and using the results to determine the weight; includes using scanner data and “visual scales”
	Assessing volume	Assessing the physical space occupied and using the result to determine the weight
	Records	Using individual pieces of data that have been written down or saved, and that are often routinely collected
	Diaries	Maintaining a daily record or log of food losses and other information
	Surveys	Gathering data on food loss quantities or other information, such as attitudes, beliefs, and self-reported behaviours, from a large number of individuals or entities through a set of structured questions
Inference by calculation	Mass balance	Measuring inputs, such as ingredients at a factory site, or grain going into a silo, and outputs, such as products made and grain shipped to market, alongside changes in levels of stock and changes to the weight of food during processing
	Modeling	Using a mathematical approach based on the interaction of multiple factors that influence the generation of food losses
	Proxy data	Using food loss data that are outside the scope of an entity’s food loss inventory, such as older data, food loss and data from another country or company, to infer quantities of food loss within the scope of the entity’s inventory

Source: Food Loss and Waste Protocol (2016).

UNIDO reports several indicators to assess food loss in international trade: the aggregate rejection rate (ARR), the unit rejection rate (URR), the relative rejection rate indicator (RRRI), and the frequency of reasons for the rejection of products (UNIDO, 2023). Rejection rates, however, provide only a crude and partial picture of the difficulties in compliance faced by developing countries with regard to agrifood exports. The data provides observations of specific instances in which an exporter attempts to gain access to the United States of America or the European Union markets but fails because of their inability to conform to the official requirements enforced at the border inspection. However, data on exporters that choose not to export due to real or perceived weaknesses in compliance capacity is not reflected by these indicators. Accordingly, Food Loss and Waste Protocol (2016) recommends focusing on broad patterns and trends of rejection data, and not overinterpret the data using a wide scatter of small numbers of rejections, as it could result in “noise” instead of concrete compliance concerns.

- Aggregate rejection rate

The Aggregate rejection rate is the simple sum of the annual number of rejections. Increases in the number of rejections can reflect increases in the volume of exports, and the rate of non-compliance to food safety and quality standards. The rate of non-compliance reflects the state of compliance capacity in the exporting country, the products exported, which means whether they are high or low risk regarding food safety, and the regulatory regime in place for these products in the importing country.

- Unit rejection rate (URR):

The number of rejections per \$1 million of exports. This measure takes into account changes in the volume of exports such that it provides a direct measure of the rate of non-compliance. It is presented as a series of a three-year moving average to smooth out often appreciable year-on-year variations. The unit rejection rate (URR) is, therefore, a more accurate indicator than the aggregate rejection rate, which considers the developing and developed countries' export capacities. However, as very small exporting countries, such as Sri Lanka, have low values of exports, the associated unit rejection rates are often extremely high, even if they have single rejections. Accordingly, they tend to distort the data in calculating average rates over the years. Countries that have high average rates of unit rejection indicate long-term problems with non-compliance. Lower-middle income and low-income countries, in particular, have the highest unit rejection rates.

- Relative rejection rate indicator (RRRI):

The relative rejection rate (log ratio) is the natural logarithm of the ratio of a country's share of total rejections to the share of total imports. This indicator provides a convenient measure of the performance of countries relative to one

another in a year or over a period. A higher relative rejection rate (log ratio) for an exporting country in one market over the other markets implies poorer performance related to food safety and quality standards in that market relative to other markets. The graphical depiction of the relative rejection rates of countries allows their comparison with one another with regard to compliance. In such a graph, the position of each country reflects their performance relative to one another. A line of 45° represents the boundary between relatively “good” and “bad” performers in terms of rates of rejections. Countries listed above the line are relatively bad performers as their share of rejections exceeds their share of exports. In contrast, those whose share of rejections is less than their share of exports are good performers and are listed below the line. Relatively poor performers among large agrifood exporters are China, Türkiye, India, Thailand, Viet Nam and the Islamic Republic of Iran in the case of the European Union, and India, Viet Nam, Dominican Republic and the Philippines in the case of the United States. Brazil, Argentina, Chile and Ecuador are relatively high performers among large exporters for the United States and the European Union, while Morocco, Ecuador and South Africa are high performing large exporters to the European Union, and Guatemala and Colombia are high performing large exporters to the United States. Sri Lanka is a relatively poor performer; it is placed above the 45° boundary in terms of rejection rates in the European Union and the United States, indicating the country’s poor compliance capacity. In addition to the compliance capacity of exporting countries, this indicator also reflects the regulatory focus of the importing country.

- Frequency of reasons for rejection:

The frequency of reasons for rejection is the total count of consignments rejected at the border of entry for a particular reason. Possible reasons for rejection are labelling, hygienic conditions, adulteration, missing documents, additives, bacterial contamination, pesticide residues, veterinary drug residues, mycotoxins, heavy metals and packaging. This indicator helps exporting countries identify areas in which capacity-building is required to attain or improve international trade standards compliance. The most important reason for rejections of food and feed imports over the period 2002–2008 in the case of the European Union is the presence of mycotoxins, which account for 40 per cent of all rejections. In contrast, in the United States, the most frequent reason for rejection of food imports is the contravention of labelling requirements, which accounts for 58 per cent of all rejections, followed by 29 per cent of rejections owing to an unregistered process or manufacturer. In the European Union and the United States, microbiological contamination is a widely referenced reason for agrifood import rejections, which comprises 13 per cent of the European Union rejections and 12 per cent of the United States rejections. The most frequent reason for rejection of agrifood products exported by Sri Lanka to the United States is also labelling requirements, which make up almost 50 per cent of the reasons for rejection of Sri Lanka exports,

followed by 25 per cent of rejections due to unregistered processes or manufacturers. The frequency of the reasons for rejections of Sri Lanka exports to the United States market is similar to the average reasons for rejections experienced by the United States with regards to other exporting countries.

National Plant Protection Organizations (NPPO) around the world are involved in regulatory activities related to the importation and exportation of plant and plant materials and provide data on food losses that occur at the borders of their respective countries. NPPOs are official services established by governments to discharge functions specified by the International Plant Protection Convention (IPPC) overseen by FAO. NPPOs coordinate all matters related to crop pests and disease control. Among the activities they are involved in are certification, quarantine control, and testing of seeds and planting material, including grading and inspection of plants and plant products at the ports of entry and exit. NPPOs are also responsible for regulating all importation and exportation of plant commodities and seeds through import clearance and export certification. NPPOs in importing countries investigate and detain imported consignments potentially contaminated with quarantine pests and/or those that have failed to comply with phytosanitary regulations. For instance, in Sri Lanka, if the consignment satisfies the import permit conditions of Sri Lanka, it is released with phytosanitary measures, but if not, it is rejected. The rejected consignments might be destroyed with expenses covered by the importer or might be re-exported to the exported country or any other buyer if the NPPO of the importing country has no objection to receiving the goods. National Plant Quarantine Service (NPQS) records details of consignments, which are subject to destruction in a separate register. In addition, it records the number of import permits issued or inspected, the number of emergency phytosanitary treatments taken on imports, the number of quarantine pests intercepted, the number of notifications of non-compliance and the number of phytosanitary certificates issued.

Primary data collection methods also can provide information necessary to quantify food losses that occur during international trade. As conducted by the FAO (2016), preliminary screening of food losses using key-informant interviews can be first carried out before a survey. Screening involves consulting experts in the food value chain by phone, email, or in person, without travelling to the field. It helps researchers obtain a rough idea of the range of losses and some main causes for those losses, as a qualitative understanding of losses is achieved and indicative quantitative data for the loss assessment are attained. Ultimately, it provides the baseline for a particular area, zone, or country, and background for the planning and implementation of the process of quantifying food loss. Screening can then be followed by a survey of a food loss assessment. For this, a questionnaire differentiated for different actors of the food supply chain, such as producers, processors, handlers or sellers, and other knowledgeable persons in the supply chain could be introduced. As implemented by FAO in 2016, researchers can obtain information for assessing food losses from experts in local institutions; departments of food science, ministries of agriculture, ministries of environment; climate change focal points; ministries of health, national statistics and research institutions;

libraries; non-governmental organizations (NGOs); international donor organizations; the private sector; ongoing projects; and media sources. Surveys, when assessed, should be complemented with ample and accurate observations and measurements. Focus group discussions can also be conducted to complement surveys. They provide a preliminary step in the development of a quantitative study, which can yield insights about perceptions, reported practices, population attributes, sources of knowledge, levels of awareness, opinions, attitudes, problems and fears, and the language (vocabularies) used to talk about these factors (Khan and Manderson, 1992). If quantitative data are sourced by primary means, its ability to reflect reality depends on the accuracy of the actors in a survey, and data from the government and other institutions in the screening process.

In primary data collection, respondents may provide responses that are socially acceptable, or are in line with the impression they want to create, and may depict an estimation of behavioural frequency rather than the recall and count response desired by the researcher (Kimberlin and Winterstein, 2008). Obtaining a representative sample and valid responses from the respondents are other issues posed by interview surveys. To ensure valid responses, interview questions must be carefully designed, evaluated, and tested (Hox and Boeije, 2005). Weighing food losses often produces the most accurate results because there is no guesswork and no need to make assumptions, assuming appropriate devices that deliver an accurate reading, such as weighing scales, and pre-calibrated containers, are used (Food Loss and Waste Protocol, n.d). The accuracy of data collected through records, diaries, and surveys varies depending on the nature of the data and how they are collected and analysed. Furthermore, data are more accurate if fewer assumptions and calculations need to be made.

As stated above, food losses can also be inferred through calculations. Calculating food loss involves estimating the amount of food loss and waste based on other data and calibrating it computationally by using models and simulations. Models that can be used to measure food losses apply factors that are known to influence the amount of food loss and waste, such as climatic or agricultural data. However, the accuracy of the resulting estimate is influenced by the quality and accuracy of the original data chosen, and the assumptions on which they are based.

2.5 Learning point

In developing regions, food loss and waste deprive the poor of opportunities to access food, cause significant depletion of resources, such as land, water, and fossil fuels, and increase the greenhouse gas emissions associated with food production (Munesue and others, 2015). In the food supply chain, approximately 25 per cent of the produced food (in terms of kcal) is lost (Kummu and others, 2012), and globally, approximately 14 per cent of food produced is lost at the post-harvest stage, up to, but excluding the retail stage (FAO, 2019). Fruit and vegetable deterioration takes place during handling, storage, transport or marketing, and numerous factors, related to the pre-harvest and post-harvest stages, influence the nature and extent of deterioration (Snowdon, 1988).

However, accurate information regarding food losses that occur during international trade is highly limited.

Global trade of agricultural produce plays a crucial role in improving the food and nutrition security of countries, especially in Asia, Africa, and Latin America (Ge and others, 2021). Food losses occur in various forms during international trade. Failure to comply with minimum food safety standards, non-tariff trade barriers and failure to “harmonize” or adopt accepted food standards result in food shipments being rejected by importing countries and compliance testing results in rejections of products at-border. The rejected agricultural produce by importing countries results in seizures and detainments of consignments, and consequent re-export to exporting countries, dumping into unsuspecting countries or outright destruction, which causes considerable economic, environmental, and social losses.

Food loss that occurs as a result of consignment rejections and detentions is costly. Such rejections, detainments, and seizures are losses that occur further along the supply chain. Accordingly, they have a higher economic value than losses earlier in the supply chain (FAO, 2019). According to UNIDO, the total value of the rejections between 2004 and 2008 for fruits and vegetables was calculated to be equal to \$9 million or 0.01 percent of the import value. The quantification of food losses that occur during international trade is necessary to devise means to reduce them. RASFF, Standard Compliance Analytics of UNIDO, and National Plant Protection Organizations present indicators and data relevant to quantify food losses. Food losses in international trade can be quantified using the Aggregate Rejection Rate, URR, RRRI and the frequency of reasons for the rejection of products. Moreover, food loss simulations and modelling, and approximation methods, such as direct weighing, assessing volume, records, diaries, discussions and surveys, are also useful methods that provide insights into the quantitative and qualitative aspects of food losses and their causes.

