UK Food Sustainability and Global Food Supply Chains: A Sustainability Impact Study of Ghana's Fresh Vegetable Exports to the UK

Emmanuel Ferguson Aikins

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Declaration of Originality

This thesis is the original work conducted by Emmanuel Ferguson Aikins. Contributions from other authors and existing literatures utilised have been acknowledged appropriately.

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Aikins, Emmanuel Ferguson   Date

Copyright Statement

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Conference Papers

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ABSTRACT

The purpose of this research is to explore the opportunities for reducing sustainability implications associated with the UK's global food supply chains by analysing Ghana's fresh vegetables exports. Existing literature assesses sustainability implications focusing on the traditional sustainability dimensions; namely, the environmental, social, and economic dimensions. Further, studies on the assessment of the UK food sustainability are yet to consider sustainability concerns generated by global food sources. To facilitate a holistic evaluation of the UK's global food supply chains and propagate its vision of global leadership in food sustainability, there is a need to consider all other relevant sustainability dimensions and their impacts associated with the activities and operations of global food suppliers. Case study data involving interviews and focus groups, together with survey data, are obtained from producers of Ghanaian fresh vegetables, such as smallholder farmers, outgrowers, local farmers, and exporters. The interviews and focus groups are first analysed using NVivo 11 software, following a thematic approach. Multilinear Regression (MLR) is performed using the Statistical Package for the Social Sciences (SPSS) to analyse the survey, in order to examine the relationship between sustainable food supply chains (sustainable FSC) and sustainability dimensions identified from the thematic analysis of the interviews and focus groups.

These findings indicate that six sustainability dimensions and their associated impacts are important in analysing Ghana's fresh vegetable exports to the UK. These are environmental, social, and economic dimensions, regulatory frameworks, collaboration, and producers' complexities in developing sustainable food supply chains (sustainable FSC). Interestingly, the survey results suggest that four of these dimensions are statistically significant; these are environmental, social, regulatory frameworks, and collaboration. The survey further revealed that an increase in regulatory frameworks and mechanisms can reduce sustainable FSC; whereas an increase in the practices and activities of the environmental, social, and collaborative dimensions increases sustainable FSC, thus improving overall sustainability. Revelations and findings from both the thematic and survey analysis were utilised to develop, test and validate the Sustainability Impact Assessment (SIA) model (thus, a conceptual framework of the study).

This study contributes to the body of knowledge in several ways. To theory, an SIA model is suggested, demonstrating the capture of all important sustainability dimensions; namely, environmental, economic, social, regulatory, collaboration, and complexities of food supply chains. It extends the discussion on sustainability impact assessments and sustainability development and encourages research in sustainability assessment. In practice, this SIA model can facilitate easy capture, examination, and evaluation of all

relevant sustainability implications and allow new insights into the development and assessment of the stream of sustainability development.

Among many other implications such as promoting collaboration, policymakers need to encourage FairTrade for producers in developing countries, and regulatory mechanisms should be re-designed to enhance profitability by using simple conformity and economic incentives. Further, food trade partners and FSC professionals should encourage smart strategies and technologies to enhance logistics that minimise food waste and energy consumption, while boosting producers' welfare. Moreover, governments and policymakers should ensure that the sustainability concerns of overseas countries are captured in food policies and strategies to help facilitate global leadership in food sustainability.

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List of Abbreviations

AVE – Average Variance Extracted

BLSS CREC – Business, Law and Social Sciences College Research Ethics Committee

CR – Composite Reliability

CIBSD – Centre for International Business Strategy and Decisions

DEFRA – Department for Environment, Food and Rural Affairs

EU – European Union

EurOMA – European Operations Management Association

FAGE – Federation of Associations of Ghanaian Exporters

FAO – Food and Agriculture Organisation of the United Nations

FAOSTAT – Food and Agriculture Organisation Corporate Statistical Database

FDA – Food and Drugs Authority of Ghana

FFTHP – Fifth Respondent

FGD – Focus Group Discussion

FGD-LSP – Focus Group Discussion involving Large-Scale Producers

FGD-SSP – Focus Group Discussion involving Small-Scale Producers

FR – First Respondent

FSA – Food Standards Agency

FSC – Food Supply Chain

FTHR – Fourth Respondent

GAVEX - Ghana Association of Vegetable Exporters

GSA – Ghana Standards Authority

I-LSP – Interview involving Large-Scale Producer

I-SSP – Interview involving Small-Scale Producer

LSP – Large-Scale Producer(s)

MLR – Multilinear Regression

MOFA – Ministry of Food and Agriculture of Ghana

NGOs - Non-governmental organisations

NTU – Nottingham Trent University

OECD – Organisation for Economic Co-operation and Development

PI – Principal Investigator

PIS – Participant Information Sheet

RO – Research Objective

RQ – Research Question

RPA – Rural Payment Agency

SC – Supply Chain

SDG – Sustainable Development Goals

SFSC – Sustainable Food Supply Chain

SIA – Sustainability Impact Assessment

SPSS – Statistical Package for the Social Sciences

SR – Second Respondent

SSP – Small-Scale Producer(s)

THR – Third Respondent

UN – United Nations

UNDP – United Nations Development Programme

UNEP – United Nations Environment Programme

VEPEAG – Vegetable Producers and Exporters Association of Ghana

WTO – World Trade Organisation

CHAPTER ONE (1)
1.0 INTRODUCTION: BACKGROUND, RESEARCH AIMS, OBJECTIVES AND STRUCTURE

1.1 Introduction

The global food system involves production, processing, packaging, distribution, retailing, and consumption of food which, together, generate major sustainability implications, e.g., CO_2 emissions, food waste, biodiversity loss, and FairTrade issues (Ritchie and Roser, 2020; Kent et al., 2022). Many authors, e.g., Staniškis (2012), Govindan (2018), Béné et al. (2019) and Friedman and Ormiston (2022) attribute the enormous negative sustainability impacts associated with global food supply chains to increasing world population and human consumption. Although policymakers, researchers, and food industry actors are progressing towards redressing the precarious impacts of the global food system (Scott-Villiers et al., 2016), the concept of a sustainable food supply chain is not widely considered (Anderson, 2019). Also, there is a lack of awareness of the possible ramifications of increasing food sourcing from developing countries, such as Ghana, China, India, Colombia, and Morocco. Ghana supplies over 50 food items to 108 countries across the globe (International Trade Statistics, 2022). Ghana's geographical location, ready logistical support services, and network with food trade partners demonstrate the country's prospects to serve broader markets (local and global) in return for significant economic benefits (Breisinger et al., 2008; Nyamah et al., 2017).

Ghana's food supply chain is characterised by a large number of producers who are facing poor transport infrastructure, weak production and supply technologies, phytosanitary challenges, market access, storage difficulties, and low productivity mostly contributed to by poor agricultural practices and inadequate support from government and other FSC actors (Darfour and Rosentrater, 2016; Torres and van Seters, 2016). It is apparent that these characteristics and food supply chain activities create sustainability concerns which are shared by other global food suppliers. However, studies have not attempted to assess the sustainability impacts of the food supply chain holistically, starting from overseas sources and taking into account different sustainability dimensions (Elkington, 2013; Malak-Rawlikowska et al., 2019).

Sustainability Impact Assessment (SIA) suggested by DEFRA (2002) and OECD (2010) is a useful tool for examining the collective environmental, social, and economic impacts of strategies, actions, and activities, and for revealing options for trade-offs and decision making. However, existing literature is yet to utilise the SIA tool for assessing food supply chains, not to mention considering the capture of sustainability implications starting from overseas sources with it.

This thesis is, therefore, concerned with exploring the opportunities of reducing the sustainability implications associated with global food supply chains by analysing Ghana's fresh vegetable exports to the UK with the SIA tool. This study is vital to help identify various sustainability impacts of food supply chains, taking into account overseas sources. Further, the findings and its implications will provide policymakers, food supply chain professionals, researchers, and educators with practical and more realistic approaches and measures of enhancing food sustainability as exemplars of responsible and global citizenship.

This introductory chapter explains the context-specific background of the study, followed by the justification, research aims, objectives, questions and then the research methods and main contributions of the study. In addition, the structure of the thesis is outlined to highlight the depth of each chapter.

1.2 Background of the Global food supply chain

The global food supply chain is complex, dynamic, and involves many actors or stakeholders. Some of these actors are embracing change and reducing unsustainability to achieve more sustainable global food supply chains. Others are utilising innovations and waste reductions to create sustainability. Global food supply chains, starting from overseas sources activities through to consumption, generate enormous sustainability concerns. Nevertheless, it is fascinating to note that global food supply chains and networks are playing a vital role in providing development and open market access for all actors, especially producers – both small and large – in developing countries. Also, increasing numbers of industry players are working towards visualisation of the supply chains (Trienekens et al., 2014), thus decoupling the information characteristics and physical flow of supply chain operations or blockchain (Shahid et al., 2020). Several research and development (R&D) communities are also investing in the adoption of Internet of Things (IoT) technologies, such as sensors, RFIDs, monitors, and connecting devices, to support the global food supply chain, from production to consumption. Contemporary management studies stress the need for collaboration to drive global food supply chains (Chen et al., 2017). Notwithstanding, holistic assessment of sustainability implications involving all factors, such as collaboration and different sustainability dimensions (environmental, economic, and social dimensions), would have more positive impacts than a one-sided study on collaboration for global food supply chains. Food sustainability scholars—for example, Anderson (2019)—emphasise that measuring sustainability impacts is an important step towards developing better priorities and policies that can nurture sustainable food systems. Yakovleva (2007), Elkington (2013), and Schmutz et al. (2018) provide some ideas regarding assessing the food supply chain using the Sustainability Impact Assessment (SIA) approach, mainly based on environmental, economic, and social dimensions of sustainability. Other authors urge food supply players (mainly producers and food trade partner countries) to address the causes of sustainability implications instead of reducing unsustainability by creating "flourishing sustainability" (Ehrenfeld and Hoffman, 2013).

The UK's food sustainability agenda, in furtherance of the Sustainability Development Goals, is to ensure healthy, safe, affordable, and sustainable food. This vision culminates in Food 2030, ensuring a high-quality sustainable food supply that encourages CO_2 emissions reduction, food nutrition, and food security (HM Government, 2010). However, critics argue that the vision is too short on the detail, too long on vision, and does not properly outline step-by-step local approaches and global responsibilities towards food sustainability, either in the short term or the long term (Barling and Lang, 2010; Marsden, 2010). This explains that the core priorities spelt out in the Food 2030 strategy do not account for the UK's government strategy towards food sourced from overseas between now and 2050, when the country is targeted to be self-sufficient in food production. Interestingly, the UK is committed to carbon neutrality, becoming the first major country to pass net zero emissions law (HM Government, 2019). However, UK food production provides only 60% of domestic consumption requirements, the rest being balanced by sourcing food from overseas producers (AHDB, 2016; Lang and Schoen, 2016). This UK reliance on global food suppliers still propagates significant sustainability impacts, which necessitates more pragmatic and holistic approaches to achieving carbon neutrality by 2050. In attempting to achieve a secure sustainable food system and carbon neutrality, the UK food supply chains need to be economically, socially, and environmentally sustainable by taking into account sustainability implications imported from global sources. DEFRA (Department for Environment, Food and Rural Affairs) claims to be working with all food industry players, the third sector, consumers, and international organisations to improve sustainability. However, while the UK is increasingly concerned with the sustainability impacts of the food supply at home, less attention has been paid to the food supply from overseas. With UK food trade concerns with the EU created by Brexit, UK needs to consider elsewhere—other than the EU—for a sufficient amount of food supply. Geographically, it makes sense for the UK to consider West Africa or Sub-Saharan Africa (SSA) as food trade partners since they offer a smaller carbon footprint than trade with Asia, America, or Australia. Interestingly, Office for National Statistics data show that food imports from Sub-Saharan Africa are increasing more rapidly than those from the EU and Asia. The consistent increase in food trade with Sub-Saharan African means there is an established network and collaboration among food supply chain actors.

It is interesting to note that Ghana's food exports to the UK between 2015 and 2019 show a consistently higher growth rate than the remaining food suppliers in SSA (author's calculation, based on FAO Dataset). Vegetables have recorded the highest percentage increase of food exported to the UK from Ghana over the last five years; thus, from 2011 to 2016, showing an increase of 112%, compared to fish – the second highest – which increased by 56% (UK Trade Experimental Statistics, 2017). It is explained that safety, healthy and quality standards are the reasons behind Ghana's fresh vegetable export improvement (Saavedra et al., 2014; Chapoto et al., 2018). In this context, assessing sustainability implications of the UK food supply chains – taking into account the activities of the food producers and different dimensions of sustainability – is ideal, especially when considering a consistent, relevant, and global food supplier like Ghana.

1.3 Justification of the study

Food accounts for about 26% of the world's greenhouse gas (GHG) emissions (Poore and Nemecek, 2018). Despite the significant detrimental implications for the earth through its production, transportation, and consumption, it is essential, as medicine and more food are likely to be needed as the world population grows. Further, different food items are usually sourced from foreign countries to complement local production, since few countries are self-sufficient in production of all food items (Brankov et al., 2021), creating more sustainability issues. Intriguingly, while authors including Wakeland, Cholette and Venkat (2012) stress that food transportation escalates emissions, Ritchie (2019) argues that food air-freighted from overseas or sourced locally matters little for the world's total emissions. Instead, Ritchie (2019) suggests that people should focus on what they eat, especially by reducing meat consumption. Nevertheless, the work of Scarborough et al. (2014) and

Garnett et al. (2016) claim that vegetables produce the highest percentage of GHG emissions in a typical western meal, after protein-related food categories such as meat and dairy. Emissions from vegetables are significantly higher than pasta, sugar, bread and alcohol. In addition, Garnett (2020) and Aikins and Ramanathan (2020) assert that vegetable exports to developed countries are rapidly increasing, making it an interesting area of study. If meat matters most in global food emissions, but emissions from vegetables are significantly high due to increasing export and consumption in advanced countries, such as the USA, the UK, Canada, and Japan, what could be the future sustainability implications?

Again, vegetable production and supply are widely debated as intensive, long, and complex (Nichols and Hilmi, 2009; Norris and Congreves, 2018). Regarding its safety, hygiene, and quality standards, countries and regional blocs have standardised procedures and rules that producers and other vegetable supply chains with which actors need to comply. For example, the EU requires exporters of plants and plant products from non-EU countries to provide a phytosanitary certificate to enable them to trade with EU countries (European Commission, 2021). Having this phytosanitary certificate ensures that the exporter's plants and plant products are properly inspected, and practically free from pests and pathogens within the standardised requirements, which are in accordance with EU plant health requirements, specified in Regulation (EU) 2019/2072. However, it is critically emphasised that, although food safety protocols are for the good of all humankind, the rules and regulations can create further critical food trade concerns, including sustainability issues in particular (Büthe, 2010). Unfortunately, vegetables have a short lifespan and are highly perishable, which generates enormous food waste and economic loss. Furthermore, vegetable producers and exporters face additional challenges, such as stringent border protocols, limited space in cargo, and competitive freight charges, coupled with poor regulatory oversight in developing countries, all of which can generate significant sustainability implications. This should be a concern for all, since minimising food waste through proactive regulatory measures can encourage considerable emissions reduction (Cattaneo et al., 2021). Complementary with this, Ghana is a signatory to the WTO Sanitary and Phytosanitary measures agreement (WTO, 1998) which came into force in 1995. Even so, between 2014 and the latter part of 2017, the EU banned some vegetable exports from Ghana for failing to comply with sanitary and phytosanitary measures (Agar, 2019). The WTO agreement states clearly that signatories must comply with the rules and framework for food safety and plant health standards. In this regard, vegetable producers must ensure both national and international phytosanitary compliance, thereby contributing to the food safety of the wider populace. This implies vegetable supply chains and research in related contexts is likely to be ideal and useful for all 160 signatories to the WTO Agreement on Sanitary and Phytosanitary measures, including both developing and developed countries.

Furthermore, Ghana’s food supply chain is characterised by a large number of producers, most of them small-scale. Challenges facing small producers include high transportcosts, limited credit facilities, poor information flow, and limited market access. These challenges increase poverty (Kwapong et al., 2021). This researcher has decided on this topic for study due to the dominance of small-scale producers. The results will exploit practical implications that can encourage competitiveness and commercialisation for small producers, leading to possible reduction of poverty among smallholder farmers in Ghana. In that country, smallholder farmers are responsible for about 90% of local agriculture food production; and the vegetable sector is highly populated by the smallholder farmers—close to 93% (Asselt, Masias and Kolavalli, 2018). Although existing research, such as Tilman et al. (2002), Yakovleva (2007), Ismatov, Dadaboev and Karabaev (2019), and Dani (2021) has facilitated possibilities in agricultural production and sustainability of food supply chains, it is important to examine the activities of the major contributors of food production and the supply chains—the smallholder farmers. This would help to redirect transformative and innovative approaches that can enhance sustainable outcomes for them, including the possibility of shifting to commercial agriculture. More interestingly, the study outcome has the potential not only to reduce farmers’ marginality and poverty but also to improve all actors’ sustainable welfare within the food supply chain, as well as contributing to food systems research; hence, contributing to the UN’s SDG goal number one—i.e., to end poverty everywhere (UNDP, 2021).

Furthermore, among West Africa’s vegetable export giants, Ghana has been the largest exporter to the UK and the rest of the world since 2014, with total vegetable exports to the UK amounting to US$7.86 million (in 2019), compared to Nigeria at US$36,000 and Ivory Coast at US$790 (UN Comtrade, 2021). In fact, Ghana comes behind only South Africa and Kenya in the top Sub-Saharan African vegetable exporting countries (FAOSTAT, 2021; UN Comtrade, 2021). Moreover, datasets presented by UN Comtrade from 2014 to 2019 show that, on aggregate, Ghana exports more than half of its vegetable production to the UK, which is more than the total for South Africa and Kenya (author’s calculation, based on UN Comtrade Dataset). Thus, about 56% of Ghana's vegetable exports are supplied to the UK, but Kenya and South Africa exports are about 43% and 32%, respectively. Saavedra et al. (2014) have explained that Ghana's continuous improvement in its supply chain network with its UK partners has encouraged greater vegetable exports to the UK than with the rest of the world. Not only that, but vegetable exports from Ghana are also expanding rapidly due to advantageous air freight rates to European markets, particularly that of the UK (Annequin et al*.*, 2010; Ghana Investment Promotion Centre, 2017). In addition, sea freight offers relatively cheap charges with short transit periods, usually taking less than nine days to reach Europe (Edwards, Tokar and Maxwell, 1997; Ghana Investment Promotion Centre, 2017). This makes logistical and transportation sense and is relatively cheaper for Ghanaian vegetable exporters than for those of other vegetable exporting countries in Sub-Saharan Africa. Although Kenya and South Africa are leading exporters of vegetables to Europe, including the UK, the increase in Ghana's vegetable exports over the last five years is exponentially higher (UN Comtrade, 2021). Moreover, the data from FAO and UN Comtrade further reveal that Ghana's vegetable exports to the UK and to the rest of the world are greater than countries such as Guinea and Zimbabwe, which have been known for more than two decades to be among the top farm producers in Sub-Saharan Africa (author's calculation, based on UN Comtrade Dataset and FAOSTAT). Further, data from multiple sources, including UN Comtrade and FAOSTAT, reveal that, although top Sub-Saharan African countries such as South Africa and Kenya export significantly larger quantities of vegetables than Ghana, Ghanaian vegetable exports to the UK and to the rest of world are more consistent and increasing at a higher rate (UN Comtrade, 2021; FAOSTAT, 2022). Some of the reasons for the consistency of Ghana's vegetable export performance is its ability to continuously expand its vegetable supply chain network, together with producers' application of sustainable practices (Legge et al., 2008; Saavedra et al., 2014; Amfo and Ali, 2021). Interestingly, Council, Rijk and Beatrixlaan (2014) emphasise that there is high demand for Ghanaian vegetables in Europe and the rest of the world due to their flavour, nutrition, and quality standards and because of the niche varieties available for vegetable producers. From this discussion and the findings from the data, it is very worthwhile carrying out this study to help provide more realistic, sustainable models and pragmatic approaches for dealing with food suppliers who are consistent and share impressive data of food trade.

Last, conducting research abroad requires collaboration and networking, as well as awareness of differing cultural, ethical, and legal conditions (Ekhaguere et al., 2006;

Barrett, Cason and Lentz, 2020), due to the multiple types of data collection involved. This is why academic and research institutions have standardised guidelines that researchers need to comply with. For example, the College Research Ethics Committee of Nottingham Trent University has standardised procedures and guidelines laid down for researchers to attain ethical approval. The policy frowns on data collection activities that are not clearly defined in the ethics application process and have not yet received ethical approval (Nottingham Trent University, 2021). Data collection in doctoral studies is indispensable; and its criticality, especially when it involves collecting data overseas, cannot be overlooked. More intriguingly, Mandiyanike (2009) bemoans the difficulties in conducting studies overseas, particularly in developing countries, and mentioning polarised political environments and participants not certain of what the use of data would be. Despite that, studies which involve foreign geography, participants, institutions, and collaboration require more time and money (Barrett, Cason and Lentz, 2020). Mandiyanike (2009) also restated the benefit of conducting research in a home country—for example, the social networks the researcher may already have—to enable access to data. Interestingly, the researcher of this project was born in Ghana, raised in Ghana, and has solid social networks and trusted relationships that can facilitate access to organisations, people and data related to the research topic. This is an alternative and distinctive reason why the researcher has focused on Ghana: to ensure collection of rich data sufficient for a successful completion of the project.

1.4 Research Aims, Objectives and Questions

1.4.1 Research Aims

In order to contribute to knowledge and address the above research gaps, the aim of this research is to explore the opportunities to reduce the sustainability implications of the UK's global food supply chain by analysing Ghana's fresh vegetables export, using case study and survey. This helps to align the sustainability implications with pragmatic strategies and measures, in order to nurture sustainable food supply for both the UK and Ghana.

1.4.2 Research Objectives (RO)

Although DEFRA, FSA, and RPA are committed to ensuring the import of safe, healthy and quality food into the UK, the rules and regulations that address the sustainability of food supply chains from overseas countries have not been fully assessed. The objectives of this study are to:

I. Identify the sustainability gaps in Ghana's fresh vegetable exports to the UK.
II. Explore alternative practices with a view to reducing the sustainability impact associated with Ghana's fresh vegetables supply chain to the UK.
III. Suggest a robust method for measuring and valuing the sustainability implications associated with fresh food exports (fresh vegetables) to the UK, taking account of the sustainability impact assessment (SIA) and life-cycle analysis of the food supply chain.
IV. Provide recommendations to encourage sustainable food supply chains for the UK and Ghana.

1.4.3 Research Questions (RQ)

This study seeks to contribute to the literature on food sustainability and sustainability of food supply chains by answering the following three research questions:

i. What are the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK?

This study's research question seeks to capture all relevant sustainability impacts associated with the UK's global food supply chain using Ghana's fresh vegetable supply chain as a case study. Further, literature—e.g., Garnett (2013), Schader et al. (2014), Govindan et al. (2018), Anderson (2019) and Kumar, Mangla and Kumar (2022)—has long considered the traditional sustainability dimensions; namely, environmental, economic, and social. This research question seeks to explore further in a quest to identify all other important sustainability dimensions evident in Ghana's fresh vegetable supply to the UK. This will enable food industry players not limited to the UK and Ghana FSC stakeholders to clearly understand the holistic assessment of sustainability impacts and utilise more realistic options for improving sustainability and sustainability development agendas.

ii. How can the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK be estimated using the available methods?

This research question seeks to explore available statistical estimation methods to measure the sustainability dimensions associated with Ghana's fresh vegetable supply to the UK. However, as long ago as 2011, Ramanathan, Gunasekaran and Subramanian (2011) pointed out the difficulty of estimating the benefits of a key sustainability dimension such as collaboration; yet attempts in the existing literature to explore this important option for improving sustainability remain limited. Meanwhile, Affum and Wang (2019) bemoan the difficulty in measuring Ghana's food supply chains, due to heterogeneity and intangibility. Other studies—e.g., Yakovleva (2007) and Malak-Rawlikowska et al. (2019)—have made crucial attempts by measuring the implications of sustainability indicators that encompass environmental, social, and economic dimensions, considering various stages of food supply chains such as agriculture, processing, wholesaling, retailing, and catering. Nevertheless, their studies are UK-based research and do not take account of food supply chains from overseas, within which are usually embedded enormous sustainability implications. This research question seeks to address the literature gap and find more robust methods among the available statistical methods to estimate the sustainability impacts associated with the UK's global food supply chain. This will enable food industry players not limited to the UK and Ghana FSC stakeholders to appropriately estimate the sustainability implications associated with supply chains, considering the activities and operations of overseas FSC actors.

iii. What are the managerial and policy implications for both Ghana and the UK?

The sustainability concerns of the UK's food supply chains are potentially overwhelming (de Ruiter et al., 2016) and require urgent, pragmatic, and all-inclusive approaches and measures to achieve balancing-off throughout its global food supply chains. Also, the UK is increasingly concerned with the sustainability impact of the food supply at home, while less attention has been given to that from overseas. Having understood the capture of the sustainability implications of Ghana's fresh vegetable supply chain and how to accurately estimate each sustainability dimension within the supply chains, there is the need to outline relevant implications, recommendations, and measures to enable Ghana and the UK to spearhead sustainable food supply chains and sustainability development agendas. Hence, this research question seeks to draw out new recommendations and implications that can facilitate the UK's quest to be a global leader in food sustainability and enable Ghana FSC stakeholders to spearhead sustainable food supply chains. This study seeks to provide theoretical, practical, and policy implications that can enable both countries, the UK and Ghana, to enhance sustainability.

1.5 Research Methods

This study adopts the mixed methods approach (Hall, 2013), utilising both quantitative and qualitative methods to address the research questions. First, the case studies approach—a qualitative research method involving interviews and focus groups is employed to address the RQ1: What are the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK? The interview and focus group data were analysed following the thematic analysis approach suggested by Braun and Clarke (2006) with the aid of NVivo 11. Having the identified sustainability implications, a quantitative method in the form of a survey was conducted to facilitate RQ 2: How can the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK be estimated using available methods? The survey data collected were statistically analysed by performing regression estimations using SPSS Statistics Version 27. The case study data (interviews and focus groups) were collected from large and small producers and survey data were collected from producers such as smallholders, local farmers, outgrowers, large producers, and exporters. It is important to mention that, to ensure the choice of the appropriate research methodology, the study follows the recommendation of Saunders, Lewis and Thornhill (2009) which stresses that the choice of research strategy should be driven by the research questions, research objectives, amount of existing literature, timeframe, resources, and the philosophical underpinnings of the study. This serves as a good practice for choosing appropriate research approaches (Opoku, Ahmed and Akotia, 2016). Therefore, this informs the researcher on the choice of research methods appropriate for the study and, thus, case research and a survey have been adopted to achieve the research aim and objectives.

1.6 Main Contributions of the Study

This study contributes to the body of knowledge in three main areas – theoretical, practical, and policy. Theoretically, this study expands the discussion of sustainability impact assessments to suggest that a broader perspective of sustainability can be incorporated into a single model or framework—the SIA model. This model reveals that a broader sustainability perspective of the global food supply chains considers all relevant sustainability dimensions—mainly, environmental, economic, social, regulatory, collaboration, and complexities dimensions and their associated impacts—to allow new insights into the development and assessment of the stream of sustainability development. This study's SIA framework is novel, extending the traditional sustainability dimensions —environmental, economic, and social dimensions—to create a comprehensive, integrated model for evaluation of sustainability. The conceptualisation of the SIA framework, supported by stakeholder theory, can encourage in-depth research in sustainability assessment. Further, this study reveals how observational, contextual, and evaluative sustainability data can be captured to facilitate the appropriate, realistic, and holistic examination and evaluation of sustainability. More importantly, the study demonstrates that the capture, measurement, and development of sustainability data start from overseas FSC actors.

In practice, the SIA framework provides food organisations, logistical services businesses, producers, and other FSC leaders with a greater degree of clarity about identifying, measuring, and resolving sustainability matters. It offers a holistic, diagrammatic model for sustainable food supply chains that governments, businesses, and FSC professionals can adopt to fashion more proactive, pragmatic, and realistic approaches in shaping their supply chains with achievable sustainability targets. Another practical implication of the study is that producers can utilise the SIA model to seek more reliable options such as smart technologies for reduction of negative sustainability implications. Smart technologies have advantages of increasing production, facilitating smart farming, reducing labour efforts, and reducing farm input costs, e.g., for fertilisers, fuel, and pesticides. Further, smart farming ensures production improvements, producing nutritious and healthier products with fewer or no food chemicals or pesticides. Moreover, the study suggests the use of transportation optimisation and technology-enabled transport systems. FSC managers should consider alternate means of reducing CO_2 emissions in logistical activities and improving sustainability. This includes the adaptation of transportation optimisation in food supply chains and innovative transportation systems that have the benefit of reducing waste in post-harvest processes and that encourage improvement in in-country and export transport activities.

In addition to practical and theoretical conditions, this study provides policy implications to improve sustainability. Policymakers, FairTrade organisations, and all the concerned stakeholders should ensure that the vegetable market is guided by FairTrade and fair prices. Regulating and guiding the vegetable sector of Ghana with FairTrade is vital. In addition, the government of Ghana should ensure that regulatory frameworks are incorporated into its food policy mechanisms. For example, the Global Food Security Strategy (GFSS) Country Plan for Ghana and the Accelerated Agricultural Growth and Development Strategy (AAGDS) are accurately supported by some regulation mechanisms that spearhead sustainability. Further, governments and policymakers should also utilise economic incentives such as tax holidays, tax benefits, and farm input subsidies to support vegetable producers in the promotion of sustainable food production and consumption. Further, it is important to champion policies, measures, and strategies that regulate and strengthen governance of producers' production and distribution activities. Unlike Ghana's food policy (such as GFSS), UK food policies including Food 2030, the Food and Farming

Policy, the Government Food Strategy, and the National Food Strategy, as well as other frameworks like the Environment Act (2020) and Agriculture Act (2020), capture some initiatives and measures for attaining more sustainable practices and objectives. However, these UK food policies too often fail to include strong collaboration and regulatory blueprints that can strengthen the sustainability agenda. Moreover, what is also missing in the food policies and strategies is measures tailored to addressing existing and current complexities in the food supply chains. Both the UK and Ghana policymakers should re-engineer collaboration among food industry players to enhance sustainability.

1.7 Thesis Structure

To facilitate the research aims specified in section 1.3, this study has been organised into seven different chapters. Each chapter articulates one or more research objectives clearly set out by the study:

Chapter One, the Introduction, provides the background of and justification for the study, highlighting current literature on the topic and the literature gaps on global food supply chains. It also sets out the research aims and objectives to clearly explain the key purpose and scope of the study. It concludes by providing an outline of the study structure, detailing how the chapters are organised and their content.

Chapter Two, the Literature Review, begins with a fundamental discussion of key topics of the study. This includes the global food supply chain, UK food supply chains, and Ghana's fresh vegetable export. These discussions are supported by a review of sustainability impact assessment; the environmental sustainability dimension; the economic sustainability dimension; the social sustainability dimension; regulatory sustainability; sustainable food supply chain collaboration; and the complexities of food supply chains. The final part of this chapter presents the conceptual framework of the study based on prior knowledge of the literature, and theoretical contextualisation of the conceptual framework is provided.

Chapter Three is the Methodology. This critically discusses the research philosophies and provides justification for choosing the paradigm suitable for the study. To support the justification for research strategy employed, the chapter demonstrates how a good practice of choosing appropriate research methodology and methods is embedded in the study. The chapter then outlines the research design; thus, the various phases deployed to answer the research objectives. A section is, however, created for data collection and utilisation to explain what kind, sources, processes, and procedures have been adopted for data collection and how the data are presented and used in the study. The discussion under this section is supported with the justification for the research strategy. Again, the chapter considers a case study and survey as sub-sectional discussions. Furthermore, the chapter includes a data analysis section to discuss the data collection and instruments, models, techniques, and tools adopted for the study. Clarity is provided on the statistical models (equations) expressed. This chapter concludes with ethical considerations for the study.

