Assessing the causes and effects of food loss and food waste

A comparative analysis of Ghana and Sweden

Mabel Addai

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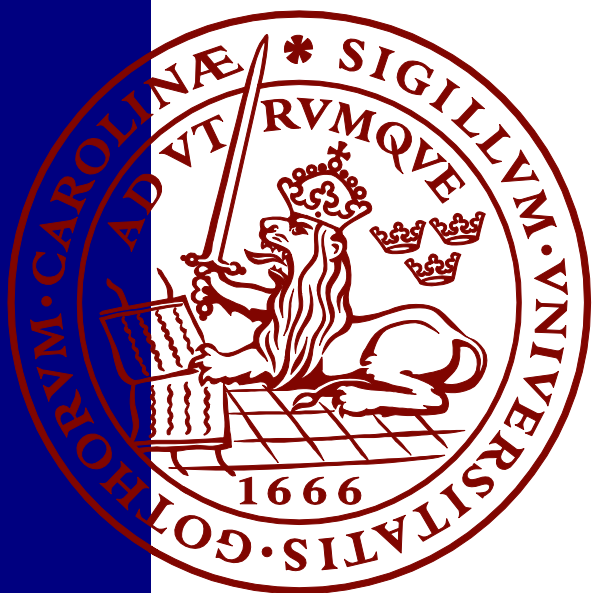

LUCSUS
Lund University Centre for Sustainability Studies

LUND UNIVERSITY

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Supervisor: Emma Johansson, LUCSUS, Lund University

Abstract

About a third (1.3 billion ton per year) of global food production is lost or wasted from the initial stages of farm production down to final household consumption and this global challenge has undesirable environmental, economic, and social effects. Notwithstanding the fact that the challenge of food loss and waste has received global attention, not much comparative studies have been conducted to leverage on the different experiences of countries, especially between developed and developing ones, where food loss occurs at different stages of the food supply chain.

My study investigates the causes of food loss and waste in Ghana and Sweden and ascertains stages of the food supply chain at which food is greatly wasted and lost. The study explores the effects of food loss and waste in relation to production and consumption in both countries and assesses how the problem of food loss and waste is addressed in a sustainable way by both countries.

The analysis is based on semi-structured interviews conducted with 18 persons in both Ghana and Sweden including farmers, operators of restaurants, schools, food processing companies and food agencies in both countries. I also relied on official government reports and relevant academic literature, drawing from diverse scholarly perspectives on the challenge of food loss and waste. Primarily, the DPSIR (Drivers-Pressures-State-Impact-Response) analytical framework guided my data collection and analysis.

The study finds contrary to existing scholarly narrative, that food loss at the pre-consumer and food waste at the consumer stages of the food supply chain are prevalent in both Ghana and Sweden. Overall, the study points to a rethink of the stereotypical differences between “developed” and “developing” stereotypes relative to the drivers, pressures and responses to food loss and waste to allow for across contexts learning.

KEYWORDS: Food loss, Food waste, Ghana, Sweden, DPSIR, Production, Consumption

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List of abbreviation

CO_2	Carbon Dioxide
CBO	Community Based Organisation
DPSIR	Driver-Pressure-State-Impact-Response
EEA	European Environmental Agency
EU	European Union
FAO	Food and Agricultural Organisation
FLW	FOOD LOSS AND WASTE
FSC	Food Supply Chain
GBN	Ghana
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HSLS	Holy Spirit Lutheran School
ILO	International Labour Organization
IPEP	Infrastructure for Poverty Eradication Programme
ISLK	International School of Lund Katedralskolan
IVL	Swedish Environmental Research Institute
JPSHS	Jachie Pramso senior High school
NGO	Non-Governmental Organisation
NRDC	Natural Resource Defence Council
OECD	Organization for Economic Co-operation and Development
PGRRI	Plant Genetic Resources Research Institute
PHL	Post Harvest Losses
PSO	Private Sector Organisation
PSR	Pressure-State-Response
RQ	Research Question
SBA	Swedish Board of Agriculture
SEPA	Swedish Environmental Protection Agency
SNFA	Swedish National Food Agency
SMED	Swedish Environmental Emissions Data
SSA	Sub-Sahara Africa
WRAP	British Waste and Resources Action Programme

1 Introduction

Food loss and waste (hereafter FLW) is a persistent global challenge to sustainability. It is estimated that about a third (1.3 billion ton per year) of global food production is lost or wasted from the initial stages of farm production to final household consumption (Gustavsson et al., 2011; FAO, 2019). Such losses have adverse environmental and socio-economic effects. With respect to the environment, FLW cause unnecessary CO_2 emissions and it has been estimated that a reduction in European food waste would potentially lead to saving in a total European Greenhouse Gas (GHG) emission of 5% (Stuart, 2009). Socio-economically, food losses affect the incomes of both farmers and consumers (Secondi et al., 2015). Many poor households are food insecure and faces hunger and undernourishment not necessarily because of supply challenges but due to limited access arising from high cost of food prices and weak purchasing power. Therefore, reducing FLW can reduce the cost of food and increase the access (Gustavsson et al., 2011).

Reducing FLW is also important for meeting the rising global demand for food (Tilman et al., 2011). World population is expected to increase by 2.3 billion people by 2050, and per capita incomes are projected to be six-fold that of today's levels (FAO, 2009). As a result, the market demand for food is expected to increase. To feed the 9.1 billion people in 2050, food production would need to increase by 70% (FAO 2009; Tilman et al., 2011). The Food and Agriculture Organization (FAO) (2018) estimates that the current food production levels of 4.5 trillion tons needs to be doubled to satisfy global food needs. With the current FLW, 870 million of the world's population starve and 2 million others are undernourished (FAO, 2013). Consequently, reducing FLW would increase food security for current and future demands.

Several studies that have explored ways of reducing FLW have established that food waste-reduction policies must target different problems that generate waste in different stages of the food supply chain (FSC) (Kantor et al., 1997; Gustavsson et al., 2011; Hodges et al., 2011; Dorward, 2012). These studies highlight the fact that in developed countries food waste primarily occurs at the latter end of the FSC, that is at the distribution, marketing, and consumption stages whereas in developing countries, losses occur at the production, harvesting and storage stages. Nonetheless, as Spang et al. (2019, p.126) argue although these broad-brush differences between the "developed" and "developing" stereotypes provide helpful insights on the possible drivers of FLW, many drivers and pressures of FLW are increasingly becoming similar across regions because of the rapid globalization

of food systems. Despite this recent recognition, not much comparative studies have been conducted to leverage on the similar and divergent experiences of developed and developing countries to address the challenge of FLW (Spang et al, 2019).

1.2 Research aim and questions

This study compares two countries, a developed country (Sweden) and a developing country (Ghana) to explore similarities and differences between drivers, pressures, and responses to FLW. The study addresses two main research questions:

- What are the differences and similarities between drivers and pressures to food loss and waste in Sweden and Ghana?
- What are the differences and similarities between responses to food loss and waste in Sweden and Ghana and what can both countries learn from each other to reduce food loss and waste at the pre-consumption and consumption levels?

Sweden and Ghana are interesting for this study because they fit into the stereotype that distinguish food systems in developed and developing countries, where developed countries suffer food waste mostly at the consumption stage and developing countries experience food losses at the early stages of the FSC. Comparing both country experiences allows me to explore the potential of reducing FLW at the pre-consumer and consumer levels. I apply the widely adopted DPSIR (Driver-Pressure-State-Impact-Response) framework to study FLW in both countries. DPSIR enables an exhaustive and systems-based understanding of the FLW that can inform FLW reducing responses, and related goals of ensuring food security and reducing the environmental and socio-economic costs of our food systems (Spang et al., 2019).

1.3 Contribution to sustainability science

FLW contribute to the depletion of natural resources such as water and energy, threatens environmental sustainability and inhibits the sustainable development of the food sector (Lipinski et al., 2013). That is why Target 12.3 of the 2030 Agenda for Sustainable Development aims at halving per capita global food waste at the retail and consumer levels and reducing production, harvest, and postharvest losses by 2030. Reaching this goal would also mean increasing the amount of food available to farmers for consumption or for sale, reducing total household expenditures on food,

freeing resources for investment in education and health. While several studies have examined the problem of FLW, few have compared the experiences of developed and developing countries to investigate the differences and similarities between drivers, pressures, and responses. This study does that, pointing to the need for similar studies in sustainability science that allow for across contexts learning to address sustainability challenges.

1.4 Thesis outline

Following this introduction of FLW as the research problem, the thesis is structured as follows: Section 2 defines FLW and discusses the literature on its causes globally. Section 3 presents the DPSIR analytical framework used for the research. Section 4 outlines the data construction methods. In section 5, I present the results. In section 6, I discuss my results relative to the existing literature and their implications. Section 7 concludes the research.

2 Food loss and waste: A survey of the literature

This section defines the concepts of food loss and food waste and synthesizes existing knowledge on the drivers of food loss in developing countries and food waste in developed countries.

2.1 Defining food loss and waste

There is no single definition for FLW because of its complexity. The Food and Agriculture Organization (FAO, 1981) defines food waste as "the wholesome edible material intended for human consumption, arising at any point in the FSC that is instead discarded, lost, degraded or consumed by pests". More recently, FLW has been defined as "the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption" (Gustavsson et al., 2011, p.2). These definitions imply that food loss or waste occurs when food that was originally meant for human consumption accidentally gets out of the FSC and directed to non-food uses, such as feed, bioenergy uses, etc. Hence, "planned" non-food uses are distinguished from "unplanned" non-food uses, which are losses (Gustavsson et al., 2011, p. 2).