3. Trade of fruits and vegetables of Sri Lanka: patterns and procedures

3.1 Trends and patterns of international trade of fruits and vegetables in Sri Lanka

The following section includes a discussion on fruit and vegetable trade involving Sri Lanka. The potential for the production of fruits and vegetables in Sri Lanka for export markets is very high. Improving the quality and safety of fruits and vegetables supplied to export markets is important for the continuous improvement of the sector, to boost the national income, as well as to generate employment opportunities. The social concern related to quality deterioration due to post-harvest losses and the presence of agrochemical residues in the harvested fruits and vegetables is a pressing issue in Sri Lanka.

Agriculture exports comprise approximately 25 per cent of the total exports of Sri Lanka during the period 2016–2020. Exports of HS Chapter 07 (edible vegetables, certain roots and tubers) and HS Chapter 08 (edible fruits and nuts; peel of citrus fruits or melons), which largely cover vegetables and fruits, accounted for 1.50 per cent and 6.28 per cent of agricultural exports, respectively. When desiccated coconuts, arecanuts, and fresh coconuts are excluded, HS Chapter 08 represents edible fruits and only accounts for 1.52 per cent during the period 2016-2020 as per the statistics extracted from the Trade Map (<https://www.trademap.org/Index.aspx>).

Some of the major exported fresh vegetable items of Sri Lanka are beans, capsicum, tomato, cucumber, leeks and mushrooms. In terms of generating foreign exchange, fresh or chilled pumpkins, squash, and gourds "*Cucurbita* spp." and fresh or chilled edible mushrooms and truffles (excluding mushrooms of the genus *agaricus*) are at the top of the lists. The main imported fresh vegetable items are carrot, cauliflower, cucumber, tomato, and asparagus. Banana (fresh), papaw, pineapple (fresh), mango (fresh), lemon (fresh), lemon (dried), pineapple (dried), guava (fresh) are the major fruit items exported from Sri Lanka. According to Perera and others (2015), the largest exported fruit is the bananas, due to the commercialization of cavendish production. Export of other local banana varieties, such as ambul, kolikuttu, sugar plantain, rathambala, and ambun is fairly limited, despite their popularity among local consumers. Due to such issues as quality, post-harvest losses, and high perishability, Sri Lanka is unable to meet the demand of the Maldivian hotel industry. Pineapples are exported from Sri Lanka in a variety of forms, including fresh, juice, dried, and preserved (canned). Perera and others (2015) also state that though there was rising global demand for Sri Lankan pineapple, the country's export market share has decreased in recent years due to the high production costs and inefficient supply chains. Apples, mandarins, dates (dried), oranges (fresh), grapes (fresh), grapes (dried), and cashews are the major imported items.

The value chains of fruits and vegetables from which products are channelled to the export market are elaborated in Hathurusinghe and others (2012), Hathurusinghe (2015), Ranathunga and others (2009) and Vidanapathirana and others (2018).

3.2 Non-tariff measures affecting trade of agri-food trade of Sri Lanka

Trade can contribute towards enhancing food security, which improves access to food, lowers costs, mitigates supply shocks, and strengthens economic and social prosperity. Many economies impose non-tariff measures (NTMs), which can enhance competition, increase product quality, mitigate market failures for consumer goods, and protect human and environmental well-being. This ultimately leads to strengthened food security. The United Nations Conference on Trade and Development (UNCTAD) defines NTMs as policy measures other than the tariffs, which are used to regulate international trade. Hence, NTMs cover a broad range of policies including traditional trade policy instruments, such as quotas or price controls. Frequency index (FI), coverage ratio (CR), prevalence score (PS), and regulatory intensity (RI) are some of the indicators used to

summarize and compare NTMs across products, countries and sectors. Table 2 shows the data on NTMs for vegetables in Sri Lanka.

Table 2: Non-tariff measures usage of Sri Lanka by sector

Sector	Frequency index	Coverage ratio	Prevalence score
Agriculture	98%	97%	11.1
Manufacturing	42%	48%	0.8
Natural resources	49%	93%	1.7

Source: UNCTAD (2022).

NTMs comprise technical regulatory measures that pursue important non-trade objectives related to health and environmental protection, such as sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT). Some NTMs create market distortions, reduce food security, and make consumers worse off. They arise from different measures taken by governments and authorities in the form of government laws, regulations, policies, conditions, restrictions or specific requirements, and private sector business practices, or prohibitions that protect the domestic industries from foreign competition. Table 3 shows NTM usage of Sri Lanka by measures.

Table 3: Non-tariff measure usage of Sri Lanka by measures

Measure	Frequency index	Coverage ratio	Prevalence score
SPS	19%	41%	3.4
TBT	13%	43%	3.5
Pre-shipment	3%	3%	1.0
Quantity	44%	59%	1.0
Price control	9%	27%	1.0
Export measures	22%	31%	3.5

Source: UNCTAD (2022).

Table 4: Non-tariff measures for vegetables in Sri Lanka

NTM Code	NTM Description	NTM Coverage ratio (%)	NTM Frequency ratio (%)	NTM affected product – count
A	Sanitary and phytosanitary measures	99.28	97.44	304
A140	Special authorization requirement for SPS reasons	6.41	12.18	38
A150	Registration requirements for importers	13.09	18.91	59
A220	Restricted use of certain substances in foods and feeds and their contact materials	98.53	89.1	278
A310	Labelling requirements	98.54	90.06	281
A400	Hygienic requirements	98.53	89.1	278
A490	Hygienic requirements n.e.s.	97.09	84.62	264
A830	Certification requirement	98.54	89.42	279
A840	Inspection requirement	98.61	93.91	293
B	Technical barriers to trade	100	100	312
B110	Prohibition for TBT reasons	0.89	1.28	4
B140	Authorization requirement for TBT reasons	18.39	14.74	46
B150	Registration requirement for importers for TBT reasons	100	100	312
B310	Labelling requirements	98.54	90.06	281
B400	Production or post-production requirements	98.53	89.1	278
B700	Product quality or performance requirement	22.94	25.32	79
B830	Certification requirement	98.53	89.1	278
B840	Inspection requirement	98.53	89.1	278
C	Pre-shipment inspection and other formalities	0.97	8.33	26
C300	Requirement to pass through specified port of customs	0.08	4.81	15
C900	Other formalities, n.e.s.	0.89	3.53	11
F	Charges, taxes and other para-tariff measures	5.53	3.85	12
F650	Import license fee	5.53	3.85	12
P	Export related measures	100	100	274
P110	Export Prohibition	0.25	1.46	4
P130	Licensing or permit requirements to export	74.72	6.57	18
P140	Export Registration requirements	100	100	274
P500	Export taxes and charges	74.49	4.01	11
P610	Inspection requirement	98.36	90.88	249
P620	Certification required by the exporting country	98.36	91.24	250

P690	Export technical measures, n.e.s.	98.36	90.88	249
P900	Export measures n.e.s.	0.23	2.55	7

Source: World Integrated Trade Solution (2022).

Note: n.e.s.; not elsewhere specified.

3.3 Export and import procedures of Sri Lanka

Sri Lanka is a signatory to the SPS agreement of WTO, which came into force in 1995. SPS measures are intended to ensure food safety and protect the health of animals and plants, as well as the environment. They are developed using international standards and are covered by IPPC, which is the relevant international standard-setting organization for phytosanitary measures, the Codex Alimentarius Commission Codex Alimentarius Commission for food safety standards, and the World Organization for Animal Health (OIE) for animal health standards, which are not supposed to use as unjustified barriers to trade. Table 5 shows the legal provisions and institutional organizations for the import and export of food commodities.

Table 5: Legal provisions and institutional organizations for import and export of food commodities

Legislation	Regulatory agency	Objectives
Food Act No. 26 of 1980 (Amended by Act No. 20 of 1991 and Act No. 29 of 2011)	Food control administrative unit of the Ministry of Health	Regulate and control the manufacture, importation and sale of food and to establish a food advisory committee
Plant Protection Act no.35 of 1999	National Plant Quarantine Service (NPQS), Department of Agriculture	To make provisions against the introduction and spreading of any organism harmful or injurious or destructive to plants and facilitate the trade
Coconut Development Authority Act 1987 (based on original 46 of 1971)	Coconut Development Authority (CDA) of the Ministry of Plantations	To regulate the development of the coconut industry and utilization of land
Sri Lanka Tea Board Act, 1975	Sri Lanka Tea Board	Development and regulation of tea industry
Export Development BoardDB Act and Gazette notification	National Organic Control Unit, Export Development Board	Competent authority for organic products, farming, processing, exports, and imports
Animal Feed Act, 1986	Department of Animal Production and Health	To regulate, supervise, and control of manufacture, sale, and distribution of animal feed
Forest Ordinance No. 16, 1907 and 65 of 2009	Forest department	Conservation, protection and Sustainable development of forest resources
Imports and Exports Control) Act, 1969	Import and Export Control Department	To provide for control of importation and exportation of goods and regulation of exports

Of the thirty agencies involved in the export and import process for regulation and compliance with the quality and other standards in Sri Lanka, the agencies listed in table 6 facilitate the trade of plant-based food and feed commodities. The following two sections focus on the certification and clearance procedures of exports and imports.

Table 6: Agencies facilitating the trade of plant-based food and feed commodities

	Agencies	Output
1.	Sri Lanka Standards Institute	Quality certificate
2.	Ceylon Chamber of Commerce/Department of Commerce	Certificate of origin
3.	Department of Animal Production and Health	Approval for the importation of feed ingredients
4.	Department of Wildlife Conservation	Permit for wild-life-based products
5.	Forest Department	Permit for timber and forest-based food products
6.	National Plant Quarantine Service	Phytosanitary certificate and Fumigation certificate
7.	Sri Lanka Ceylon Tea Board	Permit for exports
8.	Coconut Development Authority	Regulation of coconut-based products (import and export)
9.	Import and Export Controller Department	Licensing of commodities

3.4 Import certification and clearance procedure

Importation of plants, plant products, and other regulated plant-based commodities requires import permits issued by the National Plant Quarantine Service (NPQS), which acts as the National Plant Protection Organization (NPPO) for Sri Lanka. The requisite of such permits primarily depends on the phytosanitary risks likely to be associated with commodities, the country of origin or the impact of importation on the local industry. Phytosanitary risks include, but are not limited to, the introduction of harmful pests. Import permits are mandatory for food and feed commodities, such as temperate fresh fruits (cherries, nectarines, plums, apples), groundnut, popcorn, cashew, black tea, green and specialized tea, and spices to regularize their imports. However, obtaining an import permit has not been made mandatory for the majority of low phytosanitary risk dried food commodities, such as cereals, pulses and certain condiments. The major regulatory agencies dealing with various aspects of import and export procedures of food commodities are shown in table 7.