Chapter Four reports the Thematic Analysis of Case Study Data involving interviews and focus groups. To identify the sustainability implications of Ghana's fresh vegetable supply chains to the UK, NVivo 11 software is used to perform thematic analysis. The chapter further analyses the relationship between the identified sustainability implications (sustainability dimensions and their associated impacts) among large-scale and small-scale producers. The chapter concludes with a step-by-step approach to the SIA framework development, based on the revelations and findings of the thematic analysis of the interview and focus group data.

Chapter Five consists of the Statistical Analysis of Survey Data. This chapter first attempts to statistically estimate the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK, based on the findings from thematic analysis of the case study data. Before that, robustness checks such as normality test, scatter plot, and multicollinearity test are performed to consider the reliability and validity of the data, as well as the existence of multicollinearity in the data. It further analyses the relationships between a sustainable FSC and the identified sustainability dimensions. The chapter concludes with validation of the SIA framework of the study developed from Chapter Four.

Chapter Six provides Discussions and Implications. Based on the findings of the study, there is a discussion, aligned with the literature and drawing on individual results, of their contribution to the extant literature. Primarily, all identified sustainability dimensions and their associated impacts are linked with the relevant literature to provide a broader understanding of, and insights into, development and transformation of knowledge. The final part of this chapter provides theoretical, managerial, and policy implications that suggest the different strategies, measures and options available for policymakers, FSC professionals, academics, researchers, the third sector, and other stakeholders to improve sustainability and encourage the development of sustainable food supply chains.

Chapter Seven provides a Summary, Overall Conclusions, and Opportunities for Further Research. It first summarises the findings and implications of the study while aligning these with the research objectives. It is then followed by a presentation of contributions to knowledge. It is further supported with an acknowledgement of the study's limitations and suggested directions for future research and some future research opportunities. Finally, the study provides a clear Concluding Statement.

CHAPTER TWO (2)
2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews and discusses global food supply chains, sustainability impact assessments (SIA), different sustainability dimensions of the food supply chain, UK sustainable food supply chains, Ghana's food supply chain, and the conceptual framework which provides the literature and theoretical background of the study. The section on global food supply chains provides fundamental explanations for the meaning and kinds (forms) of global food supply chains. This is coupled with their benefits and development for differing sectors and economies, including the European and Sub-Saharan African countries. This discussion is supported with an analysis of how the global food supply chains are challenged by a range of complexities, including COVID-19. The final part of the section examines various assessment approaches for global food supply chains; and the limitations in the literature are clearly highlighted throughout the discussion. The chapter also explains sustainability impact assessment (SIA) development, its application, and its usefulness to different sectors and food supply chains. The section focuses on its usefulness in the food sector and reveals the gaps left unaddressed in the literature. This section is extended to provide a review of different sustainability dimensions of the food supply chains—in particular, their environmental, economic, social, and regulatory dimensions.

The following section presents the UK food supply chains, reviewing the developmental approaches towards sustainability, contributions from the government, FSC actors, and the third sector. This is also supported with the benefits of increasing UK sustainable food supply chain approaches; the challenges and progress made; and what, however, remains to be considered. The last part of this section presents a review of sustainability assessment of UK food supply chains, concentrating on the SIA approach; of food supplies from overseas sources; and of the vegetable supply chains. Following is another section on the Ghanaian food supply chain. This provides an overview, explaining the details, actors, and overarching support for and development of food supply chains and their contribution to Ghana's economy. This section further discusses producers, markets and supply chain of Ghana's fresh vegetables; the policies and structures available to enhance sustainable food supply chains; as well as explaining the contributions of vegetable supply chain actors and providing a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the sector. The section concludes with a review of the extant literature on sustainability assessment of Ghana food supply chains, clearly highlighting gaps in the literature that remain unaddressed.

These discussions and reviews are further explored to provide a conceptual framework of the study towards the end of the chapter. The section presents a diagrammatic model that the study attempts to test and validate. Before development of the conceptual framework to the status of a SIA model, this section explains the key sustainability dimensions, their associated impacts, and the life cycle of vegetable supply chains from Ghana to the UK, as captured by the framework.

The chapter concludes with a statement of the Research Questions which this study aims to answer.

2.2 Global Food Supply Chains

The global food supply chain is large, dynamic, complex, and consists of numerous actors (Astill et al., 2019; Haji et al., 2020). Further, it plays an important role in providing necessities and fundamentals for supporting a wide range of human and businesses activities (Zhong, Xu and Wang, 2017). Once food is produced, harvested, stored, distributed, or retailed, it could reach final consumers or businesses for further purposes. The global food supply chain has to sustain more than seven million people (Clark and Tilman, 2017) and has, over time, improved agricultural methods and technology (Gunarathne et al., 2018). It has contributed to economies and has opened up industries for innovation and competition. Global food supply chains can be categorised into different forms or kinds: upstream, midstream, and downstream (Reardon, 2015; Costa-Font and Revoredo-Giha, 2020). Upstream global food supply chains ensure the transactions and network between the food producers, suppliers and intermediaries (ibid.). They usually comprise the producers (farmers), suppliers, and other agricultural support service providers, such as agronomists and extension services. These upstream actors are responsible for 40% of the total value added and cost of the entire food supply chain (Reardon, 2015). The midstream supply chains cover processing, logistical, and wholesaling actors. They also contribute 40% to the total value added and cost of the food supply chains (ibid.). The remaining 20% is contributed by the downstream element. This usually involves the retailing sector, food service providers, and consumers. Costa-Font et al. (2020) explain that the downstream global food supply chains are responsible for the movement of food and exchange of information between producers and customers. Figure 2.1 presents a schematic diagram of the global food supply chain, highlighting the mainstream global food supply chain actors (shown in the shaded colour). Cao, Bryceson and Hine (2021) argue that collaborative initiatives between different streams and actors have the effect of strengthening global food supply chains across the streams, to lessen negative externalities, e.g., logistical challenges and sustainability issues. Collaboration not only provides sufficient network connections for food sourcing from world producers but also facilitates the quality and safety of the various foods sourced (Chen et al., 2017; León-Bravo et al., 2017). Zhong, Xu and Wang (2017) emphasise that collaboration has become more of a necessity than an option. Meanwhile, the global food supply chain is vulnerable to “risk ripple” effects as it usually involves multiple players in many non-transparent and complicated processes (Roth et al., 2008). Some crucial aspects of an individual FSC player’s activities and processes cannot be captured from a single perspective. Justifiably, Tai (2018) claims that there are a significant number of characteristics in the global food supply chain that make it fundamentally difficult to regulate individual FSC actors. Irrespective of the vulnerabilities, externalities, and regulatory difficulties, global food supply chains have positive impacts for both FSC participants, including producers’ countries. For developing countries, global food supply chains have increased rural income and employment, reduced poverty, and created positive welfare effects for actors (Maertens, Minten and Swinnen, 2012). Developed countries too have benefitted from increased awareness of environmental externalities, advanced technological development, and improved innovations in operations and logistical services (Beitzen-Heineke, Balta-Ozkan and Reefke, 2017; Zilberman and Reardon, 2019).

Comparing regions, food supply chains in SSA are widely dominated by short local supply chains, small-scale producers, and less consolidation (Maertens, Minten and Swinnen, 2012; van Berkum et al., 2017). Lamuka (2015) attributes such characteristics to a lack of scientific and technical capacity to comply with sanitary standards associated with global food supply, and to a weaker extension system inadequate to the task of improving farmers’ knowledge of production efficiencies. Notwithstanding, top institutions like the African Development Bank (AfDB) are empowering producers by creating favourable food supply chain environments through initiatives such as investments in agricultural value chains (van Berkum et al., 2017). Meanwhile, the EU region has a healthy, organised, and matured market, enjoying more flexibility and resilience, with high compliance with food standards and quality (Maertens, Minten and Swinnen, 2012; Roberts and Pérez Horno, 2020).

Global producers and retailers are propelled by consumer taste, preference, or demand, making global food supply chains ever more interesting and dynamic. More comprehensively, the early work of Van der Vorst, with Da Silva and Trienekens (2007), looked at the demand and supply sides of global food supply chains. They stressed that developing countries are increasingly integrating into the global food supply chain market because of high demand and sourcing from western food industries and retailers. This is also coupled with the increased consumer demand in the western world for a year-round supply of overseas products. Today, a consumer can visit the Tesco retail shop in Nottingham, the UK, or ALDI in Hamburg, Germany, and can purchase fresh tomatoes from Kenya or chillies from India. It is fascinating that the global food supply chain and network are playing such a vital role in providing opened market access for producers—both small and large—in developing countries, in addition to their local and regional markets. Interestingly, such a significant role is vulnerable to being crippled by the complexities associated with food supply chains from global sources, which is an important concern for FSC actors (Duong et al., 2020; Ramasubramaniam and Karthiayani, 2022) as they potentially create hindrances to the development of sustainable food supply chains.

Nevertheless, several studies argue that global food suppliers and producers are driven to develop a sustainable food supply chain (Smith, 2008; Lee, Gereffi and Beauvais, 2012; Vesna et al., 2017; Smith et al., 2017) and are often required to comply with some aspects of sustainable food supply (Vesna, Predrag and Milivoje, 2017) such as food safety and quality standards, traceability, and transparency. Sgarbossa and Russo (2017) restate that there has been a drive towards achieving sustainability, balancing social, economic, and environmental sustainability within global food supply chains. However, recent studies by Farooque, Zhang and Liu (2019) lament the scarcity of research concerning sustainability of food supply chains. Specifically, sustainability assessment and conceptualisation of a sustainability framework are missing in the existing literature. Global food supply chains are, in fact, widely acknowledged as unsustainable (Brunori et al., 2016; Nikkhah et al., 2021). Food supply chains face significant issues, such as enormous CO_2 emissions and high energy consumption, so that social initiatives such as FairTrade and other economic concerns, are easily overlooked, remaining unidentified and unmeasured. Notwithstanding, sustainable food supply chains are becoming more and more popular with increasing awareness (Zhu et al., 2018); however, not much attention has been directed towards a robust sustainability assessment of the entire food supply chain, starting with producers' sources. It is also not clear how the assessment of food supply chains sustainability has advanced in the business and management literature. Moreover, in the supply chain management literature on sustainability, some concepts have been introduced and discussed, e.g., green supply chains, sustainable supply chains, closed-loop supply chains, and environmental supply chains (Farooque, Zhang and Liu, 2019); yet sustainability assessment has not gained much attention in the contextual advances of these concepts.

Despite these key gaps, many scholars have contributions to make on the sustainability impacts of global food supply chains (Hamprecht et al., 2005; Apaiah, Linnemann and Van der Kooi, 2006; Yakovleva, 2007; Shokri, Oglethorpe and Nabhani, 2014; Soysal et al., 2015, Gaitán-Cremaschi, Meuwissen and Oude Lansink, 2017; Govindan, 2018; Singh, Centobelli and Cerchione, 2018; Krishnan et al., 2020; Jaikaew, 2022). For example, Soysal et al. (2015) propose a mathematical model that can reduce logistics costs and CO_2 emissions generated by transportation. Yet existing literature is not clear on a generally acceptable sustainability assessment approach for food supply chains or on what sustainability elements it should capture. Despite the development of the concept of food supply chain sustainability since the Brundtland Commission (WCED, 1987), triple bottom-line (TBL) (Elkington, 1998; 2013), win–win perspectives (Golicic and Smith, 2013), and Montabon, Pagell and Wu (2016) on ecological dominant logic, the growing literature has not yet explored the sustainability of food supply chains in a more global context. The acceptance of a more reliable sustainable assessment of global food supply chains should not only rely on the combination of effective collaboration addressing complexities, food price, food availability and food safety, but rather on food sustainability starting from overseas sources; thus, ensuring sustainable food supply chains. Vividly, suggestions raised by many food sustainability advocates, including Garnett (2013), Gamboa et al. (2016), and Tai (2018), demand much greater effort from food producers, suggesting that they can leverage and identify unsustainability links with the food supply chains which helps address any concerns. Gamboa et al. (2016) clarify that food producers can help reach desired sustainability when they are well informed about what sustainability means. Small producers and large producers usually dominate as food suppliers of global food supply chains (Saavedra et al., 2014). Small producers often lack the resources that can enable them to shift from low production to commercial scale; and from traditional approaches to sustainable practices (Chapoto et al., 2018). The term "small producers" is used to allude to small-scale farmers, outgrowers, and contract farmers. These producers usually cultivate on two hectares of arable land or less. However, some studies explain that the farmers may have more than two hectares of land in terms of area, but might still lack the capacity for cultivation of the entire holding (Wiggins, 2009; Trebbin, 2014). They are frequently characterised by a lack of vegetable infrastructure, including insufficient farm inputs and storage facilities; and they may have poor knowledge of the availability of improved inputs (Chapoto et al., 2018). Other challenges, such as poor post-harvest management systems, inadequate collaboration and networking with input suppliers and buyers (Saavedra et al., 2014), and limited agronomic practices and skills, are mentioned as being further major challenges that small producers face. However, large producers tend to work on their own land—usually more than 20 hectares—with a significant number of growers or farmers (Saavedra et al., 2014; Chapoto et al., 2018). Typical production characteristics of large producers include the usage of large quantities of fertilisers and pesticides, increased food loss and waste, high operating costs, and intense energy use (Chapoto et al., 2018; Petetin, 2020; Roberts and Pérez Horno, 2020). Beitzen-Heineke, Balta-Ozkan and Reefke (2017) emphasise that, due to economies of scale, food from small producers usually causes higher emissions than that from large producers. Nevertheless, some sustainability issues are common to all producers. In recent times, during the COVID-19 pandemic, movement of high-value perishable products, such as vegetables, was heavily disrupted due to air freight closures and challenges, leading to food waste and economic loss; thus placing further stresses on global food supply chains and food producers (Aday and Aday, 2020). Interestingly, the quick response of food supply chains demonstrated the relevance of supply chain flexibility, allowing FSC actors to tap into new avenues when existing ones became compromised (Deconinck, Avery and Jackson, 2020). However, further issues related to sustainability and its holistic assessment have still not received appropriate attention in the contexts of either uncertainties or global food supply chains, and almost seem to have been ignored by researchers and food industry players. This study, therefore, seeks to offer practical insights into assessing sustainability of food supply chains. It further sheds light on organisational theories that support the sustainable food supply chain and may be useful for guiding similar studies in the future.

It is worth noting that a considerable number of approaches have been adopted to assess the sustainability of global food supply chains. Most common approaches are Life Cycle Assessment (LCA), Strategic Environmental Assessment (SEA), and Sustainability Impacts Assessment (SIA). The LCA is an assessment and analytical method of evaluating environmental impacts (Anderson, 2000; Mogensen et al., 2009). Mogensen et al. (2009)

emphasise that LCA measures the environmental impacts of all stages of the food supply chain, from raw materials usage, processing, and distribution through to disposal. Although it can offer one final figure for some environmental concerns, such as acidification and global warming, and presents itself as excellent tool for environmental awareness, the LCA can present a biased result when researchers force convenient assumptions and aggregated impacts for assessment (McCarthy et al., 2015). The LCA has been used for assessments of environmental effects in food supply chains (e.g., Eady, Carre and Grant, 2012; McCarthy, Matopoulos and Davies, 2015; Molina-Besch, Wikström and Williams, 2019; Vidergar, Perc and Lukman, 2021). The SEA tool has also been utilised to assess sustainability (Therivel, 2012; Ioppolo et al., 2019) and in relation to food supply chains, but SEAs are more often used in energy literature—e.g., Mardani et al. (2017). Arbter (2003) refers to both SEA and SIA as participative tools for assessing sustainability; whereas Anderson (2000) had earlier pointed out the differences between them. While the former is a practical decision-supporting tool for assessing possible environmental implications (Anderson, 2000; Sebestyén et al., 2019), the latter considers environmental, social, and economic effects of plans, projects, programmes, and policies (Anderson, 2000; Hertin et al., 2009; OECD, 2010). Notably, LCA and SEA focus more on environmental impacts of the projects, plans, programmes, policies, and processes—e.g., the food supply chain—but although SIA considers environmental impacts, it focuses in addition on social and economic impacts. This makes SIA more robust in assessing and contributing to sustainability. Sustainability assessment can, though, help organisations and government strive towards sustainable development (Azadnia, Saman and Wong, 2015; Schindler, Graef and König, 2015; Schmutz et al., 2018). However, despite its exhaustive benefits, SIA is yet to be thoroughly explored by researchers in relation to the assessment of supply chains and food sustainability, or in management and business literature.

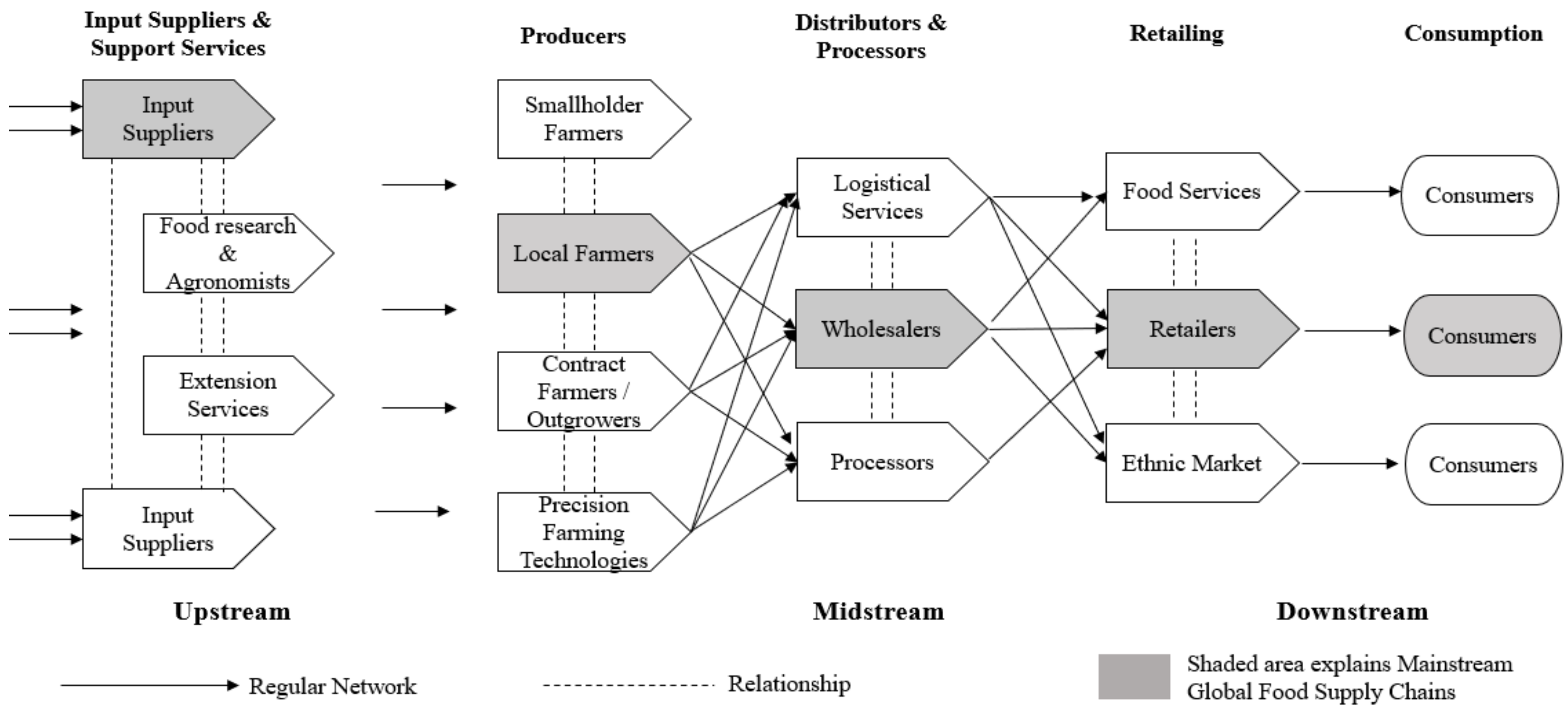


Figure 2.1 Schematic diagram of Global Food Supply Chain

2.3 Sustainability Impact Assessment (SIA) of Food Supply Chains

A Sustainability Impact Assessment (SIA) is a commonly-used policy tool or instrument for assessing three integrated sustainable development dimensions; namely, the environmental, social, and economic dimensions (OECD, 2010). The SIA is an approach for examining the collective environmental, social and economic impacts of strategies, actions, programmes, and policies. However, an early outline of SIA by DEFRA (2002) asserts that it is an aid to decision making and a heuristic device that can lighten policy choices, impacts, and compromises: "The role of SIA is restricted to identifying and characterising likely impacts and trade-offs" (ibid). The literature shows that researchers have not tended to make use of SIA more than as a tool; e.g., Verma, Rahul and Dixit (2015). Nevertheless, one core relevance of SIA is its ability to encourage innovative policy decisions. Again, the SIA is more often used as an ex-ante impact assessment (Hertin et al., 2009) that reveals choices and trade-offs to improve communication among stakeholders.

Several studies have considered sustainability assessments for a range of purposes, e.g., Weaver and Rotmans (2006) and George and Kirkpatrick (2008) for trade agreements and policies; Blok et al. (2013) on new technologies; Geurs and Van Wee (2004) and Verma, Rahul and Dixit (2015) on transportation; Miret et al. (2016) on biomass supply; and Trautwein (2021) on start-ups. Among these studies, the researchers identify different elements, indicators, and aspects regarding traditional sustainability dimensions—namely, environmental, social, and economic dimensions, and measures—for their respective implications (e.g., Verma, Rahul and Dixit, 2015). Also, some studies (e.g., Schweier et al., 2019) have reviewed sustainability impact assessments and made some wider suggestions for policymakers and stakeholders. However, these studies are either limited by geographical region; do not focus on food supply chains; or do not capture wider sustainability aspects, elements, and indicators from a global context.

There are, however, a considerable number of studies on sustainability impact assessment of food systems (Krieter, 2002; Yakovleva, 2007; Oglethorpe, 2010; Yakovleva, Sarkis and Sloan, 2012; Azadnia, Saman and Wong, 2015; Galli et al., 2015; Mackenzie and Davies, 2019; Malak-Rawlikowska et al., 2019; León-Bravo et al., 2021; Nikkhah et al., 2021; Heldman, 2022). Early studies by Krieter (2002) emphasise measuring the sustainability dimensions of different types of production in pig farming using computer simulation. Even though significant economic and social factors have been identified, their studies are silent on environmental issues and how they are estimated. Kucukvar et al. (2019), for instance, empirically assess the economic, social, and environmental aspects of food consumption categories in the US. Although the study captures relevant sustainability elements for each dimension, the study focuses on a particular chain of the food supply, does not consider other FSC actors, and is more one-country-based. The work of Galli et al. (2015) is EU-based and focuses on five sustainability dimensions, but their studies fail to measure these. The Mackenzie and Davies study (2019) produces a SIA framework that captures sustainability impacts and indicators of food sharing at the urban scale. Despite their novel work, the study considers the sustainability of food sharing, but not the entire food supply chain or other stages in the chain. Malak-Rawlikowska et al. (2019) assess the sustainability of short and long food supply chains from seven countries, including Vietnam, Italy, Poland, Hungary, the United Kingdom, Norway, and France. Their work does an important job in identifying and measuring the sustainability dimensions' impacts or indicators but fails to capture all key activities and collaborative initiatives of the food producers. Other studies that consider assessment approaches, but not for the entire food supply chain, include Yakovleva (2007), León-Bravo et al. (2021), Nikkhah et al. (2021), and Yakovleva, Sarkis and Sloan's (2012) identification of sustainability indicators. Oglethorpe (2010) and Azadnia, Saman and Wong's (2015) research identifies all key sustainability dimensions and statistically measured these dimensions; however, their studies do not consider impacts generated from overseas sources. Moreover, Nikkhah et al. (2021) focus their assessment more on environmental impacts; whereas Heldman (2022) emphasises only a few elements of food supply chains.

Despite notable research works from many authors and disciplines, developing a holistic SIA framework or model for empirical evaluation of the entire food supply chain is not yet available in the literature, to the best of this researcher's knowledge. In addition, the extant studies are yet to consider food trade or food supply considering overseas sources or producers' countries, taking account of the capture of all sustainability indicators and elements. Although Sala, Ciuffo and Nijkamp (2015) argue strongly that sustainability assessment is a complex methodological technique to adopt, it is clear in the literature that metrics and assessment approaches have not been clearly set out for the sustainability assessment of food supply chains (Johnston, Fanzo and Cogill, 2014; Prosperi et al., 2015; Mackenzie and Davies, 2019). Mackenzie and Davies (2019) clarify that understanding the sustainability impacts of the activities across the food supply chain from food production, transportation, and distribution through to consumption is crucial; and that careful consideration is required. Galli et al. (2015) point out clearly that the research community has not come up with a shared and agreed methodology that would allow robust assessment and comparisons of all sustainability dimensions; hence developing, identifying, and evaluating sustainability impacts across the food supply chain is not simple. Nevertheless, it is highly valuable that researchers are looking into development of the SIA framework for food supply chains and food sustainability, not only from the traditional dimension of sustainability itself, but also from key aspects that are highly relevant and interconnected with food supply chains, such as collaboration and the regulatory environment.

2.3.1 Environmental dimension of Food Supply Chains

The balance of the triple bottom-line of sustainability—namely, the environmental, social, and economic dimensions—is positive progress for global food supply chains (Mangla et al., 2018), although environmental sustainability has advanced much more. Yet food supply chains generate enormous environmental impacts (Krishnan et al., 2020). In response to this, several studies have evaluated the various stages of food supply chains and provided recommendations to improve environmental sustainability (Apaiah, Linnemann and Van der Kooi, 2006; Ahearn, Armbruster and Young, 2016; Clark and Tilman, 2017); whereas some previous studies considered environmental sustainability of entire food supply chains by adopting varying approaches (e.g., Del Borghi et al., 2014; Sala et al., 2017). Nevertheless, there are concerns about increasing environmental impacts as a result of human activities (Baca-Motes et al., 2013; Kumar, Manrai and Manrai, 2017). Environmental sustainability is one of the main pillars of concern when tackling sustainable food supply chains; nevertheless, agri-food supply chains have not advanced in utilising Big Data and assessment tools to examine producers' actions and sustainable contributions that help to minimise environmental impacts. Ahearn, Armbruster and Young (2016) emphasise that resolving environmental concerns is not a transparent process due to the complexities in identifying trade-offs among producers' practices. Environmental sustainability of food supply chains is a large and complex issue, which requires sustainable approaches that are achievable, reliable, and realistic (Batista et al., 2021) and ensure that all FSC actors are involved.

Many advances and contributions towards environmental sustainability within food supply chains can be credited to a stream of authors and researchers: e.g., Penker, 2006; Mogensen et al. (2009); Cerutti et al. (2011); Del Borghi et al. (2014); Ahearn, Armbruster and Young

(2016); Clark and Tilman et al. (2017); Garofalo et al. (2017); Sala et al. (2017); Tasca, Nessi and Rigamonti (2017); Enjolras and Aubert (2018); Poore and Nemecek (2018); Parajuli, Thoma and Matlock (2019); Carino et al. (2020); Majewski et al. (2020); Batista et al. (2021), Heldman (2022); and Mishra, Singh and Rana (2022). Previous studies, such as Clark and Tilman (2017), analyse environmental impacts (in particular GHGs, land, and energy use, and the potential for eutrophication and acidification) of different categories, arguing that a shift to low-environmental-impact foods has great environmental benefits. Examining the difference between long and short food supply chains among European countries, Majewski et al. (2020) find that long food supply chains generate lower negative environmental impacts than short ones when it comes to energy consumption and GHG emission per unit of a product. However, their studies concentrate on selected European countries and do not include food sourced outside the EU. Contrary to their perspective, previous studies argued that environmental impacts differ with different foods (Clune, Crossin and Verghese, 2017). This means that, despite increasing attention being given to environmental sustainability, further work requires more clarity; and environmental impacts associated with different foods and sources need holistic and robust evaluation, especially for all chains of food supply for their entirety.

In terms of food supply chains, Krishnan et al. (2020) emphasise that food waste generates negative environmental impacts and identify operational inefficiencies in FSC; they suggest a framework to enhance environmental sustainability. Applying a LCA approach mostly for assessing environmental impacts, the study attempts to measure the environmental impact of the mango FSC, considering farming, processing, packaging, and transportation. However, their studies iterate that, in addition to wastage of resources, food waste remains a negative environmental impact hotspot within food supply chains. Notwithstanding, there is a growing awareness within the food production and research community that perishable food generates a significant amount of waste and that critical attention is required (Sgarbossa and Russo, 2017). However, little attention has been paid to food supply from advanced countries, let alone developing countries, including some in Sub-Saharan Africa, such as Ghana.

Some studies have been devoted to fresh produce and, thus, the vegetable supply chain (e.g., Del Borghi et al., 2014, Garofalo et al., 2017; Parajuli, Thoma and Matlock, 2019). Del Borghi et al. (2014) reveal that agricultural production and packaging generate higher environmental impacts than processing and end-of-life. Likewise, Garofalo et al. (2017)

assessed the life cycle of vegetables and reported that waste disposal accounts for the highest environmental impact. Moreover, the environmental impacts of farming systems and agro-ecological characteristics of fruit and vegetable production under greenhouse, open-field, conventional, and organic conditions, as well as those grown in relative agro-climatic zones, are analysed by Parajuli, Thoma and Matlock (2019). Despite some attempts to analyse the environmental impacts of fresh produce, most studies do not consider all the food supply chains taking into account producers' and overseas sources; an exception being that of Penker (2006). It is argued that food supply chains connecting all partners including producers strengthen environmental sustainability, hence inducing a positive impact on environmental performance and sustainability of food supply chains (Reklitis et al., 2021). Gatzweiler and Von Braun (2016) claim that studies focusing on producers' approaches, including agricultural innovations, help producers to make better decisions and instigate more sustainable food supply chains. Yet, studies on producers' environmental impacts and their contribution towards sustainability are not well reflected in the literature.

Other studies discuss greenhouse gas emissions (GHGs—mainly CO_2 emissions) as the dominant environmental impact generated by global food supply chains, among others such as acidification, eutrophication and water degradation (Poore and Nemecek, 2018; Frankowska, Jeswani and Azapagic, 2019). Although food supply chains consist of agricultural production, processing, manufacturing, distribution, preservation, retailing, preparation and waste disposal (Garnett, 2011), agricultural production is widely argued to be the stage in the food supply chain most responsible for significant environmental impacts (e.g., Rohila et al., 2017). Examples of the type of environmental impact caused by agricultural production include loss of biodiversity, soil erosion, inefficient use of land, GHGs and water loss. Despite this finding, literature that considers producers' activities is scant on assessing environmental impacts and hotspots generated in agri-food supply chains. Meanwhile, Audsley et al. (2010) have estimated that the UK food sector is responsible for 152Mt of CO_2 emissions; while a comprehensive estimate by DEFRA (2013) reveals that the overall supply chain from all consumption activities emits 1106Mt of CO_2. The reasons given for these enormous UK CO_2 emissions are associated with the UK's reliance on food supply from global sources (de Ruiter et al., 2016). Other studies, e.g., DEFRA (2017), show that CO_2 emissions produced in the UK are higher compared to other countries in Europe. As a result, the UK has a responsibility to source food with high sustainability standards and lower environmental impacts. Although the UK is increasingly concerned with the sustainability impact of the food supply at home, less attention has been given to the food supply from overseas (Yakovleva, 2007; de Ruiter et al., 2016).

2.3.2 Economic Dimension of Food Supply Chains

Economic sustainability is a key factor in food supply chains, which has shown significant development by FSC actors across various sectors and industries: enhancing efficiency, technological advancement, price and quality (Ilbery and Maye, 2005; Christopher et al., 2011; Bloemhof and Soysal, 2017; Kirwin et al., 2017; Kusumowardani et al., 2022). There are some particular economic sustainability elements that govern the food supply chains—e.g., cost, food waste, profitability, branding and competitions (Bloemhof and Soysal, 2017; Baba et al., 2019; Konstantas, Stamford and Azapagic, 2019; Kusumowardani et al., 2022). Konstantas, Stamford and Azapagic's (2019) work on economic sustainability emphasises that utilising life-cycle cost assessment can encourage the development of economically sustainable food supply chains. Their study examines life-cycle cost (LCC) and value added for some food items in the UK, whereas others identify cost-efficiency and quality as key economic sustainability indicators (e.g., Baba et al., 2019). Moreover, Christopher et al. (2011) argue that some economic aspects, such as changes in competitiveness and cost, are usually influenced by environmental sustainability. Nevertheless, the trade-off considerations between economic and environmental aspects are fostering activities and decisions with a view to achieving sustainable food supply chains (Kuik, Nagalingam and Amer, 2011).