Food losses and food waste are distinguished based on the stage of the FSC at which they occur. Food losses occur during the early stages of the FSC: production, post-harvest, and processing stages while food waste occurs at the end of the food stage, that is at the retail and final consumption stage (Griffin et al., 2009; Parfitt et al., 2010). Another definition of FLW concerns "end-of-life options", or "destinations" (Spang et al., 2019, p. 121). Per this definition, if food remains in the FSC, redistributing safe, edible food to humans is not considered as FLW. When surplus food is used to feed animals or for biomaterial processing or production, food is removed from the FSC and these end-of-life destinations are often considered distinct from FLW because they "result in the valorization, or "upcycling" of the food materials (Östergren et al., 2014; Spang et al., 2019). Some definitions border on edibility defined not only in terms of whether the food is safe to eat at the time it is being disposed of (for example spoiled food), but whether it is expected that one can eat that food part (e.g., bones, banana peel) (Spang et al., 2019). However, some food items may be considered as inedible or harmful for human consumption depending on the cultural context; therefore, there may be a wide arrange of definitions for edibility (Spang et al., 2019). Garrone et al. (2014, p. 133) define food waste from three broad perspectives, social, zootechnical and environmental. From a social perspective, food waste is defined as leftover food that is not used for feeding humans. From a zootechnical perspective, food waste refers to surplus food that is not used

for feeding humans or animals. Lastly, food waste from an environmental perspective refers to surplus food that is disposed of and not reused or recovered in any form. The concern from an environmental perspective is whether the environmental effects of the disposal of food were lessened.

The lack of a widely accepted definition makes it difficult to understand the challenge of FLW between different cultural contexts and countries. However, as Spang et al., (2019) noted, if assumptions are clarified and the FSC stage is clearly defined, conceptual differences do not essentially inhibit comparability. In this thesis, I adopt a definition that borders on the stage of the FSC and explore food loss that occur at the primary production and processing stages and food waste that occur at the consumption stage (Figure 1).

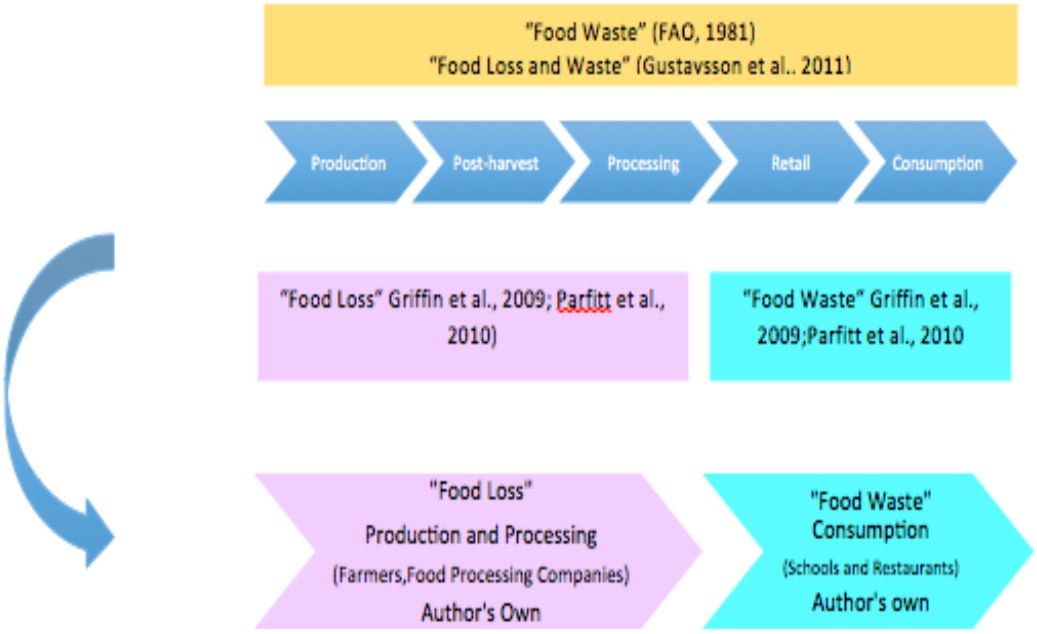

Figure 1. A representation of the stages in the food supply chain (FSC) depicted by the terminology used by different authors in the literature and as adopted and used in this study. (Adapted and modified by author from Porter & Reay 2016).

2.2 Causes of food loss

In developing countries, the largest food losses occur on or near the farm. Therefore, successful harvesting and consolidation methods are essential for reducing losses (Hodges et al., 2011). Causes of losses also differ greatly; it may occur at production, harvesting, threshing, cleaning, drying, storage, processing, and transportation (Prusky, 2011).

Preharvest production conditions can affect the quality of crops at harvest and postharvest quality, shelf life, and thereby postharvest losses. Preharvest production conditions such as water supply balance (irrigation) can cause postharvest losses. To ensure that crops are harvested at the appropriate time and under suitable physiological conditions, growing plants require constant supply of water. However, crop quality can be negatively affected when there is too much rain or irrigation, which can lead to brittle and easily damaged produce (FAO, 1989). The use of excessive fertilizer can also harm the development and postharvest condition of produce (FAO, 1989), although admittedly, the effects of fertilizer imbalance in soils on crops depend on other factors such as temperature, moisture, soil acidity, and interactions between different fertilizer chemicals (Prusky, 2011).

For many crops harvesting time and method (mechanical or manual) determine losses. Significant losses occur before or during harvesting if it is not undertaken at adequate crop maturity and moisture content. Physiological deterioration can set in when crops are harvested too early or too late. Crops that are harvested too early at high moisture content become prone to mold growth and insect infestation and spoilage (Spang et al., 2019). Harvest delays could also result in high-shattering losses as crops become exposed to birds and rodents attack, or losses because of natural events such as rain and hailstorms (Kumar & Kalita, 2017). In developed economies, harvesting of grains, roots and tubers, pulses, nuts, and perishables is often done mechanically, or sometimes manually and/or aided by machines (Kader, 2002). On the other hand, in many developing countries, harvesting is often labor-intensive and time-consuming and generally results in high losses (Xue et al., 2017).

Postharvest losses can also result from improper drying actions, insufficient cold storage facility, poor packaging, and inadequate transport infrastructure (Spang et al., 2019). For grains for example which must be threshed to detach them from the panicles, manual threshing may cause grain spillage and breakage due to excessive striking and incomplete separation of the grain from chaff (Khan, 2010; Prusky, 2011). After threshing, grains must be cleaned to separate the whole and

broken grains and to remove other materials such as chaff, sand, stones and weed sand. Poorly cleaned grains could increase insect infestation and mold growth during storage (Prusky, 2011). In developing countries with hot temperatures, most smallholder farmers expose harvested produce in the open field for sun drying before storage. Therefore, unfavourable weather conditions may prevent crops from drying adequately. Damper or cloudier conditions may lead to an increase in postharvest losses. Birds and insects may also consume the produce left in the open for sun drying and may be contaminated by stones, dust, and other foreign materials (Hodges et al., 2011).

A significant share of farm produce is also lost due to poor storage. In developing countries, harvested produce are stored for a long period to counter inconsistent production patterns, to speculate on prices and to ensure smooth income tenures (Kaminski & Christiaensen, 2014; Affognon et al., 2015). However, the storage technologies used such as the use of granaries and plastic bags, in-house storage, unprotected piles, result in substantial quantity and quality losses (Affognon et al., 2015). Without refrigerators, livestock products, fish, fruit, and vegetables lose value rapidly. The use of improved storage technology is limited by resources, information, and the availability of technology (Foster & Rosenzweig, 2010). Inappropriate packaging also diminishes food quality and safety (FAO, 2014). Smallholders lack access to appropriate packaging technologies and mechanical means to store their produce which result in high levels of food losses. Inadequate transport infrastructure, for example motorable roads and refrigerated trucks, increases spoilage and damage of food in transit (Parfitt et al., 2010; Spang et al., 2019). Another major reason for high transportation losses is several movements of crops. Kumar and Kalita (2017) report that for developing countries such as India and Pakistan, before bagged wheat is milled, it is often loaded and unloaded from vehicles for about ten times with some losses and spillages during each movement. Unlike in developed countries where efficient bulk handling systems are used, in developing countries loading and unloading of harvested produce is done mostly manually and results in high spoilage. In Southeast Asia, about 2% to 10% of rice are lost during handling and transportation (Alavi et al., 2012).

In sum, food loss occurs in the initial phases of the food supply chain and mainly due to the lack of appropriate production, harvesting and storage technologies and infrastructure investments.

2.3 Causes of food waste

Developed countries mostly suffer food waste (Gustavsson et al., 2011). The literature identifies several causes of food waste such as farmer-buyer sales agreement; food abundance; high quality standards; failure to plan; limited consumer knowledge of the wide range of meanings of food labels; lack of awareness of the prevalence of the social, economic, and environmental impacts of food waste and restaurant culture (Gustavsson et al., 2011; Wunderlich & Martinez, 2018). The underlying causes include modernization of food systems because of industrialization, economic growth, urbanization, globalization; cultural factors, socio-demographic factors (Thyberg & Tonjes, 2016). This sub-section examines some of these causes of food waste.

A major cause of food waste in developed countries is farm-buyer sales agreements. When buyers purchase products in large quantities or purchase different brands or food types, farmers tend to give them discount. Buyers are therefore incentivized to purchase more than they need, and much of the over-purchased food is wasted (Wunderlich & Martinez, 2018). Relatedly, the display of large quantities of different products or brand in supply also causes food waste in developed countries (Gustavsson et al., 2011). Retail stores tend to order large quantities and varieties of food types to get favourable prices from producers. Consumers also demand and expect retail stores to be fully stocked so they can have access to an extensive variety of products. Many products are therefore likely to reach their “best-before” and “use-buy” dates before they are sold, and therefore wasted. Fully stocked shelves and frequently restocked supplies may be positive for sales statistics, but this may mean that consumers ignore products which are near their expiry dates (Gustavsson et al., 2011).