Table 7: Different food commodities that need concurrence from other agencies for issuance of import permits by the National Plant Quarantine Service

Commodity group	Subcommodity / group / commodity	Concurrence from other agencies
Food Commodity for human consumption	Popcorn	Ministry of Agriculture
	Cashew (with shell)	Ministry of Agriculture; Sri Lanka Cashew Corporation
	Cashew kernels	Sri Lanka Cashew Corporation
	Soybean (for oil extraction)	Ministry of Agriculture

Commodity group	Subcommodity / group / commodity	Concurrence from other agencies
Groundnut for consumption	Groundnut	Ministry of Agriculture
Dried herbal tea mixtures	Green Tea, black tea	Sri Lanka Tea Board
Export agricultural spices plant products (PIP)	Ginger, cardamom	Department of Export Agriculture
Animal feed ingredients	Wheat grains, maize grains	Ministry of Agriculture; Department of Animal Production and Health
	Other ingredients, such as soybean meal	Department of Animal Production and Health

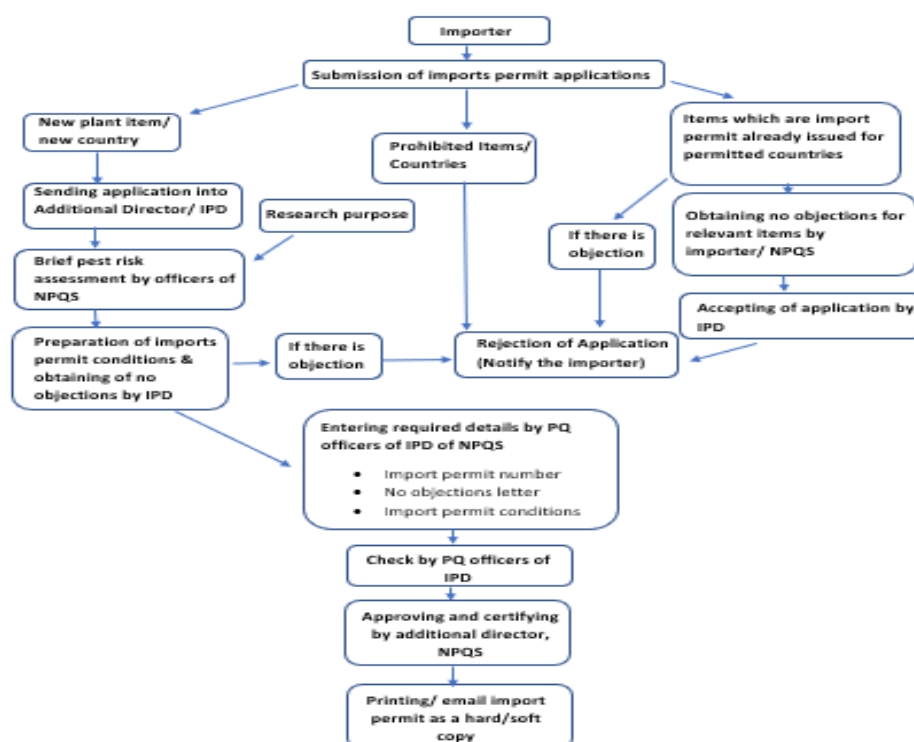
Some commodities are restricted or banned from importation under the regulations of the Plant Protection Act. These restrictions are based on the potential phytosanitary risk to the country. As an example, plant products originating in the American tropics or any country in which South American Leaf Blight (*Microcyclus ulei*) occurs are prohibited or strictly restricted to import. Thirty-seven commodities, including, among them, coconut products, coffee, paddy (except rice), fresh fruits and fresh vegetables are prohibited imports. Genetically modified organisms (GMOs) and living-modified organisms (LMOs) are also restricted for importation into Sri Lanka.

The food import control procedure is implemented at the borders by the Sri Lankan Food Control Administration Unit of the Ministry of Health to ensure that imported food items are safe for human consumption. A total of 101 food products are regulated under the Food Act No. 26 of 1980. The import consignment can be processed only if all the necessary documents are in order.

The plant quarantine clearance process begins with the submission of relevant clearance documents and the duly filled notice of the arrival of agricultural commodities to the officer in charge at the plant quarantine station, seaport or airport by the importer. If documents are missing, concessionary time is granted to produce those documents. Upon the successful submission of all necessary documents, the import item is registered and physical inspection commences. However, clearance documents of low-risk food commodities for human consumption, such as rice, chickpea, green gram, lentils, cowpea, beans, meth seeds and fennel, are submitted directed to the plant quarantine authorized officers in custom-bonded warehouses where registration, physical inspection, and quarantine clearance are also being carried out. In general, all food commodities are cleared by the plant quarantine after being granted from the clearance from Food Control Administration Unit. If any document issues are considered to not be in compliance with the import permit conditions, the authorized officer at the entry point seeks technical instructions from the headquarters of NPQS. For certain commodities, such as groundnut, popcorn, cocoa bean and soybean meal, mandatory laboratory testing is required to verify that these commodities are free from specific pests and diseases. These commodities are partially cleared instantly and permitted to keep in

consignee stores until the full clearance is granted based on the test reports. The majority of commercial food consignments are imported through the seaport at Colombo, whereas samples of food commodities, such as tea herbs and wheat flour, are imported through the airport, Katunayake. The flowchart for issuing import permits by NPQS is illustrated in figure 5.

Figure 5: Process flowchart of issuing import permits by the National Plant Quarantine Service



3.5 Export clearance procedures

Apart from local consumption, vegetables and fruits are exported to Maldives, the United Kingdom of Great Britain and Northern Ireland, India, Pakistan, Qatar, Saudi Arabia (and other Middle Eastern countries) and Germany. Germany and India are the leading fruit importers of Sri Lanka. Carrot, leeks, cabbage, cauliflower, salad leaves, beetroot, beans, bell pepper, cucumber, pumpkin and bitter melon are the main vegetables being imported whereas pineapple, melon, banana, baby jak, lime, dragon fruit and papaya are the main fruits being exported from Sri Lanka. In 2021, the value of exports of fruits and exports of vegetables was \$39.46 million and \$27.44 million, respectively (Export Development Board, 2022)

There are certain inherent issues associated with the fresh fruits and vegetable supply chain in Sri Lanka. Due to the fragmentation issue, a large number of intermediaries take a sizable amount of farmers' income. Forward and backward integration between farmers and other players in the supply chain is poor, which adversely affects the effectiveness

and profitability of the supply chain. Supply chain infrastructure is required to deliver the harvest at the right time and in the right quality. In Sri Lanka, inadequate infrastructure is one of the main impediments in the supply chain; it is causing extensive losses (Vidanapathirana and others,2018).

Proper packaging is vital to maintain the shelf life of perishables. As a result of the high cost of packaging material and lack of awareness, proper packaging during transit from field to the packhouse is not adequate. Dissemination of production technologies at the field level and lack of awareness of farmers are the main setbacks to introduce a system approach to comply with export conditions to high-end markets, such as the European Union. The poor awareness level of the farmer may hinder the efficiency of the supply chain of fresh fruits and vegetables. The supply chain needs to facilitate the delivery of fresh goods on time while adhering to phytosanitary requirements and quality standards, which have become a stumbling block to reaching the export market, apart from other issues, such as poor hygiene and safety standards.

Post-harvest losses are a major problem in the supply chain of the fruit and vegetable sector in Sri Lanka. A very large amount of losses are recorded in the supply chain of perishable food before reaching the export markets. Approximately 30 to 40 per cent of total food production is lost. Heavy losses are incurred during the transport and storage of fresh food produce (Rajapaksha and others,2021).

Withering due to water loss, senescence-associated discolouration (yellowing or browning), mechanical injury, high respiration rate and decay or rotting are the main causes of quality deterioration and post-harvest loss of leafy vegetables set for the export market (Vidanapathirana and others,2018).

Exporters are adopting good practices to minimize post-harvest losses. They are using plastic crates in refrigerated trucks/reefer trucks for packing and to transport fruits and vegetables from which losses can be reduced to approximately 5 per cent (Vidanapathirana and others,2018).

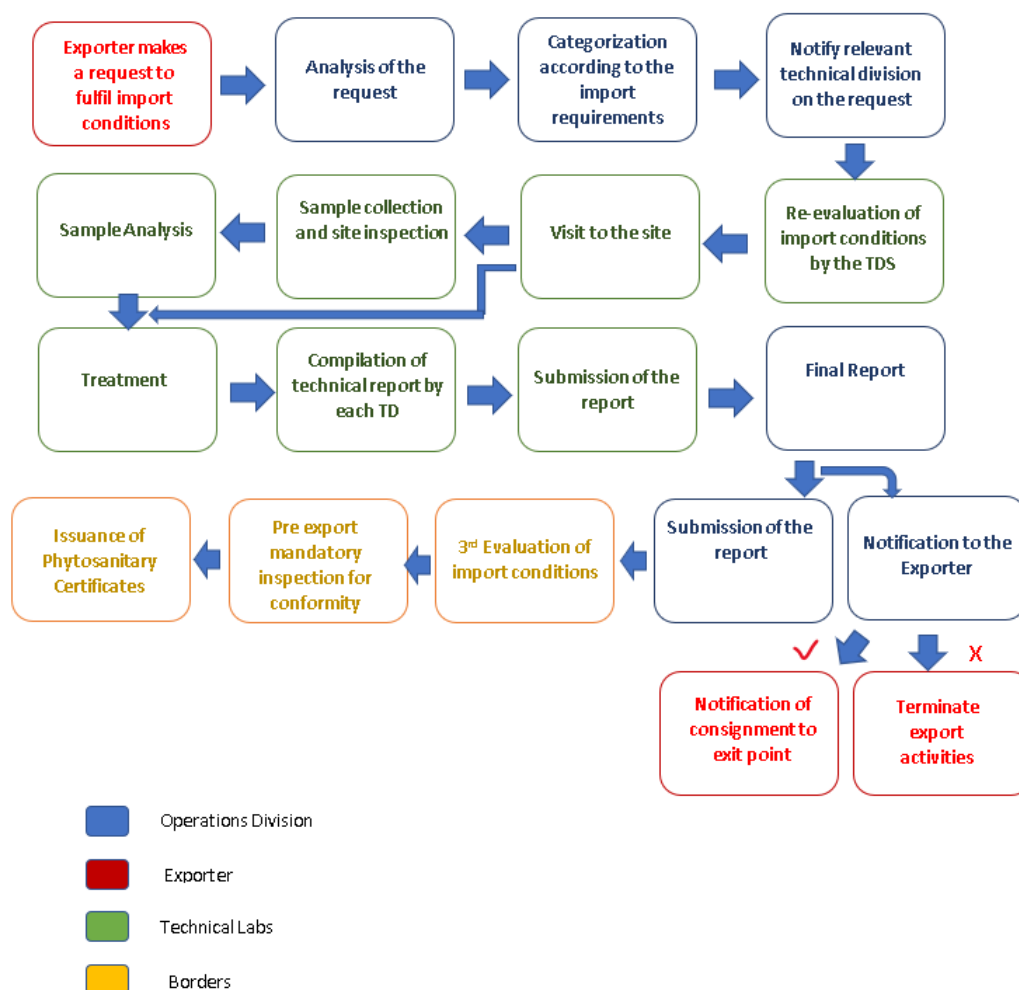
An exporter of any article of commercial value from Sri Lanka is required to complete one-time registrations with the Sri Lanka Export Development Board and obtain an Export Development Board registration number, and register with the Inland Revenue Department to get a Tax Identification Number (TIN Number/VAT Number), and also with Sri Lanka Customs. The exporter or the authorized agent must also submit a customs declaration (CUSDEC) form as per section 57 of the Customs Ordinance to dispatch the consignment. All exporters are required to make a one-time registration at NPQS, as an exporter, whose information is shared with entry point of plant quarantine stations to proceed with the export process.