Several studies have contributed to the literature on economic sustainability (Accorsi et al., 2016; Mundler and Laughrea; 2016; Zhu, 2017; Aguiar, DelGrossi and Thomé, 2018; Bottani et al., 2019; Baba et al., 2019; Konstantas, Stamford and Azapagic, 2019; Sudusinghe and Seuring, 2020; Rossi et al., 2021; Kusumowardani et al., 2022). Conventionally, some studies have examined FairTrade and its economic implications (Le Mare, 2008; Makita, 2016; Lyon, 2021; Ribeiro-Duthie, Gale and Murphy-Gregory, 2021). Although they focus on FairTrade economic implications for FSC actors, the literature is divided on whether this sustainability element lies within the social sustainability dimension, the economic sustainability dimension – or both, e.g., Blackman and Rivera (2011), Barrientos (2006), Dietz and Grabs (2022), and Kårelind et al. (2022). However, Kumar, Mangla and Kumar (2022) emphasise that FairTrade offers a great opportunity to fathom how the social sustainability of FSC can facilitate economic sustainability. Some academics stress that an extended time perspective suggests that social sustainability becomes intertwined with economic sustainability (e.g., Ringqvist et al., 2022. p22). Nevertheless, not many studies have investigated holistic economic sustainability elements capturing FairTrade, food waste, food loss, efficiency, and cost in one single project. Extant studies mainly focus on cost, e.g., Konstantas, Stamford and Azapagic (2019); and food waste, e.g., Kusumowardani et al. (2022). However, Accorsi et al. (2016) argue that measuring economic sustainability fosters the planning of sustainable food supply chains. The relevance of economic sustainability is highly emphasised as promoting regional and local development, thus contributing to job creation (Mundler and Laughrea, 2016; Aguiar, DelGrossi and Thomé, 2018).

Some authors have taken time to promote economic sustainability in vegetable supply chains and the literature on the subject, including Legge et al. (2008), Ahumada, Villalobos and Mason (2012), Bellia, Aderno and Allegra (2015), Zhu (2017), Bottani et al. (2019), Accorsi (2019), and Secondi et al. (2019). Vegetable supply chains are commonly associated with fluctuations in product quality and volume during the peak season (Ahumada, Villalobos and Mason, 2012; Accorsi, 2019). Legge et al. (2008) have evaluated the value and volume of fresh produce supply chains from some selected Sub-Saharan Africa countries to the UK, while Zhu (2017) analyses the cost and potential benefits of a traceability system for fresh produce supply chains, recognising that failure to make such an analysis can lead to the creation of significant food waste. Bottani et al. (2019) focus on an evaluation of the economic and environment sustainability of the food supply chain, taking into account the total cost of transportation, trucks used, and energy consumption. Rossi et al. (2021), on the other hand, examine economic sustainability for the intermodal transportation of fresh produce, addressing the existing low flexibility in transportation, risk of low food quality and the need to increase stocks to enhance supply chain profitability. Two years earlier, Secondi et al. (2019) had attempted to quantify the food waste and losses in tomato supply chains and showed that most tomato waste and losses end up being used in alternative activities. Despite being able to measure value for these economic elements, some key economic issues are not included, such as FairTrade and food waste.

The UK's previously-mentioned reliance on global food suppliers carries with it significant economic benefits for overseas countries (Lang and Schoen, 2016). For example, overseas countries benefitted from fresh food supply to the UK to the tune of £3.1 billion, as against

UK exports of £199 million (AHDB, 2016). In fact, food supply chains generate both more favourable economic impacts and, concurrently, unfavourable sustainability impacts, for both the UK and the food exporting countries, even though food supply chain partners have improved efficiency, reduced unemployment and created investment, especially in developing countries such as Ghana, Kenya, and South Africa (Legge et al., 2008). However, economic impacts associated with food supply chains consist of more than just value, employment, and investment. Other impacts such as FairTrade, food waste, and cost-efficient transport systems are common concerns for policymakers, industry players, and academics (Del Giudice et al., 2016). Interestingly, Hilson (2014) argues that there is a lack of policy oversight, which has led to FairTrade misinterpretations. If so, then practical and ground-breaking policies and measures are required towards food waste, inefficiencies in transport systems and FairTrade issues. Additionally, researchers need to pay more attention to assessing implications of key economic sustainability impacts, e.g., FairTrade in food supply chains involving developing countries. Surprisingly, there is no prior research that has attempted to measure the entire economic impact associated with overseas food supply chains, taking into account all economic concerns such as food waste, FairTrade, and inefficiency in transportation systems. Nevertheless, researchers and FairTrade policymakers are much more concerned about social and environmental impacts, e.g., CO_2 emissions, food quality, and safety (Yaseen et al., 2017), but the effects of food waste, inefficient transport systems, and FairTrade should not be underestimated.

2.3.3 Social dimension of Food Supply Chains

Sustainable food supply chains cannot be attained without considering their totality and all FSC actors engaged at each stage of the chain. This means that more detailed attention towards social dimensions – often ignored – is required to balance with the economic and environmental dimensions (Desiderio et al., 2021). Some recent studies, such as Schmutz et al. (2018), clearly outline the following social dimensions of food supply chains: food safety and quality; the viability of food culture and traditions; transparency and traceability; as well as food sovereignty and food security. Despite these interesting contributions to food systems research, it is worth noting that the social dimension of food supply chains has not received the necessary attention in the literature of food sustainability (Sloan, 2010; Ahmadi, Kusi-Sarpong and Rezaei, 2017; Desiderio et al., 2021). Ahmadi, Kusi-Sarpong and Rezaei (2017) stress that environmental and economic dimensions of sustainability have received sufficient attention from many practitioners and scholars, but social sustainability is either largely neglected or unpopular, particularly with studies involving developing countries. Some researchers stress that the social dimension is an arguable and broad concept (Boström, 2012), theoretically complex to explain and understand, and its meaning is usually connected to values that are universally acceptable. This is due to a lack of shared knowledge and understanding of what social sustainability means (Missimer, Robèrt and Broman, 2017). Social sustainability is a key sustainability concept, indicating its imperious support of human wellbeing in present times and the future (Janker, 2020). However, this difficulty in universally assessing social sustainability has increased its omission in public discussions (Kelley and Simmons, 2015; Gopal and Thakkar, 2016). Nevertheless, some researchers have taken initial steps to identify and investigate some important social-related sustainability dimensions and their impacts; there is, however, a shortfall in their integration into a more comprehensible framework. Also, FSC professionals have not generally understood how to incorporate, evaluate, and manage social sustainability issues (Gopal and Thakkar, 2016). The work of Voinov (2017) emphasises that, unless social-related elements are incorporated into sustainability, it makes little sense to examine sustainable supply chains at all.

Nevertheless, some work on social sustainability dimensions has been published by academics, e.g., Seuring (2013). Additionally, some scholars within the research and scientific community have attempted to explain and contribute to social sustainability itself (e.g., Hutchins and Sutherland, 2008; Nichols and Hilmi, 2009; Bai and Sarkis, 2010; Sloan, 2010; Buzby et al., 2011; Wognum et al., 2011; Martinez-Blanco et al., 2014; Principato, Secondi and Pratesi, 2015; Allen and Prosperi, 2016; Ahmadi, Kusi-Sarpong and Rezaei, 2017; Stevens, 2019; Desiderio et al., 2021; Ruiz-Torres et al., 2021; Morais and Barbieri, 2022; Ramasubramaniam and Karthiayani, 2022). Recently, the work of Tort et al. (2022) has focused on vegetable supply chains. It is argued that diversity, health, safety, and other social-related issues are important factors to take into account when it comes to social sustainability (Bai and Sarkis, 2010; Martinez-Blanco et al., 2014). Without proper food quality and safety or transparency and traceability systems, consumers are at high risk of health complications (Stevens, 2019). From a broad perspective, ISO 22000, British Retail Consortium (BRC) standards, FSSC 22000, Good Manufacturing Practices (GMP), GlobalGap, and Safe Quality Food (SQF) are observed as food quality and safety management systems (Sansawat and Muliyil, 2012). Focusing more on social sustainability, Akkerman, Farahani and Grunow (2010) have highlighted the hazard analysis critical control point (HACCP) system, the British BRC standards, and ISO 22000 as being designed as food safety systems and standards in relation to social sustainability. These social dimension elements offer a structured and unified way to identify matters relating to food safety, and management practices for reducing them. Also, some studies consider the use of traceability and transparency systems to be a suitable measure for food safety and quality, e.g., Dabbene, Gay and Tortia (2014) and Affum and Wang (2019). In that case, to ensure food quality and safety, important approaches need to be adopted to certify and regulate food traceability systems to minimise risks and problems relating to food supply chains, such as food damage, contamination, potentially unhealthy GM food, and allergens. However, food supply chains require stronger management practices to enhance safe and quality food, and to relevantly contribute to resilient, sustainable food supply chains (Leat and Revoredo-Giha, 2013). Also, some studies propose the use of traceability and transparency systems as a measure for food safety and quality, e.g., Dabbene, Gay and Tortia (2014); Aung and Chang (2014); Affum and Wang (2019); and Collart and Canales (2022). From all these discussions, all social impacts should be taken into consideration when assessing sustainability of food supply chains. Still, Yakovleva (2007) and Allen and Prosperi (2016) claim that social progress towards food sustainability recognises the needs of everyone. Current research, e.g., Schmutz et al. (2018), clearly outlines the social dimensions of food supply chains as being food safety, food quality, viability of food culture and traditions, transparency and traceability, as well as food sovereignty and food security.

Nonetheless, research is yet to consider UK food supply chain from overseas sources from a holistic perspective, taking into account all relevant social sustainability impacts. To rebut the researchers' argument (e.g., Ahmadi, Kusi-Sarpong and Rezaei, 2017) and provide the justification for the literature gap, the work of Anderson (2019) stresses that lack of statistical data across food supply chains is the main limitation on assessing social dimensions of FSC. Nevertheless, it is important to follow a holistic approach when assessing sustainability impacts (taking into account all environmental, economic, and social impacts), since social progress is important to ensure consumers' trust (Wognum et al., 2011). Moreover, more studies are also needed to understand and analyse the social sustainability dimensions in developing countries (Mani et al., 2016).

2.3.4 Regulatory dimension of Food Supply Chains

Regulation across food supply chains is inevitable because clear standards and rules safeguard quality of food and consumer trust (Shokri, Oglethorpe and Nabhani, 2014); external and regulatory pressures also have the positive impact of ensuring sustainability for food supply chains (Hinrichs, 2014; Bonisoli et al., 2019). Nonetheless, the regulatory dimension of sustainability has not received the desired attention from policymakers and academics, especially in relation to food supply chains. A few studies have considered this aspect; these include Porter and Van der Linde (1995), Bynoe (2004), Hurley and Noel (2006), Anelich (2014), Hidayat, Offermans and Glasbergen (2018), European Commission (2019), Stevens (2019), Kapała (2022), and Parrot et al. (2022). Other authors have also examined the regulations on border restrictions that limit food supply and distribution, e.g., during pandemics (e.g., Nchanji and Lutomia, 2021). Among these are some studies, including those of Anelich (2014) and Boatemaa et al. (2019), which look at the situation in developing countries; and, of these, several focus on food safety, labelling, and advertising—e.g., Anelich (2014); Gebrehiwot, Cornelius and Korsten (2019); and Boatemaa et al. (2019). However, the number of studies assessing international market and export regulatory requirements is limited, if not almost completely unavailable.

The earlier work of Bynoe (2004) emphasises that regulations can affect and promote inefficiencies in agricultural production that may affect the sustainability of food supply chains. Other studies argue that regulations regarding FSC can negatively affect producers' bottom line; and any attempt to estimate a country's regulation cost for producers or FSC actors is likely to skew downward (Hurley and Noel, 2006). In contrast, Hinrichs (2014) discusses the transition to sustainability, addressing the challenges and highlighting the relevance of regulations; thus, governance, ethics, and values that can strengthen sustainability in food systems. This latter study further investigates competing standards for sustainable food production, analysing what is protected and what is ignored by food safety regulations. Meanwhile, other current studies—Stevens (2019), for example—focus on understanding and strengthening the policies, regulations, and rules governing traceability in food systems. The study reveals that, although some crucial improvements have been made in rules and regulations towards food supply chains, certain key hindrances persist such as a lack of globally-harmonised criteria and requirements. More recently, the work of Kapala (2022) identifies the legal instruments supporting food supply chains in France. It is clearly argued in these works that a legal framework for food supply chains encompasses policies, laws, and initiatives that take into account environmental, social, and solidarity values; and they are good examples to follow. Nevertheless, Hidayat, Offermans and Glasbergen (2018) emphasise that the main regulatory challenge concerns combining a more reliable implementation mechanism with a credible balance between economic interests and sustainability objectives. In Europe, pressure from different advocacy and pressure groups is promoting and influencing the regulatory framework (European Commission, 2010). In America and Asia, food producers ensure that produce meets stringent international regulatory standards and the requirements of western markets. However, producers from African countries lack the necessary institutional oversight (Sumberg, 2005; Parrot et al., 2022).

Nevertheless, some countries have improved their regulatory frameworks to enable them to compete in the international market and supply of food. Ghana, for instance, has notable institutions, including its Food and Drugs Authority (FDA), Ghana Standards Authority (GSA), and Plant Protection and Regulatory Services Directorate (PPRSD), which have regulatory powers to oversee the production, supply, and distribution of fresh produce to international markets, including Europe (Affum and Wang, 2019). Moreover, the European laws and regulations are not extra-territorial, meaning that they do not apply directly to any other country or trade partners outside the EU. Therefore, EU traders, retailers, and importers must follow the laws, and the legal and market requirements, that the third-country food supplier must comply with to enable them export or trade in EU markets (Graffham, 2006). EU regulations on vegetable imports require overseas food suppliers to hold a valid phytosanitary certification from their local authorities to enable them to export vegetables to the EU region (European Commission, 2019). Similarly, food producers require a phytosanitary certificate to export vegetables to the UK (DEFRA, 2022a). However, although food suppliers are complying with the regulations, vegetables identified with harmful bacteria are often seized and destroyed. This results in significant social, environmental, and economic loss to overseas food suppliers. Even though there is additional regulatory support, such as HACCP (Barney and Bedford, 2008), still more sustainability regulations need to be put in place to manage the supply of processed foods, low carbon-produced food, and reduced food waste in the food supply. Although UK gatekeepers (i.e., DEFRA, FSA, and RPA) are committed to ensuring safe, healthy, and quality food coming into the UK, their rules and regulations designed to enhance the sustainability of food supply chains from overseas countries are not properly assessed. More interestingly, the impact of regulatory frameworks and policies and their interconnectedness in propagating further social, economic, and environmental impacts are still unaddressed. The current study by Parrot et al. (2022) stresses that producers and export-driven FSCs have high respect for official rules and regulations; however, no impact assessment on FSC and international food trade context has yet been considered.

2.3.5. Collaboration for Sustainable Food Supply Chains

Collaboration means that chain members are engaged in coordinating activities beyond their usual business-to-business relationships: like-minded people or enterprises operating together with similar objectives (Ramanathan, Gunasekaran and Subramanian, 2011). It shows that people or businesses acknowledge the relevance of working together to achieve a common goal (McCarthy and Golicic, 2002; Cao and Zhang, 2011; León-Bravo et al., 2017). Rota, Reynolds and Zanasi (2013) argue that supply chain collaboration provides an alternate approach to avoid challenges that may arise from markets and hierarchies. In addition, Zhong, Xu and Wang (2017) stress that SC actors should see collaboration as a necessity. On the other hand, Dania, Xing and Amer (2016) argue that maintaining collaboration among SC actors in order to achieve a common objective such as sustainability can be complex. Still, the work of Ramanathan et al. (2021) confirms the importance of the collaboration among SC actors towards achievement of sustainability.

Notable studies that have considered collaboration in the context of supply chain and sustainability include McCarthy and Golicic (2002), Markley and Davis (2007), Lozano (2008), Rota, Reynolds and Zanasi (2013), Ramanathan and Gunasekaran (2014), Fawcett et al. (2016), Chen et al (2017), León-Bravo et al. (2017), Blackmar et al. (2018), Lozano (2018), Fobbe (2020), Ramanathan et al. (2021), Gajdić, Kotzak and Petjiak (2022), and Venegas Vallejos, Matopoulos and Greasley (2022). Markley and Davis (2007) and Rota, Reynolds and Zanasi (2013) suggest that supply chain collaboration should be added to the traditional dimensions of sustainability—that is, the environmental, social, and economic dimensions—to ensure effective assessment of sustainability. Rota, Reynolds and Zanasi further highlight collaboration as an important element of businesses’ relationships that can enhance sustainability. Ramanathan and Gunasekaran (2014) emphasise that collaborative approaches between supply chain partners are likely to yield future long-term collaboration. Interestingly, extant studies are yet to consider collaboration for any sustainability impact assessment (SIA) model or framework. Earlier research, such as that of Linton, Klassen and Jayaraman (2007), highlights the fact that academic literature on supply chain collaboration and sustainability is at an immature stage. However, collaboration for sustainability literature is rapidly increasing, exploring business performance and sustainability collaboration with regards to environmental, social, and economic metrics (Chen et al., 2017). Nevertheless, collaboration between SC actors to achieve sustainability is poorly studied (Ali, 2018). This is because existing studies only focus on a few sustainability metrics (e.g., cost, environmental or social) and mostly in the context of some SCs in advanced countries, ignoring sources from overseas or from developing countries. Meanwhile, there is a need to examine the collaboration among FSC actors from a broader and holistic perspective since it creates innovative practices resulting in sustainable food supply chains (Krishnan et al., 2021). However, as long ago as 2011, Ramanathan, Gunasekaran and Subramanian pointed out the difficulty of estimating the benefits of collaboration; yet attempts in the existing literature to explore and measure collaboration for sustainability of the food supply chain among actors, considering overseas sources and all other sustainability dimensions, is still in its infant stage. This study attempts to show that collaboration practices can be measured, with a view to informing stakeholders of the collaborative practices required to improve sustainability for FSC actors.

2.3.6 Complexities of Food Supply Chains

The complexities involved in global food supply chains have increased significantly since the mid-1990s as a result of globalisation, innovations, and new technologies (Loring and Sanyal, 2021). Although these complexities generate novel problem-solving strategies and approaches, some are creating unsustainable issues for the supply chain. Long and complex food supply chains are characterised by different challenges, including high levels of waste from unsold and damaged fresh food and increased operational costs (Genovese et al., 2017; Loring and Sanyal, 2021). Kristin et al. (2017) therefore advise retailers and food service providers to source locally-produced fresh foods and processed alternatives instead of sourcing food from long distances. However, insufficiency of domestic food production can make this suggestion nearly a mirage. To deal with this, Brunori et al. (2016) have proposed the simplification of supply chains—e.g., innovation by subtraction—which creates more resource efficiency and resilience; for example, direct marketing focusing on the end-customer base and eliminating distributors and wholesalers. Notwithstanding, global food supply chains still suffer from complexities and inefficiencies ranging from energy costs to wage inequalities and food wastage (Robinson and Carson, 2015, p. 195; Gamboa et al., 2016; Tai, 2018).

Complexities in global food supply chains are clearly highlighted by scholarly researchers, including Genovese et al. (2017), Zhong et al. (2017), Tai (2018), Duong et al. (2020), Nasereldin et al. (2020), Abideen et al. (2021), Loring and Sanyal (2021), and Ramasubramaniam and Karthiayani (2022), as important concerns for FSC actors. Genovese et al. (2017) point out that some global concerns such as waste, greenhouse gases, and holistic assessment and management are left unaddressed. Loring and Sanyal (2021) revealed that trajectory complexities have created negative impacts on food system inputs and low return on investments. In addition, market dynamics and uncertainties present key complexity issues in global food supply chains (Nakandala and Lau, 2018; Khan et al., 2021). These can create strong growth in demand, falling supply, and productivity decline, all of which are usually generated by food losses, inappropriate handling, storage inefficiencies, and poor distribution (Heady and Fan, 2010; Kummu et al., 2012; Nakandala and Lau, 2018; Aday and Aday, 2020). Furthermore, global economic shocks caused by uncertainties and pandemics, such as COVID-19, have created other key complexities for FSC actors, including limited market access, financial liquidation and inadequate credits for small and medium agri-businesses (Nasereldin et al., 2020; United Nations, 2020), which also spearheaded issues of unsustainability, e.g., food waste and food loss concerns for fresh produce businesses— mainly vegetable producers and other related FSC actors (Aldaco et al., 2020; Ivanov and Dolgui, 2020). The COVID-19 pandemic has presented a massive test for the world's food supply chain resilience and for businesses. Still COVID-19 threatens to ask questions about the gaps and consideration required in the global food supply chains. During the pandemic, global food supply chains were tested and flattened where shorter food supply chains proved to be more resilient (Thilmany et al., 2021).

A number of complexities that FSC actors are forced to deal with include speed, safety, cost, supply, and logistical challenges. However, few steps have been taken to mitigate them, especially in the developing countries; such countries were, therefore, hit harder (Aday and Aday; 2020; Deconinck et al., 2020). Rapid technological changes and sudden disruptions are key challenges facing FSC actors including producers and retailers. In regard to these, FSC actors and businesses require strategies, adaptability, and a planning system to manage complexity. However, complexities in food production and supply chains come in a wide range of forms (Lin et al., 2021). Accordingly, the literature is not clear on an assessment model or a single indicator useful for assessing complexities. Some studies bemoan the difficulty in measuring complexification in agricultural production and supply chains (Serdarasan, 2013; MacDonald et al., 2015; Lin et al., 2021). Interestingly, despite this impact of complexities on sustainable global food supply chains, the literature is yet to consider a robust empirical assessment, starting from identification and evaluation of overseas' food suppliers challenges, issues, or complexities and taking into account different challenges and complexities facing producers and other FSC actors. Therefore, there is a need for sustainable global food supply chains to monitor uncertainties and upheavals due to the global and ripple effects that may impact on FSC actors. Such concerns require a comprehensive approach, factoring all FSC processes and activities into an integrated form and considering the complexities of food supply chains as a sustainability dimension; and carefully applying a sustainability impact assessment tool or model to evaluate or assess its implications for sustainability.

2.4 UK Sustainable Food Supply Chains

UK Food 2030 is an initiative of the UK government's Department for Environment, Food and Rural Affairs (DEFRA), which seeks to revolutionise food production and consumption, striving for sustainable food supply chains. Efforts put in place include encouraging local food (importantly, working with local producers), education and research institutions to achieve a sustainable food system by the year 2030 (HM Government, 2010, DEFRA, 2022b). Further support is sought from the third sector on sustainability; from retailers and researchers on carbon labelling and carbon footprinting of food (Gadema and Oglethorpe, 2011) to enable consumers to make active choices towards sustainable food. Earlier, in 2000, the Food Standards Agency (FSA) was established, focusing on the consumer as the driver for achieving food policy goals. These goals also sought to bind and modernise farming to contribute to an efficient food supply chain, a process begun under the 1990 Food Safety Act (Barling and Lang, 2010), which entrusted the food supply chain to conduct due diligence to improve its safety procedures. It actually de facto tasked the retailers to be leaders in food standards. Following the Foot and Mouth crisis in 2001, the Sustainable Food and Farming Scheme (SFFS) was developed, following recommendations by the Curry Commission, which prioritised environmental sustainability: how farm environments are managed and the environmental impacts of farming and food production. This initiative reclaimed control of an in-country UK agricultural environment policy, which was previously only available through the Common Agricultural Policy (CAP) of the European Union (EU) (DEFRA, 2006; Beddington, 2011), hence providing an opportunity for the UK to create a holistic approach to sustainable farming. However, the coincidence of environmental impact and food health triggered the Food Matters Report in 2008, which considered a more integrated food policy for the UK (Cabinet Office, 2008). Food 2030, launched in 2010, provides a step forward towards a secure and sustainable food system, which involves initiatives by all industry players. To add to that, a consumption-led policy centred on ensuring that consumers make sensible choices is a vital food policy ideal for 21st-century food sustainability.

Food 2030 can be best explained from four perspectives: overview, vision, strategy, and critics (Barling and Lang, 2010; Global Agricultural Information Network, 2010; Marsden, 2010):

1) Overview: Food 2030 summarises the UK's aims for a secure, affordable, nutritious, safe, and sustainable food supply chain to feed its own people. It makes the consumer central to achieving a sustainable food system for the future, endorsing choice "editing": educating and helping consumers to make choices that are sustainable.

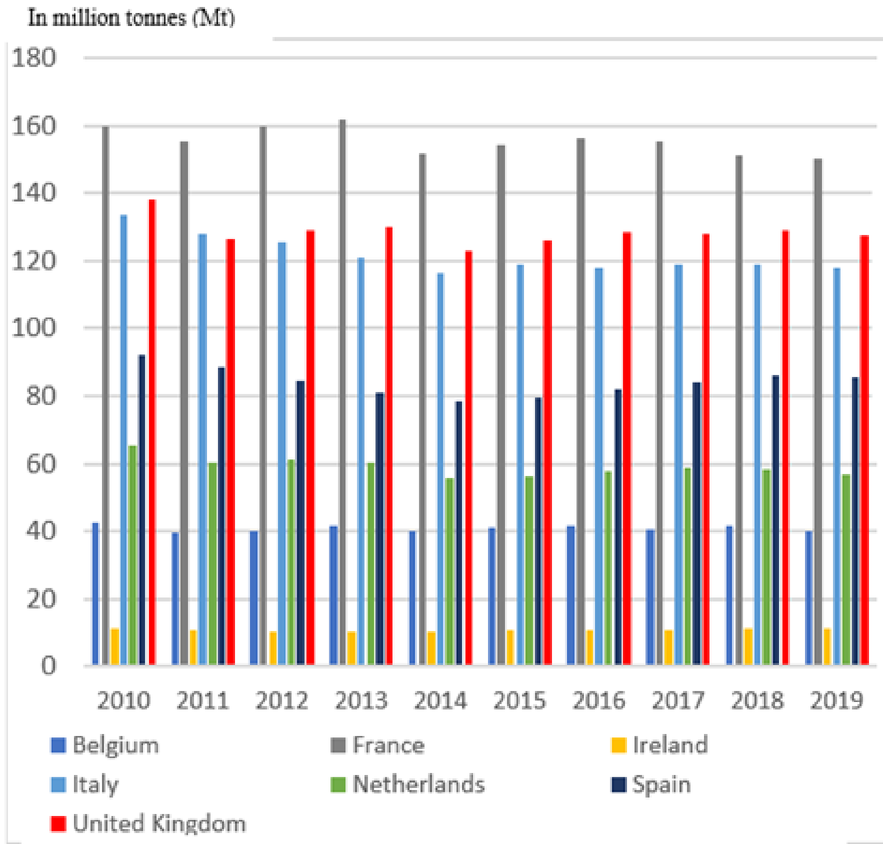
2) Vision: the UK seeks to ensure that food is produced, processed, and distributed to feed a growing world population in a way that is safe and environmentally sustainable; contributes to significant positive rural communities; considers high standards for animal health and welfare; and enables the UK to demonstrate global leadership in food sustainability.

3) Strategy: Food 2030 considers six core issues for a sustainable food system— a) Trade: to ensure a resilient and economically sustainable food system; b) Production: to increase sustainable food production; c) Health: to enable and encourage people to eat a sustainable healthy diet; d) Climate Change: to reduce the food system's greenhouse gas (GHG) emissions; e) Energy: to reduce, re-use and re-process waste; and f) Technology/Skills: to possess the appropriate research, skills, knowledge and technology.

4) Critics: the vision lacks new government intervention, and it relies heavily on voluntary efforts. The vision does not properly outline what can be done locally in the UK to address its global responsibilities in either the short term or long term. Moreover, the vision fails to address the concentration within food supply chains and the balance of power that the large supply chains display. It is too short on detail and too long on vision (Barling and Lang, 2010; Marsden, 2010).

It is worth noting that collaborative initiatives by DEFRA, the Sustainable Development Commission (SDC), and food industry players have spearheaded robust actions, such as promotion of local production, which is mostly argued to be more sustainable (Smith, 2008; Schmitt et al., 2016). However, the UK is not self-sufficient in food production, but imports nearly 40% from overseas sources (AHDB, 2016; Lang and Schoen, 2016). Before Brexit, the UK took part in the EU's single-market sharing farm and food regulatory policies, along with other EU members. The EU is the main source for the UK's food exports and imports: it consumes about 80% of the UK's food exports, and about 60% of the UK's food imports are sourced from the EU (Barling and Lang, 2010; DEFRA, 2010). However, the UK food supply chain became more complicated after Brexit (Rivington et al., 2021) with food trade disruption caused by border closures and travel restrictions. Yet, a large amount of UK food is still sourced from EU countries. The UK's reliance on EU food suppliers and the rest of the world has a huge economic and environmental impact, often involving unfavourable environmental effects at the same time as favourable economic effects for both the UK and the food suppliers' countries. On environmental impact, significant carbon emissions are generated from logistical services (Nilsson, Sternberg and Klaas-Wissing, 2017; Karaduman et al., 2020). Moreover, as explained above, other environmental impacts are also associated with global food supply chains, such as acidification, eutrophication, and water loss, e.g., freshwater withdrawals (Poore and Nemecek, 2018). Further, there are significant sustainability concerns created at each stage of the food supply chain — i.e., from food production, processing, storage, transportation, distribution, retailing, consumption, and disposal (Barney and Bedford, 2008). The sustainability concerns of the UK's food supply chains are potentially overwhelming (Yakovleva, 2007; de Ruiter et al., 2016) and require urgent, pragmatic, and all-inclusive approaches and measures to achieve balancing-off throughout and to be setting the pace for the advanced countries. However, none of these important discussions has progressed further than documentation, retailers' intervention, and localisation, while the UK still imports a significant amount of food from global sources.

More importantly, UK consumption is increasingly overpowered, with enormous CO_2 emissions (de Ruiter et al., 2016). Figure 2.2 and Figure 2.3 show the UK's final consumption emissions and carbon emissions respectively, compared with other food trade partners in the EU region. From the consumption emissions figures, although France generates more emissions than the UK and the rest of its food trade partners, the UK—which aspires to lead global responsibility towards sustainability—has consumption emissions which are still significantly high, even since the launch of Food 2030. The consumption figure clearly shows UK emissions which are higher than those of Spain, Ireland, Belgium, or the Netherlands. The main reason for these higher UK figures is the differences in population. However, the UK's consumption emissions have steadily increased since 2014. Similarly, Figure 2.3 shows that the UK generated more CO_2 emissions than the rest of its food trade partners, including France. Even though the data reveal a decrease in UK CO_2 emissions since 2012, the amount produced is considerably higher than most of its food trade partners in the region. Moreover, in 2016, DEFRA estimated overall supply chain emissions from all consumption activities at 1106Mt of CO_2. de Ruiter et al. (2016) clarify that these huge UK CO_2 emissions are associated with the UK's reliance on food supply from global sources.