High quality standards also cause food waste, with food items that do not fit the required shape or aesthetic standards being rejected (Hodges et al., 2010; Girotto et al., 2015). Retailers and consumers have high quality standards concerning the weight, size, shape, and appearance of crops. Retailers reject some farm produce at the farm gate because of rigorous quality standards and food originally meant for human consumption is diverted to other uses (Stuart, 2009). There is also growing consumer intolerance for substandard or suboptimal foods or aesthetic defects such as blemishes and misshapen produce (Hodges et al., 2010; Lipinski et al., 2013). Suboptimal or imperfect food are products that differ from normal or optimal products based on appearance standards, regarding weight, shape, or size; based on their date labelling, for example, close to or

past the best-before date; or based on their packaging, for example, a torn wrapper, a dented can, without deviation on the intrinsic quality or safety (De Hooge et al., 2017, p. 81).

Generally, consumers are unwilling to purchase suboptimal products which results in edible foods being discarded. Bunn et al. (1990), for instance, in a survey of 229 supermarket shoppers in northern and southern California, United States, found that about 63% of the respondents were only inclined to purchase suboptimal fruits (cosmetically imperfect oranges) when they were sprayed with pesticides. Loebnitz and Grunert (2015) found in a survey of a representative sample of 212 Chinese consumers that consumers were more likely to purchase normally shaped fruits and vegetables than moderately or extremely abnormally shaped food. Consumers also rely on the package to assess key aspects such as quality, desirability, and health of a product (Scott et al., 2008). White et al. (2016) also found that consumers who were under high cognitive load, that is, those engrossed in other tasks, considered superficial packaging damages such as a torn wrapper or dented can, as a sign of potential contamination and the product was therefore posed health and safety risks. Consumers also avoid purchasing foods that are close to the best-before date, with Newsome et al. (2014) finding in a survey in the United States that most consumers (62%) were more inclined to purchase foods with the longest remaining shelf lives.

Another major cause of food waste is consumers' limited knowledge of the true meanings of the different phrases used for product date labels. This leads to large amounts of food being discarded because it has passed the stated date. Consumers have different beliefs about food labels and though they were created as indicators of freshness, for many consumers food label dates indicate spoilage. Even if the date expires, a product should be safe, wholesome and of good quality if handled and stored properly. But Wunderlich & Martinez (2018) argue that in the United States, for instance, one of the main sources of food waste is the misuse of food labels. In 2013, 54% of consumers are reported to have believed that eating food that had passed its sell by or use by date was harmful (NRDC & Harvard, 2013 cited by Wunderlich & Martinez, 2018, p. 334).

Further, low levels of awareness of the environmental effects lead to food waste. Quested et al. (2011, p. 464) report for the UK that there is a relatively low level of awareness of the environmental impact of generating food waste with only 39% of the population thinking that discarding less food has a high impact on climate change reduction. 56% thought switching off lights which has a much smaller environmental impact instead had a higher impact on reducing climate. Low environmental

awareness was also expressed in the respondents' motivation for reducing food waste: nearly 80% noted the potential to save money and a little above 70% wanted to manage their home efficiently. Just over 50% of the population cited food waste's impact on the environment. Graham-Rowe et al. (2014) also found similar results in a survey of 15 UK household food purchasers based on semi-structured interviews. Not all their respondents were aware of the adverse environmental effects of throwing food away. Some of the respondents did not consider food waste as a real problem while others felt that food waste was unavoidable and there was no need to reduce it. For many, wasting food was the norm.

Food waste also occurs when consumers fail to plan. Failure to plan leads to over-purchasing which in turn results in foods expiring, rotting, or passing their "best-before" dates (Wunderlich & Martinez, 2018). For restaurants, many of them lack ingredient crossover in their menus, they provide customers with large portions and their kitchen practices that cause overproduction and poor inventory management (Wunderlich & Martinez, 2018).

On a broader level, Thyberg and Tonjes (2015) examines the impacts of food system modernization on food waste generation, including effects that relate to food system industrialization, urbanization, globalization, and economic growth. Industrialization of food systems that results in the transfer of food production and preparation from the home to factory affects the types of food people consume and the types and quantities of food waste. Where there are industrialized food systems with large amounts of food processing, people buy pre-made or canned and frozen foods. Consequently, for instance, pea pods and corn husks become industrial waste while packaging becomes household waste. Some components of food may also be discarded as waste by industry during processing in industrialized food systems (Thyberg & Tonjes, 2015, p. 115). Further, as an economy grows and incomes rise, food expenditures assume a small share of income. In developed countries, food is somewhat cheap compared to other expenses such as housing and people can waste food (Pearson et al., 2013). The reckless attitude of consumers who can afford to waste food is one of the major contributors of household food waste (Gustavsson et al., 2011). Urbanization also requires extension of food supply systems which leads to diet diversification and a disconnection from food sources which may cause increase food wastage (Thyberg & Tonjes, 2015). Globalization has also caused changes in diets and people may be more likely to dispose of food which they do not have a deep connection to or an understanding of.

3 Analytical framework

I use the Driver-Pressure-State Impact Response (DPSIR) framework to understand the drivers and responses to FLW in Ghana and Sweden to capture similarities and differences. The DSPIR framework was developed by the European Environmental Agency (EEA) in 1999 and has since been widely used in studying environmental challenges (Carr et al. 2007). It is useful for describing processes for the analysis of cause-effect relationships (Burkhard & Müller 2008). The Organization for Economic Co-operation and Development's (OECD, 1994), Pressure-State-Response (PSR) framework, itself is an offshoot of Rapport and Friend's stress-response model that preceded the DPSIR framework. With their focus on anthropometric pressures and responses in evaluating environmental problems, DPSIR antecedents neglected natural variability, did not consider the underlying social conditions for environmental problems and the motivations for responses to changes in the state of the environment (Carr et al., 2007). These factors necessitated a new framework for integrated assessment, hence the DPSIR framework. The framework is shown in Figure 2. The main components and functions of the elements in the DPSIR framework are described thereafter.

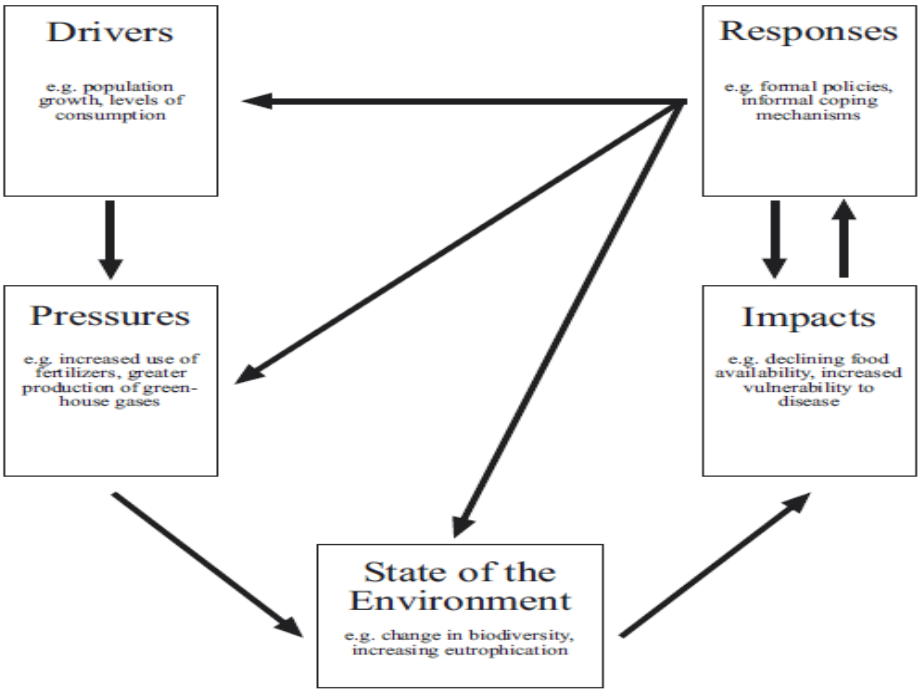

Figure 2. The DPSIR Framework, adapted from Carr et al. (2007, p.545).

Drivers or driving forces refer to factors that shape human activities that have an impact on the environment. On an individual level, driving forces are the need for shelter, food, water, and other conditions needed for a good life, good health, security, and freedom (Kristensen, 2004). Kristensen (2004) notes that for an industry, a driving force could be the need to produce efficiently, reduce production costs and be profitable, while for a country, a driving force could be the need to reduce the levels of unemployment.

Pressures are the human activities that result from driving forces and natural processes that affect the environment (Carr et al., 2007). Production or consumption processes exert "pressures" on the environment such as overuse of environmental resources, changes in land use and emissions of chemicals and waste, to air, water, and land (Kristensen, 2004). Pressure indicators, unlike drivers are, easily measured and they are often linked to definite causes.

State is the physical, chemical, and biological conditions of the environment at a particular time because of pressures. It refers to the quantity and quality of various environmental compartments such as air, water, soil, as regards to the functions that they perform (Kristensen, 2004). State indicator helps to find the appropriate measures and activities to solve the specific conditions. This study however based on responses, captured and follows to large extent Spang et al.'s (2019, p.13.3) definition of 'state' as the state of the food system defined by "how much, where, and what type of food is lost and wasted".

Impacts are how changes in "state" affect human well-being (Carr et al., 2007). Changes in the quantity and quality of the ecosystem may have environmental and economic "impacts" on human welfare and their life-sustaining abilities and on the economic and social performance of a country (Kristensen, 2004).

Response is the action of the society either voluntary or mandatory to lessen "impact" by altering or eliminating "driving forces", "pressures", "state" and "impact" (Kristensen, 2004). Response instruments may include legislative prescriptions, planning, taxes, information, and education (Kristensen, 2004). Prospects for responses depend on the environmental and economic area of application and available instruments.