For key export categories of food commodities, namely tea, coconut-based products, spices, fruits, and vegetables, plant quarantine certifications and export clearance are required. Sri Lanka received an increased number of non-compliance notifications from the European Union in 2017 due to regular failure to fulfil phytosanitary conditions for

fruit and vegetable consignments. This prompted NPPO to introduce a field certification programme (system approach) for exporting food commodities to the European Union. As an initiation, production fields of high-risk crops such as snake gourd, guava, mango, mugunuwanna (*Alternanthera sessilis*), and thampala (*Amaranthus tricolor*), are being certified by adopting an integrated crop management package developed with the technical support of relevant agricultural research institutions working to control the key problematic pests of these crops. The production process of these fields is closely monitored by field-level agricultural extension officers and plant quarantine authorized officers. Some other exported crops, such as okra and brinjal, have not yet been placed under this field certification programme.

The next step is export inspection and phytosanitary certification of plants and plant products at the plant quarantine station at the airport. The phytosanitary certificate is a document issued by the NPPO of Sri Lanka, which confirms the health status of a plant material (plant or plant product) being exported. Afterward, shipping and clearance documents are verified. If all necessary documents are in order, the samples are inspected for any pests; the consignment is rejected if regulated non-quarantine pests, other pests, soil and other extraneous matter are detected or there is a lack of homogeneity, and the products are prohibited by the importing countries. If the consignment is not in compliance with required phytosanitary conditions, the quarantine officer at the plant quarantine station can hold the consignment; the rejections are notified to the exporter/forwarding agent by the plant quarantine officer with a copy including all the details of the rejected consignment. The most common reason for such internal rejections at the entry point is the presence of harmful organisms. If all the conditions are fulfilled, the phytosanitary certificate issued to the exporter/forwarding agent. Figure 6 is a flowchart of the export certification procedure of NPQS for plant products.

Figure 6: Export certification procedure of National Plant Quarantine Service for plant products



Gunaruwan and De Silva (2014) reported the issues faced by exporters pertaining to the quality and safety of fruits and vegetables, which were conveyed through a survey conducted by the Ceylon Chamber of Commerce. These issues are (a) indiscriminate use of agro-pesticides due to lack of knowledge on standards on the application, (b) high post-harvest losses compared to the competitor countries, (c) lack of extension services provide by the Department of Agriculture, which forces exporters to establish an ad hoc extension programme by themselves, (d) lack of good quality seeds for cultivation, (e) lack of laboratory facilities to carry out testing in the country and (f) no domestic certification institutes to provide internationally accredited organic certification.

3.6 Sanitary and phytosanitary requirements for the exportation of fresh fruits and vegetables

The World Trade Organization (WTO) agreement on the application of SPS measures and agreement on technical barriers to trade (TBT) have significantly and positively

affected the international trade of food commodities. Failure to meet the standards and exporting poor quality food leads to the rejection of shipments. SPS standards regulations in Sri Lanka has yet to reach the international SPS standards, particularly in terms of sanitary standards for fruits and vegetables. However, of the two standards, phytosanitary standards are adequately looked after by the authorities of Sri Lanka. Furthermore, interventions at the production and growing stage to ensure sanitary and safety are minimal. The Food Act of Sri Lanka is being revised in line with international standards. Recently, the Registrar of Pesticides formulated maximum residue levels for pesticides stipulated by different international laws for fruits and vegetables. The establishment of good agricultural practices, good manufacturing practices, and the Hazard Analysis Critical Control Point (HACCP) programme together with SPS measures in Sri Lanka assures to cover all aspects of growing, harvesting, packing, transportation, processing, and distribution of fresh fruits and vegetables, which ultimately lead to effective cross-border trade with minimum food losses (Vidanapathirana and others, 2018).

According to the provision of Plant Protection Act No. 35 of 1999 and regulations therein imposed by NPQS, phytosanitary aspects are being looked after in exporting and importing fruits and vegetables. For exports of fruits, a phytosanitary certificate issued by an authorized officer of the Plant Quarantine Service of the country of origin is compulsory. Furthermore, no plant or plant products can be imported without a valid permit obtained from the Director General of Agriculture.

3.7 Challenges in fresh fruit and vegetable trade toward food loss

Specific policies directed towards the cross-border trade of food are either inadequate or a low priority. National regulatory standards must be formulated and reviewed based on a risk assessment and incorporate available scientific evidence. These standards must be harmonized with international standards of the Codex standards, IPPC and OIE, as per the conditions stipulated in the SPS agreement.

Lengthy and complex border control procedures with a many paper-based documents may lead to unintentional errors in fulfilling requirements and documentation errors. Either delays or refusal can be experienced due to non-compliance of the total set of requirements.

Potential reasons for food loss are not properly communicated with all players in the supply chain and all stakeholders. The food loss management approach consists of a food loss risk assessment, risk management and risk communication, and provides a framework for governments to effectively assess, manage and communicate food loss risks among all relevant stakeholders.

Officials involved in food inspection are not adequately trained and equipped for systematic food inspection based on the food safety and phytosanitary risk associated with them. Accordingly, competent officials must be trained in ensuring consistent, transparent and effective food inspection so that wrong decisions may not be made.

Food testing laboratories with laboratory infrastructure are not adequate to provide timely service across the country. Consequently, samples are required to send long distances for testing, and a sufficient number of laboratory facilities with trained technical officers are required to establish to meet international standards.

Lack of awareness of stakeholders in cross-border trade on import and export requirements, including legislative, quality, sanitary and phytosanitary requirements. The Information must be disseminated through education, communication and training so that stakeholders are fully aware of every aspect of cross-border trade requirements.

Highly diverse regulatory requirements on cross-border trade with different countries. It is a challenge to make sure compliance is with all requirements of the destination country.

The potential for cultivating fruits and vegetables in Sri Lanka for export markets is high. Improving quality, sanitary and phytosanitary compliance is of utmost importance to assure cross-border trade without refusal, otherwise food losses may occur. Managing overall quality and assuring the safety of fruits and vegetable supply chains is one of the most challenging issues in Sri Lanka.

In Sri Lanka, considerable quantities of fruits and vegetables are lost due to pest damage and improper post-harvest operations. The post-harvest losses of fruits varied from 20 to 40 per cent, with the highest losses recorded for papaya, while for vegetables, it was 20 to 46 per cent, with the highest loss recorded for okra (Vidanapathirana and others,2018). Post-harvest losses are also high in Sri Lanka due to hot and humid climate conditions and lack of awareness and knowledge of stakeholders related to fruit and vegetable supply chains. Every actor in the supply chain of fruits and vegetables has an important role to play in assuring the quality, sanitary and phytosanitary standards, which can be deteriorate due to lack of pest management practices, improper pre-harvest, harvesting, poor handling and poor logistical operations, inappropriate packaging, storage and transportation. The causes of losses are biotic and abiotic, including pest, disease, physiological, physiochemical and mechanical damages. Some food commodities are lost due to contaminations with pesticides beyond the maximum residue limits (MRLs) and the occurrence of natural contaminants, such as mycotoxins. Pesticide usage is not properly regulated because of ineffective legislation and poor awareness and technical know-how among the farming community in Sri Lanka.

The task of ensuring sanitary and phytosanitary requirements of food in Sri Lanka is conducted in an ad hoc manner. Responsibilities are dispersed across several government agencies and departments, such as the Department of Agriculture, the Consumer Affairs Authority, the Sri Lanka Standards Institute, the Atomic Energy Authority, Sri Lanka Customs, the Department of Animal Production and Health and the Ministry of Health, based on their respective areas of expertise. The lack of national standards to measure food safety and the absence of an effective institutional mechanism to enforce food safety at different stages in the food chain affect the process.

Compliance to the WTO agreements on the application of sanitary and phytosanitary measures and agreement on TBT are important requirements in the international trade of food. Non-compliance may lead to the refusal of imports or exports and, in turn, contribute to food loss. For the export of fruits and vegetables, it is important to follow good agricultural practices, good manufacturing practices, International Organization for Standardization (ISO) 9001 quality management system and hazard analysis and critical control points (HACCP) standards. Sri Lankan standards for fruits and vegetables, and leafy vegetables to control microbial, chemical and physical hazards associated with all stages from production to packaging of fruits and vegetables have been formulated by the Sri Lanka Standards Institute. In addition, compliance with phytosanitary requirements is monitored by NPQS, in collaboration with the field extension arm of the Department of Agriculture.

4. Data and variable selection

4.1 Data collection

As identified in earlier sections, the analysis of food losses in international trade is primarily performed under four different indicators.

1. Aggregate rejection rate (ARR)
2. Unit rejection rate (URR)
3. Relative rejection rate indicator (RRRI)
4. Frequency of reasons for rejections

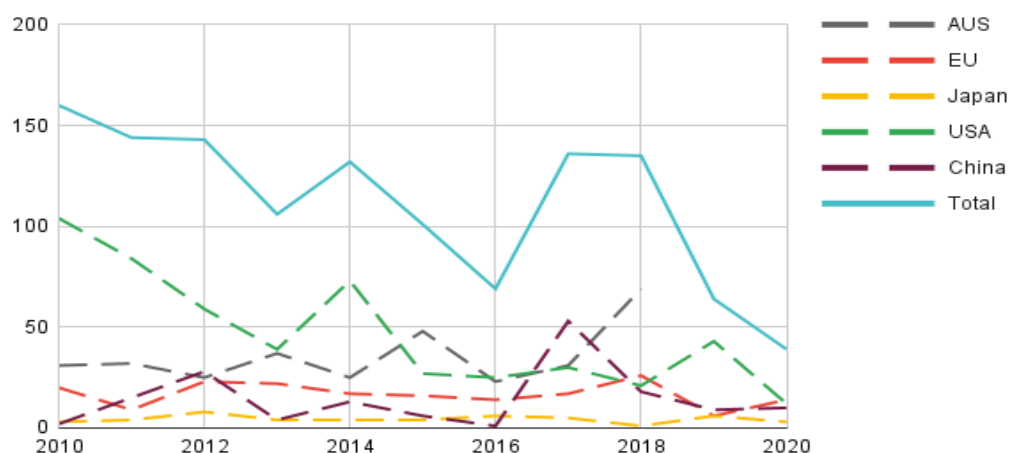
Data required for the analysis were gathered from the knowledge hub of (UNIDO) from five international markets, namely Australia, China, the European Union, Japan and the United States, and China.

4.2 Result and discussions

4.2.1 Aggregate rejection rate (ARR)

Figure 7 displays the total rejections of food and feed exports originating from Sri Lanka for the eleven years from 2010 to 2020. The aggregate rejection rate for the five separate markets is marked on in the figure separately in dotted lines. Even though the ARR values of the individual markets have randomly fluctuated over the years, the total ARR (solid blue line) displays a downward trend. Although this conveys a reduction in the rejections, it can be caused by either a reduction in the rate of non-compliance or a reduction in the volume of exports. Overall, there have been a total of 1229 rejections for food and feed exports originating from Sri Lanka from 2010 to 2020.