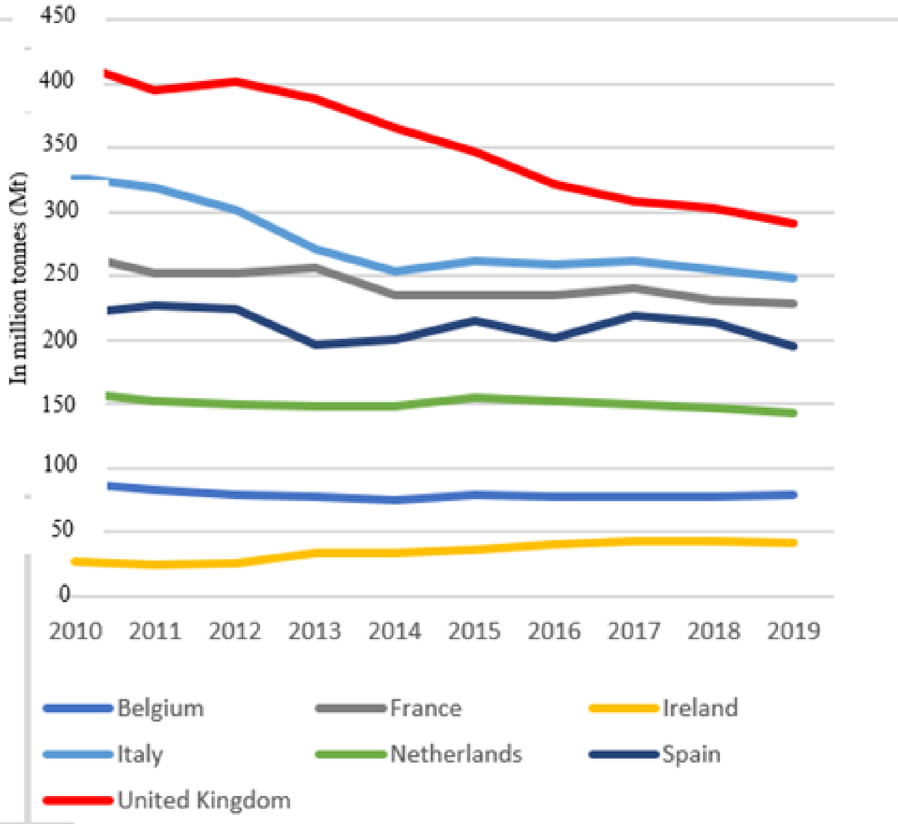


Figure 2.2 UK Consumption-based emissions (in CO_2) compared with other food trade partners in Europe

Figure 2.3 UK CO_2 emissions compared with other food trade in Europe

Sources: Data collected from the International Energy Agency (2021) and the OECD (2021)

Regarding economic impact, food-supplying countries have improved efficiency, reduced unemployment and created investment, especially in developing countries such as Ghana, Kenya and South Africa (Legge et al., 2008; Pretty et al., 2008; Xie et al., 2014). Consequently, the UK needs to source food with high sustainability standards that are healthy, safe and have lower environmental impacts. This would significantly contribute to the UK CO_2 emissions and other greenhouse gas emissions reduction targets (i.e., by at least 80% of the 1990 level by 2050) set by the Climate Change Act 2008 (Committee on Climate Change, 2008) while providing some environmental and economic benefits. However, some food sustainability researchers, such as Yakovleva (2007) and de Ruiter et al. (2016), strongly emphasise that the UK is increasing concerned with the sustainability impact of the food supply at home, while less attention has been given to that from overseas. Moreover, studies of the sustainability impact in the UK food supply chain which take into account exporting countries are limited. Previous work (de Ruiter et al., 2016; Poore and Nemecek, 2018; Schmutz et al., 2018) focused on estimating the environmental impacts (mainly CO_2 emissions) without assessing the degree of compliance by both UK and the exporting countries with the dominant environment impacts.

Although DEFRA is working with various food trade partners and food industry players to enhance sustainability of the UK food system at home and abroad, key issues are still not being tackled in the furtherance of sustainable food for Food 2030 and the UK's vision to be a global leader in food sustainability. These gaps include measuring and valuing sustainability with a coherent and robust method, considering the three traditional sustainability dimensions (3D)—social, economic and environmental—as well as taking into account a life cycle analysis of the food supply chain. The 3D view of sustainability helps to capture all activities of food supply chain players as being either sustainable or unsustainable. However, a careful 3D sustainability assessment of all food supply chain actors' activities is yet to see the light in a food policy document, or in contemporary management or supply chain literature. Table 2.1 provides a brief description of the activities of some key UK food supply chain actors and their potential contributions to sustainability. Despite several roles played by different food supply chain actors, there is a need for food policymakers and industry players to adopt more practical approaches that enhance sustainable food supply chains, bearing overseas producers in mind. To address this gap, research needs to focus on sustainability implications associated with all food supply chain actors, starting from overseas and involving all key players' activities. This holistic approach would help capture every activity or process of the food producer, the exporter and logistical and distribution agencies, through to the UK retailers and consumers. This would enable the development of a more solid, pragmatic, and detailed strategy that minimises policy limitations and can significantly help to achieve the UK goals of Food 2030 and global food sustainability leadership, as well as more pragmatic and holistic approaches capturing the involvement of all government agencies, sector players, and external contributors to help achieve carbon neutrality by 2050 (HM Government, 2019). Importantly, Schmutz et al. (2018) stress that the food supply chain needs to be economically, socially, and environmentally sustainable, meaning that there should be systematic thinking about each aspect of sustainability (economic, social, environmental, and regulatory) in all the key stages of the UK food supply chains. However, in food trade with foreign producers or suppliers, a number of regulatory frameworks are enforced to ensure that consumers have safe and healthy food. So, with the inclusion of a regulatory dimension to assessing sustainability, a much broader, holistic perspective of sustainability is clearly suggested. This would assist in identifying appropriate problem areas and feeding into policy development to guide stakeholders in sustainable food supply. Intriguingly, academics and policy analysts have argued that the UK's decision to withdraw from the European Union creates further sustainability issues for its food systems (Benton et al., 2019). It means that food needs to be sourced from alternative producers, a process which can possibly be complex, long, and offer negative sustainability impacts. This discussion clearly catapults upwards the inevitability and relevance of identifying and exploring the sustainability implications of food supply chains from global sources to the UK, thereby enabling stakeholders to tackle the implications, while enhancing sustainable food supply across different chains and for each food trade partner.

Table 2.1 Activities of some key UK food supply players

Food Supply Chain Actors/ Players	Activities or Roles	Impact on Sustainability
Department for Environment, Food and Rural Affairs (DEFRA) and other government institutions, e.g., National Food Strategy and Rural Payments Agency (RPA).	Responsible for protecting and improving the environment through growing a green economy, and supporting world-leading farming and food industries.	Contributing to sustainability by addressing environmental and health issues regarding the food system, security of the food supply, and ensuring the maximisation of the agricultural technology revolution. Oversees standards and builds national and international collaboration and support to enhance sustainable food production, distribution and consumption, as well fostering consistent food trade.
The 434 Local Authorities	Responsible for inspections and enforcement of food safety, hygiene, and food standards legislation.	Transforming the food system to a more sustainable one through social, environmental, and regulatory supervision.
Food Standard Agency (FSA)	Protect consumer interest in food and support systems that regulate food businesses, ensuring food is safe, affordable and that consumers are informed to make right choices.	Create social sustainability through transparency.
Wholesalers and Distribution Centres, e.g., New Covent Garden Market, Western International Market, Menzies Distribution and Time Wholesale Services	Create food supply chain solutions through sales and distribution, usually between the producers, retailers, and consumers.	Support sustainability using improvements in technology, optimal operations and

		collaboration on sustainability matters.
Retailers, e.g., Tesco, Asda and Sainsbury	Work with food producers (farmers and growers either small or large), food processors, and manufacturers to mutual benefit.	Improve food supply chain sustainability through sourcing locally where practical and initiating joint sustainability programmes, such as carbon footprinting.
Logistical services, e.g., Mango Logistics Group, CN, and Global Cargo & Commodities Ltd.	Offer improved logistics and adopt smart technologies to reduce fuel consumption, food miles and improve their own workers' welfare.	Contribute to sustainable agriculture by supporting farmers and suppliers, and reducing food miles through eco-efficiency in logistics.
NGOs and Civil Society, e.g., Sustainable Development Commission, Water & Resource Action Programme (WRAP), Food & Drink Federation (FDF), and Food Ethics Council.	Highlight concern and problem areas, as well as providing insights and expertise for improvements.	Promoting sustainability through sharing knowledge, advocacy ,and collaboration.
Farmers and growers, e.g., Dhillon Farms, Woodmarsh Producers and Fram Farmers	Develop network with important buyers, build relationship towards continuous sustainable business.	Contribute to addressing ethical, environmental and social issues, as well as livelihoods along the food supply chain.
Consumers	Show food-buying habits that ensure a nutritious, healthy, and sustainable diet.	Support social and environmental sustainability through buying foods which are FairTrade, locally produced, and making sustainable choices using carbon footprinting.

Research & Development institutions, partners and corporations, e.g., REAMIT of Nottingham Trent University, Food Innovation Centre of the University of Nottingham and Institute of Sustainable Food of the University of Sheffield.	Provide in-depth understanding of sustainability issues and their links with food production, distribution, and consumption.	Support sustainability through development of smart technology for tracing, tracking, blockchain, and waste management

Sources: Adapted from Smith (2008), Wakeland, Cholette and Venkat (2014), and DEFRA (2010; 2020).

DEFRA can attempt to collaborate more with different institutions and food industry players at home and abroad to further its Food 2030 aims. Researchers can support this innovative and collaborative initiative by assessing the entirety of the food supply chain, starting overseas. This can begin by choosing one overseas food trade partner which is not in the European region, assessing the activities of the major key players in the food supply chain, taking into account the life cycle and 3D sustainability assessment, and not forgetting inclusion of the regulatory dimension. Statistically, the UK agri-food contribution to national gross value-added (GVA) stands at £120.2 billion (in 2019); and the food sector employs 4.1 million people, representing 13% of the UK's labour force. The food trade deficit is at £24.3 billion in 2019, even though food exports increased by £600 million in 2019 (DEFRA, 2020), meaning that the 45% of UK food sourced from the EU, Africa, America, Asia, Australasia, and Europe outside the EU is still significant to create such an economic loss. Out of this, 45% are sourced from global food producers, the EU represents 26%; Africa, North America, South America, and Asia contribute 4% each; and the remaining 3% comes from the rest of Europe and Australasia (ibid.). Moreover, there has been consistent food supply from Sub-Saharan African (SSA) countries, among which Kenya, South Africa, Ghana, and Tanzania are the leading food exporters to the UK. These countries generate substantial revenue from food trade with the UK, while creating jobs and improving in technology, regulatory frameworks, and enhanced production systems (Saavedra et al., 2014; van Berkum et al., 2017). Interestingly, there is nothing in the literature on the UK food supply chains estimating the sustainability dimensions of food supply from SSA countries, considering different sustainability dimensions including regulatory mechanisms. The existing body of literature covers either European food suppliers (e.g., Frankowska, Jeswani and Azapagic, 2019), Asia and America (e.g., Saunders and Hayes, 2007) and fails to comprehensively capture the three sustainability dimensions and entire food supply chains from the producers' sources to the UK.

2.4.1 Sustainability assessment of UK food supply chains

The UK is increasingly promoting policies, measures, and strategies to foster sustainable food supply chains. This vision has attracted attention from academics, researchers, and different research community groups to assess sustainability of the food supply chains with different approaches and for different food categories. However, while some studies have considered a sustainability assessment of one dimension, such as environmental or economic (e.g., Jones, 2002; Marriott, 2005; Saunders and Hayes, 2007; Webb et al., 2013;

de Ruiter et al., 2016), others have attempted to discuss and assess all three (e.g., Smith, 2008; Tsolakis et al., 2018; Schmutz et al., 2018). Extant studies have shown more support for examining the environmental aspects of the UK food supply chains. For instance, Jones (2002) analyses the environmental impacts of transportation of food supply chain of fresh produce. Although the study takes account of global sources, other sustainability dimensions, such as social and economic dimensions, are not assessed. Likewise, Marriott (2005) examines air transportation of fresh produce into the UK from non-EU countries, focusing on Kenya, Ghana, the USA, Pakistan, and South Africa, between the period of 1994 to 2004. Their results reveal that consumer demand, and producers' interest derive most economic benefits that drive the airfreight of fresh produce to the UK. Similarly, Saunders and Hayes (2007) attempt a cradle-to-grave assessment of fresh produce supply to the UK, but their studies focus mainly on environmental aspects. Notwithstanding earlier work in furtherance of environmental sustainability, current studies have examined the factors hindering the implementation of sustainability measures in food supply chains (e.g., Ghadge et al., 2021), to foster development towards all sustainability dimensions.

In the quest for sustainability, a few studies have covered a holistic assessment of the UK food supply chains taking into account all sustainability dimensions of various food categories, at different stages of food supply chains, and/or from different overseas sources (Ilbery and Maye, 2005; Vasileiou and Morris, 2006; Yakovleva, 2007; Shokri, Oglethorpe and Nabhani, 2014; Schmutz et al., 2018; Malak-Rawlikowska et al., 2019; Anastasiadis and Tsolakis, 2021). For example, Schmutz et al.'s (2018) work is focused on using SIA to gain an insight into how FSC actors measure the sustainability impacts of different kinds of short food supply chains. SIA enabled the researchers to find out that community-suggested agriculture (CSA) provides much more social benefit than economic or environmental benefits. However, this research was limited to an urban city—metropolitan London. Otherwise, Yakovleva (2007) and Malak-Rawlikowska et al. (2019) measure the implications of sustainability indicators that encompass environmental, social and economic dimensions, considering various stages of food supply chains such as agriculture, processing, wholesaling, retailing, and catering. Nevertheless, their studies are UK-based research and do not take account of food supply chains from overseas, within which are usually embedded enormous sustainability implications. Moreover, these studies do not consider vegetable supply chains.

Contributing to the sustainability assessment of vegetable supply chains, ideally suggesting approaches to reducing some sustainability aspects of fresh produce, the work of Frankowska et al. (2019) and Aikins and Ramanathan (2020) can be cited as important exemplars. Franskowska et al. (2019) present a comprehensive assessment of environmental impacts of vegetables consumed in the UK, stressing that CO_2 emissions associated with vegetable imports from overseas sources like the EU are significantly higher (viz., five times more) than those produced locally. Their environmental impacts assessment of the fresh produce food supply chain from overseas sources like the EU—similarly to Mason et al. (2002) and Saunders and Hayes (2009), who assess LCA (transportation CO_2 emissions) of fresh produce—take account of production, storing, curing, processing, packaging, transportation, household preparation, and waste. Nevertheless, their work does not capture any other sustainability impacts relating to social and economic aspects. Aikins and Ramanathan (2020) examine the key factors of UK food supply chains, considering overseas sources. The study focuses on LCA (CO_2 emissions) of the key factors, such as growers' field, inland logistics, transportation, and sales and distribution of fresh produce, i.e., both fruits and vegetables. Despite their interesting results that transportation and sales and distribution significantly affect UK food supply chains, their research also ignores social and economic contribution from the selected overseas sources. In addition, their studies cover fresh produce—both fruits and vegetables — but do not fully examine the vegetable supply chains. It is clear in the literature that assessing environmental impacts of food supply chains in the UK has gained considerably more attention than the other sustainability dimensions. However, all sustainability dimensions offer a unique and balanced contribution to achieving sustainable food supply chains that are holistic and reliable and that suggest leadership in sustainable development. Moreover, many sustainability issues (mainly economic, environmental, and regulatory) of the UK fresh produce supply chain involve complexities and a wide range of FSC actors (Zurek et al., 2020); thus, examining the sustainability implications associated with each stage of the supply chain and actors' activities provides a more realistic and pragmatic approach towards enhancing sustainability within the food supply chains. Contrastingly, the extant literature does not consider any SIA framework for assessing the entire food supply chains from overseas sources to the UK by identifying and measuring the sustainability impacts. This study attempts to develop an SIA framework for Ghana's fresh vegetables to the UK that identifies and measures all key sustainability dimensions and their associated sustainability impacts.

2.5 Ghana's Food Supply Chain—Vegetables

The Ghanaian food supply chain consists mainly of agricultural production and harvesting, packaging and storage of produce, transportation, manufacturing, distribution, retailing, food service and, finally, home consumption (Ababio, Adi and Commey, 2013). It has created enormous employment and supported economic growth (Legge et al., 2008; Pretty et al., 2008; Xie et al., 2014; Nyamah et al., 2017), and contributed to global food supply (Yeboah et al., 2014). Nevertheless, Affum and Wang (2019) highlight managerial skills, technological development, poor agricultural infrastructure, irrigation development, market access, and natural resource management as the major challenges facing the food supply chain (including the food industry and export sector) in Ghana. Additionally, there is no doubt that Ghana's food supply chain was considerably affected during COVID-19: it affected food production and supply chains due to the lockdown restrictions, creating food production shortages, price increases, and shortages of farm inputs and limited market access, both locally and globally (Benton, 2020; Agyei et al., 2021; Galanakis et al., 2021). Despite past and present challenges, Ghana has consistently been a global food supplier, and export to the UK in 2021 soared to £58.8 million (Department for International Trade, 2022); thus, there exists huge broader market potential for different food commodities from Ghana. Major food commodities supplied by Ghana to the rest of world include cashew, soya, vegetables (tomatoes, peppers, aubergines (eggplant), okra, onions), groundnuts, and shea nuts. Vegetables top the list of food commodities supplied to overseas markets. Vegetables, in fact, consistently record high volumes of supply to overseas countries among food commodities exported, but also fall within the top five exports to Europe overall—cocoa, timber, rubber, vegetables, and fish (Department for International Trade, 2022). The research and data from Asselt, Massias and Kolavalli. (2018) and FAO (2021) communicate that Ghana's fresh vegetable supply to overseas has grown significantly since 2011. This achievement is principally contributed by proactive initiatives of both government institutions and private sector associations, such as the Ghana Export Promotion Authority (GEPA), the Plant Protection and Regulatory Services Directorate (PPRSD), and the Federation of Associations of Ghanaian Exporters (FAGE). Initiatives like export financing, a sustainability hub, trade facilitation, and international cooperation programmes have made vegetables from Ghana more acceptable, marketable, transparent, nutritious, healthy, and safe (Ababio et al., 2013, Asselt, Masias and Kolavalli, 2018; Affum and Wang, 2019; GEPA, 2021). Meanwhile, Ghana's food supply chain (vegetable export sector inclusive) is comprised of producers who are smallholder farmers, outgrowers, contract farmers, traditional farmers, and new-style "professional" farmers.

Contributions from regulators (e.g., the Ghana Standards Authority; Food and Drugs Authority; and Plant Protection and Regulatory Services Directorate) and agricultural development supporters—e.g., food researchers, agronomists, food exporters, NGOs in agriculture and authorities overseeing food production, distribution and consumption—are also facilitating Ghana's vegetable production and supply (Saavedra et al., 2014; Tsiboe, Asravor and Osei, 2019).

2.5.1 Producers, market and supply chain of Ghana fresh vegetables

Producers usually involved in the vegetable production and supply are classified as small-scale, medium-scale, or large-scale. Saavedra et al. (2014) emphasise that producers in Ghana's vegetable production and its supply chain are mainly small-scale or large-scale producers. Further, smallholder farmers, who have less than two hectares of land, significantly dominate production (Darfour and Rosentrater, 2016; Chapoto et al., 2018). Some small-scale producers or exporters who do not own land rely on smallholder farmers' produce and gather it through informal relationships. Small-scale producers are mostly smallholder farmers, but include outgrowers and other local farmers. The vegetable trade plays a key role in smallholder producers' livelihood in most developing countries (Schreinemachers, Simmons and Wopereis, 2018) and Ghana is no exception, providing sources of income and creating employment for players within the food value chain with strong agribusiness possibilities. Nevertheless, producers in Ghana and other developing nations face multiple limitations, not only regarding vegetable production, but also across the entire food supply chain (Adams, Balana and Lefore, 2020). These challenges include poor volume of production; poor transportation and infrastructure in farming areas; limited access to extension services; and limited access to finance and farm input credits (Asuming-Brempong et al., 2016; Affum and Wang, 2019; IFPRI, 2020). Asuming-Brempong et al. (2016) contend that, even though smart technologies are available for smallholder producers to enhance production, the cultural, political, economic, and social factors limit their capability to utilise these technologies adequately. On the other hand, the large-scale producers engage contract farmers and outgrowers, usually own over 20 hectares, and engage in production and export of several foods (Chapoto et al., 2018). Inadequate irrigation facilities, volatility in wholesale prices, limited availability of improved seeds, and inadequate credit facilities are also common challenges for large producers of vegetables in Ghana (Osei-Assibey, 2015). Dhillon Farms is notably the largest producer and exporter of vegetables of different varieties. Other producers (including large and small producers) include Joekopan Enterprise, Joeveg Farms, Trostky

Farms, Volta Veg, Srighan Farms, and Whytebage International Ltd. (FAGE, 2020). Undeniably, Ghana supplies 10,000 tonnes of vegetables annually overseas (GEPA, 2021; FAOSTAT, 2021). The majority of these vegetables landing in Europe, South Africa, and India are transported via Kotoka International Airport (KIA) at Accra, Ghana's capital. These vegetables are mostly supplied to the UK and more than 50% of exports to Europe are shipped to the UK (Saavedra et al., 2014; UN Comtrade, 2020). For the last five years, therefore, from 2016 to date, the UK is the major recipient (importer) of Ghanaian vegetables. Vegetable supply has boosted agri-business for farmers, enabling better income and welfare, especially for smallholders (Asselt, Masias and Kolavalli, 2018; Chapoto et al., 2018). In comparison to vegetable exports, Ghana's domestic vegetable market consists mostly of supermarkets, corner shops, stalls, and open markets. The most popular open markets are in locations such as Agbogbloshie, Makola, Techiman and Nsawam. The remainder of the vegetables end up in tabletop shops, corner shops, hotels, and restaurants (Sasu, 2019). On the other hand, Ghanaian vegetables supplied to the UK market are mostly patronised by the ethnic market and end up in convenience stores and small retail shops (Saavedra et al., 2014: Asselt, Masias and Kolavalli, 2018).

Ghana's vegetable supply chain involves several activities (Council, Rijk and Beatrixlaan, 2014). These include supply of farm inputs, seed selection, seed-bed and land preparation, planting, crop protection, pest and weed prevention, fertilising, harvesting, sorting, packaging, supplying, processing, wholesaling, retailing, local consumption, and export to foreign markets. The Ghanaian agricultural sector plays a significant role in the country's economic growth and development. It contributes to growth in GDP, poverty reduction, and reduction of hunger (Attoh et al., 2014). Of all the agricultural production, the crops sub-sector is the main component of the country's agricultural sector (MOFA, 2010). Interestingly, Asselt, Masias and Kolavalli (2018) explain that producing and supplying vegetables such as chillies in Ghana is more profitable than traditional staple foods, e.g., rice and maize. The local market for vegetables is growing faster than 10% annually and export potential is estimated at US$250 million (Council, Rijk and Beatrixlaan, 2014). Vegetable production is carried out across the country and year-round, but is highly dependent on market windows and weather conditions (Council, Rijk and Beatrixlaan, 2014; Saavedra et al., 2014; Adams, Balana and Lefore, 2020). However, the work of Robinson and Kolavalli (2010), Attoh et al. (2014), and Saavedra et al. (2016) indicates that vegetable production mostly occurs in some concentrated areas in the Northern, Upper East, Ashanti, Brong Ahafo, Volta, and Eastern Regions. Ghana has two food growing seasons—a dry season and a wet season. The dry season runs from October through to February, while the wet season is from March to September. Vegetable producers usually grow during the rainfalls in the wet seasons. From these facts, Ababio et al. (2013) conclude that producers rely heavily on unpredictable weather conditions. Nevertheless, with technological innovations and proper irrigation schemes (Saavedra et al., 2014; Affum and Wang, 2019), farmers grow vegetables throughout the year. Interestingly, irrigated vegetable farming is increasing, resulting in the development of new production areas in Northern Ghana and around the Volta River, as well as some specific areas in the Greater Accra region (Asselt, Masias and Kolavalli, 2018; Adams et al., 2020: Mordor Intelligence, 2021). Ghanaian fresh vegetables, including chillies, onions, tomatoes, aubergines and okra, are widely produced. The vegetable production area accounts for around 88,000 hectares, mainly for primary and Asian vegetables, such as hot chillies (peppers), ravaya (a form of aubergine), garden eggs (aubergines), and gourds, but mainly for tomatoes (Saavedra et al., 2014; Asselt, Masias and Kolavalli, 2018; Tsiboe et al., 2019; FAOSTAT, 2020).

Further, vegetable supply is supported by traders popularly called “market queens”, who often buy the vegetables in any quantity from smallholders and local farmers at the farm gate (Robinson and Ngeleza, 2011). The market queens then trade these vegetables at the big markets at Techiman, Agbogbloshie, Makola, Amasaman, Nsawam, and Abinkyi (Saavedra et al., 2014) and also supply some exporters. Exporters who double as small or large farmers also source and sort the vegetables in good condition, of high quality, and free from infestation before packaging. Packaging, mostly in paper, is usually carried out at the exporter’s warehouse or home before transportation to the airport (Kotoka International Airport, Accra) (Saavedra et al., 2014; Sasu, 2019). Sasu (2019) bemoans packaging of the vegetables as the one major challenges facing suppliers, and the process of open-air handling and packaging at the airport can potentially lead to low shelf-life and a reduction in quality. Exporters complain that clearance time for shipment often exceeds airline cargo loading time. In that event, food waste or loss may occur if the vegetables are forwarded on the next day’s flight (Saavedra et al., 2014). Ghana’s vegetable supplies to the UK land in Heathrow, London, like most other horticultural products from SSA countries. The major vegetable wholesalers, such as New Covent Garden, the Western International Market, and New Spitalfields Market, are usually responsible for distribution to other food distributors, retailers, and large ethnic markets in the UK. The latter are highly informal and certification is not required to supply to a particular market or retailer

(Saavedra et al., 2014). The producer–buyer or exporter–retailer relationship is highly informal and purely based on networking. Figure 2.4 presents Ghana's vegetable supply chain to the UK, diagrammatically identifying all key actors highlighting the network between small producers, large producers, and the rest of vegetable supply chain actors through to the UK consumer.

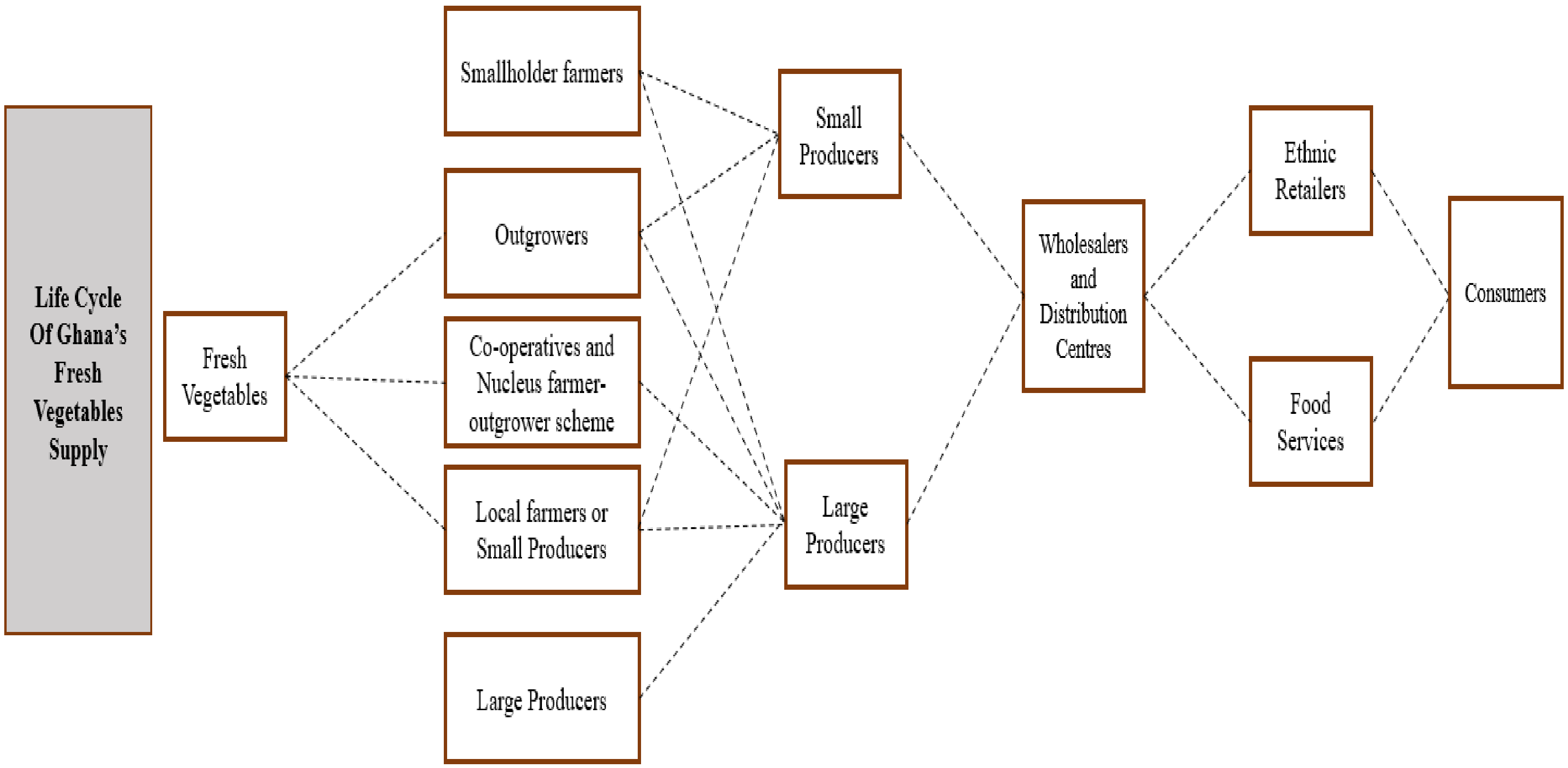


Figure 2.4 Ghana vegetable supply chain to the UK adapted from Saavedra et al. (2014), Council, Rijk and Beatrixlaan (2014), Asselt, Masias and Kolavalli (2018), and Sasu (2019).

2.5.2 Policies, initiatives, and roles of FSC actors in Ghanaian vegetable production and supply chains

In 2014, the EU temporarily banned Ghanaian vegetables such as aubergines, gourds, and peppers following an infestation of vegetables with thrips (Agar, 2017; Sasu, 2019), but the ban was lifted in January 2018 (Asselt, Masias and Kolavalli, 2018; Sasu, 2019). The Ministry of Food and Agriculture (MOFA), authorising and supporting institutions and vegetable producers, collaborated and developed a strategy to improve on vegetable production, thus enabling the removal of the restrictions (Asselt, Masias and Kolavalli, 2018). These initiatives included implementation of traceability to ensure that infested food can be appropriately traced to the producer or source (Sasu, 2019). GEPA, FAGE, and other export associations are further providing various services for exporters and producers to enable expansion of vegetable production, find more markets abroad, and to help them grow the vegetable business. Moreover, MOFA and other government agencies are also providing education, export information, marketing and production planning, and sustainable support to exporters, to enable utilisation of their resources to help enhance their supply to various targeted markets (Sasu, 2019; FAGE, 2020; MOFA, 2020). MOFA, in particular, has a range of projects, such as the Outgrower and Value Chain Fund (OVCF), the Ghana Commercial Agriculture Project (GCAP), and the Savannah Zone Agricultural Productivity Improvement Project (SAPIP), which are enabling vegetable producers and exporters with funds and technological knowhow to increase productivity (FAO, 2015; MOFA, 2020). Previously, the Government of Ghana through the Ministry of Food and Agriculture (MOFA) declared producer-oriented policy decisions—e.g., agricultural modernisation, block farming, irrigation development, and fertiliser subsidy programmes—to support food production and the supply chain (FAO, 2015). While more attention is directed towards increasing economic benefits, collaboration, regulatory frameworks, and social impacts, it is important that actors should make environmental sustainability the central construct to enhance competitiveness while making a contribution to global food sustainability and sustainable food supply chains. Table 2.2 presents the activities of some key Ghana vegetable supply chain actors and their respective contributions to sustainability.

Table 2.2 Activities of some key Ghana vegetable supply chain actors

Food Supply Chain Actors/ Players	Activities or Roles	Impact on Sustainability
Ministry of Food and Agriculture	Promote sustainable agriculture through technology and research development and provide extensive and other agricultural support services to food traders, producers, and processors for improved livelihood.	Contributing to agricultural sustainability through provision of research and development, technology as well as extensive support services.
Ministry of Trade and Industry	Promote sustainable economy through innovative, technology-driven trade and industry programmes and policies to create economic benefits including employment and high economic growth.	Support sustainability using innovative and technology-driven trade approaches.
Ghana Export Promotion Authority	Provide producers and exporters with relevant market information to tap export opportunities. Also, provide guides, facilitation, and support services regarding markets, trade and export, thereby enhancing business network, income, and expansion for producers and exporters.	Create economic and social sustainability environment.