4 Methodology

4.1 Research design

The study follows a qualitative research design. A qualitative study allows for exploration and explanation and enables the researcher to gain comprehensive and contextual understanding of a phenomenon through the lenses of the research participants (Creswell, 2014). The researcher can explore people's views to understand factors that drive their actions and influence certain outcomes. A qualitative design is well suited for this study since it seeks to capture diverse context specific drivers and responses to FLW.

4.2 Case selection and description

The study focuses on Sweden and Ghana because as mentioned earlier they fit into the mold of developed countries primarily experiencing food waste and developing countries experiencing food loss. Although Sweden has taken steps to reduce the volume of food waste, avoidable food waste is still at high levels (Ghosh & Erikson, 2019). In 2018, more than 1.3 million tonnes of food waste were generated across Sweden, approximately 4% more than in 2016 (IVL, 2020). In that year, an average Swede threw away 133kg of food. Households accounted for a large share of the country's food waste of about 70%, grocery stores, 8% and agriculture 7% (IVL, 2020).

Data on food losses in Ghana is patchy. However, some estimates show that at least 30% of farm produce valued at $700,000 is lost annually through post-harvest losses (GBN, 2020). Post-harvest cereal loss could be as high as between 50 and 70% in Ghana. Darfour & Rosentrater (2016) also estimate that between 20 and 30% of fruits, vegetables, roots and tubers, cereals, and legumes, are lost at the post-harvest stage of the food system every year. Losses before consumption is particularly acute for horticultural crops ranging typically between 20 and 35%.

The study focuses on FLW of farmers and food processing companies (mainly fruits and vegetables) at the production stage and schools and restaurants at the consumption stage of the FSC in Sweden and Ghana. I focused on fruits and vegetables at the production stage because they are easily perishable and therefore constitute a large share of food losses. Almost half (45%) of the total fruit and vegetable produced in the world goes to waste. In the EU, fresh fruit and vegetables contribute to almost 50% of the food waste generated while in sub-Saharan Africa, it is estimated around 54% (De Laurentiis et al., 2018). For the consumption stage, I focused on restaurants and schools because

they contribute significantly to food waste in both countries and therefore need comprehensive study just like that of household level. For example, in Ghana, restaurants and schools contribute to 40%, that is, $80 billion worth of food that goes to waste (Addo, 2016). In Sweden, about 10 kilos of school lunch per child goes to waste each year (SNFA, 2018). I did not focus on households because households especially in developing countries do not keep records of the amount of food discarded. Food wastes are not collected separately hence making it hard to get accurate data at the household level.

4.3 Data collection methods

I used qualitative data collection methods such as semi-structured interviews and a review of existing literature and relevant policy documents in both countries. Interview guides based on the research questions were prepared and sent to the identified participants through emails (Interview guide in appendix) and some were conducted on phone. Some participants were found online and through the help of government agencies. There were no pilot interviews and therefore I ended up doing follow-up interviews to achieve the research objectives. Some of the interview sessions were recorded digitally with the express consent of the interviewees.

4.4 Sampling

In qualitative research, the researcher purposefully selects participants who provide information that enable the researcher to answer her research questions (Creswell, 2014). I therefore used the purposive sampling technique and selected participants by "informational considerations" (Mikkelsen, 2005, p. 139). The respondents and the institutions sampled are shown in Table 1 below.

Table 1. Total number of institutions that participated in the study.

Institutions	**Farmers**	**Agro-processing companies**	**Schools**	**Restaurants**	**Government agencies in charge of food management**	**Total**
Ghana	Citrus farmer Mango farmer Tomato farmer	EKA Food Processing Company Nutrifoods Ghana limited Juice Plus	Jachie-Pramso senior high school Saint Lutheran school	Jofel catering services limited	Ministry of Food and Agriculture	10

Sweden	Stadsåkern (ekonomisk förening)	Kullabygdens Musteri AB Juicekällan	*Vildandens Förskola (Preschool)* ISLK International School of Lund Katedralskolan.	The Herbivore Mat och Destillat	Livsmedelsverket/ Swedish National Food Agency	8
Total	4	5	4	3	2	18

In all, I contacted 26 people to be interviewed out of which 18 responded. In line with the research objective of identifying similarities and differences in drivers and responses to FLW in Sweden and Ghana, I interviewed persons from government agencies in both countries who seek to address the challenge of FLW. In Ghana, an official of the Ministry of Food and Agriculture was interviewed and in Sweden, and official of the Livsmedelsverket/Swedish National Food Agency (SNFA) was interviewed.

In Ghana, three farmers and three food processing companies were interviewed. The farmers had farm sizes of 1.5, 2 and 15 acres and they cultivated orange, tomato, and mango, respectively. The processing companies I interviewed had about 775 employees in total and they processed and packaged spices and vegetables, and fruits into fruit juice. At the consumption stage of the FSC, two schools and one restaurant responded to the survey. The schools were “Holy Spirit Lutheran School (HSLS)” and Jachie Pramso senior High school (JPSHS)”. HSLS was a private school (from preschool to junior high school) while JPSHS was a public school. Together, both schools had a total number of 4,600 students. HSLS provided lunch and fruits for their students while the JPSHS provided breakfast, lunch and supper all prepared in the school kitchen. The restaurant was “Jofel catering” and had 108 employees in their two branches and their concept was both eat-in and take away.

In Sweden, one farmer and two food processing companies responded to the interview. The farmer had a farm size of 0.5 acre and the crops cultivated were kale, salad, beans, peas, summer, and winter squash. The processing companies, “Kullabygdens Musteri AB” and “Juicekällan” had about 20 employees in total and were involved in processing of apples into juice, and smoothies and selling healthy bars, respectively. At the consumption stage, two schools and two restaurants responded to the interview guide. The schools were “Vildandens Förskola (Preschool)” and “ISLK International School of Lund Katedralskolan” (preschool to high school). Both are public schools with a total number of 491 students. Both schools provide breakfast, lunch, and a snack for their students. The lunch is partly prepared in a kitchen outside the preschool while other meals are prepared at the

preschool. Students in grade 7 to 9 at ISLK could leave the school grounds to buy food or snacks during the day, even if they are meant to eat lunch in the canteen. The restaurants were “The Herbivore” and “Mat och Destillat” which together had about 21 employees and their concept was both eat in and take away.

4.5 Data analysis

Data collected from the interviews was categorized into patterns and themes that emerged from the interviews using the Drivers, Pressure, State, Impact, Responses analytical framework as a guide. The data was transcribed manually into text and observational notes from interviews were made as well. The interview manuscripts were then read thoroughly and categorized into themes.

5 Results

This section presents the results of the study from interviews and government documents. I have categorized the results under DPSIR components guided by the research questions. With respect to research question 1, I point out the differences and similarities in drivers, pressure, state, impact of food loss and waste in Ghana and Sweden. I start with the production stage of the FSC based on interviews with farmers and food processing companies and subsequently, the consumption stage of the FSC based on interviews with school authorities and restaurant operators. Under responses, I present results on how both countries deal with the challenge of food loss and waste in answering my second research question. Key findings on FLW in Ghana are summarized in figure 3 while findings from Sweden are summarized in figure 4.

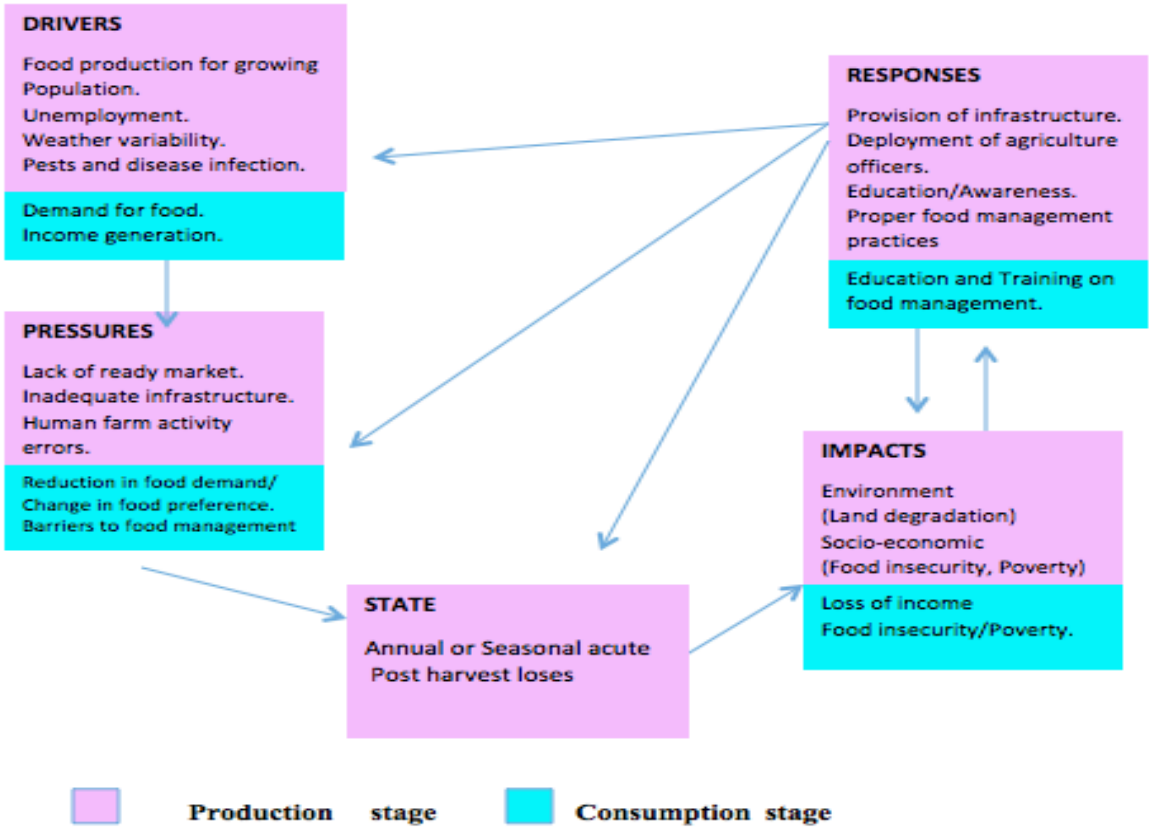

Figure 3. Outcome of the DPSIR framework base on the study's indicators of FLW at the production and consumption stages of the FSC in Ghana (Author's illustration, 2020).