Figure 7: Aggregate rejection rate 2010-2020 (Food and Feed Exports originating from Sri Lanka)

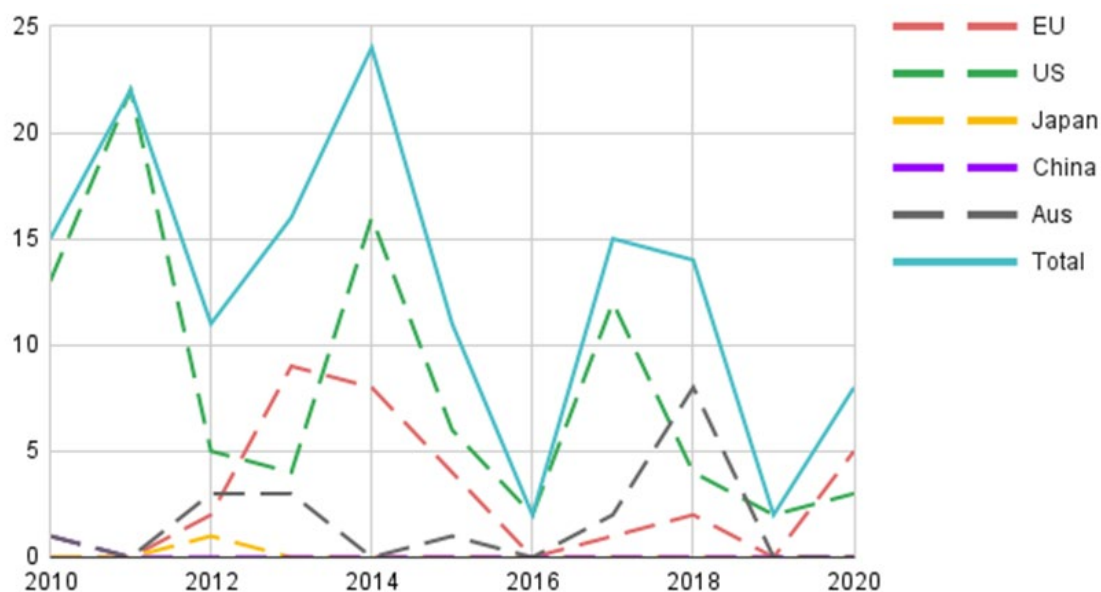


Source: Authors' compilation using data extracted from Standards Compliance Country Profile of UNIDO.

Code: AUS: Australia, EU: European Union, USA: United States of America

Focusing on the exports belonging to the product categories Chapter 07 (vegetables and certain roots and tubers; edible) and Chapter 08 (fruits and nuts, edible; peel of citrus fruits and melons), which largely include fruits and vegetables, ARR can be redrawn for the same markets during the same period.

Figure 8: Aggregate rejection rate 2010-2020 (HS07 and HS08 exports originating from Sri Lanka)



Source: Authors' Compilation using Data extracted from Standards Compliance Country Profile of UNIDO

The figure reflects a clear fluctuation in the total ARR which is somewhat similar to the ARR graphs for the entire food and feed exports. Rejections from the United States

market are observed to heavily affect the shape of the total ARR curve, indicating that most of the rejections are from the United States market. This is further evident by analysing the total rejections for the period by the market. Total rejections of fruit and vegetable exports originating from Sri Lanka for the period 2010-2020 is 140. This accounts for 11.4 per cent of the overall rejections for the entire food and feeds exports.

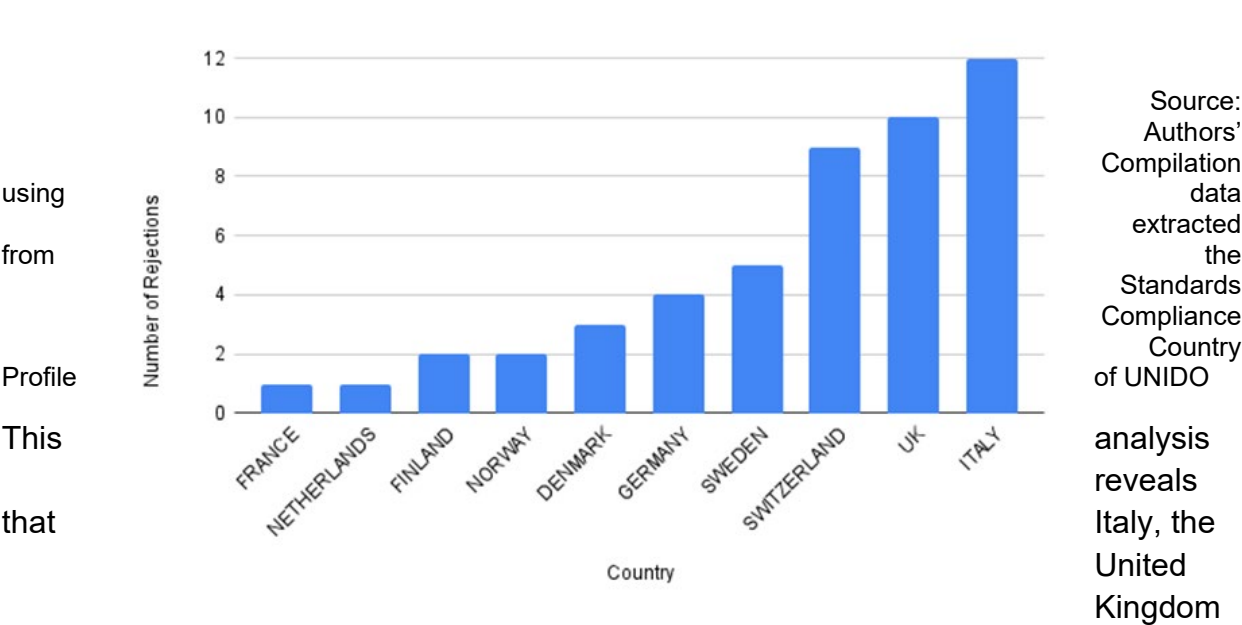
Table 8: Number of rejections from Chapters 07 and 08 for imports from Sri Lanka (2010-2020)

Market	Number of rejections (2010-2020)	Percentage
United States	89	63.6%
European Union	31	22.2%
Australia	18	12.8%
Japan	1	0.7%
China	1	0.7%

Source: Authors’ Compilation using data extracted from Standards Compliance Country Profile of UNIDO

The highest aggregate rejection is from the United States market and the second highest is from the European Union accounts. While the United States market represents a single country, the European Union market represents the political and economic union of twenty-seven member countries. Using RASFF databases, the European Union rejections can, therefore, be further analysed by the rejecting country.

Figure 9: Aggregate rejections by the United Kingdom and the European Union countries (2007-2020)



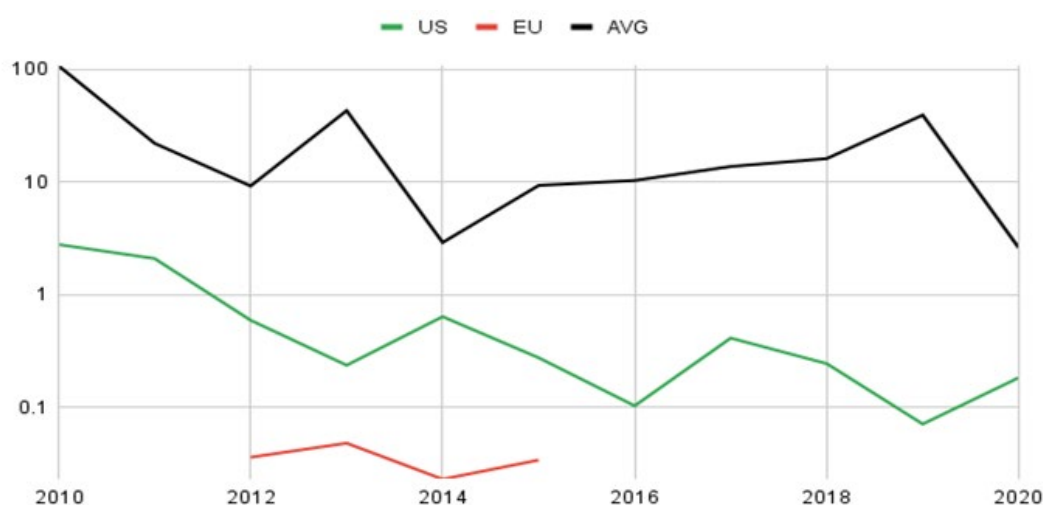
and Switzerland accounted for more than 6.63 per cent of the total the European Union rejections.

4.2.2 Unit Rejection Rate

The aggregate rejection rate can reflect either change in the rate of non-compliance or the volume of exports. The unit rejection rate (URR) considers the possible changes in the export volume and thereby provides a direct measure of the rate of non-compliance.

A country's URR is compared with the average URR for the world bank income group of the country. Hence, Sri Lankan URR is compared to the average URR of the lower-middle-income countries.

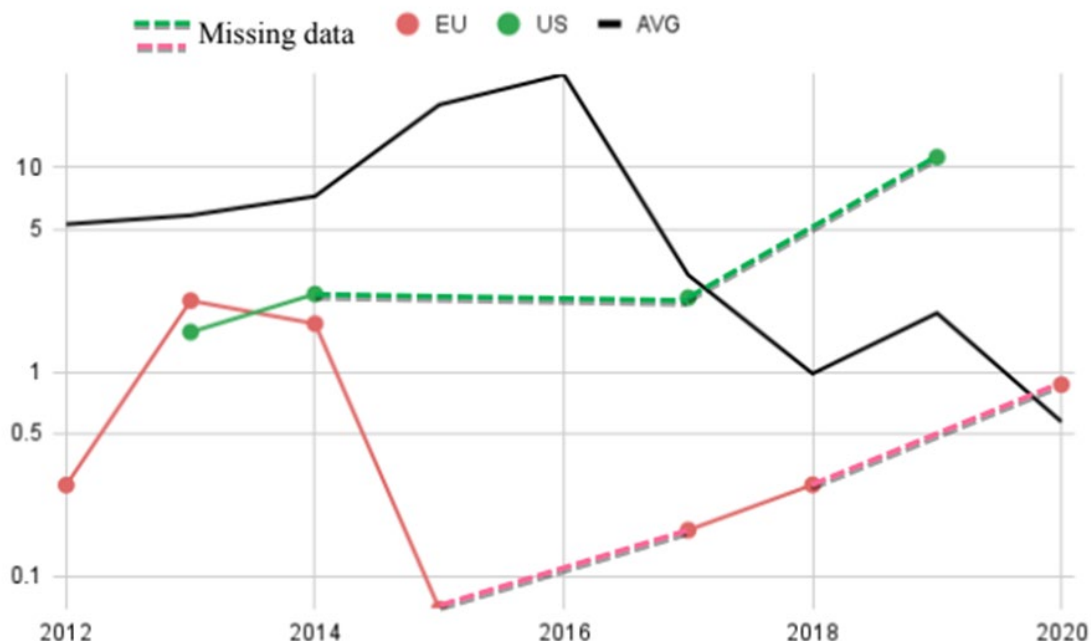
Figure 10: Unit rejection rate for Exports originating from Sri Lanka (HS08: fruits)



Source: Authors' Compilation using Data extracted from Standards Compliance Country Profile of the UNIDO

The unit rejection rate for fruit exports from Sri Lanka by the European Union and the United States markets has been below the average lower-middle-income over the years. This indicates that the rejection rate of fruit exports from Sri Lanka to the European Union and the United States are relatively low compared to other lower-middle-income countries. Comparatively, Sri Lankan fruit exports display higher rates of non-compliance in the United States market than in the European Union market. This could be due to strict food safety and quality standards in the United States market, which, in turn, results in a higher number of rejections per million of United States dollar exports, as discussed in a subsequent section of this report. This was also observed in the aggregate rejection rate whereas the United States market accounted for the most rejections.

Figure 11: Unit rejection rate for exports originating from Sri Lanka (HS07: vegetables)



Source: Authors' compilation using data extracted from the Standards Compliance Country Profile of UNIDO

The unit rejection rate for vegetable exports from Sri Lanka by the European Union and the United States markets has mostly been below the average for lower-middle-income countries. It has, however, exceeded the average URR in two separate instances. The URR for the United States market in 2019 (11.24) is considerably higher than the average URR (1.94) for lower-middle-income countries, which is concerning, but the URR for the European Union in 2020 was 0.87 as compared to the average of 0.57, which is less concerning.