Regulatory Bodies, such as Food and Drugs Agriculture (FDA) and Ghana Standards Authority (GSA)	Oversee production, distribution, and exportation of all exported food items to meet the quality standards of international markets, including health, safety and sanitary standards.	Promote regulatory sustainability through oversight, inspection, and certification.
Environmental Protection Agency: Ghana	Enforces environmental law, formulates environmental policy, and coordinates and supervises activities of producers that can have an environmental impact.	Promote environmental sustainability.
Plant Protection and Regulatory Services Directorate (PPRSD)	Regulate, organise and implement plant protection programmes and services that support sustainable agriculture.	Promote regulatory sustainability and collaboration for sustainability through oversight, inspection, and certification.
Vegetable Producers and Exporters Associations, e.g., Federation of Association of Ghanaian Exporters (FAGE) and Vegetable Producers and Exporters Association of Ghana (VEPEAG)	Provide producers and exporters with training and export advice as well as packaging and storage support services to enhance continuous food trade.	Promote collaboration for sustainability and economic sustainability.

Food Producers, including local farmers, smallholders, outgrowers and large producers	Comply with good and sustainable agricultural practices to ensure safe and healthy vegetables are produced.	Support economic, social, regulatory, and environmental sustainability through following various sustainable agricultural practices, collaboration and other procedures set by regulatory bodies and food trade partners abroad.
Exporters	Produce and source vegetables that meet international market standards for importers or consumers overseas.	Contribute to sustainability through compliance and collaboration.
Logistical Service Providers, such as Airport Cargo Handling Companies and Freight Forwarders	Support and provide transportation, storage and distribution services for producers, ensuring flow of the food supply chain, consistent and timely supply.	Improve food supply chain sustainability through efficient and innovative logistical activities.
NGOs, e.g., Cabi, TechnoServe and GTZ Farming Systems	Provide agricultural support services, such as training, extension services, supply of farm inputs, and limited credit facilities for producers.	Promote sustainability through knowledge-sharing and provision of farm support.

Retailers, e.g., ethnic markets and convenience stores	Source and import vegetables whose safety and health standards from producers are certified to trade food in international markets.	Improve food supply chain sustainability through sourcing or importing vegetables from certified producers.
Consumers	Show vegetable-buying habits and concerns about safety and health standards.	Contribute to sustainability through making sustainable choice using health and safe standards

Sources: Adapted from Osei-Assibey (2015), Sasu (2019), and MOFA (2020).

Over and above the roles of individual FSC actors, there is a need to build capacity to unceasingly provide innovative ways of doing business, comply with international food trade regulations, and meet market standards. This would ensure a continuous internationally competitive and sustainable vegetable supply chain that supports inclusive economic development. This objective can be achieved by factoring sustainable production, distribution, and consumption of vegetables that involve collaboration and intensive research into the sustainable food supply chain. In general, Ghana's vegetable exports have a comparative advantage over other vegetable-exporting countries, such as South Africa and Kenya, due to relative transportation distance and favourable climatological conditions (Council, Rijk and Beatrixlaan, 2014; Saavedra et al., 2014). Table 2.3 provides a SWOT analysis of Ghanaian vegetable exports, detailing their strengths, weaknesses, opportunities, and threats. Ghana's vegetable supply chain to the UK offers great opportunities for growth. However, it requires innovation, collaboration, and investment to encourage cheaper farm inputs and improve export logistics services, quality inspection, and credit availability (Council, Rijk and Beatrixlaan, 2014).

Notably, there are programmes and bloc agreements that facilitate a welcoming business environment and open market for Ghana's vegetables in the EU and the rest of world. These programmes include the Economic Partnership Agreement, African Growth and Opportunity Act, and the National Export Strategy (Osei-Assibey, 2015). Also, the Government of Ghana seeks to maximise potential by production of some vegetables under the Food Crop module of the Planting for Food and Job Initiative (MOFA, 2021). In addition, key associations such as the Federation of Associations of Ghanaian Exporters (FAGE) and the Vegetable Producers and Exporters Association of Ghana (VEPEAG) are supporting vegetable suppliers to the UK with market networking, access and storage, and packaging services. This support contributes to maintaining consistent food trade with the UK all year round (VEPEAG, 2020). However, there remains a need to promote sustainability initiatives to enable Ghana vegetable suppliers to maximise potential and be able to compete with other vegetable suppliers from Asia and North America who show high, consistent compliance with international food standards and regulations (van Berkum et al., 2017). Regulatory bodies in Ghana, such as PPRSD, the Ghana Standards Authority (GSA), and the Food and Drugs Authority (FDA) are supporting food suppliers to comply with domestic and international food safety and health standards (Osei-Assibey, 2015). These include providing initiatives, protocols, monitoring, and oversight controls that help the food suppliers meet good and sustainable agricultural practices as well as phytosanitary requirements. For example, Green Label is the domestic certification provided to producers or food suppliers to encourage safe food production and sustainable agricultural practices (Ghana Green Label, 2018). Moreover, the international Global G.A.P certification is awarded to farmers and food suppliers who ensure safe and environmentally and socially responsible farming (Global G.A.P., 2021). However, PPRSD provides phytosanitary certification to enable food producers or suppliers to export overseas, ensuring that quality and safety procedures and practices are complied with in vegetable production (Saavedra et al., 2014). The vegetable producers' activities are inspected and monitored and advice is given, ensuring that all quality, health, and safety checks are properly satisfied before the phytosanitary certification is awarded.

Further, the Food and Drugs Authority (FDA) ensures regulation of exportation and importation of international traded goods, safeguarding the safety and health of consumers around the globe. The authority outlines procedures and guidelines for permits, as well as the release of vegetable consignments and their inspection. The guidelines clearly ensure that food producers or suppliers provide labels and avoid supplying non-conforming and rejected vegetables, as well as meeting the requirements for trade in international markets (Food and Drugs Authority, 2020). In addition to possessing phytosanitary certification, vegetable suppliers must ensure that their businesses are duly registered, have certified storage facilities, possess the approved electronic permit for exportation of the vegetables, and have provided export information (including Harmonised System Codes, unit of quantity, full address of the supplier, contact details of both supplier and importer and the type of permit) (ibid.). Notwithstanding these requirements, the main challenges facing vegetable producers or suppliers are limited production technologies, poor collaboration between supply chain actors, and weaknesses in sanitary and phytosanitary systems oversight (Saavedra et al., 2014; Osei-Assibey, 2015; Asselt, Masias and Kolavalli, 2018). These challenges are causing high food waste, reduced exports, and other food sustainability issues. For a revolutionised Ghana vegetable production and supply chain, vital approaches need to be directed towards examining the overall sustainability concerns regarding the vegetable supply chain.

Table 2.3 SWOT analysis for Ghana vegetable production and supply chain (Ghana vegetable export)

Strengths	Weaknesses
• Year-round and across-the-country production. • High-quality production. • Favourable climate conditions, distance to Europe and airfreight charges. • Appropriate policy initiatives and programmes by government and support agencies enhancing modern agriculture and opening market to international community. • Great potential for expansion, commercialisation and diversification, due to vast agricultural lands, huge labour size (employment ratio) involved and demand from abroad.	• Mostly characterised by traditional farming practices. • Low production compared to other SSA countries' vegetable producers, such as South Africa and Kenya. • Smart and innovative technologies not mostly employed for vegetable production and supply. • Organised market information limited and lack of farm-to-market chain information. • Food loss and waste caused by poor post-harvesting handling and packaging. • Poor collaboration: There is poor network between food supply chain actors including the farmers, transporters, traders, exporters, and regulating authorities.
Opportunities	**Threats**
• Wider markets for fresh produce in Europe and advanced countries in the rest of the world. • Micro-credit facilities, investment projects, bank credits, and loans, e.g., Agricultural Development Bank (ABD), Export Development & Investment Fund (EDIF), and provision of wider opportunities for vegetable commercialisation. • Government projects favouring collaboration in food production, supply, and consumption, e.g., Planting for Food and Jobs Projects.	• Price volatility as a result of changes in demand and supply in domestic and international markets. • Advanced and smart technologies enabling high productivity employed by global food suppliers in some regional areas and developed countries. • Unstable and competitive cargo space in airlines for vegetable exporters • Competitive threat from North Africa and Asia,

Source: Adapted from Legge et al. (2008), Council, Rijk and Beatrixlaan (2014), and Asselt, Masias and Kolavalli (2018).

2.5.3 Sustainability assessment of Ghana food supply chains

It is difficult to find any sustainability assessment of Ghana's fresh vegetable supply chain in the literature. Most extant studies on sustainability are focused on other food categories and their related impacts. In general, there are a few research works on sustainability and sustainability assessment of the Ghanaian food supply chain. For example, Dompreh, Asare and Gasparatos (2021) examine the social and environmental implications of food certification in cocoa and palm oil production; Marfo et al. (2021) utilise a regression model to assess sustainable agricultural practices (SAP) elements among maize farmers; and Raheem et al. (2021) review economic losses of cereal grains. Other notable studies include Asselt, Masias and Kolavalli (2018), Tanko, Ismaila and Sadiq, (2019), and Tsiboe, Asravor and Osei, (2019). Other authors who have investigated the food industry include Darfour and Rosentrater (2016), Nyamah et al. (2017), Affum and Wang (2019), and Kwapong et al. (2021); while Diao et al. (2014), Yeboah et al. (2014), Glover et al. (2017), and Nchanji et al. (2017) have all explored the agri-food supply chain. Nevertheless, the existing literature has failed to consider any assessment of traditional sustainability dimensions, or the sustainability impacts associated with the entire food item supply chain. Extant studies focus either on estimations of the sustainability aspect of the food item; assessing one sustainability dimension; or tackling certain sustainability aspects of the food supply chain.

Interestingly, there are a handful of studies that examine certain sustainability aspects of fresh produce and supply to the UK. Work by Garside, McGregor and Vorley (2008), Hoffmann and Vossenaar (2008), Legge et al. (2008), Ababio, Adi and Commey (2013), Rutten and Verma (2014), and Asselt, Masias and Kolavalli (2018) has made necessary assessments of fresh produce and supply (vegetables included) to the UK or Europe but not addressed sustainability assessment in a broader context. Their studies consider few sustainability aspects or elements and only one sustainability dimension; for example, they might examine economic benefits, food waste, food loss, or environmental impact (CO_2 emissions from airfreight transportation). For instance, Ababio, Adi and Commey (2013) investigate the availability and efficiency of the food traceability approach (social sustainability). The study administered questionnaires to workers in key food supply chain businesses to analyse the documentation and effectiveness of traceability systems. Having utilised SPSS to find the correlates between the variables, the study found that there is awareness of traceability systems among food supply chain businesses; however, its documentation and effectiveness were found to be weak because a significant number of participants had limited knowledge of technology and its application, or did not return the questionnaires. Rutten and Verma (2014) focused on the economic impacts of food losses by using the MAGNET (Modular Applied GeNeral Equilibrium Tool) model. However, their work lacks robustness and offered no understanding of the capture of sustainability impacts, i.e., food waste. Their data and estimation of possible food waste reductions are biased; they did not provide appropriate justification for the method, sampling, and data and certain indicators selected for food waste elements were based on assumptions without appropriate justification. Asselt, Masias and Kolavalli (2018) discuss the competitiveness of vegetable supplies to the UK and rest of Europe. Using survey data from vegetable producers and multiple secondary sources, e.g., FAOSTAT and Ghana's Ministry of Trade and Industry (MOTI), the study estimates the economic benefits of vegetable supply. However, the true assessment of economic sustainability is weak since the study only considered profits while ignoring costs, food waste, branding, and competition which are considered as economic sustainability elements (Stamford and Azapagic, 2019). Furthermore, their study did not adopt a robust approach in estimating the economic relevance of the vegetable supply.

Moreover, Affum and Wang (2019) bemoan the difficulty in measuring Ghana's food supply chains due to heterogeneity and intangibility. Nevertheless, some existing studies have utilised research approaches to assess the relevant sustainability aspects of Ghanaian food supply chains that are considered important and adoptable. Nyamah et al. (2017), for instance, employ the ordinary-least square regression model to investigate the risk components of food supply chains in Ghana. Their study collected survey data and, while their results reveal that regulation or policy can affect food supply chain performance insignificantly, the study sample (area) selection is biased focusing on the northern part of Ghana while a significant number of potential participants and industry players are located in southern Ghana. Siaw et al. (2018) employ an autoregressive distributed lag (ARDL) model to assess the impacts of agricultural exports, such as cocoa, banana and pineapple, on the economic growth of Ghana. Tanko, Ismaila and Sadiq (2019) use inverse propensity score-weighting techniques to assess the effect of planting for food and jobs (PFJ) on rice farmers' productivity. While some studies in the food sector used surveys (Diao et al., 2014), interviews (Kwapong et al., 2021), and the case study method (Yeboah et al., 2014), recent research work by Affum and Wang (2019) developed sustainability innovation and dynamic quality models using a review and analysis of literature as an analytical and measures framework for innovation and quality of the food industry. Still, to the best of the researcher's knowledge, there is no existing study that considers Ghana's food supply chains or vegetable production and supply that utilises an overarching sustainability assessment and takes into account the traditional sustainability dimensions and the capture of sufficient impacts associated with them. This study seeks not only to provide a new methodological approach to developing such a model (SIA model) for sustainability dimensions from literature and current data but also to derive a robust assessment of sustainability dimensions and associated impacts of Ghana's food supply chains.

2.6 Conceptual Framework of the Study: Rationalisation and Development

The conceptual framework of the study is basically designed following the recommendation and emphasis of Ehrenfeld and Hoffman (2013), Elkington (2013), and Montabon, Pagell and Wu (2016) on sustainability and sustainability dimensions; Garnett (2013) and Anderson (2019) on food sustainability; Govindan et al. (2018) on sustainable production and consumption; Schader et al. (2014) on sustainability assessment approaches; and DEFRA (2002), OECD (2010), and Gibson (2013) on sustainability impact assessment (SIA). This conceptual framework shows the capture of sustainability impacts associated with the entire Ghanaian fresh vegetable supply to the UK, clearly highlighting all the different sustainability dimensions, and their related impacts possibly generated by vegetable supply chain actors. Figure 2.5 presents a diagrammatic conceptual framework of the study.

First, the framework throws light on Ghana's vegetable supply chain actors and activities by utilising the work of Nyamah et al. (2017) highlighting the actors in Ghana's food supply chains; Saavedra et al (2014), Council, Rijk and Beatrixlaan (2014), and Chapoto et al (2018) on activities and actors of vegetable supply to the UK; and Asselt, Masias and Kolavalli (2018) on vegetable sector competitiveness and supply chain to the UK. These research works show that vegetable production is mostly carried out by smallholders, co-operatives, small and large farmers, or exporters. Studies like those of Rohila et al. (2017), Asselt, Masias and Kolavalli (2018), Chapoto et al. (2018), and Wu and Huang (2018) are able to explain that land use, biodiversity, organic farming, energy use, vehicle transport, packaging, and storage are usually associated with vegetable farming and the activities of smallholders, co-operatives, plus other small and large producers. This can be referred to as "environmental sustainability implications associated with farming practices". Also, Wangler (2006), Yakovleva (2007), Legge et al. (2008), McCarthy, Matopoulos and Davies (2015), and Wu and Huang (2018) indicate that vehicle transport, storage, packaging, and airfreight transportation are the likely sustainability impacts associated with exporters. This is referred to as “environmental sustainability implications associated with exporters” (thus, “local exporters’ sustainability implications”). As emphasised by Marriott (2005), Wangler (2006), Yakovleva (2007), de Ruiter et al. (2016), and Frankowska, Jeswani and Azapagic (2019), the framework captures other sets of sustainability impacts, such as storage, packaging, energy use, vehicle transportation, and waste, which are closely associated with the UK food distributors, who are mainly wholesalers, food service providers, and ethnic retailers. This can be referred to as “UK food distributors’ environmental sustainability implications”.

Away from the environmental dimension, the framework captures FairTrade and efficiency concerns, such as food waste and transport costs, as suggested by Yakovleva (2007), Govindan (2018), and Zhu et al. (2018), as the economic sustainability impacts that are generated at each of the three categorised stages. Hence, economic sustainability implications associated with farming practices, economic sustainability implications associated with local exporters (local exporters’ sustainability implications), and economic sustainability impacts associated with UK food distributors reflect as FairTrade, food waste, and transport costs through the economic dimension of sustainability of the framework. Similarly, Akkerman, Farahani and Grunow (2010), Vesna, Predrag and Milivoje (2017), Schmutz et al. (2018), and Affum and Wang (2019) suggest transparency and traceability, Global G.A.P., and ISO 22000 as the sustainability impacts of international recognition that embody the social dimension of sustainability. Global G.A.P. is an international standard and certification for good sustainable agricultural practices for farm production. The certification ensures that producers’ food is safe, traceable, environmentally friendly, and healthy (Vesna, Predrag and Milivoje, 2017). These are possible social sustainability impacts that can be generated along Ghana’s fresh vegetable supply chain to the UK. The framework captures the sustainability implications (sustainability dimensions and their associated impacts) for each categorised stage: namely, social sustainability implications associated with farming practices; social sustainability implications associated with local exporters; and social sustainability implications associated with UK food distributors.

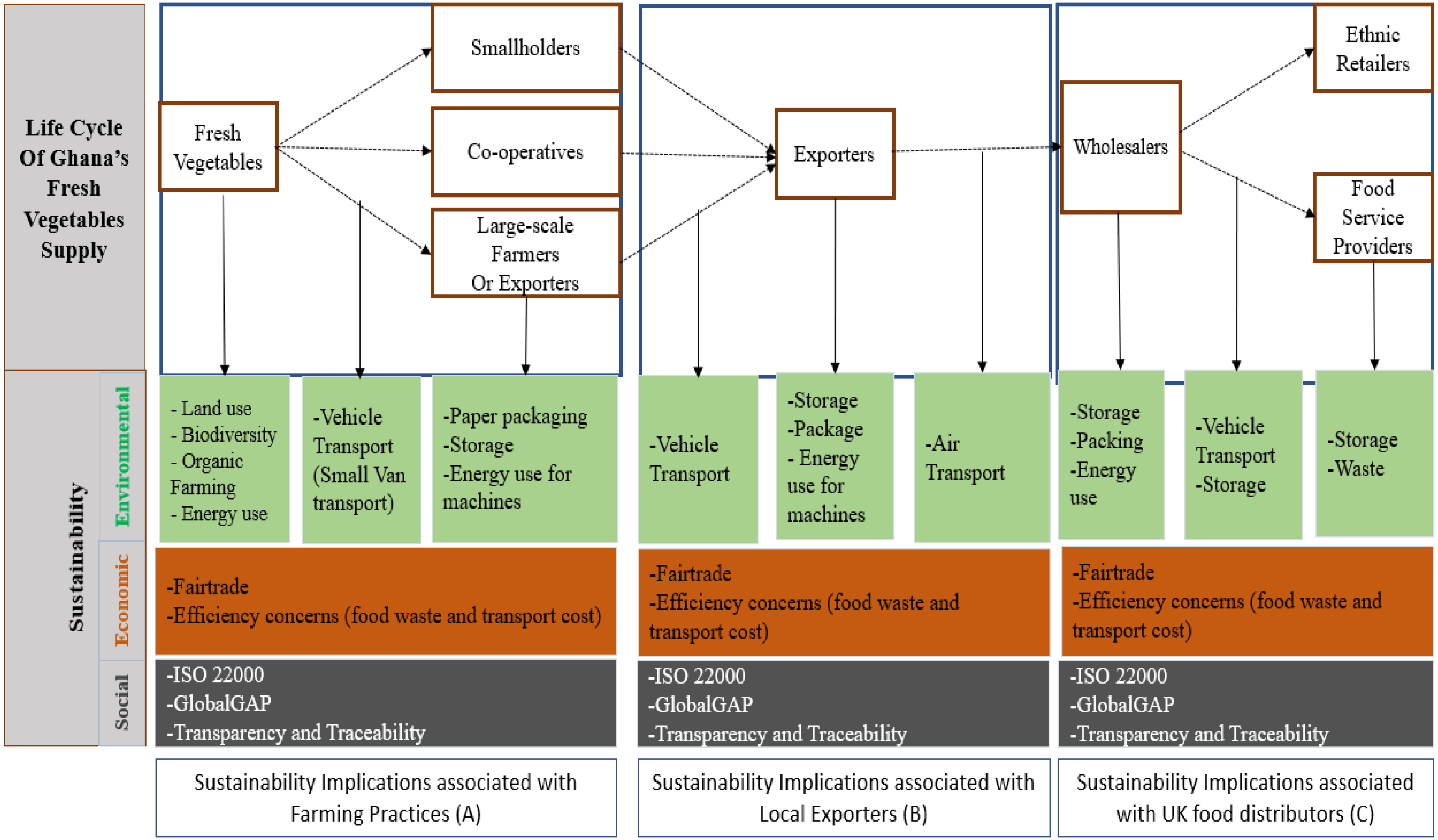


Figure 2.5 Conceptual Framework of the study (Sustainability Impact Assessment – SIA model) adapted from DEFRA (2002), Yakovleva (2007), Gibson (2013), Schader et al. (2014), Govindan (2018), Schmutz et al. (2018), and Affum and Wang (2019).

The development of this conceptual framework of the study (SIA model) answers the calls from much of the literature, e.g., Fredriksson and Liljestrand (2015), for more realistic research on proactive models that assess sustainability concerns affecting food supply chains. A previous study by Srivastava (2007) developed a sustainability framework to support strategic operational areas, but the framework does not cover the social dimension. Likewise, Manzini and Accorsi (2013) designed a framework for sustainability of food supply chains, but theirs fails to capture the social aspects of sustainability. In addition, several scholarly research works—e.g., Sgarbossa and Russo (2017), Gunarathne et al. (2018), Govindan (2018), and Kumar, Mangla and Kumar (2022)—suggest frameworks and ideas for evaluating sustainability and sustainable food supply chains; nevertheless their frameworks fail to highlight sufficient impacts associated with sustainability dimensions and/or do not consider assessment of the sustainability dimension from overseas sources. The conceptual framework in the present study considers all three sustainability dimensions and assessment of sustainability impacts starting from overseas. The relevance of models or frameworks in enhancing sustainability is clear in the extant literature. For example, Akhtar et al. (2016) introduce a model that supports actors in the global food supply chain in encouraging non-financial and financial sustainability. Also, Manning and Soon (2016) promote sustainability improvements in the food supply chains; whereas the framework by Azadnia, Saman and Wong (2015) suggests maximising overall environmental, social, and economic benefits. Recently, Mangla et al. (2018) have presented a framework that enables the applicability of sustainability initiatives in fresh produce supply chains. More progressively than the existing literature, the conceptual framework of this current study seeks to enhance sustainable food supply chains for all stakeholders by identifying relevant sustainability dimensions and their associated impacts, thus triggering opportunities and measures for holistic sustainable development within food supply chains.

Before further development and testing of the conceptual framework with data, the study makes a novel modification to the conceptual framework by including the regulatory dimension. This inclusion serves as a key ingredient of the conceptual framework, emphasising that the sustainability of food supply chains is duly monitored, coordinated, and regulated by authorising bodies in the global market context. The inclusion of the regulatory dimension in the conceptual framework is prompted by reading HM Government

(2010), Stevens (2019), and the European Commission (2019), which reveal the relevance of regulatory frameworks and mechanisms such as hazard analysis and critical control point (HACCP) and phytosanitary certification to food supply chains. Hence, the under-developed conceptual framework is modified, and Figure 2.6 is the output (modified conceptual framework) before further developing and testing with data. The study collects data from various sources, including case study data from large and small producers and survey data from producers such as smallholders, local farmers, outgrowers, large producers, and exporters. The data are analysed and utilised to further develop, test, and validate the conceptual framework as a sustainability impact assessment (SIA) model meaningful for the capture and assessment of sustainability data. In a further quest, this study attempts to address the research questions of the study.

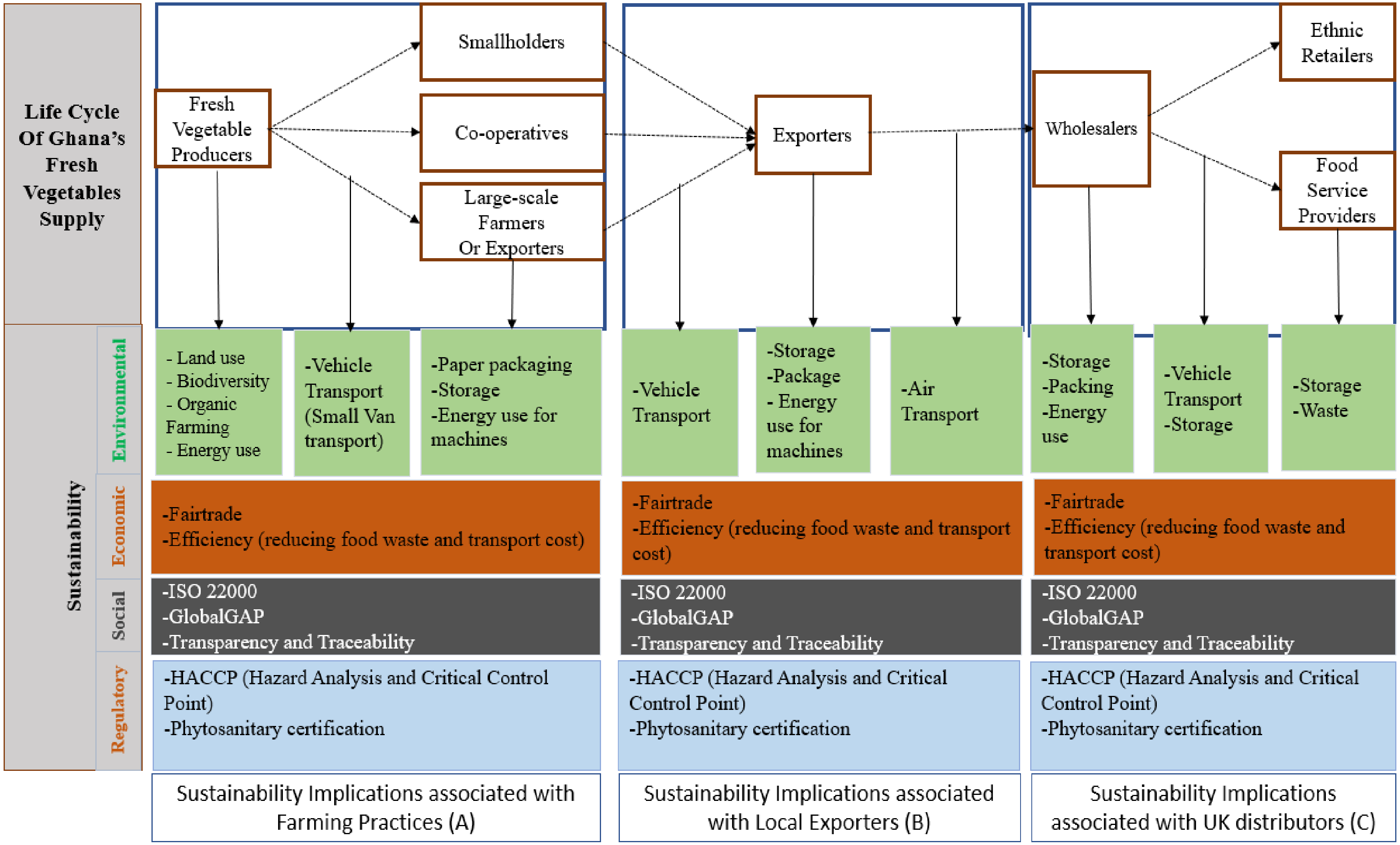


Figure 2.6 Modified conceptual framework

2.7 Theoretical Contextualisation of the Framework

The review of the literature led to the capture of four sustainability dimensions and their associated impacts, justifying that environmental sustainability, economic sustainability, social sustainability, and regulatory frameworks can be included in a single sustainability model. Hence, the development of the conceptual framework of the study is strengthened.

However, the development of the conceptual frameworks (Figures 2.5 and 2.6) is grounded in stakeholder theory (Freeman 1984). Stakeholder theory suggests that businesses generate externalities that affect several individuals or parties, both external and internal to the businesses (de Camargo Fiorini et al., 2018). Freeman's (1984) definition of a stakeholder is any individual or group who is affected by or can be affected by the achievement of an organisation's purpose. Stakeholder theory has been applied by different authors to explore multiple stakeholders' interest in sustainability management (Hörisch et al., 2014; Dameri and Ferrando, 2022) and food supply chains (Chkanikova and Mont, 2015; León Bravo et al., 2021). Further, the work of Hörisch et al. (2014) on sustainability and stakeholder theory clarifies that "what belong together, grow together", explaining the fit between stakeholder theory and sustainability management. To add to that, the concept of sustainability requires actors, parties, or businesses to make vital contributions towards the economy, society, and the environment (Schaltegger and Burritt, 2005, p.195). Hence, both sustainability and stakeholder theories refute the notion of 'ethical' 'sustainable' concerns separated from the business operations. Rather, they promote real value created for stakeholders thereby contributing to sustainable development, mainly connecting environmental and social concerns to the core activities and operations of the business (Freeman et al., 2010). In other words, to achieve a sustainable food supply chain, a proactive and careful consideration of activities and operations of all key stakeholders' interests towards sustainability can enhance sustainability development agendas and sustainability improvement.

Starting with Figure 2.5, the life cycle of Ghana's fresh vegetable supply chain to the UK reveals the FSC actors (stakeholders): from fresh vegetable producers such as outgrowers, local farmers, and large-scale farmers, to exporters and then to wholesalers who are linked with ethnic retailers and food service providers. The framework shows the capture of sustainability impacts under environmental, economic, and social sustainability dimension, generated by the FSC actors—outgrowers, local farmers, and large-scale farmers. The arrows show the interconnectedness of the sustainability impacts among the FSC actors (stakeholders). Also, other sustainability impacts generated by other FSC actors such as exporters, wholesalers, ethnic retailers, and food service providers are carefully captured in the framework. The development of the conceptual framework demonstrates the stakeholder perspective, thus offering an alternate way of understanding how businesses (food supply chains) and people (actors) create value and trade (sustainability impacts) with each other (Freeman, Harrison and Zyglidopoulos, 2018). Due to the interconnectedness within the supply chain, some FSC actors (stakeholders)—for example, ethnic retailers and wholesalers—are sharing some sustainability impacts such as vehicle transport and storage. Value creation by interdependent stakeholders fundamentally considers the form solving collective action concerns and challenges (Bridoux and Stoelhorst, 2016). To enhance sustainable food supply chains, sustainability impacts generated by interdependent stakeholders must be considered and captured in the framework. The stakeholder approach is widely argued to be associated with business ethics and the environmental and social impacts of business firms (Wicks and Harrison, 2017). This framework extends the stakeholder's theory approach, arguing that business ethics should cover broader perspectives and should capture the environmental, social, and economic impacts of business firms. This shaped the development of the conceptual framework (Figure 2.5) and the modified conceptual framework (Figure 2.6).

Figure 2.6 provides the modified conceptual framework capturing an additional sustainability dimension (the regulatory framework) and their associated impacts for the FSC actors (stakeholders) extending the work of Wicks and Harrison (2017) on the stakeholder perspective. Therefore, the environmental, economic, social, and regulatory sustainability impacts associated with each FSC actor (stakeholder) within the fresh vegetable supply chain life cycle are identified and captured in the framework. This aligns with stakeholder theory which conceptualises the sustainability dimensions and their associated impacts associated with each stakeholder as aggregate sustainability impacts generated within Ghana's fresh vegetable supply chain. Hence, the development of the conceptual framework aligns with the logic of stakeholder theory, thereby justifying that stakeholders' (FSC actors') contributions can reduce negative sustainability impacts and increase positive sustainability impacts (Sarkis et al., 2011; Freeman et al., 2017). This starts by capturing all key stakeholders and their associated sustainability impacts in a single conceptual framework to facilitate the evaluation and improvement of sustainability. The modified conceptual framework (Figure 2.6) is to ensure that all stakeholders benefit from sustainable food supply chains by enhancing sustainable practices within the chain. It is built on the logic that FSC actors or businesses can improve on their sustainability development agenda by considering all sustainability impacts regarding environmental sustainability, economic sustainability, social sustainability, and regulatory mechanisms in a single framework or model connecting stakeholders. They can then consider options for sustainability improvement. The study seeks to validate the modified conceptual framework using case studies and survey data collected from the key stakeholders.