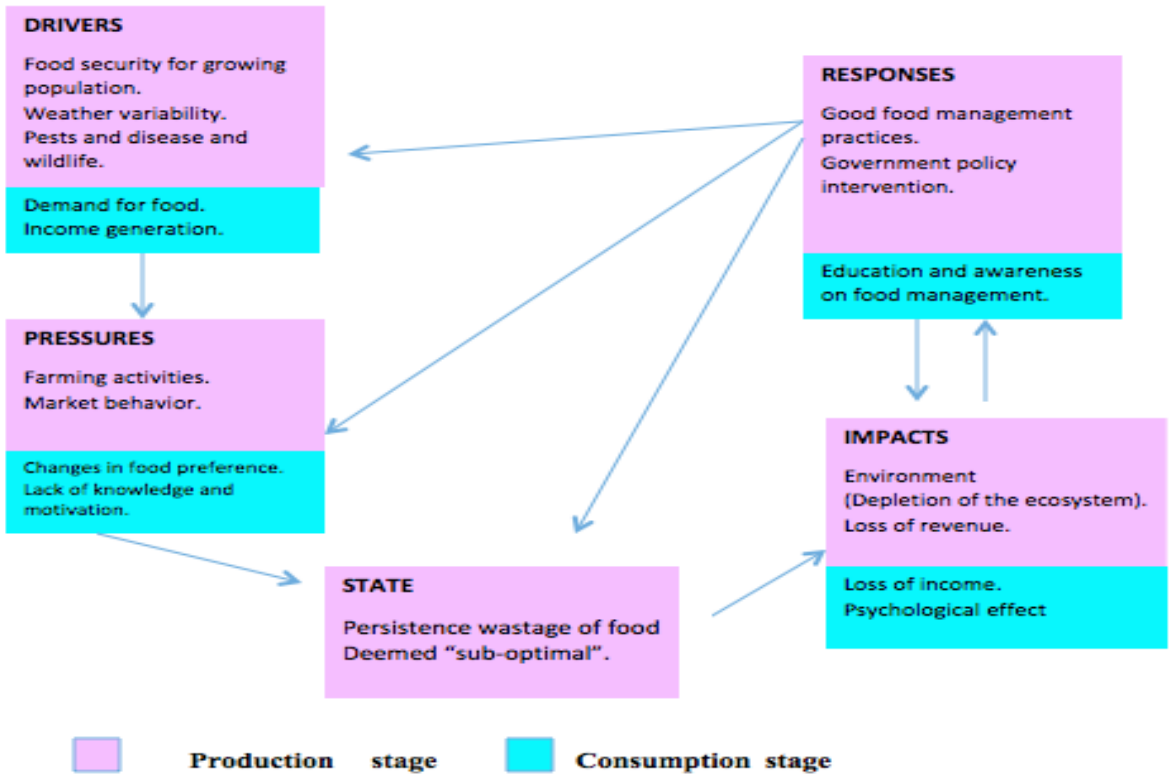

Figure 4. Outcome of the DPSIR framework based on the study's indicators of FLW at the production and consumption stages of the FSC in Sweden (Author's illustration, 2020)

5.1 Drivers of FLW

Drivers are factors such as the need for food, income and security that give rise to human activities, which affect the environment. The responses I gathered indicated that the drivers of food loss in Ghana include population increase, weather variability, and pests and disease infection. As mentioned earlier in the 'driving forces' component of DPSIR, such factors shape human activities and exert pressure on the environment. Increasing demand for food caused by population growth has led to the need for increased food production. As a result, many are increasingly engaged in food production and food processing activities. Many of the farmer respondents mentioned that they engaged in farming activities to cultivate food for their own consumption and then sell the surplus to others for income. The tomato farmer for instances said that, *"I cultivate tomatoes so that my family can use some to prepare our meals; I sell the rest to pay my children's school fees".*

On the part of the food processors, they pointed to health reasons and income were the driving forces of food loss. Nutrifoods and EKA said that they engaged in their activities for income, while Juice Plus's was for health purpose. Juice Plus produced fruit juice mainly to encourage people to

desist from taking frizzy drinks and soda which is bad for human health. At the consumption stages the driver of food waste identified was the demand for food by a growing population. Food was provided mainly to feed people and to make income as recorded from the restaurants. The students on the other hand needed to be energized to go about their school activities and the schools made nutritious food available.

In Sweden, factors that shape human activities which eventually lead to food waste were like those in Ghana. Respondents from Sweden, the farmer and food processing companies mentioned that they were driven to provide food to feed the growing population and to earn income from their sales. *Stadsårkern*, for instance, offers locally grown food for sale to restaurants and private individuals in Sweden. At the consumption stage of the FSC, operators of restaurants and schools interviewed also highlighted the provision of food for the growing population. For restaurants they were primarily driven by income generating objectives.

Another driving force for food loss and waste that was common to both Ghana and Sweden that was identified from the interviews was random changes in weather patterns. The farmers I interviewed indicated that they normally rely on the different climate seasons for their farming activities. In seasons of drought, they resort to irrigation for crop growth. The tomato farmer who opts for irrigation complained that sometimes the crops are not able to properly absorb the water causing the crops to die or unable to yield well. In Sweden, weather variability due to climate change was also identified as the driving force for food waste. *Livsmedelsverket* pointed out that every so often the weather is not favourable for crop cultivation especially when there are heavy rains, while *Stadsåkern* said that night frost and drought are the main reasons for crop damage. In recent years, it is not uncommon for there to be heavy rains in the summer which can cause crop damage.

Further, pest and disease infestation on the field was identified from the respondents as a driving force for loss of crops. The Ministry of Agriculture (MOFA) has compiled pests and diseases that negatively affect crop production in Ghana. Amongst them are Webworms or cabbage borer (Hellula undulalis), Cucumber mosaic virus disease (CMV), Tomato mirid bugs (Cyrtopeltis teriuis), etc. The farmers corroborated these findings indicating that fungal, pest and insect infections, as well as birds consuming ripe crops, contributed to food loss.

Similarly, in Sweden pests, diseases and wildlife activities were pointed out by both *Stadsåkern* and *Livsmedelsverket* as drivers of food loss. Wildlife, such as wild boars, were explained to cause destruction to field crops making them fall short of sale standards while *Stadsåkern* pointed out that animals (e.g., rats, rabbits, hares) and pests (e.g., moths, wireworm, larva) either scavenge or infect the crops and this result in the loss of food. In sum, from the interviews, there were no marked differences in factors that shape human activities that cause food loss and waste in Ghana and Sweden.

5.2 Pressures of FLW

The above-mentioned factors drive human activities that affect the environment. In Ghana, respondents highlighted lack of ready market, absence or inadequate infrastructure and poor cultivation and food processing practices as pressures. At the production level, lack of available market for farm produce was identified to be a pressure for food loss. As a result of low incomes and weak purchasing power, during "bumper harvest"[1] farmers are unable to sell everything they produce, and the rest are normally left to rot. Similarly, processed foods, which are not sold before their expiry dates go bad and are lost. For example, the citrus farmer indicated that, he could lose as much as 20 bags of oranges out of the 51 bags cultivated while the tomato farmer loses 1 box of tomatoes out of the 4 boxes cultivated every farming season. For the processing companies, EKA company said it throws away 10% of the total production every month because of low sales.

Weak purchasing power and limited availability of market was unique to Ghana as one would expect for many developing countries. In Sweden, market behaviour was instead identified as the pressure for food loss at the production stage. In Sweden, trade standards require food, especially fruits and vegetables, to appear aesthetically good, to be mature, before they are sold to consumers. Foods that do not meet such standards are discarded. Although *Stadsåkern* was able to make profit and sometimes broke even due to good farming practices, it however lost about 15 to 20% of crops one time due to market behaviour. Impressively, the food processing companies interviewed did not engage in activities that cause food loss.

[1] Bumper Harvest is when farmers unusually cultivate large amount of farm produce and in good quality on a farming season.

Another pressure that was identified from Ghanaian interviews was the already inadequate infrastructure for storage, processing facilities and transportation which have been stretched by increased food production, therefore causing food loss. The respondent from the Ministry of Food and Agriculture (MOFA) mentioned that the available storage and processing equipment facilities at the various districts are unable to meet increasing demands from food producers hence resulting in food loss. All the farmers, that is, mango, citrus and tomato farmers confirmed that, they are compelled to sell off their produce cheaply or record losses if all farm produce are not sold early because of the unavailability of storage facilities. All the food processors interviewed noted that the lack of cold storage rooms, along with recurrent power outages cause raw materials and sometimes the processed food to get spoilt. Additionally, the lack of good road transportation was identified by MOFA as a pressure for food loss.