Similar to fruit exports, Sri Lankan vegetable exports have higher rates of non-compliance in the United States market as compared to the European Union market. It should, however, be noted that URR Sri Lankan exports has increased after 2015 while the average URR has trended lower.

4.2.3 Relative rejection rate indicator

The relative rejection rate indicator (RRRI) reflects the performance of countries compared to one another over the years. Higher values of RRRI indicate that the country performs comparatively poorly in terms of non-compliance. The RRRI values for Sri Lanka were extracted from the UNIDO databases. They were compared with the median values for the particular year from 2010 to 2020. RRRI values were analysed separately for Chapter 07 (vegetables) and Chapter 08 (fruits) exports and based on market.

Figure 12: Relative rejection rate indicator for fruit exports to the European Union

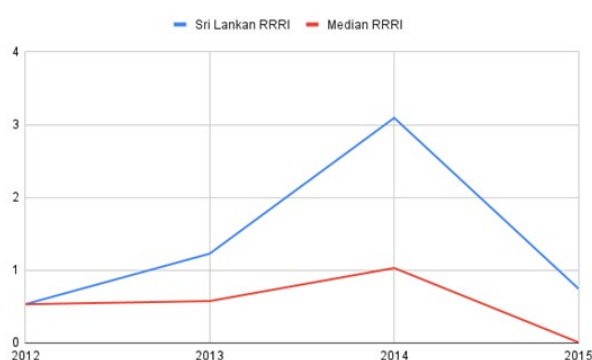
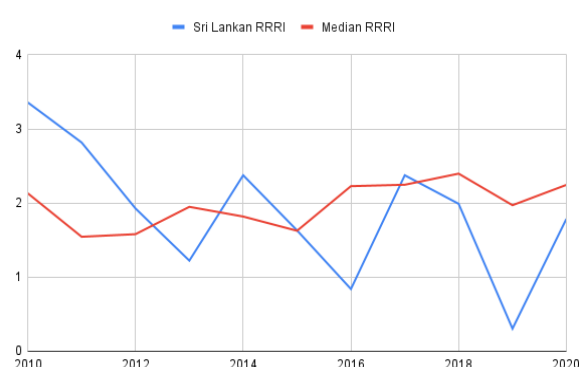


Figure 13: Relative rejection rate indicator for fruit exports to the United States



Source: Authors' compilation using data extracted from the Standards Compliance Country Profile of UNIDO

Sri Lankan RRRI values for Chapter 08 (fruit) exports have mostly been above one, indicating that the country's share of rejections is more than the share of imports. In the European Union market, the Sri Lanka RRRI values have exceeded the median values, indicating that the country performs poorly in this regard. The performance in the United States market is comparatively better whereas RRRI for Sri Lanka has remained below the median value for several years.

Figure 14: RRRI (Vegetables exports to the European Union)

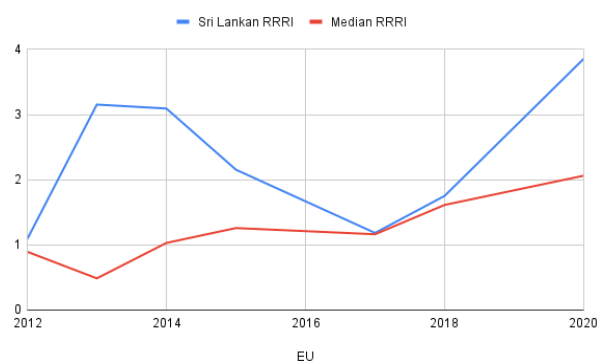
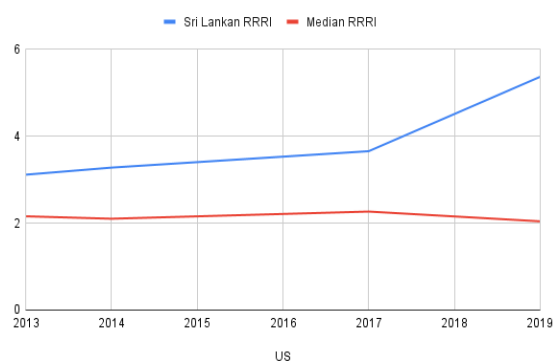


Figure 15: RRRI (Vegetables exports to the United States)



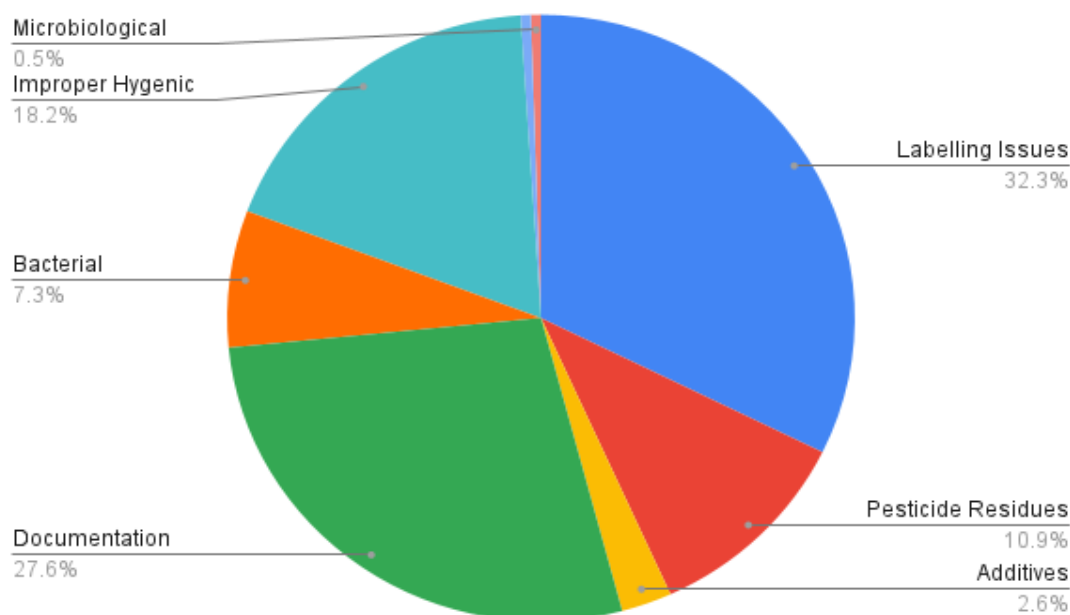
Source: Authors' compilation using Data extracted from Standards Compliance Country Profile of the UNIDO

Compared to fruit exports, Sri Lankan vegetable exports display adverse performances in RRRI values. It is crucial to note that the country's RRRI values have always been above the median values in both markets. Unlike fruit exports, a clear distinction is observed between the two markets as well. RRRI values in the United States market are relatively higher than the RRRI values in the European Union market. This illustrates that the country performs much poorly in the United States market.

4.3 Frequency of reasons for rejections

Figure 16 presents a frequency analysis of the reasons for rejections in five international markets, (the European Union, the United States, China, Japan, and Australia) for fruits and vegetable (Chapters 07 and 08) exports originating from Sri Lanka from 2010 to 2020. The most prevalent reason for rejection was improper labelling, which accounted for 32.3 percent of total rejections. These rejections arise from the contravention of labelling requirements. It is important, however, to note that this is not a requirement in some international markets. This can be elaborated by analysing the reasons for rejections by the market.

Figure 16: Frequency of reasons for rejections in all markets for fruits and vegetable exports (2010-2020)



Source: Authors' compilation using data extracted from the Standards Compliance Country Profile of UNIDO

4.3.1 Frequency of reasons for rejections by market

Information on the reasons for rejections is available in the United States and the European Union markets from UNIDO databases. It is summarized in table 9.

Table 9: Frequency of reasons for rejections in the European Union and the United States for fruits and vegetable exports (2010-2020)

Reasons for rejection	Frequency		Percentages (%)	
	European Union	United States	European Union	United States
Improper labelling	0	54	-	36.7
Pesticide residues	14	4	53.8	2.7
Adulterations and missing documents	0	53	-	36.1
Improper hygienic conditions	0	35	-	23.8
Bacterial contaminations	7	1	26.9	0.7
Presence of mycotoxins	1	0	3.8	-
Other microbiological contaminations	3	0	11.7	-
Additives	1	0	3.8	-

Source: Authors' compilation using data extracted from the Standards Compliance Country Profile of UNIDO

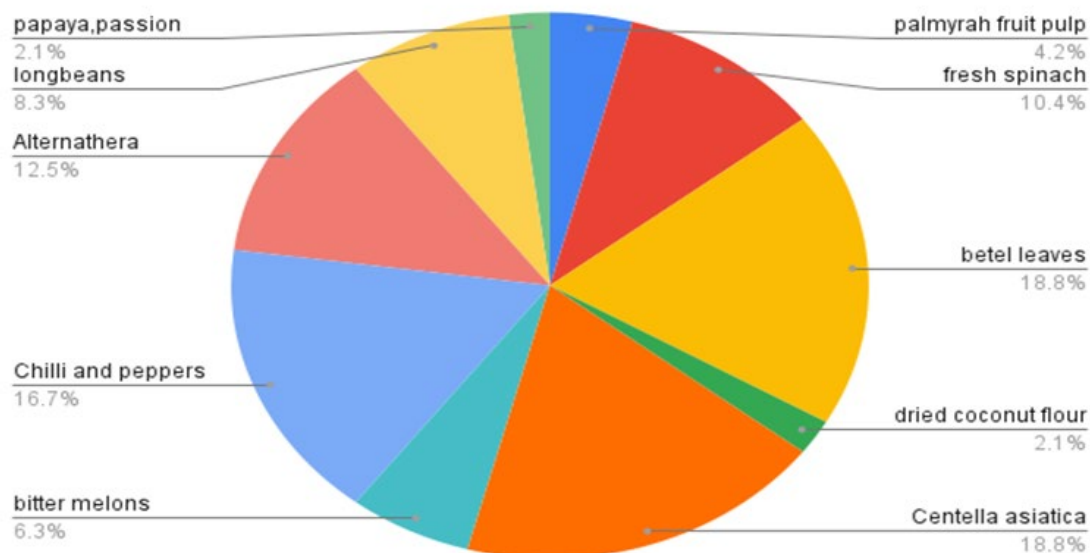
There is a stark difference in reasons for rejection between these two markets. Even though improper labelling is the major reason for rejections in the United States market, it is crucial to note that there are no rejections for this reason in the European Union market. This is because the European Union does not enforce labelling requirements through border inspections.

Similarly, the second highest reason for rejection in the United States market, adulterations and missing documents, is not reported in the European Union market. The most prevalent reason for rejection in the European Union market is the presence of pesticide residues. These residues are unauthorized substances, including, but not limited to, chlorothalonil, carbofuran, acetamiprid, profenofos, acephate, and methamidophos. Bacterial contamination is another prominent reason for rejection in the European Union market. The most common contamination of these cases is *Escherichia coli*.

The European Union market rejections can be further analysed by rejected product types using RASFF datasets.

4.3.2 Frequency of reasons for rejections by product type

Figure 17: Frequency of rejections of in the European Union market for fruits and vegetable exports originating from Sri Lanka by product type (2010-2020)



Source: Authors' compilation using Data extracted from RASFF

Most of the European Union rejections of fruit and vegetable exports originating from Sri Lanka from 2010 to 2020 were fresh leaves, including, among them, *Centella asiatica* (locally known as 'Gotukola'), *Alternathera sessilis* (locally known as "mukunuwenna"), *Piper betel* and fresh spinach. Collectively these four products account for 60.5 per cent of total rejections. Rejections of *Centella asiatica* and *Alternathera sessilis* are entirely caused by pesticide residues. *Piper betel* rejections are solely caused by microbial contaminations by *Escherichia coli* and *Salmonella enterica*. Spinach rejections are caused by both of these reasons.