2.8 Research Questions (RQ)

This study endeavours to fill the literature gap identified above and contribute to the literature on food sustainability and sustainability of food supply chains by answering the following research questions:

i. What are the sustainability implications associated with Ghana’s fresh vegetables supply chain to the UK?

ii. How can the sustainability implications associated with Ghana’s fresh vegetables supply chain to the UK be estimated using available methods?

iii. What are the managerial and policy implications for both Ghana and the UK?

2.9 Summary

This chapter provided fundamental discussion and review of key topics of the study. It started with the global food supply chains, sustainability impact assessment (SIA), and UK food supply chains through to Ghana’s food supply chain—vegetables. To support the sustainability impact assessment (SIA), the chapter reviewed the literature on the environmental sustainability dimension; the economic sustainability dimension; the social sustainability dimension; the regulatory dimension; sustainable food supply chain collaboration; and the complexities of food supply chains. From this, a modified conceptual framework of the study is developed, based on prior knowledge derived from the literature.

CHAPTER THREE (3)
3.0 METHODOLOGY

3.1 Introduction

This chapter discusses and reviews the research methods, data, and models employed for the study. It discusses the research paradigms (research philosophy), approach, and different phases of the research design utilised to achieve the research aim and objectives. Further, it presents the justification (rationale) for the philosophical underpinning of the study and research strategy chosen. This is with the aim of exploring the opportunities to reduce the sustainability implications of the UK’s global food supply chain by analysing Ghana’s fresh vegetable export.

To achieve the aim of the study, the choice of appropriate research methodology was important. The study follows the recommendations of Saunders, Lewis and Thornhill (2009) which stress that the choice of research strategy should be driven by the research questions, research objectives, amount of existing literature, timeframe, resources, and the philosophical underpinnings of the study. This serves as good practice for choosing the appropriate research approaches (Opoku, Ahmed and Akotia, 2016). Therefore, this informs the researcher on the choice of research methods most appropriate for the study. Thus, case research and a survey have been adopted to achieve the research aim and objectives.

The chapter is divided into the following sections: Section 3.2 focuses on research paradigms, explaining the philosophical underpinning of the study. Section 3.3 discusses qualitative, quantitative, and mixed methods research to draw on the relevance of choosing a mixed methods approach. Meanwhile, the justification for selection of the research philosophy and research methods is provided in Section 3.4. Further, the chapter presents research design in section 3.5, discussing the appropriateness of the chosen methods and the phases (tasks) of the study. Section 3.6 explains the research strategy that focuses on case studies (interviews and focus group) and survey. Section 3.7 discusses data collection and instruments, while section 3.8 presents justification for the research strategy, and good practice of choosing research methods. Section 3.9 presents the data analysis, outlining the tools and approaches adopted. Section 3.10 explains the models used in the study; and the concluding section (3.11) covers ethical considerations.

3.2 Research Paradigms

Philosophical underpinning in research is necessary to lead the investigation to a specific paradigm governing the subject. Every subject of study encompasses a prevalent paradigm in which the research is carried out. While Blaikie (2009) refers to it as the "research paradigm", Saunders et al. (2009) explain it as the "research philosophy" and others, e.g., Creswell (2014) describes it as the "worldview". Therefore, choosing a specific research philosophy or paradigm provides the baseline for the motivation, expectations, and purpose of the research (Mackenzie and Knipe, 2006; Rao, 2019). Rao (2019) stresses that it is necessary to appreciate how our perspectives on nature or the world can affect the design and the explanations (interpretation) of research. In other words, research is a social practice conducted by research communities. What constitutes "truth", "knowledge", "correct approach", and "objectivity" is, however, explained by the research community and through the research paradigms or philosophies which modify its work (Scott and Usher, 1996 p.17). The research paradigm is a fundamental set of techniques, values, and beliefs shared by members of a specified society that guides research investigations or actions (Guba and Lincoln, 1994). Although many are suggested by researchers, there are four common research paradigms—constructivism, positivism, critical theory, and pragmatism. Each paradigm in turn comprises of four components—ontology, epistemology, methodology, and axiology. In other words, a paradigm explains the ontological, epistemological, and methodological narratives and questions related to a specific problem. The common features of how a piece of scientific research is structured, approached, and explicitly interpreted is referred to as a "paradigm" (Kuhn, 1996; Jones, 2000; Rao, 2019). Further, in choosing an appropriate research method for a paradigm, Johnson and Onwuegbuzie (2004) emphasise that certain research methods are most useful under a specific paradigm. This does not imply, however, that there is a constant relationship between the research methods and paradigms, as certain research methods or approaches can fall under both qualitative and quantitative paradigms.

3.2.1 Positivism paradigm

The positivism paradigm assumes that experiment can be utilised to discover an objective "reality". This paradigm attempts to establish a valid contribution to the body of knowledge via evidence, rather than discourse or judgement. Positivism stresses the use of statistical methods to analyse finite observations (Saunders et al., 2009). Remenyi et al. (1998, p.33) emphasise that "there are independent causes that lead to the observed effects, but evidence is critical, that parsimony is important and that it should be possible to generalise or to model, especially in the mathematical sense, the observed phenomena". Moreover, positivist philosophy encourages replication through the adoption of highly structured methodologies (Johnson and Gill, 2010). Nevertheless, opponents of positivism argue that the conduct of value-free and fully objective study is a myth; nonetheless, the governing principle of objectivity can be a useful one (Johnson and Onwuegbuzie, 2004). Other critics argue that the positivist approach is too complex to be merely explained with laws in the natural sciences (Saunders and Lewis, 2016). Be that as it may, "the strength of positivism lies in the fact that it works with observable realities and the end product of such research can be law-like generalisation" (Remenyi et al., 1998; p. 32).

3.2.2 Pragmatism paradigm

Pragmatists seek to establish the practical meaning of knowledge within a particular context (Saunders et al., 2009). They attempt to completely ignore the qualitative–quantitative debate, based on the belief that methodology is an independent epistemological stance (Hall, 2013). However, proponents argue that there is more than one way of discovering a reality and, depending on one worldview, to completely explain observed reality; and their associated complexities should be re-visited (Feilzer, 2010). In that case, the central point of pragmatism is to instigate critical reasoning and purposeful inquiry (Simpson, 2017). Interestingly, most pragmatic researchers stress that a step-by-step process-based technique should be utilised to investigate a reality instead of looking at it from a metaphysical perspective. Therefore, an inquiry that aims to explain the process and interpretation of reality should involve the emotional, social, and contextual components (Morgan, 2014). Hence, a pragmatist begins with the conceptualisation of the problem and then aims to find practical answers for the furtherance of future practices, meaning that, in order to provide practical solutions for problems, pragmatic researchers utilise a wide range of methods, techniques, or approaches (Saunders et al., 2009; Feilzer, 2010; Saunders and Lewis, 2016). Pragmatists using both qualitative and quantitative research approaches provide in-depth insights of how a reality or phenomenon can be understood (Mitchell, 2018). In addition, Maarouf (2019) argues that the reality cycle embraces a practical pragmatic perspective, believing that reality is stable most times and changes from time to time. In this instance, the reality cycle evolves from reality, perceptions, behaviours, and context. For pragmatists, regarding the reality cycle position that acknowledges the existence of one reality and the relevance of social contributors' perceptions of this reality sometimes enhances the purpose of explaining reality in like-law generalisations for pragmatic benefits; and at other times probes social contributors' perceptions for in-depth and true understanding of the reality. The holistic ideal of pragmatism is conceptualised in a manner that considers both qualitative and quantitative research approaches as an integrated philosophy (Saunders, Lewis and Thornhill, 2016; Maarouf, 2019).

3.2.3 Interpretivism paradigm

This paradigm aims to explain reality based on subjectivity and human consciousness. The researcher provides an individual perspective of knowledge rather than considering herself as a detached researcher/observer. This paradigm is concerned about the idealism viewpoint and signifies different viewpoints; these are hermeneutics, phenomenology, and social constructivism. It further clarifies that, due to the complexities of reality, there is a need to understand what complexities influence the human being's position in the environment. In other words, interpretivists acknowledge the peculiarities in conducting studies with humans as opposed to extinct objects (Bryman, 2011; Graue, 2015). The ontological stand of interpretivists argues that reality is socially constructed, and the reality constantly changes (Sale, Lofeld and Brazil, 2002). This paradigm does not assume that the world has an objective reality, but rather argues for reality with a subjective consciousness. From an epistemological perspective, there is a clear relation between the observed reality and the researcher (Bryman, 2011). Interpretivists' viewpoints are not distinguished from the observed reality and consider the complexities of a world view with an acceptable and in-depth understanding that actors and the observed reality within it significantly contribute to its meaningfulness. Critics of interpretivism stress that findings from interpretivist studies can be generalised due to possible non-existence of realty in the near future (Remenyi et al., 1998), meaning that reality may discontinue existence over a period and can vary between different researchers, with each researcher's life experiences and judgement influencing the perceived findings. Nonetheless, the interpretivism argument claims that the world is complex; hence, adopting scientific approach in research is likely to result in narrow-mindedness, reducing the world's complexities and loss to possible law-like generalisations (Saunders et al., 2011).

3.2.4. Critical theory

Critical theory confronts the status quo and endeavours to achieve a democratic and balanced society, unlike the traditional paradigms, which confirm and explore the status quo. This paradigm is concerned with power interactions within society and the relations of gender, religion, race, economy, class, and education to make a meaningful contribution to a societal system (Asghar, 2013). Some clarification provided by some scholars, e.g., Tyson (2014), suggests that critical theory must be explanatory about the challenges of the current social reality; it must specify the initiatives required to cause change and must provide clear means for transformation and criticism. Critical theorists explore the problem, and find means, alternatives, and strategies to ensure a successful impact on society. Critical theorists accept empirical methods (Cohen, Manion and Morrison, 2017), but are more open to constructive possibilities (Richards, 2003). This does not imply that critical theory and the other philosophical approaches or paradigms are in total agreement. Arguments for the critical paradigm, on the other hand, do not imply that other perspectives are obsolete. It is only to underline that the critical paradigm is more philosophical in nature and, thus, more accommodating than other paradigms that are more methodological and less involved with the independent nature of reality or truth of life. Proponents of critical theory contribute to a social set-up based on equality for all parties. Interestingly, critical theory has accrued different explanations and interpretation from different researchers, creating room for non-specificity and disagreement. Critical theorists are flexible on methodological approaches in their quest to contribute to advancement in the unequal social system. It is argued that critical researchers may adopt quantitative, qualitative, or mixed methods. Nevertheless, Hussain, Elyas and Nasseef (2013) emphasise that critical researchers sway more to qualitative research approaches. The main difference between interpretivist and critical research is the natural reformative drives in the latter (Asghar, 2013; Cohen, Manion and Morrison, 2017).

Basically, ontology is the study of the nature of our beliefs about reality. Ontology further clarifies what exists and what is the nature of the world, providing an idea of what is the subject matter that needs to be examined (Tombs and Pugsley, 2020). Epistemology, on the other hand, explains the study of the nature of knowledge and how the knowledge is acquired and justified. Looking at the epistemological perspective, this philosophical concept reveals where knowledge originates from and whether it is capable of "discover", leading to what kind of ideas the researcher is attempting to establish, which could further lead to providing meaningful interpretation of how social life is endorsed or established and/or universal laws. Methodology is the research design, approaches, and techniques used to investigate the research and attempts to address how the researcher wishes to discover and validate what she or he thinks exists, provoking the approaches and methods ideal for the collection of data. Meanwhile, axiology refers to the ethical considerations to be made when planning to undertake research (O'Gorman and MacIntosh, 2015; Tombs and Pugsley, 2020). Table 3.1 below explains the different paradigms or philosophical underpinnings and their ontological, epistemological, and methodological interpretations.

Table 3.1 Different paradigms or philosophical underpinnings and their ontological, epistemological, and methodological interpretations

Positivism	Interpretivism	Pragmatism	Critical Theory
Ontological Assumptions The reality is ordered, objective, and governed by natural laws that can be achieved, realised or understood through experience.	**Ontological Assumptions** The reality is socially interaction and internally experienced and interpretative and is usually based on the explanation people give to it.	**Ontological Assumptions** Reality is understood in objective and subjective form at the same time, believing both the existence of one reality and that others have multiple explanations of the reality.	**Ontological Assumptions** The reality is socially interactive, and differences can be made regarding class, gender and race.
Epistemological Assumptions Knowledge exists in the form of natural laws. It can be found and explained, and it is likely to control events and forecast their occurrence.	**Epistemological Assumptions** Knowledge is understood in the subjective form and explanation people give to social and physical objects and the actions they take in response to them in a public or social context.	**Epistemological Assumptions** Knowledge can be understood in an objective and subjective form using suitable research methods to meet research objectives.	**Epistemological Assumptions** Knowledge is understood in the subjective form, allocating the researcher and respondent cocreate understanding.
Methodologies Fixed Choice Questions Experiments Structured Interview Randomised Control Trials Surveys	**Methodologies** Action Research Unstructured interview Observation Ethnography Case studies Focus Groups	**Methodologies** Quantitative and/or qualitative methods may be utilised. The methods are mostly matched to the particular research questions and the purpose of the study.	**Methodologies** Mixed methodology. The methods are mostly qualitative.

Sources: Adapted from Asghar (2013), Maarouf (2019), and Tombs and Pugsley (2020).

3.3 Quantitative, Qualitative, and Mixed Methods Research

Whether a researcher wants to adopt qualitative or quantitative methods, the choice for studying phenomena is part of a long-lasting debate. Proponents of each method claim that their approach is superior to the other, while Maarouf (2019) emphasises that some researchers have purist notions to the concept that both methodological approaches can be combined. Meanwhile, a group of researchers emerged in the 1990s that proposed a mixed methods approach, combining qualitative and quantitative research methods (Johnson and Onwuegbuzie, 2004; Glogowska, 2015). The qualitative research method entails the collection, assessment, analysis, and interpretation of data that cannot be easily converted or reduced to numbers. It is mostly associated with the social world: the concepts and people's behaviour within it (Anderson, 2010; Eriksson and Kovalainen, 2015). Qualitative data comprise recordings and transcripts of semi-structured interviews, audio, open-ended structured interviews, videos, field observation notes, case study notes, documents, observations notes, press, photographs, images, and diaries. Qualitative researchers usually focus on using interviews, focus groups, case studies, observations, conversational analysis, document analysis, and ethnography (Gummesson, 2000; Pope, Ziebland and Mays, 2000; Eriksson and Kovalainen, 2015), but are criticised for over-utilising focus groups and interviews at the cost of other approaches (Anderson, 2010).

Even so, the qualitative research method is used to investigate a limited number of cases in depth. It is also very useful in tackling complex phenomena, as it has capacity to provide rich and valuable details. However, the results from qualitative research cannot be generalised in other contexts. In addition, it is time consuming in collection of data and in analysis (Johnson and Onwuegbuzie, 2004; Maarouf, 2019). It also has some shortcomings: first, qualitative methods can only handle a small amount of data; and second, qualitative research has no notable agreed model, allowing researchers unnecessary flexibility and liberty, which could be disadvantageous to inexperienced researchers (Robson, 2002; Silverman, 2013). Nevertheless, Richards (2003) iterates that neither qualitative nor quantitative research is always the most appropriate method for understanding a phenomenon; rather, it solely depends on the research problems which determine the most appropriate method to adopt for exploration or discovery of the truth or knowledge. Essentially, the quantitative method is concerned with measuring of amount or quantity, while the qualitative method focuses on quality, uses words, applies reasoning, and is descriptive and non-numerical. The qualitative method seeks meaning or feeling and describes the situation. Another way of looking at it would be that, if an individual seeks to examine why some data are random, then it is a qualitative approach. On the other hand, if the purpose is to learn how random the data are, and what their distribution, means and variance are, then it is quantitative research (Creswell, 2009; McCusker and Gunaydin, 2015; Strijker, Bosworth and Bouter, 2020). Thus, quantitative research methods dwell on mathematical, statistical, or numerical analysis of data collected via questionnaires, polls, and surveys. In addition, it considers manipulating secondary (or pre-existing) statistical data, often using computerised techniques and programs for analysis.

Quantitative research methods handle objective stances, logic, and numbers. Studies related to quantitative approaches focus on unchanging data, convergent reasoning, and numerical data instead of divergent reasoning (i.e., dealing with a variety of ideas regarding a research problem in free-flow, spontaneous manner) (Gregar, 1994; Creswell, 2009). It also considers gathering numerical data and generalising it across groups of people to provide an understanding of a particular phenomenon. Final reports from quantitative research are usually structured as: Introduction; Literature and theoretical background; Methods; Findings; and Discussion (Creswell, 2014; Morgan, 2017). The quantitative method collects and analyses quantitative data (Johnson and Christensen, 2012). It is a deductive or confirmatory method, as its main objective is to test hypotheses and theories by investigating the relationship among variables (Creswell, 2014), while the qualitative method follows an inductive or exploratory approach that attempts to grasp and explore the meanings that groups or individuals confer to a social phenomenon (Gregar, 1994; Johnson and Christensen, 2012; Creswell, 2014). Be that as it may, many researchers argue that both quantitative and qualitative methods can be combined to assist the course of social inquiry, mainly for two reasons: first, the decision between qualitative and quantitative methods is based on the relationship of the conducted research to the theory, meaning that a quantitative method motivates a deductive approach to testing a theory; whereas, second, a qualitative method dwells on an inductive approach to develop the theory (Saunders et al., 2009). One difference between qualitative approaches (such as semi-structured interviews and unstructured interviews, which have the capacity of identifying and dealing with unobservable mental variables) and quantitative approaches is that quantitative research methodologists use quantitative tools in the capture of data which restrains the participant or human responses that can support addressing the research problem (Ma, 2012; Maarouf, 2019). Quantitative researchers only acknowledge and accept observable measurable knowledge, even though the variables that the researchers measure are not observable by nature and the measuring process in the social sciences does not benefit from the same degree of reliability and validity.

Interestingly, it is argued that the mixed methods approach is embraced by a new generation of academics and researchers who choose not to recognise the philosophical differences between a multiple paradigm approach and a paradigmatic position. Rather, the researchers acknowledge the practical distinctions and approach a problem with the notion that qualitative and quantitative techniques are mere tools that can be utilised and incorporated in answering research questions (Sale, Lohfeld and Brazil, 2002). Further, adoption of the mixed methods approach is increasing rapidly. Maarouf (2019) stresses that about 1800 mixed methods published articles were available in 2013, showing a big jump compared to nearly 20 mixed methods articles per year in leading journals in the 1990s. Since then, the mixed methods research has been spreading in different disciplines, including sociology, psychology and business research, international relations, health services, education research, and library and information sciences (Sale, Lohfeld and Brazil, 2002; Molina-Azorin, 2016; Pratt, 2016; Johnson and Christensen, 2019). Nonetheless, it is argued that, even now, the mixed methods are insufficiently utilised and represented in the social sciences, considering the invaluable and rich insights that it delivers (Barnes, 2019). Some authors suggest different research philosophies to justify the mixed methods (Barnes, 2019; Ghiara, 2020). However, between all the existing research philosophies, pragmatism is considered by many scholars to be the most popular philosophical justification (Hall, 2013; Biddle and Schafft, 2015).

Over the last three decades, the mixed methods research is increasingly recognised as the third research methodological approach and a mixed methods researcher utilises a mix of qualitative and quantitative methods in one research work or a combination of related research (Ma, 2012; Hall, 2013; Biddle and Schafft, 2015; Maarouf, 2019). This can be performed either simultaneously, when adopting both methods at the same instant, or chronologically, when adopting one method first and the other method later. The main rationale for adopting the mixed methods is that combining qualitative and quantitative methods offers an absolute understanding of and insights into a research problem, as opposed to adopting one research method (Molina-Azorin, 2016). The work of Mitchell (2018), which conducted two case studies involving mixed methods, shows that using both quantitative and qualitative approaches provide the best explanation of data and great insights into the phenomena researched therein. However, Hall (2013) and Blumberg, Cooper and Schindler (2014) argue that mixed methods research should not be confused with a multiple-method approach, because the latter focuses on collecting of data using the method that belongs to the same research method type, whether that is qualitative or quantitative. Sale, Lohfeld and Brazil (2002) clearly outline the two main advantages of mixed methods. First, the mixed methods research has complementary strengths, implying that one research approach has the strength to support and enhance the other. Second, it has the advantage of triangulation, enabling the researcher to strengthen and enrich the research findings by utilising different data collection and analysis approaches to study a particular phenomenon, to help provide a complete understanding of and insights into that phenomenon. However, the mixed methods research requires money, significant effort and time, adding to that the fact that the project would require different stages (Molina-Azorin, 2016), and different skills may be required at each stage. However, researchers who adopt the mixed methods research have a great opportunity to enhance their research skills, experiences, and talents by being schooled in and keeping abreast of new research techniques, methods, and alternatives for addressing research problems (Molina-Azorin, 2016; Maarouf, 2019).

3.4 Justification of Research Philosophy and Research Methods

Regarding the research paradigm of this present study, the researcher follows the pragmatic paradigm. Researchers of pragmatism argue that it is impossible to access the truth about reality by using a single scientific method (e.g., Morgan, 2017; Saunders and Lewis, 2017). The pragmatic paradigm advocates the use of mixed methods as a practical and pluralistic way of undertaking research, so this current research employs both qualitative and quantitative methods. The qualitative method considers multiple case studies, which involves using interviews and focus group discussions; and the quantitative approach is based on a survey. This research paradigm clearly iterates that there is no single ontological reality (i.e., there is a non-singular single reality and all participants have their unique and own interpretations of that reality); a relational epistemology (thus, the researcher determines the processes and procedure to undertake the research); a mixed methods methodology (thus, the use of qualitative and secondary research methods); and a value-laden axiology (which explains that the study is conducted to benefit people).

This researcher considers pragmatism appropriate for this study, for the following reasons: first, the pragmatic worldview enables the researcher to establish a link between theory and data. The researcher is able to identity and establish the truth between existing literature and current data, enabling society's actors or the research community to appreciate the changes that exist in the truth, perceptions, behaviours, and context. Second, it allows the researcher to identify, understand, and explore the sustainability implications associated with Ghana's fresh vegetable exports to the UK from a non-singular perspective. Thus, both case study and survey research are used to explore different perspectives, experiences, and both observable and unobservable mental variables, in order to establish the sustainability implications that exist between Ghana and the UK as regards the vegetable food trade. Third, the researcher is taking advantage of subjective suggestions, based on survey results and analysis, observations, and reflections from the case studies (interviews and focus groups) and a more objective conclusion, drawn from interconnected findings of the case study and survey analysis. The combination of approaches for undertaking this research, involving collection of different types of data and analysis approaches, allows for elaboration and triangulation. Further, the adoption of empirical approaches implies that findings and conclusions will be drawn, based on hard evidence collected from engagement and experiences with observations (Goundar, 2012).

3.5 Research Design, Methodology, and Appropriateness of Chosen Methods

The research design informs the framework for the research, providing the background process for linking the research procedures with the research purposes. In other words, it connects "why" (i.e., the research questions) with "how to" (i.e., appropriate methods of addressing the research questions) (Creswell and Creswell, 2003; Marczyk, DeMatteo and Festinger, 2010). It explains the overall strategy that the researcher has adopted, aligned with different components of the study, integrated in a logical and coherent way to address the research problem(s) and achieve the research aims (Williams, 2007; Sileyew, 2019). This involves the blueprint, plan for data collection, data analysis, and deadlines for each stage of the research.

Following the research aim and objectives, this research design consists of five tasks (phases), outlining an appropriate framework and interrelated decisions for the study. Task 1 covers the thematic literature review (Castleberry and Nolen, 2018) on key concepts or topics relevant to the research. This also enables the researcher to identify sustainability impacts associated with Ghana's food supply chain to the UK which, in turn, has enabled the design and development of prior conceptual framework of the study. At this first stage, the researcher is able to identify interesting sustainability impacts associated with Ghana's fresh vegetable exports to the UK, composed of four sustainability dimensions—environmental, social, economic and an additional dimension, i.e., regulatory—based on knowledge attained via prior engagement with the literature.

A pilot study is then carried out as Task 2, to help utilise preliminary observations with data, to support the revision and development of the conceptual framework (SIA framework) of the study. To conduct the pilot study, semi-structured interviews (Creswell and Poth, 2016) were utilised, and five participants were recruited via convenience sampling, purposive sampling, and snowball sampling (Etikan, Musa and Alkassim, 2016; Naderifar, Goli and Ghaljaie, 2017). Participants involved in the semi-structured interviews are local exporters who double as farmers, either on a small- or large-scale basis. These consist of two smallholders, two large-scale farmers, and an ethnic retailer based in Nottingham, the UK. Varying sustainability impacts across the four sustainability dimensions are found from the pilot study. The researcher then revised the conceptual framework for the furtherance and development of the SIA framework of the study. Further research as a part of the research design is conducted to revise, test, and validate the SIA framework. In addition to the development of the conceptual framework, the semi-structured interviews provided understanding of and exploratory insights into the sustainability implications associated with Ghana’s fresh vegetables supply to the UK, assisting in the reconstruction and development of literature and future research instruments of the study. Table 3.2 presents a summary of details of the participants (cases) recruited for the pilot study, while Table 3.3 presents the cases (participants) and interview summary.

Table 3.2 Summary of details of the participants (cases) recruited for the pilot study.

Participant	Brief Description
Case 1 (Participant 1)	The first case study is a large-scale vegetable farmer who doubles as a local exporter of the fresh vegetables to the UK. The company employs about 100 people, including local farmers, operations staff, and administrators. They produce vegetables like peppers or chillies in addition to marrow, turia, ravaya, and tindah. The company stated that 4000 to 5000 kilos of vegetables are airfreighted daily via British Airways. The vegetables are supplied directly to a financier and agent in the UK, who takes control of their distribution. The semi-structured interview lasted 29.3 minutes.
Case 2 (Participant 2)	The second case study is a low- to medium-scale vegetable farmer, located in a suburb of Accra. The company deals with Asian vegetables, e.g., marrow and ravaga, as well as Ghanaian vegetables, such as okra, chilli, and garden eggs (aubergines). Produce is supplied to various wholesalers in the UK. Details of quantities of vegetables supplied to the UK regularly and employees working for the company are yet to be received. The interview lasted 33.4 minutes.
Case 3 (Participant 3)	The case study is a small-scale business (located in a suburb of Accra) whose farming activities are supported by the family and five other local farmers. Vegetables, e.g., pepper, okra, tomatoes, and onions, are sold to different distribution centres and wholesalers in the UK. The interview lasted for 37.2 minutes.
Case 4 (Participant 4)	The case study is a medium-scale farmer (business) who supplies high-end fresh vegetables and herbs to the local markets. Most of this company's vegetables are purchased by export agencies and intermediates in Ghana, and are then sold to distribution centres and wholesalers in the UK. Details of vegetable quantities sold to intermediaries (including local export agencies) and employee numbers are yet to be received. The semi-structured interview lasted 26.6 minutes..
Case 5 (Participant 5)	The fifth case study is a local ethnic retailer based in Nottingham, UK, who sells fresh vegetables (onions, tomatoes, okra, peppers and aubergines) imported from Ghana. These vegetables are supplied to the retailer at her own convenience at the shop, without any need to travel, by a distribution company located in Birmingham, the UK. The retail store is managed by one person, the owner. The interview lasted 22 minutes.

Table 3.3 Cases (participants) and interview summary

Case	Details	Location	No of Participants (Interviewees)	Level of the Participants (interviewees)	Length of Interviews (in Minutes)	Date of Interview
Case 1	Large-scale farmer and export directly to the UK	Drobo – Greater Accra	2	General Manager and Head of Accounts	29.3	29 July 2019
Case 2	Small-scale farmer and export directly to the UK	Dodowa – Greater Accra	1	Co-owner	33.4	30 July 2019
Case 3	Small-scale farmer and export directly to the UK	Amasaman – Accra	1	Owner	37.2	30 July 2019
Case 4	Large-scale farmer/producer sells locally to export companies who supply to clients in the UK	Tema	1	Head of Operations	26.6	02 August 2019
Case 5	Local ethnic retailer in the UK	Nottingham	1	Owner	22	15 September 2019

Task 3 focuses on the case study of small producer and a large producer in order to properly understand and gain insights into the activities of producers of fresh vegetables in Ghana, i.e., the perspectives of small producers and large producers. This phase supports identifying sustainability implications that culminate in the development of the SIA framework; facilitates interpretative insights into mechanisms, processes or measures that can enhance sustainable food supply chains; and increases the validity of the study. To facilitate Task 3, the researcher uses interviews to gather experiences, activities, and processes of producers directly and indirectly related to sustainability issues. The owner of the small producer business is interviewed, and the manager/head of administration of a large producing vegetable firm was recruited and interviewed as a representative of large producers. Data were collected through audio-recording and later transcribed for analysis. The researcher cross-checked and analysed the transcripts; mapped any sustainability impacts observed from the interview from each case; and conceptualised the findings and fed them into the conceptual framework (SIA framework). Thematic analysis approaches suggested by Braun and Clarke (2006), and further recommendations by Nowell et al. (2017) and Peel et al. (2019), were utilised to make sense of the data and produce insightful analysis, identifying sustainability dimensions and impacts, and exploring meaningful patterns within the interview.

Following up with focus group discussions as Task 4 helped revise the SIA framework and identify expert or in-field professional sustainability implications and solutions, to ensure reliable and practical measures that foster sustainable food supply chains. Focus group discussions also enabled the researcher to gather data on how to present managerial implications for both the UK and Ghana on enhancing sustainable food supply chains, as well as being utilised to ensure data saturation in identifying sustainability impacts. The first group discussion was made up of three small-scale producers and an authorising body representative from PPRSD (Plant Protection and Regulatory Services Directorate under the Ministry of Food and Agriculture, Ghana). The second group discussion was made up of four large-scale producers and an authorising body representative from PPRSD. Focus groups were conducted and recorded online (via Microsoft Teams) and later transcribed. The transcripts were thematically analysed, following the recommendations of Braun and Clarke (2006), to make sense of the data and identify sustainability dimensions, and impacts, and to explore meaningful patterns generated in the focus group discussion.

Task 5 (Phase 5) involved a survey (online-based) using Qualtrics (Qualtrics, 2020) to capture responses from a wider range of actors within the food supply chains, including outgrowers and small- and large-scale producers, together with exporters in charge of fresh vegetable exports to the UK. This contributes to the testing and validation of the SIA framework. This task seeks to make empirical and scientific contributions to the body of knowledge in the context of global food supply chains, through the capture of sustainability data and food sustainability information which is largely dominated by qualitative research.

It is important to mention that the four tasks (tasks 1, 2, 3, and 4) sum up the qualitative research of the study (Yin, 2009; Creswell and Creswell, 2017), and are theorised following the suggestion of Eisenhardt (1989), by defining the research question, selecting the cases, designing data collection instruments, collecting data, analysing data, searching for evidence and relationships, linking with literature, and reaching closure (saturation). This provides reliability and enhances the validity of the study, as well as utilising the findings to revise the SIA framework. To demonstrate, following the work of Eisenhardt (1989), the researcher clearly defined the research questions from prior knowledge of literature e.g., Legge et al. (2008), Garnett (2011) and Schmutz et al. (2018). This enabled the first development stage of the SIA framework as tentative hypotheses to be addressed. Cases were selected using convenience sampling and snowball sampling (Bryman, 2016) complemented by purposive sampling (Patton, 2014). This technique enabled us to identify cases that met our selection criteria and provided rich information. In the end, we selected two cases, consisting of a small-scale producer and a large-scale producer of vegetables who regularly participate in Ghana's vegetables supply chain to the UK. The selected producers also double as exporters and, thus, have global supply chain links with retailing, distribution, and wholesaling businesses mainly located in the UK. Data were then collected from a variety of sources, using interviews and focus group discussions to help provide synergistic and divergent views of evidence from the selected cases. The researcher then overlapped data collection and analysis, to help reveal themes and take advantage of individual unique case characteristics. Both within-case and cross-case thematic analyses were carried out to help observe evidence through multiple lenses. In addition, the researcher tabulated evidence for each construct (each dimension of the SIA framework of the study) for development and validation. Further, comparison with similar and conflicting literature was carried out to further build internal validity and enhance conceptual development of the framework. The study, however, operationalises theoretical saturation to ensure that the tentative hypotheses (SIA framework) are adequately addressed and studied, and that the research design is acceptable for the aim and objectives of the study. This is achieved by ensuring the SIA framework is comprehensively studied and that the overarching theory has been objectified to achieve rigorous research.