Other pressures that were highlighted in the interviews from Ghana but not Sweden, were poor cultivation and processing activities of farmers and food processors. Some farmers used wrong procedures, seedlings, and planting materials and either planted late or harvested too early, and did not apply adequate or right amount of fertilizer and chemical for pests and insects' control. Sometimes farmers are compelled to harvest crops prematurely due to poverty, fear of theft or urgent need for food or cash. Another contributory factor to food loss is the inaccurate measurement of ingredients by the processors. For instance, the EKA company said that "*we have to throw our products away sometimes because some workers put in more or less of the required ingredient needed for the tomato paste mixture".*

At the consumption stage, pressures that lead to food waste in Ghana were identified as reduction in the demand for certain kinds of food due to changes in food preference and barriers to food management. The respondent from Jofel catering pointed out that, there are times when customers do not buy certain foods they have prepared because they would prefer other foods to what is available. The respondent indicated that, if there is a change from ordering certain kinds of foods to the other, some ingredients or materials especially of tin or packaged foods with short shelf lives expire. In such instances these foods are discarded because they can neither be used nor recycled. The restaurant also pointed out that, in most cases, spoilage of food was as a result of careless handling, poor packaging and improper storage practices. The respondent noted that when this happens, some food pieces and scraps do not match standard portions used in their service delivery and therefore waste are recorded. Asked if it was able to recycle the food waste, the response was

that the restaurant's operating licence did not permit them to recycle waste food. The interviewee claimed that the process of recycling requires a separate unit managed by well-trained personnel with the required tools, equipment, and regulatory procedures and that the restaurant's licence allows for only the production and serving of food and beverages.

From the interviews conducted with restaurant operators in Sweden, food waste did not seem to be much of a problem. Respondents indicated not much food was wasted because they normally keep low stocks on groceries and prepare food in small quantities based on demand. Nonetheless, they had some leftovers after food preparation, scraps, and leftovers after eating.

For schools in Ghana, the respondent from JPSHS indicated that not all students are satisfied with the school's meal plan and they therefore throw away food not eaten by the students. The Holy Spirit Lutheran school, on the other hand, claimed that they do not usually record food waste. The respondent pointed out that "*the food lost is insignificant because food served contains all the needed and required nutrients and therefore children are satisfied with the meals served".*

The cause of food waste in Swedish schools was similar to the cause of food waste in Ghana. Different food preferences caused food waste. With respect to food preferences, although both ISLK and *Vildandens Förskola* responded that most of the students were somewhat satisfied with their food and therefore not too much goes to waste, it was noted that some students were choosy with their food and would prefer different types of food other than the one given them. For instance, the respondent from ISLK stated that,

"*The other challenge is the younger students (3-9) as they are pickier with the food. The youngest are served by their teachers, so they might not eat all the food that is served. Also, many young kids have play time just after lunch and just want to go and play, so many of them say that they are full even though we think they are not but we cannot force them to finish their plate in the same way as a teenager who knows what he/she can eat.*"

Besides, it was mentioned that some of the school staff were not fully aware of the implications of food waste. Although it was recognized that it would be useful for the teachers to be educated on the consequences of food waste, it was a challenge to get them to be engaged in such efforts as the teachers lacked any motivation.

5.3 State of FLW

State is defined in terms of the state of the food system as defined by the type and quantity of food lost and wasted. Operators of farms, food processing companies, schools and restaurants in both countries did not have consistent records over time on the kind and quantity of food lost. On the national levels for both countries though, some studies have estimates on the kinds of food usually wasted and their quantities. I refer to these in the discussion section.

5.4 Impacts of FLW

Food loss and waste in Ghana and Sweden had some environmental, social, and economic impacts which respondents in both countries identified. With the environment, the farmer respondents typically used fertiliser for weeds management. Fertilizer application and excessive chemical spray against pests and weeds causes land degradation which affect plant growth and biodiversity loss. On this, the citrus farmer said, *"I think the weedicide I apply makes the land acidic which causes the land to be infertile and doesn't make crops grow again."* Environmental effects were not highlighted by respondents from Sweden rather *Livsmedelsverket* has documented such information in their action plan and they indicated such in their response in which amongst others included ecosystem depletion.

On socio-economic effects in Ghana, food loss raises poverty and causes food insecurity. It has been established in the pressure stage that, financial gains or losses by farmers depend on available market. The existence of ready market incentivises farmers to sell more produce at harvest time. The citrus and tomato farmers indicated that during bumper harvest, they are forced to sell their produce at reduced prices due to the absence of ready markets and in so doing incur substantial losses. Sometimes, poor-quality food crops harvested by the farmers as a result of diseases, pesticide use and poor irrigation are not bought by consumers which results in food loss. Though it was not mentioned by the respondents, it is known that such losses create artificial shortages and instability in the system resulting in increased demand for the few remaining quantities of food. This process drives the prices upwards causing substantial number of people to go hungry. This imbalance between demand and supply creates food insecurity which calls for the need for food importation. Such imports are a drag on the economy and create a dependency situation. Further, they change the food preferences of locals for foreign goods hence disincentivising the local population from engaging in agricultural activities. For instance, from the interview, the tomato

processing company had to import semi-processed tomato from China. Such imports could eventually eliminate locally produced tomatoes.

In Ghana, food loss also meant loss of income for the restaurants. The Jofel Catering restaurant noted that, on the average food waste was between 2% to 4% of its total yearly income. For instance, it had recorded 2% of food waste in 2019 and that represented a substantial loss of income. Responses to the challenge of food loss and its associated environmental, social, and economic effects are described below.

Income effects of food waste were also mentioned by respondents in Sweden. It was established from the respondent of the SNFA that primary producers like farmers have the lowest profitability in the food chain and are not able to sell as much as possible when most food is wasted as result of market standards. This adversely affects the Swedish economy. They noted that to meet market standards, Sweden imports almost half of its food which could have been avoided if trading activities of farmers and processing industries were strengthened.

5.5 Response of FLW

Responses to food loss in Ghana as indicated in the interviews are the provision of infrastructure, deployment of agricultural extension officers, education, and proper food management practices. On infrastructure, the government, through the Ministry of Food and Agriculture, has begun the construction of storage facilities throughout the country. This was implemented as part of the Infrastructure for Poverty Eradication Programme (IPEP) where 50 warehouses were constructed by the government to provide storage facilities for the crops of smallholder farmers. Processing companies have the advantage of the stability of electricity supply for food processing and preservation.

To reduce food loss, the government has recruited more extension agents to provide technical support for all the agricultural actors including the players in the food value chain. Extension agents organize training for farmers on healthy farming practices that include proper application of fertilisers and other agro-chemicals, as well as post-harvest loss prevention. According to MOFA, participatory approaches are used in these training programmes where they have had the opportunities to establish the Women in Agricultural Development programme that trains Women's group on how to preserve and process crops to prevent food loss. The citrus farmer confirmed that

the extension agents have taught him new methods in the application of fertiliser and natural manures to replenish the acidic soil that arises from the use of weedicides. The food processors have also been provided with processing machines through the engineering department of MOFA. Agricultural inputs like seedlings are easily accessible to farmers from the Plant Genetic Resources Research Institute (PGRRI), a unit under MOFA. The PGRRI advises the farmers on good production practices. To a greater effect, MOFA observed that, more farmers are beginning to depend less on food processing companies and are learning to process their produce and this also helps prevent loss especially during bumper harvest.

At the consumption stage, educating restaurant and school workers was one of the measures taken to reduce food waste. Jofel Catering restaurant pointed out that they recruit and train qualified personnel to periodically educate their workers on good management practices. These practices involved putting together procedures aimed at reducing cost in the purchase of food, cooking, and service delivery. The procedures are strengthened by constant and proper supervision in the production units. The respondent from Jofel Catering also indicated that left-over ingredients and which will not be enough for restaurant services are added to meals prepared and served to staff daily, and others are stored in the freezer to be served when needed. Besides, food waste that cannot be consumed are sorted and given to local Waste Management Company for further disposal.

The schools have also adopted practices to prevent loss. JPSHS revealed that, food which are not consumed are properly drained from liquid or fluids after which they are packaged and disposed into their designated waste collection containers. These food wastes were subsequently collected and given out as animal (pigs and dogs) feed. The HSLS said that they often cook food in right quantities according to the student population, and food that is less preferred by students is usually reduced in quantity when being supplied to the cooks to avoid food waste.

In Sweden, responses to food waste came more from individuals rather than coordinated state policy interventions by the state as in the case of Ghana. Good management practices on the part of farmers and restaurants and education and awareness creation were identified as responses to food waste. To begin with, some of the respondents were engaged in good management practices that helped to prevent food waste. For instance, many small-scale farmers did not waste much food because they cultivated the amount that they reasonably anticipated will be demanded. Crops were

also cultivated and harvested timeously to prevent food waste. Food processing companies also said they use the waste generated for biogas, and some also goes in the bin for compost. This could also be said for the schools and restaurants, where the restaurants normally purchase the right amount of ingredients for food preparation, so food waste is avoided. Leftovers after food preparation and consumption are decomposed and recycled to biogas. Schools do same as food is sorted and thrown into paper bags from *Lunds Renhållningsverk* for biogas production. Additionally, the respondents invest time and resources to ensure sustainability. For instance, one of the restaurants only serves 100% plant-based food and beverages and uses locally produced products. In schools, leftover food in the kitchen is reused the following day or as snacks instead of being disposed. Further in schools, some teachers teach food waste management practices to create student awareness. For example, at the ISLK, the children were taught the importance of food waste recycling such as portion sizes, recycling to fuel and composting. There was also a subject being taught at high school level that discussed food management called "MYP2 Science Healthy body systems unit". It was discovered though that some teachers were reluctant to engage students on food waste issues because when students are constantly instructed to consider such issues, resultant feelings of guilt will not be good for their wellbeing. Below is a table summarizing the results of the DPSIR of FLW in both countries.

Table 2. Summary of similarities and differences of DPSIR analysis of FLW in Ghana and Sweden.