4.4 Actions after rejection

After being rejected for the reasons discussed above, the border agencies decide on the actions to be taken. These actions can range from no action to destruction, the latter bearing the most food loss. They are analysed for the European Union rejections of Chapters 07 and 08 exports originating from Sri Lanka from 2010 to 2020 using RASFF datasets.

Table 10: Actions after rejection

Action	Frequency	Percentage
Informing authorities	13	31.6
Destruction	9	22
Redispatch	7	17.1
Official detention	4	9.8
Withdrawal from the market	2	4.9
Public warning-press release	2	4.9
Import not authorized	2	4.9
Recall from consumers	1	2.4
No action taken	1	2.4

Source: Authors' compilation using data extracted from RASFF

Table 10 shows that 22 per cent of rejections result in the destruction of the food product, which is the second highest action taken. This is a matter of concern as it directly leads to food loss. Other actions, such as not authorizing and redispatch, may lead to losses due to subsequent quality deterioration, further indirectly contributing to food loss through shorter shelf life.

Analysing these four indicators have provided valuable insights into the food losses in Sri Lankan international trade. The aggregate rejection rate suggests similar fluctuations patterns in fruit and vegetable rejections, as well as total food and feed rejections. The highest rejection rate was for the United States market, followed by the European Union and Australia. In this regard, however, Sri Lanka has performed well compared to other lower-middle-income countries. In fact, considering the relative rejection rate indicator, the country performed comparatively well with regard to fruit exports. The frequency of reasons for rejection analysis suggests that the United States market is strict on labelling requirements, which raised considerable conformity issues. Furthermore, pesticide residues and improper documentation are also reasons for many rejections. The next section provides stakeholder views on the causes of losses in international trade

5. Views of the stakeholders on causes of losses in international trade

When exploiting the export potential of fresh fruits and vegetables, meeting quality, safety, and phytosanitary requirements is mandatory. Accordingly, effective quality control systems need to be in place to meet export market requirements to export fresh fruits and vegetables from Sri Lanka. In September 2016, the European Union conducted an audit in Sri Lanka to evaluate the supply chain of fresh fruits and vegetables to verify that the commodities are produced in line with the European Union phytosanitary requirements. It has been mandatory to introduce a systematic approach for each commodity under which the entire supply chain was monitored, evaluated, and certified by plant quarantine officers at critical points so that the chances of the final product having harmful pests are unlikely. Products not being produced under this programme are not accepted for exportation to the European Union.

Two groups of stakeholders, government officials and private sector agents, were quizzed for their views on the causes of losses in international trade. The views of government officials were gathered by conducting consultations with officials attached to the National Plant Quarantine Service and perusal of various government publications. Formal focus group discussions were conducted to obtain the views of importers and exporters of perishable food items on the causes of losses in international trade. Primary data were gathered during the data collection process. The views of government officials are covered in the first part of this section, followed by the views of the private sector agents.

5.1 Entry point rejections at the border and the nature of losses in the importation of fruits and vegetables

According to government officials, importing fresh vegetables, including tropical vegetables, is mostly not allowed in Sri Lanka. The entire local demand for vegetables is met through local production and only a negligible share has been imported to meet the special demand of tourist hotels and airlines. Food products imported under Chapter 07 (vegetables) are either frozen or dehydrated. The losses of such semi-processed or processed items at the border are negligible. However, the final decision with regard to compliance with phytosanitary requirements is taken by the Sri Lanka PQS, which checks whether the produce adheres to Sri Lankan phytosanitary laws and regulations. Clearance may be subject to delays until the requirements are fulfilled and additional compliance costs.

Considering the importation of fruits, only temperate fruits, such as apples and mandarins, are allowed to be imported. Furthermore, it is prohibited to airlift such commodities to make sure that cold treatment is applied to the consignment for an adequate period time during the sea voyage to eradicate any chances of fruit fly. These guidelines are strictly followed by importers and losses are minimal. There are, however,

some incidences of refusal of imports of fresh apples into the country due to, for example, importation without a valid import permit or failure to submit a valid phytosanitary certificate. Similarly, diplomatic consignments of mangoes from Bangladesh and Pakistan dispatched without adhering to phytosanitary requirements of Sri Lanka have been destroyed at the border, as such tropical fruits are considered to be prohibited commodities into Sri Lanka.

Accordingly, entry point rejections at the border occur mainly due to non-compliance and errors in documentation. The payments made as “demurrage” tend to underestimate the monetary cost of food losses at the import ports of Sri Lanka provide some evidence regarding losses at the entry point.

Food commodity markets all around the world have faced significant uncertainties due to the COVID-19 pandemic. Sri Lanka has been identified as one of the most vulnerable middle-income countries to the economic fallout from the COVID-19 pandemic (Central Bank of Sri Lanka, 2020). The country made a policy decision to restrict and ban the import of non-essential commodities under 156 HS headings, which include a variety of food and agriculture commodities. The decision to temporarily suspend certain commodities was not communicated quickly, instantly and properly with Sri Lankan importers. Consequently, many consignments of food commodities, such as rice, millet and turmeric, reached Sri Lanka after the temporary suspension was imposed, resulting in many of them being detained at the port of entry without clearance, which has led to payment of large demurrages, reshipments and also destruction.

5.2 Exit point rejections and the nature of losses in the exportation of fruits and vegetables

The most common fresh vegetable export items are okra, three types of brinjals (purple long type (*batu/Solanum melongena*), small-sized green type (*thibbatu/solanum torvum*), and medium-size green type (*thalana batud solanum melongena*), bitter guard, and green leafy vegetables. Semi-processed products of vegetable mixtures are also exported. Food losses at the border are evident through the NPQS documents on issuing phytosanitary certificates. The issuance of these certificates is specific to the product and the country of destination as per the phytosanitary requirements of the destination country. The main reason for rejections at the exit point (at the border) is the presence of harmful pests, which is, in turn, considered to be non-compliance of phytosanitary requirements of the international trade of food commodities. Failure to comply with recommended practices at the farm level and along the supply chain has been identified as the root cause for the detection of damages from pests during the inspection, which eventually leads to internal rejections at the border even though the consignment is passed in quality checking in other critical points.

Sri Lankan fruit and vegetable exports are shipped to different international markets, most of which demand different phytosanitary conditions and entry requirements. For example, the requirements and standards of the European Union are very stringent. Due

to the inadequacy of the Sri Lankan research and extension system, meeting the European Union standards has been difficult. This was reflected by the rejections at the destination. Non-compliance notifications are generated by the NPPO of the destination when consignments are found not to comply with phytosanitary conditions. More than forty non-compliance notifications were received against Sri Lanka in 2021.

The COVID-19 pandemic resulted in a dual shock on food trade, which has affected both supply and demand. On the supply side, restrictions on movements have disrupted production and supply, which drastically affected the local supply chain. On the demand side, the downturn in consumption across most of the key export markets has led to cancelled or no orders. However, as agricultural trade of Sri Lanka has been dependent only on a limited basket of exports and export destinations, the country is not highly exposed to global supply chain disruptions during the COVID-19 disruptions.

5.3 Causes for rejections of fruits and vegetables at the border of Sri Lanka

Delays in administrative procedures are a major cause for rejections in Sri Lanka. Most border and regulatory agencies take more time for their administrative procedures due to a lack of staff, stringent lengthy procedures, and the requirement of unnecessary documentation. Furthermore, documentation errors from the clients' side can also extend the time of the clearance process. These delays are considered the harshest burden for traders.

Inspection of commodities with high phytosanitary risks takes a considerably long time, which can lead to quality deterioration of perishables and adversely affect the cooling of commodities. Moreover, in certain cases, the same consignment is inspected multiple times by various agencies at different places at the border. Efforts to export inferior quality products require inspection and testing of multiple samples to ensure compliance with phytosanitary conditions, which invariably take up additional time and lead to a deterioration in the quality and commodities that are unfit for exportation. Similarly, if intentional efforts to smuggle certain commodities illegally within the consignment are unveiled, the entire consignment is rejected, leading to food loss. A certain number of such incidences are evident in fruit and vegetable exports.

Most of the border and regulatory agencies are confined to the port premises. Inadequate space for expansion and development of infrastructure in the ports hinders the option to improve the services provided by border agencies. It was noted that regulatory agencies have been given minimum facilities, which, in turn, affects the quality and efficiency of the service rendered. Furthermore, trade facilitation is constrained by the inadequacy of warehousing, transporting, and refrigerating facilities for the food trade.

The large number of lengthy and complicated documents required to clear imports and exports also results in errors, delays, and food loss in trade. Most of the agencies in the international trade process provide manual clearance procedures. Among the few that do not are the Lanka Customs, the Sri Lanka Standard Institute, the Sri Lanka Ports

Authority and Sri Lankan Cargo. These agencies are also not fully automated. Although some agencies accept online documents, hard copies are required to be printed prior to clearance. Most payments are also made manually although all border agencies have been committed to go for e-payments as per obligations to the National Trade Facilitation Committee established provisions of the Trade Facilitation Agreement (TFA)-WTO.

High charges made by certain agencies may not be affordable for small and medium-scale entrepreneurs. Even though some agencies, such as Sri Lanka Customs, the Department of Commerce and Private Accredited Treatment Providers, the Export Development Board and Industrial Technology Institute (ITI) charge excessively higher prices for registration, testing and inspection. Other agencies, such as NPQS, provide most of the services free of charge or at a nominal rate. The unaffordable fees may eventually cause border rejections as the extended time is taken to source the required funds.

In Sri Lanka, a proper mechanism does not exist for publishing and disseminating important trade information and sudden procedure changes. The Sri Lanka Trade Information Portal (SLTIP), which was implemented by the Department of Commerce; Sri Lanka, has uploaded certain information on cross-border trade. However, the most critical information on food regulations concerning plants, animals and human health is either not available or not updated. SLTIP can only facilitate traders to readily access the trade information so that all regulatory requirements are fulfilled, if SLTIP is regularly updated. Some traders have lost heavily from commodities suspended from being imported due to poor awareness. Furthermore, sudden changes in flight and vessel timing are not informed properly. Failure to disseminate information leads to severe food losses. Simplification of trade procedures and documentation, harmonization of the trade practices and rules, and transparent information and procedures of international flows help minimize trade losses. Officers handling SLTIP are recommended to follow the ESCAP course on trade information portals (<https://www.unescap.org/training/etip>)

Lack of training, experience, motivation, and enthusiasm of officers leads to inconsistent and non-responsive behaviours at work, which ultimately results in inconsistent trade and eventually food losses. Moreover, there are no simple appeal or dispute settlement procedures in Sri Lanka. Even though the world is moving towards third-party certification systems for import and export clearance, certain agencies in Sri Lanka do not accept test reports and certificates even from recognized national laboratories. Hence, the lack of recognition of test reports or certificates of other agencies is causing trade issues, which eventually can lead to food losses.

According to the views of government officers, there is poor border cooperation and collaboration among regulatory and border agencies. Sri Lankan border and regulatory agencies have been working independently. However, agencies should no longer work independently, but, instead, strive to work collaboratively to ensure effective and efficient cross-border trade. The proposed single window allows traders to submit trade information in a virtual location that communicates with the relevant government

agencies and obtain certificates, permits, licenses (CPLs), and approvals electronically without going in person.