The five tasks are illustrated using Table 3.4 below. It also captures the methods of data collection, data analysis, and timeframe for the research design. The methodological approaches of this study (as explained) constitute both qualitative and quantitative research approaches. A summary of the study which matches the research description, and the methodology is presented as Table 3.5. The appropriateness of the chosen methods is clearly explained in this research design (section 3.3). However, it is important to stress that the researcher carefully selected the research methods with the aim of appropriately satisfying the research objectives of the study. Justification for the chosen methods (research strategy)—i.e., qualitative methods using semi-structured interviews and focus group discussions and quantitative methods using the survey—are discussed in section 3.7.

Table 3.4 Research design
(Phases of the study, methods of data collection, data analysis, and timeframe)

Task/Phase		Data collection	Data Analysis	Deadline (Started and Completed)
1	Thematic literature review	Journal articles, books, briefings and reports and conference papers	Thematic literature review	October 2018 to May 2022
2	Pilot study	Semi-structured interviews with farmers, local exporters and ethnic retailer.	Qualitative Thematic analysis (within-case and cross-case analysis)	Started in July 2019 and completed in September 2019.
3	Interviews	Visits to companies' premises for interviews	Qualitative Thematic analysis (within-case and cross-case analysis) using NVivo 11	Started in September 2020 and completed in October 2020.
4	Focus group discussions	Group discussion interviews with smallholders, local farmers, local exporters and authorities in charge of food export to the UK	Qualitative Thematic analysis (within-case and cross-case analysis) using NVivo 11	Started on January 20 2021 and completed in on 29 January 2021.
5	Survey	Online/paper-based survey responses from smallholders, local farmers, local exporters and authorities in charge of food export to the UK	Statistical analysis (regression analysis) using SPSS	Started in October 2021 and completed in March 2022.

Table 3.5 Summary of the study: Matching research description and methodology

Research Questions	**Research Objectives**	**Research Method**	**Explanation**	**Possible Contributions**
RQ1. What are the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK?	RO1. Identify the sustainability gaps in Ghana's fresh vegetable exports to the UK.	Multiple case-study method (interviews and focus group).	Following the review of literature to design a conceptual framework of the study, the researcher collects data using interviews and focus group discussions to answer RQ1 and achieve RO1. Both preliminary observations and findings from the interviews and focus groups aligned with the literature to suggest alternative practices that can reduce the sustainability impacts (thus achieving RO2).	The development of the SIA framework.
	RO2. Explore the alternative practices of reducing the sustainability impact associated with Ghana's fresh vegetables supply chain to the UK.	Multiple case-study method (interviews and focus group).		

RQ3. How to estimate sustainability implications associated with Ghana's fresh vegetable supply chain to the UK be estimated using available methods?	RO3. Suggest a robust method for measuring and valuing the sustainability implications associated with fresh food imports (fresh vegetables) to the UK, taking account of the sustainability impact assessment (SIA) and life cycle analysis of the food supply chain.	Survey method	The researcher utilises survey (online-based survey) using Qualtrics, analysed using SPSS test, and validates the SIA framework.	Testing and validating the SIA Framework Scientific estimation of sustainability impact (or sustainability price). Robust method of measuring sustainable food supply chains involving global sources The SIA model for the capture and assessment of sustainability.
RQ4. What are the managerial and policy implications for both Ghana and the UK?	RO4. Provide recommendations to enhance sustainable food supply chains for the UK and Ghana.	Multiple case-study method (interviews and focus groups).	The researcher collects data using interviews and focus group discussions to answer RQ4. The experiences, recommendations and advice are mapped and aligned with the literature to provide managerial and policy implications (thus achieving RO4).	Practical Implications for Food Supply Chain Professionals and Emerging Countries. Policy Development in Food Sustainability.

3.6 Research Strategy: Case study and Survey

The researcher uses case-study and survey research as research strategies (Remenyi et al., 1998) to facilitate the research aim and objectives of the study.

3.6.1 Case study

The case study is the most common qualitative research approach (Alavi and Carlson, 1992). Yin (2009) explains the case study as an empirical inquiry approach that examines a current phenomenon within its real-life context when there are clear evidential boundaries between the context and the phenomenon. The methods used in facilitating case studies include interviews, document review, observations, focus groups, and artifact analysis (Simons, 2009; Yin 2015). Several studies have contributed to the development of case-study research, e.g., Stake (1995), Yin, (2009; 2015) and (Merriam and Tisdell, 2015). Case study has been used for numerous disciplines including business, social sciences, law, health, and education to answer a wide range of research topics (Harrison et al., 2017). The continuous use of case study by different disciplines to address complexities of practices, mechanisms, and institutions has demonstrated case-study utility for researching sophisticated issues and testing practices useful for diverse disciplines. The case study is now seen as a valid approach of inquiry to explore a wider scope of sophisticated issues, especially when the topic of interest focuses on social interactions and human behaviour (Flyvbjerg, 2011). For this reason, the study finds the case study as a more useful approach to explore the activities, practices, and systems of food supply chain actors involved in the supply of Ghana's fresh vegetables to the UK. This enables the holistic study of each actor's practices and responsibilities towards ensuring sustainable food supply chains, taking account of very insignificant sustainability details to major issues. In addition, the choice of case-study research is intended to bridge the methodological gap in global food supply chains studies.

Case-study research is often referred to as qualitative inquiry (Merriam and Tisdell, 2015) and can cover interpretive, explanatory, descriptive, and exploratory objectives. This study has exploratory and interpretive objectives; hence, the use of case studies will provide in-depth understanding of and solutions to practices, processes, and relationships within the food supply chains that can enhance sustainable food. Sustainability impacts associated with food supply chains in the context of this study require an exploratory and interpretive approach to clearly address the research questions of how and what to do to enhance sustainable food supply chains for both Ghana and the UK.

Case studies of two Ghana local producers/exporters who supply vegetables from Ghana to the UK on regular basis are considered for the study.

> Case study I: The first case study is a large-scale producer and exporter of fresh vegetables to the UK. The company employs about 100 people, including local farmers and operations and administrative staff. They produce vegetables like peppers or chillies, in addition to marrow, turia, ravaya, and tindah. The company stated that between 4000 to 5000 kilos of vegetables are airfreighted daily via British Airways. The vegetables are supplied directly to a financier and agent in the UK, who takes control and organises distribution of the vegetables. The semi-structured interview lasted for 22 minutes and 34 seconds and was conducted on 28 September 2020. The interviewee is the head of operations of this large-scale producing company.

> Case study II: The case study is a small-scale producer, located in a suburb of Accra, whose farming activities are supported by their family and five other local farmers. Vegetables, e.g., peppers, okra, tomatoes, and onions, are sold to various distribution centres and wholesalers in the UK. The interview lasted for 24 minutes and 25 seconds and was conducted on 6 October 2020. The interviewee is the owner of the small-scale producing company.

Therefore, the methods used to facilitate the case research of the study are interview and focus group. The study seeks that to use interviews and focus-group discussions for data collection to facilitate a valid, reliable research design, and also to achieve the research aim. Although some studies criticise the inability of the case study to support generalisability (Mills and Birks, 2014), case research can, nevertheless, provide rich, more detailed, complete, and in-depth study of a unit or a single case (Flyvbjerg, 2011). This helps the researcher to explore, evaluate, and theorise sustainability issues concerning each case to ensure generalisability.

3.6.1.1 Interview

Interviews are generally used in conducting qualitative research. They have the advantage of providing "facts", understanding, and insights into opinions, activities, experiences, and predictions (Rowley, 2012). Interviews can be conducted in person or online either with one individual or with a group.

This study has conducted face-to-face (in person) interviews, due to the availability of the participants recruited for the study, and at the time, there were no travel restrictions. The interview is utilised to identify and explore the sustainability gaps and impacts within the food supply chains; semi-structured open-ended interviews were used to capture the overarching sustainability implications relating to the local producers' activities and experiences. Such semi-structured interviews enable the interviewee to explore the main questions adequately. Data collection using interview can be more time consuming and demanding than using other case research methods, such as document review (Simons, 2009; Bryman, 2016). However, developing an interview schedule protocol requires less prior knowledge and can be easier than other case research methods (Flyvbjerg, 2011; Rowley, 2012; Bryman, 2016). Nonetheless, this study follows recommendations by Rowley (2012), which provide some guidelines for deciding the questions to ask, how many people should be interviewed, how long the interview should last, ensuring interviewees understand your questions, and how to ensure interview flow. A copy of the transcript of the interview with the large-scale producer (I-LSP) is attached as Appendix 1.

3.6.1.2 Focus group

A focus group is a qualitative approach that can provide in-depth understanding of social issues. The approach is used to obtain data purposefully from a selected group of individuals instead of a statistical representative sample of a wider population (Nyumba et al., 2018). Focus group and group interview are used interchangeably (Boddy, 2005). Focus group can be conducted either online or face-to-face. Online focus groups ensure online environments by using chat rooms or online means (Kamberelis and Dimitriadis, 2005) such as MS Teams. The opportunities of online focus groups are modernity, dynamism, and competitiveness that overshadow the challenges with face-to-face focus group (Edmunds, 1999; Nyumba et al., 2018). However, online focus groups require access to the internet and are possibly prone to technological issues such as poor internet connectivity, unable to capture non-verbal data, and technological device failure (Dubrovsky, Kiesler and Sethna, 1991). Nevertheless, focus groups can take place either in a formal setting e.g., classrooms, offices, and MS Teams (online) or in an informal setting, e.g., shopping malls and street corner assigned by the researcher where participants respond to invitations to take part in a study. It is important to mention that recommendations for best practice in conducting focus groups suggested by Nyumba et al. (2018) are followed. Their recommendations include providing clear justification for the choice of focus groups, being aware of biases, ability to be flexible to adapt to the flow of the discussion and having good listening skills. This study included the focus group as part of case research methods due to its strength in generating insights into participants' shared understanding of sustainable food and sustainability impacts associated with the food supply chains.

Focus group participants were chosen based on their vast experience in vegetable production, involvement in Ghana's fresh vegetable exports to the UK, and willingness to contribute to the study. Two focus group discussions were conducted. The first group discussion consisted of four participants. Three were small-scale producers and there was one authorising body representative from PPRSD (Plant Protection and Regulatory Services Directorate under the Ministry of Food and Agriculture, Ghana). The focus group was held on 20 January 2021 and lasted 1 hour, 9 minutes. The second group discussion was made up of five participants; four were large-scale producers and one was an authorising body representative from PPRSD. The discussion was held on 29 January 2021 and lasted 1 hour, 14 minutes. It is important to mention that the two cases (Case study I and Case study II) were included in their respective individual focus group discussion. A copy of the transcript of the focus group discussion with small-scale producers (FGD-SSP) is attached as Appendix 2.

3.6.2 Survey

A survey can be explained as the collection of data from a sample of participants through their answers or responses to statement items (i.e., questions) (Check and Schutt, 2012; Ponto, 2015). This research approach involves recruitment of participants, collection of data, and utilisation of other instruments for data collection and extraction. Survey researchers usually engage in large sample-size data collection, with the aim of obtaining data that describe the features of the sample size or participants. Currently, survey research has developed into a more rigorous technique for researchers, allowing scientific testing, proficient survey method (i.e., what and how to distribute) and minimising non-respondents' errors to ensure a robust and quality outcome or findings (Ponto, 2015). A survey must clearly outline the research objectives, strategies for sampling and recruitment of participants, instruments for data collection, and administration technique. Collection of data in surveys mostly involves interviews and questionnaires. The questionnaire can be administered by a group, an individual, a professional, or electronically. Ideally, the reader is provided with clarity regarding the content and purpose of the survey questionnaire in order to interpret the validity and reliability of the survey instrument. There are a number of internet-based programs available that support administration of survey instruments (Dillman et al., 2014; Ponto, 2015). These include SurveyMonkey, Qualtrics, and Survey Sparrow. However, Dillman et al. (2014) stress that there is a need to combine different methods of administering surveys in order to help increase sample coverage and minimise coverage errors. Administering surveys via emails, groups, or the internet can be practical and effective for a large sample size and incur low cost (Check and Schutt, 2011).

3.7 Data collection and instruments

The interview protocol guide, a focus group discussion guide, and the survey instrument were designed for data collection. A interview schedule protocol is attached as Appendix 3, focus group discussion guide as Appendix 4, and survey instrument as Appendix 5. The interview protocol was designed as a semi-structured open-ended interview to collect data experiences, practices, and opinions of different sustainability dimensions—environmental, social, economic, and regulatory. These interviews were conducted face-to-face and were captured using an audio recorder.

Focus group discussions were conducted online using Microsoft Teams and were audio-recorded using the Teams recorder function, The focus group assesses the opinions, thoughts, and group's perspectives and understandings of sustainability implications associated with Ghana's fresh vegetables chain to the UK. Their responses, opinions, views, or experiences are mapped, to help identify the sustainability gaps in Ghana's fresh vegetable exports to the UK and also provide managerial and policy recommendations to enhance sustainable food supply chains for the UK and Ghana.

Based on the results of interviews and focus groups, the survey instrument was designed and distributed through Qualtrics. This is an online software platform that provides opportunities of asking questions, getting responses from participants and responding with relevant feedback or actions. The survey, designed as Likert-scale items, consists of questions which cover sustainable food supply chains, environmental sustainability, social sustainability, economic sustainability, the regulatory dimension of sustainability, collaboration (i.e., sustainable food supply chain collaboration) and complexities (that is, complexities in developing sustainable food supply chains). Before carrying out the main survey for the study, a pilot survey was conducted and 11 participants responded, which included exporters, smallholders, local farmers, and outgrowers. This pilot survey provided the researcher the opportunities to re-design certain questions (items) to avoid confusion, eliminate difficulties, improve clarity, ensure participants understand the questions and maximise useful responses data. Table 3.6 presents a summary of research participants, data collection method, and timeline.

Table 3.6 Summary of participants, data collection method, and timeline.

Participant	Number of Participants	Data collected method	Date
Small-scale Producer (Owner/Manager—Case study I)	1	Interview	6 October 2020
Large-scale Producer (Head of Operations—Case study II)	1	Interview	28 September 2020
Small-scale producers (including owner/manager—case I)	4	Focus group	20 January 2021
Large-scale producers (including owner/manager of case II)	5	Focus group	29 January 2021
Outgrowers, small- and large-scale producers and exporters	163	Survey	October 2021 to January 2022

3.8 Justification for research strategy

This section is divided into two (2). First, it explains the justification for research strategy—case study and survey and second, the good practice of choosing research methods.

3.8.1 Justification for research strategy—case study and survey

The researcher has adopted this strategy of combining case-based interviews and focus groups, complemented by a survey, mainly for the purpose of triangulation in order to understand the phenomenon in a comprehensive and in-depth manner. This approach provides depth of inquiry and enhances the richness of data that can facilitate high-quality contributions to the body of knowledge in the area of study. First, data are collected through interviews and then focus groups. The study maps a pattern from both sources of data (interviews and focus groups), to understand and identify the sustainability implications associated with Ghana's fresh vegetable exports to the UK. The results are utilised to design the survey in the furtherance of understanding and establishing an appropriate and robust approach to measuring sustainability impacts associated with food supply chains. Although this study is carried out in the context of particular countries (i.e., Ghana and the UK), this empirical work could produce conceptual insights into sustainable food supply chains and the food trade, and the results can be generalised to other geographical contexts. Moreover, following this approach also responds to three main challenges: 1) practicality; 2) the need to compare and contrast participants' perspectives; and 3) to strive towards data confirmation or completeness. In achieving the latter, each method the researcher adopts contributes and reveals different parts of the phenomenon of the study and provides a more in-depth understanding by obtaining expanded or in-depth findings (Lambert and Loiselle, 2008). The interviews explore individual experiences; the focus groups prompt opinions, collective experiences, suggestions, and beliefs about sustainable food supply chains; whereas the survey attempts to statistically measure the impacts of sustainability dimensions (implications) associated with Ghana's fresh vegetable exports to the UK, based on the results from the interviews and focus groups.

A significant body of research has previously used this approach (i.e., interviews, focus group, and survey) for a single research work. These include Guzman and Stanton (2009); Kwong et al. (2010); Micheli, Mura and Agliati (2011); Black and Neill (2014); Azam (2015); Sweeney, Grant and Mangan (2015); and Urumsah (2015). By adoption of this research strategy, the researchers were able to carry out in-depth study, explore changes and development, make greater sense of data, and obtain a direction and test for validity of the study variables. This is similar to the approach of this present study.

3.8.2 Good Practice of Choosing Research Methods

This section explains the good practice of choosing an appropriate research methodology or methods, following the work of Saunders, Lewis and Thornhill (2009) and the illustration from Opoku, Ahmed and Akotia (2016). It also simplifies how chosen methods or appropriateness are embedded in the study. Table 3.7 presents the research process, selected research tools and procedures, reason for the choice, limitations and how these were mitigated to demonstrate good practice for choosing and ordering the most appropriate approaches.

Table 3.7 Good practice of choosing research methods.

Research Topic: UK food sustainability and global food supply chains: Sustainability impact study of Ghana's fresh vegetable exports to the UK				
Research Aim: to explore the opportunities to reduce the sustainability implications of the UK's global food supply chain by analysing Ghana's fresh vegetables exports				
Research process	Selected research tools and procedures (how embedded in the study)	Reasons for the choice	Limitations/Challenges	How limitations were mitigated
Research philosophy	Pragmatism This study adopted a pragmatic philosophical stance by using quantitative and qualitative methods to achieve the research aim. This means that the study considered both positivist and interpretivist stance to address the research questions.	Studying food sustainability and global food supply chains is broad, important, and can be complex. Hence, it requires philosophical underpinning that provides diverse research methods and examination of the variety of the contexts and positions.	Employing this research philosophy can be time consuming and also requires multiple or diverse research skills in handling both quantitative and qualitative methods.	Timeline was well designed for the research to enable data collection and data analysis within the project timeframe. Despite COVID-19 creating restrictions and extending the project timeline, the researcher adopted other data collection and analysis approaches such as using Microsoft Teams and SPSS to facilitate completion of the research.
Research approach	Abductive reasoning (Watson, 2014). This first involves an incomplete set observations and proceeds to possible explanations and solutions for the set or with information at hand.	Food sustainability and global food supply chains using Ghana's fresh vegetable export have diverse dimensions. In that regard, different research approaches must be utilised to	Time consuming, extensive reading, and requires multiple research skills.	Timeline was well designed, allocated sufficient time for reading on theoretical foundation, concepts, topics and themes under the study, and attending different workshops, conferences, and events

	Based on the review of literature regarding Ghana's fresh vegetable supply to the UK and sustainability, certain sustainability dimensions (implications) were identified and a conceptual framework of the study was developed. It offered the researcher opportunity to be creative and explore other sustainability dimensions that may exist within Ghana's fresh vegetable exports to the UK, in order to establish possible or alternative measures that can help improve sustainability and enhance sustainable food supply chains.	identify and reveal the richness of data for the research questions under examination.		to acquire relevant research skills for the project e.g., data collection, interviewing, and critical analysis.
Research strategy	Multiple strategies This study adopted multiple strategies and were divided into five phases: Review of literature (Phase 1), Pilot Study (Phase 2), Interview (Phase 3), Focus group (Phase 4) and Survey (Phase 5).	It is important to mention that no single research strategy can establish, identify, and solve sustainability impacts of global food supply chain. Hence, there is a need to use multiple strategies to help uncover all relevant sustainability dimensions and their associated impacts to facilitate holistic evaluation for	Time consuming, diverse research skills required and difficult in recruiting participants for the study.	Timeframe extended at some point to accommodate data collection, transcription of interview and focus group data. Attended conferences and workshops to enhance research skills. Communicated with contacts in authorising institutions, e.g., PPRSD, to help recruit

		sustainable food supply chain.		participants for the study.
Research choices	Mixed methods This study adopted mixed methods research approach by using both qualitative and quantitative methods. Hence, case research (interview and focus group) as qualitative method and survey as quantitative method.	Mixed methods research using both qualitative and quantitative inquiry has the advantage of providing a more comprehensive and complete insights into Ghana's fresh vegetable exports to the UK and food sustainability.	Time consuming. Limited number of cases.	The researcher needed to extend the data collection period to enable collection of sufficient data for the study. Due to the limited number of cases (case studies) for the research, the research ensured that sufficient number of participants respond to the survey by using reminders and contacts.
Methods used for data collection	Case research method (thus, interview and focus group) and survey. This study used interviews and focus group to collect data from small-scale and large-scale producers. Additionally, it used survey to collect data from producers including smallholders, outgrowers, local farmers, and exporters.	Interview and focus group provide understanding and exploratory insights into sustainability implications associated with Ghana's fresh vegetables supply to the UK, assisting in the reconstruction and development of literature and future research instruments of the study. The survey provides a wider view	Time consuming. Participants' availability. Internet connection. Challenges. Location challenges.	The researcher needed to extend the data collection timeframe to enable collection of sufficient data for the study. The researcher ensured that the date and time are suitable for all participants for the interview and online focus groups.

		and allows scientific testing.		
Unit of study	Producers with Ghana's fresh vegetable exports to the UK. This includes smallholders, outgrowers, local farmers and exporters.	To establish the sustainability implications associated Ghana's fresh vegetable exports to the UK, clearly identifying the hidden sustainability dimensions within the food supply chains and exploring opportunities for improving sustainability.	Vegetable producers are spread across Ghana. Accessing some of these producers require transportation to remote areas, accommodations for several days at remote areas, internet access and trust.	The study focused on the southern belt of the vegetable producers. The southern regions including Ashanti, Volta, and Greater Accra have good transportation, internet access and most exporters or producers are allocated in these regions. In addition, snowball sampling, purposive and convenience sampling adopted by the study were easy due to trust received from participants.
Data analysis technique	The case study data (including interviews and focus groups) are analysed following thematic analysis suggested by Braun and Clarke (2006) using NVivo 11 and the survey data are analysed using SPSS Statistics Version 27.	To produce insightful analysis, identifying sustainability dimensions and impacts, and exploring meaningful patterns within the interview and focus group data. To statistically estimate the sustainability implications associated with Ghana's fresh	Transportation challenges. Time consuming. Identifying appropriate model for the survey data. Internet connection issues with participants.	The researchers hired a car to contact several producers in remote places even though most of them turned the request down due to availability and continuous presence at the farm. Understanding the best time that participants have good internet

		vegetable supply chain to the UK. To utilise statistical results of sustainability dimensions to test and validate the SIA model developed from thematic analysis of the case study data.	Consistent communication with contacts and authorising bodies in Ghana.	connectivity at the areas and set reminders to encourage them to participate in the study. Set calendars, charts and schedules to establish relationship and contact as well as setting reminders to keep update with activities for the project.

3.9 Data Analysis

Various approaches were considered to analyse the data collected. For qualitative data (i.e., from interviews and focus groups), the researcher employed thematic analysis, as suggested by Braun and Clarke (2006), using the software program NVivo 11 (Mortelmans, 2019; QSR International, 2020); and IBM's SPSS Statistics Version 27 (IBM Corporation, 2020) was utilised to perform regression analysis for the survey data.

3.9.1 Case study—Interviews and Focus group discussions

Interviews and focus groups were transcribed and the transcripts were analysed using NVivo 11. The text data from the transcripts are coded to break down the data and reveal the richness in the data. "Coding is a process of analysing qualitative text data by taking them apart to see what they yield before putting the data back together in a meaningful way" Cresswell, 2015, p. 156). Coding provides an opportunity of mapping the data, highlighting unrelated and different views of the data which allows the researcher(s) to make sense of the data with regards to the research question(s) (Elliott, 2018). The recommendation of coding suggested by Cresswell (2015) and supported by Elliott (2018) are followed to code the text data of the interview and focus group. Nevertheless, the analysis of the interview and focus group are guided by the steps suggested by Braun and Clarke (2006) and recommendations from Nowell et al. (2017) and Peel et al. (2019) using NVivo 11.

The six steps of thematic analysis clearly outlined by Braun and Clarke (2006) were carefully followed, including familiarisation with the dataset, generating initial codes, searching the themes, reviewing, defining and naming them, and producing the report. NVivo 11 has the capacity to organise, analyse, and visualise data in addition to other advantages such as classifying, sorting, and arranging data to be able to capture themes and patterns. In addition to using NVivo 11 for thematic analysis, the study also exploits its capacity for visualisation of the data, e.g., for polar diagrams and word clouds. Further, the study employs the coding facility in NVivo 11 to test and validate the sustainability dimensions and impacts identified from the thematic analysis of the interviews and focus group data for the development of the SIA framework of the study.

3.9.2 Survey

The survey data were analysed using IBM's SPSS Statistics Version 27 (IBM Corporation, 2020). The IBM Statistical Package for the Social Sciences (SPSS) has the advantage of analysing data effectively and can deal with statistical analysis from basic to advanced levels, including descriptive statistics, graphing, inferential statistics, univariate analysis, regression analysis, multinominal logistic analysis, factor analysis, and generalised linear regression (Meyers, Gamst and Guarino, 2013; Kafle, 2019; IBM Corporation, 2020). Other statistical software such as R programming, MATLAB, EViews, and STATA are available for regression analysis; however, the researcher chose SPSS due to its advantages of allowing data analysts to specify multiple models in a single regression instruction or command. Also, SPSS is capable of performing a robust test when examining cause and effect relationships and multivariate regression analysis, using simple and clearly-defined steps or procedures (Ong and Puteh, 2017; Kafle, 2019). Survey data were collected using Qualtrics and extracted in comma-separated values (.csv) format to SPSS for analysis.

3.9.2.1 Data Cleaning and Descriptives—Survey

Overall, 163 responses were collected using the survey instrument, which was made up of 45 questions (items) ranging from the sustainable food supply chain to sustainability dimensions. The sustainability dimensions questions (items) designed for the study cover environmental, economic, social and regulatory aspects, collaboration, and complexities. At the end, there are seven categories of sets of Likert-scale items (questions), covering sustainable food supply chain (SFSC) and all the sustainability dimensions (Appendix 5 presents a sample of the survey instrument). To ready the survey data for statistical analysis, data cleaning is performed. This is a critical and important process in data analysis. It helps to ensure that the dataset is correct and lacks errors. To ensure that the data are appropriately cleaned and ready for analysis, the study followed the steps recommended by Lee et al. (2021), which emphasise checking all variables cosmetically and diagnostically, as well as exploring data programming with data cleaning, to ensure that a closer eye is kept on the data so that the researcher is able to delete variables or data that are corrupt, erroneous, or inconsistent. Table 3.8 below explains the phases and processes adopted for the data cleaning of the survey.

Table 3.8 Phases and processes adopted for data cleaning of the survey.

Phase or Process	Activity
1	Data or responses collected using Qualtrics are exported after cleaning the researcher's trial response to the survey. A total of 163 responses are exported in SPSS format.
2	Columns of Data format (spreadsheet) which provide start date, end date, status, IP Address, Duration, Finished, Recorded date, RecipientLastName, RecipientFirstName, RecipientEmail, ExternalReference, LocationLatitude, LocationLongitude, DistributionChannel, UserLanguage are removed. This ensures that data for the analysis are simplified and easy to follow. Meaningful columns, such as Progress and Responseid, are left in the data format.
3	Questions or items are properly categorised under their sustainability dimensions or factor names to reflect what the study actually wants to measure. For example, questions or items under environmental aspects are appropriately specified to indicate the items/variables under the factor "environmental aspects".
4	The questions or items Q2 and Q3 are used to indicate if the respondent is a small- or large-scale producer. Then, the data in SPSS are corrected to specify responses from small- or large-scale producers.
5	Responses that are less than 50% complete are removed. The 163 responses are thus reduced to 138.
6	Responses that are not 100% complete are removed. The 138 responses are thus reduced to 133.
7	Cross-checking is carried out to ensure the SPSS system data are as accurate as they should be. For example, 100% responses can be seen as 89% which should not be the case. So, any system errors are checked and corrected.
8	The variable view is appropriately labelled with the specific factor (SFSC and sustainability dimensions) names for reference.
9	After the cleaning process, 133 complete, meaningful, and useful responses remained for analysis.

3.9.2.2 Survey—Description of population and survey sample size

Ghana, a west African country, has a population of 32.8 million according to the World Bank (2023). The primary sector employs 34% of the workforce and contributes 19% to GDP, and it is important to mention that the production of cocoa, maize, and vegetables is the major primary activity (Ferreira et al., 2022). Further, it is mentioned that about 12,000 smallholder farmers are involved in vegetable farming (Abdulai et al., 2017). However, the study recruited about 85% of the participants from the Ghana Association of Vegetable Exporters (GAVEX) and the Vegetable Producers and Exporters Association of Ghana (VEPEAG). Both VEPEAG and GAVEX have over 500 members across seven regions in Ghana—Northern, Brong Ahafo, Ashanti, Eastern, Volta, Accra, and Central region (Federation of Associations of Ghanaian Exporters, 2020; VEPEAG, 2023). The study recruited participants mainly from these groups due to the sampling method (convenience, purposive, and snowball sampling), their consistence in vegetable production contributing significantly to Ghana's fresh vegetable to the UK, and their strong relationship with authorising bodies such as PPRSD as well as their commitment to supporting sustainable food production and consumption (Ghana Export Promotion Authority, 2018).

Out of 133 participants, 91 can be classified as small producers, who work on farmland less than five hectares in size, while 42 work on farmland bigger than 20 hectares. Small producers comprised 43 smallholder farmers, 25 outgrowers, and 23 local farmers with three of them actively engaged in export of the produce to the UK. The large producers comprised 30 local farmers and 12 exporters. The exporters also own farming lands bigger than 20 hectares. It is important to note that survey data were obtained from vegetable farmers located within the southern sector, mainly in Accra, Nsawam, Dodowa, Koforidua, Volta, and Ashanti regions. This is due to the transportation, accommodation, and access to internet issues. Table 3.9 presents a brief background of the participants who make up the study sample.

Table 3.9: Brief background of participants – Sample size

Participant	Number (N)	Farming Capacity	Classification of Participants
Smallholder farmers	43	Less than 2 hectares	Small Producers
Outgrowers	25	Less than 2 hectares	Small Producers
Local farmers	50	20 local farmers have less than 5 hectares farming capacity	Small Producers
		30 local farmers have more than 20 hectares farming capacity	Large Producers
Exporters	15	3 exporters have less than 5 hectares farming capacity	Small Producers
		12 exporters have more than 20 hectares farming capacity	Large Producers
Total	133		

3.10 Models

In an attempt to estimate the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK (RQ 2), the study performed multilinear regression models (Uyanık and Güler, 2013; Jolliffe and Cadima, 2016) using SPSS. Beforehand, factor analysis (principal component analysis: PCA) is employed as a data extraction approach (Zuccaro, 2010; Jolliffe and Cadima, 2016; Shrestha, 2021) to accrue meaningful data for the regression analysis.

3.10.1 Multilinear Regression

Multilinear regression (MLR) is a statistical technique that models the relationship between a dependent variable (sustainable SFC in this case) and a set of independent variables (the sustainability dimensions—environmental, economic, social, regulatory, collaboration, complexities) (Zuccaro, 2010; Uyanık and Güler, 2013). Zuccaro (2010) further explains that MLR models the variability of the dependent variable (Y) as a linear function of the variability of the predictor (thus, independent) variables (Xj). This statistical model can be expressed as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots\ldots + B_p X_p + \varepsilon_i \,, \qquad \text{Eq. (1)}$$

where Y is the dependent variable values; β_0 is the constant or intercept; $\beta_1, \beta_2 \ldots \beta_p$ are the coefficient of the independent variables; and ε is the random or error term. Therefore, following the MLR model suggested by Zuccaro (2010) and Uyanık and Güler (2013), this study attempts to statistically test:

> Null hypothesis (H_0): There is no significant relationship between the sustainable food supply chain (SFSC) and the sustainability dimensions items of the study.
>
> Alternative hypothesis (H_1): There is a significant relationship between the sustainable food supply chain (SFSC) and the sustainability dimensions items of the study.