DPSIR / STAGES OF THE FSC		**COUNTRY**	
		GHANA	**SWEDEN**
DRIVERS	**Production**	Food production for growing Population. Unemployment. Weather variability. Pests and disease infection.	Food security for growing population. Weather variability. Pests and disease and wildlife.
	Consumption	Demand for food. Income generation.	Demand for food. Income generation.
PRESSURES	**Production**	Lack of ready market. Inadequate infrastructure. Human farm activity errors.	Farming activities. Market behavior.
	Consumption	Reduction in food demand/ Change in food preference. Barriers to food management.	Changes in food preference. Lack of knowledge and motivation.
STATE		Annual or Seasonal acute Post harvest loses	Persistence wastage of food Deemed "sub-optimal".
IMPACTS	**Production**	Environment (Land degradation) Socio-economic (Food insecurity, Poverty)	Environment (Depletion of the ecosystem) Loss of revenue
	Consumption	Loss of income	Loss of income

		Food insecurity/Poverty.	Psychological effect
RESPONSES	**Production**	Provision of infrastructure. Deployment of agriculture officers. Education/Awareness. Proper food management practices	Good food management practices. Government policy intervention.
	Consumption	Education and Training on food management.	Education and awareness on food management.

6 Discussion

Reducing FLW in an increasingly globalized world requires an understanding of drivers and responses to it in both developing and developed country's context, to learn from each other's experiences. This section discusses the findings of the study and its broader relation to existing literature. In line with the study's research aim to identify the similarities and differences to the drivers and responses to food loss and waste in Sweden and Ghana, the first sub-section focuses on these issues and their broader implications. In line with the second research, the subsequent sub-section discusses how both countries can reduce FLW at the pre-consumption and consumption levels.

6.1 Differences and similarities in drivers of food loss and waste in Ghana and Sweden

Results from the study indicate that the underlying driving force for FLW in both countries is the need for increased food production necessitated by increasing population growth in both countries. The World Bank estimates an annual growth rate of 2.2% in Ghana's population with an estimated population of 30 million by the end of 2020. Many are therefore engaged in agricultural activities to provide food for the growing production to earn their livelihoods. As indicated earlier, respondents from Sweden also mentioned rising population and the need to earn incomes as the main reasons for engaging in agricultural activities.

In Ghana, however, an additional dimension to increasing population which was not highlighted in the interviews is increasing unemployment levels. Although it is difficult to find an accurate statistic on the extent of unemployment in Ghana, the International Labour Organization (ILO, 2020) indicates that as of June 2020 about 9.46% of the labour aged between 15 and 24 were unemployed; in 2017, the figure stood at 8.84%. Amongst the many solutions adopted to address the unemployment challenge is the government's Youth in Agriculture" and "Planting for Food & Jobs" programmes. These programmes seek to motivate the teeming unemployed youth to participate in the agricultural sector, to promote food security and to ensure that selected food crops are immediately available on the market and to provide jobs (Ministry of Food and Agriculture (MOFA), 2020). These programmes have meant that more people are engaged in food production now and large parcels of land have been brought under cultivation. As of 2016, 69% of the country's total land area of 238,539 km^2 was classified as 'agricultural land', an increase of about 3% from 2006 (World Bank, 2020). In 2019, the World Bank (2020) estimates that agriculture employed about 29.3% of the population and contributed to about 17.31% of Ghana's Gross Domestic Product (GDP)

and provides most of the country's food needs. Therefore, in Ghana, agricultural expansion as a strategy for food security, job creation and economic development have also been identified as major drivers of food loss. Agricultural expansion for economic growth has not been the case for Sweden in its modern development as its main drivers of growth are other sectors.

A common driver of FLW in Ghana and Sweden was weather variability. For the case of Ghana, this is in line with previous studies which show that bad weather is responsible for food losses in many sub-Saharan African countries (Affognon et al., 2015). Changes in weather patterns have however not been identified in previous studies as an important driver of food loss in Sweden. This is presumably because of the traditional view in extant studies that food waste in developed countries occur at the later stages of the FSC. Pre-consumer level drivers of food waste have therefore received less attention (Spang *et al*., 2019).

Pest and disease infestation on the field was a common driver of FLW in both countries. Again, while this has been highlighted in previous studies for the case of Ghana, that has not been the case for Sweden where existing food waste studies have focused on retail and household stages of the FSC and food service institutions (see for example, Engström & Carlsson-Kanyama, 2004; Miliute-Plepiene & Plepys, 2015; Ghosh & Eriksson, 2019).

Driving forces like increased demand for food leads to increased food production. However, in many developing countries, such as Ghana, increased food production leads to food loss because of the unavailability of markets and storage facilities and poor road infrastructure as indicated by the study's respondents. Previous studies have also identified these factors as drivers of food loss in Ghana. Lack of market outlets, limited preservation infrastructure, price fluctuations and poor distribution systems cause farmers to discard harvested fruits and vegetables (Aidoo et al., 2014). Losses in root and tuber crops such as yam and cassava are caused by delays in market delivery, poor handling, and limited use of effective cold storage systems (Ansah et al., 2017). Insect pests are the main causes of postharvest losses of maize and rice which are important cereals in Ghana (Danso et al., 2018). Lack of proper storage facilities leads to insect infestation with significant losses in Ghana's most important grain legume, cowpea (Mutungi & Affognon, 2013).

With regards to the state of food systems defined in this study as the kinds of food lost and wasted, as mentioned earlier there was limited data from respondents in both countries. However, in the

case of Ghana, some studies estimate that between 20 and 30% of fruits, vegetables, roots and tubers, cereals, and legumes, are lost at the post-harvest stage of the food system every year. Ridolfi et al. (2018) observe that postharvest losses are particularly acute for horticultural crops which typically range between 20 and 35%. As shown in Table 2, the total losses for maize, tomato and mango have been estimated at 14%, 38% and 46% respectively for 2018. Further, the table shows that transportation and marketing are the major loss hotspots.

Table 3: Losses and loss hotspots for selected commodities in Ghana (Ridolfi et al., 2018, p. 3)

Commodity	Total losses (%)	Key loss hotspots
Maize	14	Harvesting operations (3.9%); on-farm storage (2%); transportation operations (3.4%)
Rice	13.5	Preliminary processing (5.9%); on-farm storage (4.3%)
Cowpea	10	
Yam	31.4	On-farm storage (9.8%); transportation (10.2%)
Cassava	33.6	Harvesting (4.6%); on-farm assembling (4%); transportation (7.4%); processing (8.5%); storage of dried product (5%)
Groundnuts	6.6	Packaging & bagging (1.5%); transportation (2%)
Fish	21.5	Capture (2.1%); transportation (15.5%); sorting (2.5%)
Tomato	37.5	Harvesting (4%); sorting (13.8%); transportation (14.4%)
Okra	24.2	Harvesting (16.6%); retailing (5.1%)
Mango	45.6	Sorting (5.4%); transport (13.4%); marketing (16.2%)
Orange	5	Sorting (2.2%)

With respect to infrastructure, Sweden is typical of developed countries where limited market outlets and infrastructure are not pressures resulting in food losses. Instead in Sweden, market behavior as the results show tends to be one of the major pressures for food waste. High standards for food quality means that sub-optimal food products are wasted (Ghosh & Eriksson, 2019). Nevertheless, although transportation of fragile foods in recommended trucks is standard practice, with mechanized and well-coordinated loading and offloading, some foods were identified to be lost during these processes notwithstanding. In Ghana, food loss occurred mostly because of mishandling and delays in transportation.

For food waste at the consumption stage, similar pressures were identified in both countries. Differences in food preferences in schools and restaurants in both countries led to food waste.

Previous studies have not focused on consumption stage losses in the case of Ghana. In Sweden, some studies have shown significant food losses of 20% on average (Engström and Carlsson-Kanyama, 2004). In a study of four kitchens: two in schools and two in restaurants in the inner city of Stockholm, Engström and Carlsson-Kanyama (2004) showed that about one-fifth of food delivered was lost. Losses related to storage, preparation and serving were relatively small. They made up between 4% and 11% of the amount delivered. Plate waste, that is what the diner leaves on the plate, were the largest source of loss, making up between 11% and 13% of the amount of food served. While respondents from my study were unable to provide such figures, they mentioned that plate waste constituted significant losses and were mainly due to consumer food preferences.

Another difference between both countries related to the management of waste was, in Ghana, food wasted in restaurants and schools were either thrown away or used to feed animals while in Sweden, they are used for composting, biogas or energy, a more sustainable practice. Further in Sweden students were taught and engaged in food waste management practices while that was not the case for schools in Ghana. Differently from Sweden too, I observed that the interviewees in Ghana had limited knowledge or was not mainly concerned on the environmental consequences of FLW.

Overall, however, this study shows that the stereotypical broad differences between developed and developing countries, with food loss mostly prevalent at the pre-consumer stage in developing countries and food waste mostly common at the consumer stage of the FSC in developed countries does not hold for Ghana and Sweden. There are limited stark differences between the drivers and pressures for food loss and waste in both countries and food is lost and wasted both at the pre-consumer and consumer stages of the FSC in both countries. This result must be interpreted cautiously though given the limitations of this study. The study is focused on primary producers, food processors and consumers. The packaging, wholesale, retail and household stages, which also constitute a large share of FLW in developed countries (Hodges et al., 2010) are not discussed. This would have given a more complete picture of the drivers of FLW in the entire food chain. Nevertheless, this result should not be surprising given Spang et al. (2019)'s claim that many drivers and pressures of food loss and waste are becoming increasingly similar across regions due to globalized food systems.

6.2 Responses to Food Loss and Waste in Ghana and Sweden

The study also shows that responses to FLW have largely come from individuals and at the local level in Sweden rather than state-driven efforts in Ghana. This is perhaps because the drivers and pressures of food loss in Ghana such as limited road and storage infrastructure, market failures require large scale investments only the state can make. However, in Sweden, documents from state bodies also show that the government has been involved in combating food waste.