Food losses in trade also occur due to sanitary and phytosanitary issues. Although SPS measures protect human, animal, and plant life, and health, the European Union and other developed countries continue to impose additional phytosanitary measures on agricultural food commodity imports, which are very hard to comply with. As an example, the exportation of curry leaves (*murraya koenigii*) to the European Union was banned due to the presence of the insect vector (*diaphmnia citri*) in Sri Lanka. Some of these conditions are stricter than agreed international standards. Delaying the submissions of the documents, submission of incomplete documents, and the submission of fraudulent and falsified documents prevent the clearance of consignments causing food losses in trade, according to government officials. Interception of regulated harmful organisms in imported consignments may also lead to the rejection and destruction of the consignments resulting in food losses.

5.4 Views of the private sector agents

Formal focus group discussions were conducted to find out the most egregious non-tariff barriers (NTBs) and procedural obstacles⁴ in Sri Lanka. Data were gathered from a sample of 50 exporters and importers. The discussions were facilitated by NPQS officers. Identification of the most egregious NTBs that may pose trade barriers was done by using a pairwise matrix ranking tool under which participants were asked to indicate the types of barriers and rank them accordingly. This ranking tool was used to assign priorities to the availability of multiple options. The pairwise ranking consists of non-tariff barriers to trade based on the trader's votes (weight). The pairwise comparison refers to the process of comparing alternatives in pairs to judge which entity is preferred over others or has a greater quantitative property. Descriptive statistical methods were used to analyse the collective data.

The information gathered from experienced respondents of trade (with an average of 10 to 12 years of experience) revealed 21 major generic drivers of NTBs to trade. They are comprised of compliance barriers/restrictions from government agencies, government policy changes (importation of agriculture inputs), incorrect identification of HS codes by officers, delay in sharing test reports by government agencies with relevant entry points, operational delays due to lack of staff (mandatory activities delayed), lack of availability of communication system between NPQS officers and clients (with regard to issues/non complacence/regulation update), lack of opportunities for meeting with NPQS/PQS to discuss issues, lack of certified fruit and vegetable fields to provide year-round supply (more critical at Northern Sri Lanka), delays in becoming aware of global regulation

⁴ See <https://www.unescap.org/publications/APTIR2019> for a discussion of a difference between NTBs and procedural obstacles.

changes by NPQS officers, demanding traders comply with unnecessary additional declaration for certain items, documentation errors (ePhyto is not an issue in accordance with the packing list), lack of truthful overseas buyers, certain harassment from PQS officers during inspections, taking too much time for inspection of documents, no green channel to facilitate trade procedures and trusted traders, perishable food inspection by various border agencies at different time, lack of advice from NPQS for technical development of exporters (packhouse), different farmgate purchasing prices among exporters, lack of available packing materials, attempts of unauthorized exportation affect the entire trade community and no proper exporter registration procedures. Table 11 shows the pairwise comparison ranking of NTBs and procedural obstacles, identified by the traders.

Table 11: Pairwise comparison ranking of barriers identified by traders

Non-tariff barriers and procedural obstacles		Cumulative total votes	Rank
U	No proper exporter registration/certification	522	1
B	Government policy changes (protectionism) on agricultural products exports and imports	521	2
I	No adaptation to global regulation changes	434	3
S	Lack of agricultural inputs for national food production	426	4
F	Lack of proper communication system between NPQS and clients (with regard to issues/no compliance/regulation updates)	420	5
J	Requesting non-required additional declaration for export items by plant quality officers	393	6
D	Test reports from government agencies are not properly shared with entry points	364	7
K	Documentation errors due to officers' negligence (ephyto is not issued per the packing list)	350	8
G	Lack of opportunity to discuss issues through regular meetings with NPQS/PQS	347	9
A	Compliance barriers/restrictions from government agencies	310	10
Q	Lack of advice from NPQS for technical development of exporters; pack-house	303	11
C	Incorrect identification of HS cords by plant quality officers	300	12
P	Multiple inspections of perishable food at different time and place	269	13
R	Anomalies in the farmgate prices of food commodities by different exporters	223	14
T	Unauthorized exportation leads to a bad image on good exporters	209	15

H	Lack of certified farmer fields to provide year round supply	205	16
N	Too much time taken for the inspection of the documents	179	17
E	No adequate staff (mandatory activities get delayed)	170	18
M	Certain harassment from PQS officers; inspections	162	19
O	No green channels or trusted trader facilitation	139	20
L	Lack of truthful buyers	116	21

Pairwise analysis has indicated that “not having proper exporter’s registration” is the most critical barrier. This kind of export registration is required to opt for recognition and authentication at the destination end, which invariably helps in the fast clearance of food commodities. The least important barrier is the lack of truthful buyers. These barriers can be broadly divided into two groups “technical measures”, which include regulations, standards, testing, and certification, SPS and TBT measures and “non-technical” measures, including quantitative restrictions (quotas, non-automatic import licensing), price measures, forced logistics or distribution channels. These barriers directly or indirectly lead to food losses at multiple points in the value chain due to rejections at the packhouse level, at existing points, and at the export destination.

While the private sector and government officials discuss various aspects of food losses at the Sri Lankan border, there are few similarities between the two perspectives. Both parties believe that the complex and unnecessary documentation processes together lead to inefficiencies and, eventually food losses. Furthermore, it was mutually discussed that the lack of information dissemination leads to food losses. This is especially true concerning new regulations and requirements from international markets that do not reach the exporters in time to take necessary actions. This, in turn, leads to rejections.

6. Recommendations

The comprehensive analysis of quantitative data gathered and the stakeholder views present the basis to provide recommendations to reduce food loss in trade. These recommendations are thoroughly discussed in this section.

Sri Lanka trades a wide range of food commodities along with numerous individual traders. Trade procedures on import and export certification and clearance have direct, indirect (procedural delay), and hidden (smuggling, informal trade, corruption, and bribery) trade costs that pose a burden for traders. As discussed, food losses during trading occur due to various causes while creating additional costs for traders.

Adoption of improved practices and prevention of pest infestation and other contaminations at various stages of supply chains are the best options for assurance of quality products. Emphasis should be given to formulating a national policy to comply with sanitary and phytosanitary conditions and to minimize post-harvest losses of fruits and vegetables. The Government should make arrangements to allocate resources to

improve supply chains of fresh fruits and vegetables with the objective to minimize pre-harvest and post-harvest losses at every critical point along the supply chain. Improved pre- and post-harvest practices are crucial in managing quality and assuring the safety of horticultural produce in the supply chain. **Accordingly, adequate measures must be taken at every step of the supply chain from production through harvesting, post-harvest handling, processing, packaging, storage and marketing of produce.** As an initiation, the country's good agricultural practices needs to be in place to produce and market good quality fruits and vegetables.

The establishment of an adequate number of certified fruit and vegetable fields can assure quality products that meet the requirement of high-end markets. This may also attribute to minimizing the rejection of commodities at the border. **Registration of fields, regular monitoring of the crop to assure the adoption of recommended practices and harvesting are to be assigned to field-level agricultural extension officers for regular inspection and monitoring.**

Support must be provided for upgrading the infrastructure facilities of farmers, collectors, transporters, packhouse operators, and exporters to ensure the delivery of quality products can be and minimize food losses. Improper handling in transportation and poor packaging practices lead to high post-harvest losses in fruits and vegetables. **It is important to take measures, such as maintain cold chain and introducing appropriate packages for different crops to maintain the quality of produce.**

Initiatives are needed to prevent indiscriminate pesticide use, improve food safety standards and reduce contamination. Recently, the Registrar of Pesticide in a Gazette issued MRLs for fruits and vegetables. The new regulations can be introduced to **prohibit sale of fruits and vegetables containing residues of pesticides.**

The majority of producers are highly concerned about the production of quality products with export requirements. Accordingly, an export-oriented supply chain must be established so that food losses can be minimized.

It is important to have a collaborative team to make sure sanitary and phytosanitary regulations are implemented at each point of the supply chain based on the international recommended Codex Alimentarius Commission standards and a code of practice and IPPC.

Food consignment rejections are critical issues for food losses at the borders. From the analyses of rejections, it is undeniable that there is room for improvements in fruit and vegetable exports. As evident by the ARR and URR analyses, comparisons made between European Union market and the United States markets reveal underlying issues with exportation to the United States market where a majority of export rejections have been recorded. Moreover, the RRRI values are also an indication of the relatively poor performance in the United States market by Sri Lankan exporters.

Rejections in the United States market predominantly are the result of contravention of labelling requirements. This is particular to the United States market, as the European Union market does not enforce labelling requirements. Accordingly, it is recommended to thoroughly review labelling requirements of the United States market, disseminate this information to local exporters and follow a supervision procedure at local borders to ensure compliance with these standards. Stakeholder consultations also revealed the need to implement proper mechanisms to disseminate trade information. **The timely updating of websites that disseminate trade information and regulations, such as labelling requirements, and changes in the procedures, changes in the timing of flight and vessels, must be communicated through updated channels to local exporters to avoid consignment rejections at borders.** Furthermore, government officials should disseminate information to exporters about company registrations as it affects the clearance process. In supervising consignments that are to be exported at local borders, the agencies involved must effectively coordinate among them and minimize overlaps of functions of different agencies. Since it was revealed that the communication between NPQS officers with exporters and Plant Quarantine Service (airport, seaport) is poor, there should be an effective communication channel among the stakeholders. Collaboration, cooperation, and connectivity among border agencies, as well as with the traders, must be enhanced, as it will positively affect trade and minimize food losses. **Regulatory agencies and institutions must be provided with facilities to expand in order to further facilitate trade.**

Analysing fruit (Chapter 08) and vegetable (Chapter 07) exports separately provides insights into how these two export categories behave comparatively. It was observed through URR and RRRI indicators that vegetable exports perform poorly relative to fruit exports. Considering the rejections by product type, vegetables accounted for most of them. It was noted that pesticide residues and microbial contaminations are the key causes of these rejections. It is, therefore, advisable to reinforce quality control measures at domestic borders to avoid these rejections. Moreover, in Sri Lanka, the lack of awareness of global regulatory changes negatively affects the clearance procedures that ultimately cause detainment or destruction of consignments leading to food losses. **Hence it is suggested that government agencies properly disseminate information on the global regulatory changes to traders, ensuring that the information reaches the farmers of fruits and vegetables, making them aware about export regulations related to pesticide usage and microbial contaminations in particular.**

The results of the study revealed the inconvenient and hefty nature of the administrative procedures and documentation processes related to international trade that currently exist in Sri Lanka. **It is undeniably high time to automate the administrative procedures to minimize delays for traders.** The large number of different documents mandatory for international trade, which leads to cumbersome and lengthy procedures, should be downsized, and the documentation processes and payment processes should be automated and made available online. **It is also advisable for government agencies to adopt green channel facilitation, which is a fast-track system under**

which export clearance is competed with a minimum routine examination. Appeal procedures should also be made simpler, especially since perishable food does not withstand the complicated appeal procedures. Most of the food losses occur due to delays in the submission of the documents or the submission of incomplete, fraudulent, and falsified documents by the traders. Accordingly, **government officials, while improving their efficiency, should also raise awareness of the traders in this regard.**

In addition, the study revealed that the data for the other three markets (Japan, China and Australia) were scarce compared to the United States and the European Union markets. This may indicate lower levels of exportation to these international markets. With the European Union and the United States being marketed with heavier regulations and quality control, **it may be beneficial to seek alternative export destinations which provide opportunities for lower levels of rejections and food losses. However, the exploration of alternative options must be coupled with the recruitment of skilled, motivated, and expert officials for effective trade facilitation.** The recruitment of officers should be conducted responsibly because lack of knowledge and inconsistent and irresponsible behaviour of the officials cause burdens and additional costs to traders.

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