The SNFA/Livemedelverket, the Swedish Board of Agriculture (SBA)/Jordbruksverket, and SEPA have undertaken steps to reduce food waste. In its Swedish Waste Prevention Programme for 2014 to 2017, SEPA (2013) outlined the steps to address its waste challenges. SEPA set for itself the objective of ensuring that "food waste in the entire FSC should be reduced compared to 2010 levels". To this end, it adopted four strategies to reduce avoidable food waste: first, improving awareness of where and why food waste occurs in the FSC; second, enhancing coordination and consensus within the FSC on why steps must be taken to reduce total food waste; third, continuously measure avoidable food waste and monitor the effects of various steps taken to reduce food waste; and fourth, increase awareness of food safety and avoidable food waste among consumers (SEPA, 2013, p. 32). In 2017, the Swedish government tasked the SNFA, the SBA and the SEPA to continue to pursue these strategies between 2017 and 2019 (SNFA, 2018). They, working together with other stakeholders, were tasked to develop an action plan focused on long-term measures to reduce FLW. These measures are to contribute towards the realization of the United Nations Sustainable Development Goals, 2030 on FLW. Four interrelated points were noted as requirements for successful effort: the setting of national goal and the development of monitoring methods, effective collaboration among relevant players in the FSC, changes in consumer behaviour and efforts that will anchor the implementation of the action plan such as investigation, research, and innovation (SNFA, 2018, p. 4). A major challenge to the success of such plans identified by the SNFA (2018) is the lack of a baseline for assessing the impact of various needed steps to address FLW, which might make prioritization of different actions difficult.

Other private initiatives are also worth mentioning. Avfall Sverige (The Swedish Management Association), which comprises 400 members from both public and private waste management and recycling sectors, is working together with Swedish municipalities to ensure that by 2025, the total amount of food and residual waste will be reduced by 25% per person as compared to 2015. Avfall aims at a "Zero Waste" Sweden, where Sweden will no longer generate food waste. The association

monitors these goals by waste quantities, waste indicators and solid waste analyses which are reported annually (Avfall Sverige, 2019). As seen in Table 2, from its latest figures though, not much seemed to have been achieved in reducing food waste, and the collected volumes of food waste increased marginally between 2014 and 2018.

Table 4. Collected Volumes of Food Waste and Residual Waste, 2014-2018 (Avfall Sverige, 2018, p. 9)

Collected volumes of food waste and residual waste, 2014-2018 (tonnes)

	2014	**2015**	**2016**	**2017**	**2018**
Food and residual waste	2,221,720	2,221,280	2,240,690	2,213,540	2,214,320
Of which food waste	318,850	336,940	358,790	373,100	389,810

Collected volumes of food waste and residual waste, 2014-2018 (kg/person)

	2014	**2015**	**2016**	**2017**	**2018**
Food and residual waste	228	225	224	219	216
Of which food waste	33	34	36	37	38

In Ghana, some studies confirm the results of this study which show increased government efforts to address the challenge of FLW. Successive Ghanaian governments have adopted several strategies to mitigate the problem of food loss. These interventions have included building the capacity of producers in better harvesting, transportation and storage methods, the introduction of grading methods and the creation of linkages between producers and markets (FAO, 2011, p. 6). Other interventions to increase the economic value and the shelf life of produce have also been pursued. Value addition interventions have included warehousing, agro-processing, and packaging and distribution (FAO, 2011, p. 6). Several private sector organizations (PSOs), community-based organizations (CBOs) and non-governmental organizations (NGOs) have also assisted producers in adopting proper handling and storage practices (FAO, 2011). However, like many other developing countries, a major challenge in efforts to reduce post-harvest losses is the lack of precise assessments of the actual levels of losses, making it difficult to set reduction targets and measure progress against such targets. Ambiguous estimates of post-harvest losses and unclear understanding of the stage along the FSC where losses occur and the drivers of food losses could lead to the pursuit of sub-optimal post-harvest losses reduction strategies (Affognon et al., 2015).

Ghana and Sweden can however learn from each other to reduce or prevent FLW. Ghana needs to invest in transport and storage infrastructure to support food producers as in the case of Sweden. Agricultural technologies such as irrigation systems, mechanized harvesting, and disease-and drought-resistant crop varieties have been identified as important for reducing food losses and increase production (Tilman et al. 2011; Foley et al., 2011; Spang et al., 2019). Postharvest food losses can be addressed using technologies such as cold storage, drying and packaging to extend the shelf life of farm produce. In Ghana, government bodies can monitor production and markets and make available to farmers estimated demands of food crops seasonally. This will help farmers to cultivate the right amount of produce to the consumer market to avoid or reduce food loss.

At the consumption stage, food loss can be reduced in Ghana when restaurants adopt the strategy of buying and preparing small quantity of food often per demand by customers as done in Sweden. Also, instead of throwing food away, it can be collected and converted to energy or biogas by the government institutions. In both Ghana and Sweden, there is the need for continuous education and awareness creation on the environmental, social, and economic effects of FLW. Consumer education campaigns to create awareness on proper portion sizes, food purchasing skills, meal planning, how to use leftovers, food disposal behavior, and interpreting sell-by or use-by dates have been found to help ensure a commitment to handling food better (Hodges et al., 2011). In both countries, taxing foods that contribute a lot to waste, increasing cost of and tax of waste disposal may discourage food wastage and building strong partnerships among stakeholders along the FSC could help reduce FLW.

7 Conclusion

Increasing global population has led to the need for increased food production and a strain on the already limited resources used for cultivating food. To ensure food security without saddling the natural environment, reducing food loss and waste must be part of any strategy to increase food availability. This study has therefore examined the problem of food loss and waste in both Sweden and Ghana, analyzing the similarities and differences in drivers and pressures and responses to food loss and waste using the DPSIR framework. Although considerable attention has been given to the drivers and responses to FLW globally, few comparative studies of developed and developing countries exist investigating both contexts can leverage on each other's experiences to deal with FLW. In this study, I have explored the drivers, pressures, state, impact, and responses to FLW at the production and consumption levels of the FSC in both interviews. The analysis is based on interviews with 18 respondents from both countries including farmers, operators of food processing companies, schools, restaurants, and government employees.

The study finds, contrary to the traditional view in existing studies, that food loss at the pre-consumer stage of the FSC and food waste at the consumer stage of the FSC were prevalent in both Ghana and Sweden. Drivers and pressures of food loss and waste in both countries at the production level included increasing population growth, increased food production, pest and disease infestation and changing weather patterns. Infrastructural problems were, however, unique to Ghana. At the consumption stage, common drivers, and pressures to FLW in both countries were identified as changing food preferences and limited education and awareness on the environmental, social, and economic effects of FLW. High food quality standards were, nonetheless, unique to Sweden as pressures. The study also highlights areas of learning from the experiences of both countries such as investment in appropriate agricultural technologies and consumer education campaigns. Generally, the study points to a rethink of the conventional distinction between developing and developed countries in analyses of the drivers, pressures and responses to food loss and waste to allow for across contexts learning.

As a Way forward, my wish is for this study to contribute to the development of Ghana and other developing countries especially in terms of sustainability wise, by adopting and leapfrogging strategies of FLW prevention from other developed countries. There should be therefore the need for actions to be undertaken so that all stakeholders, both state and individuals become actively

engaged in measures that appreciate the environmental, social and economic interrelationships which are vital to sustainable development.

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9 APPENDIX

9.1 Sample of key informants interview guide

SURVEYS

FOOD WASTAGE IN PRODUCTION AND CONSUMPTION: A COMPARATIVE ANALYSIS OF GHANA AND SWEDEN

This questionnaire is for education purpose. It is conducted as a fufillment of LUMES (Environmental Science and Sustainability Studies) Masters Programme.

SCHOOL

General information about the school

1. Name.....

City ..... Country .....

2. Type of school
Private ( ) Public ( )

3. Number of students/children in the school .....

4. Meals provided by the school. (Multiple answers allowed)
Breakfast ( ) Lunch ( ) Dinner ( ) Snack ( )

.....
.....
.....

5. Does the school own a kitchen where the meals are prepared?

Yes ( ) No ( )

6. Are students/ allowed to buy food from a canteen/elsewhere aside the school's meal?

Yes ( ) No ( )

7. Are students allowed to bring their own food to school beside the provided school meal?

Yes ( ) No ( )

8. Are you satisfied with your current meal plan arrangement?

Completely Satisfied ( ) Somewhat satisfied ( )
Completely Unsatisfied ( ) Somewhat Unsatisfied ( )

9. Would you say the children are satisfied with the food the school gives?

10. Please indicate the amount of food left during an average meal. (Indicate with your own measurement)

.....

11. What happens to the leftover meal in the kitchen?

.....

12. What happens to the food waste by students/children?

.....

13. Would you your solution plan for leftover meal and food left by students is sustainable enough?
Yes ( ) No ( )

14. Give reasons for your choice of answer.

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.....

15. What measures have you implemented to reduce the amount of leftover food?

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16. How effective have these measures been?

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17. What challenges do you face in implementing these measures?

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18. Are there any lessons on activities about food education at school?
Yes ( ) No ( )

19. If yes indicate

.....
.....

20. Any concerns or important information regarding food waste you would like to share?

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.....
.....

Thank you for taking time to complete the questionnaire.

FOOD PRODUCERS/FARMERS

General information

1. Name of institution.....

2. How big is the farm? .....

3a . What crops are cultivated?.....

3b. How do you access your crop seedlings?

.....

.....

4. What agriculture technology is engaged?

.....

.....

.....

.....

5. Amount of crops sold? (in your own measurement)

.....

.....

6. Do you normally break even?

Profit ( ) Break even ( ) Loss ( )

7. How much crop is lost? (in your own measurement)

.....

.....

8. What happens to the crops when there is bumper harvest?

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9. The reasons for crop wastage/loss if any?

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10. What options do you take for waste minimization and utilization?

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11. What are the reasons for not harvesting or selling?

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12. What was done with the waste?

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13. How do you engage in waste reduction?

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14. How do you think waste could be better utilized?

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15. What support do you get from the government?

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16. Knowledge on food waste management?

17. Any additional information that might be of importance on food waste management?

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.....

Thanks for your time