This can be further explained by a statistical equation depicting the relationship the dependent variable (sustainable FSC) and independent variables (sustainable dimensions) (in Eq. (2)):

$$\text{Sustainable FSC} = \beta_0 + \beta_1\text{Environmental} + \beta_2\text{Economic} + \beta_3\text{Social} + \beta_4\text{Regulatory} + \beta_5\text{Collaboration} + B_6\text{Complexities} + \varepsilon_{i,} \qquad \text{Eq. (2)}$$

where sustainable FSC is the dependent variable expressing factors of sustainable food supply chain defined by actors, stakeholders, or producers; β_0 is the intercept; environmental, economic, social, regulatory, collaboration, and complexities are the independent variables that explain the different sustainability dimensions; β_1 through to β_6 are the coefficients of the regression; and ε is the error term. Obtaining a significant statistical relationship and relevance between sustainable FSC and sustainability using MLR can suggest a measurement or method of valuing the sustainability dimensions (or implications) associated with Ghana's fresh vegetable supply chain to the UK. In a broader context, it can suggest a robust and novel relationship and measurement between sustainability implications and sustainable FSC. The study further explores the relationship between large- and small-scale producers, sustainable FSC, and sustainability dimensions. It is important to mention that large producers and small producers used in the regression equations are treated as dummy variables. Before the regression models are estimated, the study performed validity and reliability tests of the survey data to understand their usefulness and accuracy.

3.11 Ethical Considerations

Ethical considerations were outlined for this research and approval was given by the College Research Ethics Committee (CREC) of Nottingham Trent University (NTU) before any collection of data. Before the initial data collection through semi-structured interviews for the pilot study, participants were provided with a participant information sheet to read. This explained the details of the research, its aim, objectives, relevance, and all the information participants needed to know to make a rational and informed decision on taking part in the research study at NTU. Having decided to participate in the research, a consent form was provided to the participants to carefully read and sign. The Participant Information Sheet (PIS) and Consent Form proforma provided for participants are attached as Appendix 9 and Appendix 10. Participants were asked to take part in the research voluntarily and withdraw within a month after participation. The research instrument, i.e., the semi-structured interview protocol, was also provided to the participants and carefully explained before the interview started. All interviews were audio-recorded. Also, the researcher took notes of discussions before and after the interview recordings. The exercise of providing participants with participants' information sheets and consent forms and briefing participants about the project was carried out for the pilot study (interviews), the case studies (interviews and focus groups), and the survey. This study follows the Research Data Management set out by NTU for all researchers and also follows NTU's Research Ethics Policy and Code of Practice for Research. To maintain confidentiality of participants, all participants' names or identity were anonymised.

To obtain ethics approval for this PhD project, the researcher first submitted a completed Business, Law and Social Sciences College Research Ethics Committee (BLSS CREC) application form, together with a consent form and participant information sheet on 22

May 2019, to the Chair of the CREC. The research project duly received ethics approval on 27 June 2019. Approval was also provided for collection of data using observations, interviews, document review, and focus group (i.e., a case study approach) and the use of the quantitative approach research (survey) for the research project. Due to COVID-19, the researcher was asked to discontinue face-to-face data collection—which already started —between 28 September 2020 and 6 October 2020. A new BLSS CREC application form was submitted, in addition to amended consent form and participant information sheets and focus group discussion guide, as revised submission of this study's ethical application no. 2020/268 (amendment to 2019/118) to the Schools of Business, Law and Social Sciences Research Ethics Committee (BLSS REC) on 6 October 2020, requesting ethical clearance for the project entitled: *UK food sustainability and global food supply chains: Sustainability impact study of Ghana's fresh vegetable export industry to the UK*. This new ethics approval was provided on 20 October 2020. This ethics approval covered the collection of data using interviews (online), focus group discussions (online), and survey.

Throughout the project, the researcher has ensured that participants are appropriately and well briefed about the project; participant information sheet and consent form were given to participants to read for a minimum period of a week and a maximum of two weeks before the interview; and focus groups were conducted. The survey was carried out online using Qualtrics and was available online for a period of three months. Participants were given up to three months to read the information sheet and consent form, and to complete the survey. The survey was discontinued for participants if they did not sign the consent forms. Throughout the study, all ethics protocols defined and outlined by CREC were duly complied with.

3.12 Summary

This chapter discussed the research methodology of the study. It drew highlights from research philosophies, selected pragmatism as the research philosophical underpinning, and justified the choice of paradigm suitable for the study. The chapter demonstrated how a good practice of choosing appropriate research methodology and methods is embedded in the study to support the justification for the adopted research strategy. It presented how both case study and survey data are analysed, and concluded with ethical considerations for the study.

CHAPTER FOUR (4)

4.0 THEMATIC ANALYSIS OF CASE STUDY DATA—SUSTAINABILITY IMPLICATIONS OF GHANA'S FRESH VEGETABLE SUPPLY CHAINS TO THE UK

4.1 Introduction

This chapter is structured to achieve three purposes: a) identify the sustainability implications (sustainability dimensions and their associated impacts) associated with Ghana's fresh vegetable supply to the UK from large- and small-scale producers' perspectives; b) distinguish a relationship between the sustainability dimensions among large- and small-scale producers; and c) develop the conceptual framework of the study, i.e., the sustainability impact assessment (SIA) model. This chapter first attempts to identify the sustainability implications associated with Ghana's fresh vegetable supply to the UK, based on case study data (interviews and focus group of large- and small-scale producers). Thematic analysis, suggested by Braun and Clarke (2006), is employed to analyse both interview and focus group data, to identify themes and sub-themes that can be further defined and finalised as the sustainability implications. Second, the study further utilises the results of the interview and focus group analysis to distinguish the relationship between large- and small-scale producers in relation to sustainability implications. This is accomplished by the use of matrix coding and visualisation tools, such as the polar diagram and word cloud.

Third, to contribute to knowledge and literature, the study develops the conceptual framework further, based on the results of the case-study data analysis. The outcome is a Sustainability Impact Assessment (SIA) model ideal for assessing and the capture of sustainability implications of food supply chains, operations, and other supply chains.

4.1.1 Identifying Sustainability Implications of Ghana's Fresh Vegetable Supply Chains to the UK

In an attempt to answer RQ1 i.e., "What are the sustainability implications associated with Ghana's fresh vegetables supply chain to the UK?", this study thematically analyses interviews and focus group data from large- and small-scale producers to identify sustainability dimensions and their associated impacts by deploying NVivo 11 (Mortelmans, 2019; QSR International, 2020). Following thematic analysis approaches suggested by Braun and Clarke (2006), and further recommendations by Nowell et al. (2017) and Peel et al. (2019), the study makes sense of the data to produce insightful analysis, identifying sustainability dimensions and impacts, and exploring meaningful patterns within the interview and focus group data. Table 4.1 simplifies the six steps of thematic analysis suggested by Braun and Clarke (2006) and shows how the study employs these steps for the analysis. Following the six steps in Table 4.1, tentative themes and sub-themes related to different sustainability dimensions are identified after collating the codes from the interviews of the case of a large-scale producer and a small-scale producer. The six themes that emerge include environmental, economic, social, and regulatory aspects, promoting sustainable food supply chain collaboration (Collaboration), and producers' complexities in developing sustainable food supply chains (Complexities). Within each theme, different sub-themes are identified and extracted. In addition, some sub-themes have codes within them, highlighting various sustainability impacts associated with such sub-themes.

Further, a focus group discussion involving a group of small-scale producers (comprising four participants) is analysed, and tentative themes and sub-themes indicating sustainability dimensions and impacts emerge. Then, another focus group discussion involving a group of large-scale producers (comprising five participants) is conducted and data analysed to identify themes and sub-themes until the point where no new sustainability dimensions or impacts were emerging.

Data saturation was reached after the focus group discussion with small-scale producers. It happened that the small-scale producers were saying and repeating the same data raised by the large-scale producers and that new themes and codes were not arising from the data. For example, when the principal investigator asked "*Can I ask a further question on that? Yes! Like, does the way they handle the things (vegetables), does it create a kind of waste or waste or damage to some of the vegetables?", all the small-scale producers in the focus group answered "Yes". The FP-FGSP (thus, First Participant of Focus Group involving Small Producers) clearly expressed: "Yes! As I said, some loaders at the airport are not trained. The loaders, those who offload the things and load it on the palette are not trained. Sometimes, they damage our produce. When they are loading it in the container or the palette in Ghana here at our Airport*". This information provided by the small-scale producers was not new, but similar to that provided by large-scale producers. The achievement of saturation is significant in ensuring that relevant and key sustainability implications are identified and appropriately mapped across participants' responses (i.e., both large- and small-scale producers) (Fusch and Ness, 2015). This enabled emergence of tentative themes, sub-themes, and codes that are finalised as sustainability implications associated with Ghana's fresh vegetables supply chain to the UK, based on the case study data (interview and focus group discussion). Using this data analysis, the study provides descriptions of themes, sub-themes, codes, and sources in Table 4.2 and further finalises the themes, sub-themes, and codes as the overarching sustainability implications associated with Ghana's fresh vegetables supply chain to the UK. Final themes, sub-themes, and codes explaining the identified six sustainability dimensions and their associated impacts are presented in Table 4.3.

Table 4.1 Thematic Analysis – Steps for identifying sustainability implications.

Steps	Activity	Example
Step 1: Familiarising with the dataset	The researcher carefully familiarises himself by reading and re-reading the transcripts of the interviews and focus group data, and notes are taken from early observations or impressions of the data.	This extract gives an impression of environmental aspects of sustainability: "Into general, into general every agriculture … it doesn't matter the way you are producing, every agriculture will affect the environment".
Step 2: Generating initial codes	Having the research question in mind, the researcher codes segments of the data relevant to the research questions deductively (based on theoretical foundation of Braun and Clarke, 2006). Also, the researcher studies the data, line by line or sentence by sentence, to code meaningful lines or sentences inductively (based on what the data reveal). A more open coding approach is, however, considered, where the researcher compares codes, re-thinks about them, and then modifies them before engaging with the remaining transcripts. This helps to modify the existing ones or generate new codes.	Codes identified in the extracts: Food losses and food waste concerns "As we are discussing now, what I loaded yesterday is still at the airport and they said they are going to send it today and I don't even know what will happen today. So we don't have flights, direct flights, a cargo flight which is moving from here to the UK" Inadequate credit facilities and financial support: "Credit facility for the exporters on this challenges time, but we didn't get that support. The little one we have that is what we are turning around with it".
Step 3: Searching the themes	The codes are examined and patterns that clearly fit together are put into a theme. At this point, the codes organised into a theme reveal some specific or relationship to the research question.	These extracts coded are examined and put into a theme as "Food losses" and "Food waste concerns". "They can go and harvest it in somebody's farm. So we too we want to make sure that we put a sanitary and the quality check is there. And so that is the platform, the software we are using now for our farm". "As we are discussing now, what I loaded yesterday is still at the airport and they said they are going to send it today and I don't even know what will happen today. So we don't have flights, direct flights, a cargo flight which is moving from here to the UK". "The labourers at the airport are not trained on how to handle vegetables. Sometimes, when they offload the things from your car and they pack it on the container or on the palette, they force some of the boxes and they break the produce."

Step 4: Reviewing themes	The researcher ensures sense-making by reviewing, modifying, and developing the initial themes. At this point, sub-themes are put into main themes. Also, whether the data supports the theme and there are no other themes within the data are double checked.	These extracts coded are examined and put into a theme as "Economic Aspects of Sustainability". "You know the whole issue is; price can never come from a farmer. Because we are exporting the produce so per what we are selling over there is what will also measure to buy the produce from the farmers". Coded as on-FairTrade market. "There is no watchdog but, the ministry also check because they work closely to them". Coded as Lack of institutional proximity. "The labourers at the airport are not trained on how to handle vegetables. Sometimes, when they offload the things from your car and they pack it on the container or on the palette, they force some of the boxes and they break the produce". Coded as Food waste concerns.
Step 5: Defining and naming themes	The researcher defines the essence of each theme, clearly explaining what the themes and sub-themes mean and how they relate with each other.	From the example of step 4, the Economic Aspects of Sustainability reveal the activities, encounters and concerns about the producers' operations and supply chains that imply some economic impacts. This can be food loss, food waste, food sorting, FairTrade issues, or other initiatives that can provide economic value or loss for producers.
Step 6: Producing the report	The researcher extracts or exports codebook, matrix coding output and word cloud provided by NVivo 11 for writing up of the final analysis to answer the research question(s) of the study.	See Tables 4.2, 4.3, and 4.4 as well as sections 4.2 and 4.3 as examples of outputs for the report.

Source: Author's work based on Braun and Clarke (2006).

4.2 Identifying Sustainability Implications of Ghana's Fresh Vegetable Supply Chains to the UK—Sustainability Dimensions and Impacts

Following the thematic analysis suggested by Braun and Clarke (2006) and presented in Table 4.2, this study identifies tentative themes and sub-themes that can explain the sustainability implications associated with Ghana's fresh vegetables supply to the UK. The tentative themes and sub-themes extracted are supported with quotations from the interviews and focus group data. To be clear, some key reflective words, phrases, and sentences are underlined and italicised within the supportive quotations to draw attention to producers' experiences, operations, and activities that instigate the themes and sub-themes.

4.2.1 Tentative Theme I—Environmental Aspects of Sustainability

This is one of the sustainability dimensions identified according to the producers' experiences and responses. This sustainability dimension (theme) captured three sustainability impacts (sub-themes), which are: CO_2 emissions related to logistical activities; environmental concerns; and promoting environmental sustainability. These sustainability impacts (sub-themes) are derived from various codes that are intertwined.

4.2.1.1 Sub-theme I: CO_2 emissions related to logistical activities

Producers discuss negative environmental impacts, mainly CO_2 emissions relating to their operations and logistics activities, e.g., packaging, warehousing, and transportation of fresh vegetables. This sub-theme, CO_2 emissions related to logistical activities, is coded as "Logistical activities CO_2 emissions". Producers' responses clarify this sub-theme:

> "*We harvest the produce, then <u>transport</u> it from the farm to the packhouse ... and then after sorting everything, we transport it again to the ... the airport for the goods to arrive to its destination"* (from I-LSP).
>
> "*because it is <u>a perishable product</u>, it has to be transported by ... an air freight"* (from I-LSP).
>
> *"issue about <u>the carbon and emissions</u>. We have an issue in Ghana. So we didn't take any action to reduce it"* (from SR of FGD-LSP). Appendix 11 provided as evidence.

Key words identified: *Transportation*, *perishable food* and *CO_2 emissions* are generated from the codes to create the sub-theme, "CO_2 emissions related to logistical activities".

Despite significant logistical activities, CO_2 emissions that emerge from producers' production and supply chains, it is emphasised that CO_2 emissions generated are mainly associated with airfreight of the vegetables to the UK. For example, one large-scale producer stresses: “Apart from Airfreight, that is”.

4.2.1.2 Sub-theme II: Environmental Concerns

Environmental concerns emerge as another sub-theme of environmental aspects of sustainability. According to the producers, environmental awareness, environmental licensing, and inspections for environmental sustainability account for environmental concerns of their fresh vegetables supply chain to the UK. Producers (both large- and small-scale producers) expressed their awareness of the environment; however, the large-scale producers are more associated with environmental licensing. Despite that, respondents indicated that producers are licensed by the Environmental Protection Agency (EPA) of the country. This environmental licensing restricts producers from using chemicals, machinery, and approaches that have negative environmental impacts and encourages them to redirect their operational activities to positive environmental or sustainable practices. Also, producers clearly indicated that the authorities (e.g., EPA) conduct field inspections regularly to enable enhanced environmental sustainability. Following are excerpts from the producers’ responses indicating environmental concerns, i.e., environmental awareness, environmental licensing, and inspections:

> *“Into general every agriculture ... it doesn’t matter the way you are producing, every agriculture will affect the environment. Because ... we are into ... our input will definitely affect environmental […] ... our… yes effect not in large quantity but definitely ... once is ... cultivation is increasing there will be deforestation and also when we are ... you know using ... input definitely will affect the water body and all ... all those things not in large quantities. But yes! Minorly yes. We cannot say hundred per cent we are safe, no. minorly yes”* (from SR of FGD-LSP).

> *“The smoke of the pumping machine affects the environment though”* (from a SR of FGD-SSP).

> *“We harvest the produce, then transport it from the farm to the packhouse ... and then after sorting everything, we transport it again to the ... the airport for the goods to arrive to its destination. Now, what we are doing to…I mean to reduce the impact of the CO_2 is this… Moving forward, we plan of having an enclosed van… like a cold van which can convey the thing from the farm to the packhouse and then same convey it to the packhouse to the ... to the airport”* (from I-LSP).

"We are registered under their supervision. They are …doing the right thing or checking us on what we should do or we should not do" (from I-LSP).

Keywords identified: Producing, affect environment, deforestation, water body, pumping machine, packhouse, and supervision are generated from the codes to create the sub-theme, environmental concerns.

4.2.1.3 Sub-theme III: Promoting Environmental Sustainability

Producers' responses suggest that they are engaging in several practices and activities that are promoting environmental sustainability. This sub-theme (promoting environmental sustainability) is grouped or categorised into farm sustainability, reducing environmental impact, and sustainable agriculture practices. In other words, the sub-theme is derived from the codes—farm sustainability, reducing environmental impact and sustainable agriculture practices—that are intertwined. These are the approaches and practices on the farmlands and at the warehouses (packhouses) which enable producers to contribute to environmental sustainability. It can further be explained that both types of producer (large- and small-scale) show similar interactions regarding promotion of environmental sustainability. Several claims from the interviews and focus groups indicate producers' contributions towards promoting environmental sustainability. These include producers maintaining good agricultural practices, e.g., planting trees, using field traps, planting trees instead of pesticides, that reduce environmental impact:

> *"Yes! I think I said something earlier mainly when you … the first thing that you have to tackle is how you can keep good agricultural practices on the field. Then after it you then look at your pest management, low you can manage your pest. Managing the pest… is what I said earlier … by what we currently known for now to do more of trapping on the field… So that, and then"* (from I-LSP).
>
> *"So even some of us planting trees and other things in the farm"* (from SP of FGD-LSP).
>
> *"how we dispose our chemicals and residues…We normally use them … to prevent them not to go to the water bodies so […] … And… we use it as a compost […]. … So […] and then … "* (from FR of FGD-LSP).

Keywords identified: Pest management, trapping, planting trees, and prevention are generated from the codes to create the sub-theme, Promoting Environmental Sustainability.

4.2.2 Tentative Theme II—Economic Aspects of Sustainability

This is the second sustainability dimension themed from the producers' responses, economic aspects of sustainability. It is explained that there are some value, cost, loss, investment, or price (thus, economic aspects) associated with producers' activities, role, and yield (produce). Respondents reveal that the economic aspects of the sustainability dimension (theme) consist of two sub-themes, i.e., FairTrade concerns and food waste concerns. These sub-themes (impacts) of the sustainability dimension are derived from codes that are intertwined.

4.2.2.1 Sub-theme I: FairTrade concerns

FairTrade concerns is one of the sub-themes under economic aspects raised by producers. Producers further discuss that the FairTrade concerns of Ghana's fresh vegetable supply chain are characterised by lack of institutional proximity and Non-FairTrade market. Both the large- and small-scale producers who participated in the interviews and focus group bemoan the non-existence of institutional guidance and FairTrade affecting economic value or relevance of their activities or produce. Following are excerpts from some of the producers:

> *"That is what we don't have in the vegetable sector. So, if it is possible to have something like this. But then it's going to take time and then a lot of resources, research need to be done to be able to come out with a clear-cut criteria or whatever we have. So, that might take a while but it is possible I'm sure it's possible but it might take a while*" (from THR of FGD-SSP). Appendix 12 provided as evidence.

> *"Sometimes, when they go to the farm, they ask the farmers the price. How much do we pay them per kilo and all those things. Because we work together with them. So there is but, there is no institution we have. You know in Ghana we don't have ... formally price across. Like how are other countries do… you go to Kenya or Ivory coast. If its mango, mango price is uniform. You go to Kenya, okra price is uniform across. But Ghana is not like that, people sell with basket, people sell with sack. So we don't follow the price with a kilo. It's a big challenge. So we pay prices because the farmer knows ... the outgrower knows the price it is going to pay is going to sell to the exporter before he even starts growing. So we follow that, so there is no institution like a watch dog. No no no! There is no institution"* (from FR of FGD-LSP).

"You know the whole issue is; price can never come from a farmer. Because, we are exporting the produce so per what we are selling over there is what will also measure to buy the produce from the farmers" (from FR of FGD-SSP).

Keywords identified: Vegetable sector, price, no institution, watch dog, farmer, exporting and produce are generated from the codes to create the sub-theme, FairTrade concerns.

4.2.2.2 Sub-theme II: Food losses and food waste concerns

Also, producers' responses indicate that another relevant sub-theme under economic aspects of sustainability is food loss and food waste concerns. Respondents express concerns and issues related to their vegetable production, operational practices, and supply chain that generate economic loss, such as food loss and food waste. This sustainability impact (food losses and food waste concerns) further highlights other codes, such as food sorting, food waste concerns, and reducing food waste. These codes explain producers' operational and supply-chain activities leading to loss or waste from harvesting, through to the airport to the UK, and the measures that producers have adopted to reduce some of the impacts. Following are excerpts from producers indicating this sustainability impact, food loss and food waste:

"At least 5% I think that is what goes to waste" (from I-SSP). Appendix 13 provided as evidence.

"The labourers at the airport are not trained on how to handle vegetables. Sometimes, when they offload the things from your car and they pack it on the container or on the palette, they force some of the boxes and they break the produce" (from FR of FGD-SSP).

"Before, you even get it to the airport, there's no flight, or your load is even left behind and they will tell you it's going to go the next day before you realise, it left behind again. All these are issues that are bothering we the exporters and even the farmers as well. So, if the field is good to go, at least we are able to make maximum and even able to maximise profit on the field before even" (from SR of FGD-SSP).

Keywords identified: Waste, not trained, handle vegetables, pack, force, break, no flight and load are generated from the codes to create the sub-theme, Food losses and food waste concerns.

4.2.3 Tentative Theme III—Social Aspects of Sustainability

The third sustainability dimension (theme) identified from the data is social aspects of sustainability. This indicates measures, approaches and systems in place ensuring consumers and other FSC actors know the source of the vegetables and that the vegetables are safe, healthy and nutritiously produced. This theme consists of two sub-themes: promoting transparency and traceability, and traceability of local producers.

4.2.3.1 Sub-theme I: Promoting transparency and traceability

Promoting transparency and traceability emerges as the first sustainability impact (sub-theme) of social aspects of sustainability. This impact identified from producers' responses describes the use of "Farm codes" to ensure that vegetables produced and supplied are transparent and traceable. It is clear from the responses that these Farm codes are acceptable both locally and internationally.

> *"Apart from the <u>Farm code</u>, what happens is … the Farm code helps you to <u>trace</u> to the farm what we have been doing because, whatever we have <u>information</u> that is sent to"* (from I-LSP). Appendix 14 provided as evidence.

> *"Normally we have the … […] <u>traceability</u> … […] system. Whereby we also take the GPS <u>coordinates</u> of the farm and we attach it to the goods of that farm"* (from THR of FGD-LSP).

> *"We have a Farm code and all our <u>outgrowers are having it</u>"* (from FR of FGD-SSP).

Keywords identified: Farm code, trace, information, traceability, coordinates and outgrowers identified are generated from the codes to create the sub-theme, Promoting transparency and traceability.

4.2.3.1 Sub-theme II: Traceability of local producers

Another sub-theme identified is traceability of local producers. This impact suggests how producers are adopting additional approaches to make their vegetables traceable. Although this might not have international recognition as the previous impacts (Farm code), producers are utilising this approach to provide information (additional sheet) for consumers and other FSC actors and avoid any other challenges that may arise from the supply chain.

> *"Before in the UK in 2019 or just 2018, we have an issue on when we send goods to the UK was interception all the farm produce as 1. Even if is gone from <u>different</u>*

code. ... but they are intercepting everything as one. Once they have found in one then they are destroying all the goods. But later let ... on 2018 September, I think September I was in the UK myself alone. I had an issue with a UK authority that's DEFRA. ... And I went to talk to them that 'no you cannot destroy all the product at a time because we have been having different code' and later they got to know. And they have been advising us to how to indicate on the additional sheet. From that we start additional ... declaration sheet and now everything is going on smooth and all the goods is arriving there have a traceability system but we can (trace back) to where the goods come from, in case of any problem" (from SR of FGD-LSP).

"First with manual indicated at you that we are manually doing it. So specially, just example, product X. product X came from farmer A to, we recorded this so many boxes came from farmer A to product X. Then total number, like product ABCD and especially all the farmers, maybe XYZ farmers. So all those farmers' total and the total of export, it needs to be tallied. That means all this product we have been bought it and whatever rejected , we have been internal manual system that. To check the goods that is it up to standard before it gone to PPRSD. So when they go to PPRSD, PPRSD will also check, when it's okay then we know that this number of boxes have been left from Ghana to export to the UK" (from FR of FGD-LSP).

Keywords identified: Different code, additional sheet, traceability system, manual, from farmer A to product X (identification) and internal manual system are generated from the codes to create the sub-theme, Traceability of local producers.

4.2.4 Tentative Theme IV—Regulatory Aspects of Sustainability:

"Regulatory" is revealed as another theme (sustainability dimension) from producers' responses. All local and international regulatory frameworks, protocols and procedures that producers need to comply with are themed as regulatory aspects of sustainability. The sustainability dimension (theme) consists mainly of two sub-themes—external regulatory oversight and internal regulatory oversight.

4.2.4.1 Sub-theme I: External regulatory oversight

This sustainability impact (sub-theme) clearly highlights the protocols and standards set out by international authorities that producers need to comply with to export overseas or to the UK. Producers must adequately follow these regulations before getting approval with a phytosanitary certificate from their local authorising body to be able to export their vegetables overseas. The following excerpts from interviews and focus group clarify:

> *"I was talking about the standards. The international standards for phytosanitary measures. That is the one document [...] that directs all our exports from the... the countries that are in the trade"* (from THR of FGD-LSP). Appendix 15 provided as evidence.

> *"Oh okay, it seems he has said it all but one thing too is that the EU also have their regulation that the PPRSD is also depending on. So, everything that SR said is being extracted from the EU regulations so that we meet their demands... So, if it happens that we do not meet the demands from the EU, it means that our produce can't go"* (from SR of FGD-SSP).

> *"Yes we follow those, all the regulations. EPA, ... Food and Drugs Board, ... Ghana Standard Authority. We follow all those ones but PPRSD; we work closely with them more than the rest of the organisations"* (from FR of FGD-LSP).

Keywords identified: International standards for phytosanitary, exports, EU regulation, and all regulations are generated from the codes to create the sub-theme, External regulatory oversight.

4.2.4.2 Sub-theme II: Internal regulatory oversight

The local authorities, such as PPRSD, provide regulatory oversight for both international and local institutions. The responses from the producers suggest internal regulatory oversight (sub-theme) as another sustainability impact associated with the regulatory dimension. However, the internal regulatory protocol culminates in producers receiving their phytosanitary certificate for following all procedures and protocols from the local authorities. Responses from producers indicate the existence of local checks:

> *"As I mentioned, we have an institution called PPRSD Ghana. So before we export for ... when you go to them, they will tell you to register their company from there, you also have to register with GIPA. And then, they also like to know your farm, they visit your farm, and then from your farm, you know we have protocol developed by PPRSD, you have to follow that protocol for your production. And also from there, they also ensure that you have a pack house; a standard pack*

house; it's not just a place pack house but they will come and check if everything is fine. And also they will check the vehicles the you will be using to carry the things, transporting the things from the warehouse to the airport so when they check and all these things are working before they will give you the green light to export. And also, your produce from the farm, they will pick samples to the lab and test and if your produce is okay, they will issue a certificate based on that you can use" (from FR of FGD-SSP).

"A lot organisation, <u>Food and Drugs Board is there, Ghana Standard Authority</u> […] even helps in terms of the <u>export requirements</u>. You have to follow the export protocol which they develop. We develop together with them" (from FR of FGD-LSP).

"Then, we have this agency, that is the Ghana Standard Authority. With some of the agencies that come around, sometimes they do ask you or if you want to renew <u>FDA certificate</u>, they check and see whether you've done MRL test on your produce before they can certify you again" (from SR of FGD-SSP).

Keywords identified: Local authorising body, local protocol, other local food authorising bodies, export requirements and local certification are generated from the codes to create the sub-theme, Internal regulatory oversight.

4.2.5 Tentative Theme V: Promoting Sustainable Food Supply Chain Collaboration

Another sustainability dimension (theme) extracted from the producers' responses is promoting sustainable food supply chain collaboration. Although the four themes (environmental, economic, social, and regulatory) are critical, the respondents' opinions indicate that collaboration is vital; and there are a considerable number of collaborative activities between producers and other FSC actors. This theme produces three sub-themes: a) activities of food supply chain collaboration for sustainability; b) institutions of food supply chain for sustainability; and c) smart partnership, supply chain contracts and relationship. These sustainability impacts (sub-themes) are derived from different codes that are intertwined.

4.2.5.1 Sub-theme I: Activities of food supply chain collaboration for sustainability

According to the producers, activities of key institutions (both public and private), by partnering and providing collaborative initiatives, are spearheading a sustainable food supply chain. These activities include those of institutions such as PPRSD, overseeing environmental sustainability; activities of institutions such as EPA and Global G.A.P., overseeing environmental sustainability; activities of institutions such as PPRSD and Ministry of Food and Agriculture (MOFA), overseeing environmental sustainability; and activities of institutions such as Global G.A.P., FAGE, and PPRSD overseeing environmental sustainability. Sustainable agriculture initiatives, training and education, supervision, and networking events are some of the examples of the activities from the key institutions that are spearheading food supply chain collaboration for sustainability. Excerpts of producers' responses highlight that:

> *"We do go for meeting; we are under them and they make sure that whatever that we are sending we… they train us properly how to handle those things.…And Pokuase officers are also involved. The Agric officers PPRSD… They go for inspection, they inspect. Before they give you traceability or code they make sure they go to farm and check what you are doing and then before they can allow you to export. We don't just get up and then send those…And I think they give a kind of training to our up growers, people are suppliers"* (from I-SSP).

> *"They are regulating our vegetable sections and then giving us a fair idea what we have to make our regular market"* (from I-LSP).

> *"So those are some of the few engagement we … we engaged the ministry for … and then … in terms of the … inputs… like seed, we also engaged the dealers to talk to them and they… also they are … working towards … by the second month or third month of this year those input will start coming"* (from FR of FGD-LSP).

> *"We do attend meetings for that kind of things and they train us purposely for… those things"* (from I-SSP).

Keywords identified: Meeting, training, inspection, regulating, engagement and collaboration are generated from the codes to create the sub-theme, Activities of food supply chain collaboration for sustainability.

4.2.5.2 Sub-theme II: Institutions of food supply chain for sustainability

From the data, it is apparent that key institutions are providing different roles, initiatives, and activities to support producers in their contributions towards sustainable food supply chains. The producers indicate these key institutions as a sub-theme (i.e., institutions of food supply chain for sustainability) The sub-theme consists of four main institutions which are from intertwined codes: institutions overseeing traceability; institutions promoting environmental sustainability; institutions promoting regulations; and institutions promoting sustainable practices. Some of the excerpts from the respondents clarify that:

> *"Yes! Government regulation that are helping us is the PPRSD – Plant Protection and Regulatory Services Department which they which they are more into"* (from I-LSP).
>
> *"But because Global G.A.P. certification is the… external auditors that come to ensure that you are doing A, B, C, D …"* (from FTHR of FGD-LSP).
>
> *"Yeah there is a lot of engagement we do with … our mother ministries; the Ministry of Trade and Ghana Export Promotion Authority"* (from FR of FGD-LSP). Appendix 16 provided as evidence.

Keywords identified: Government, departments, external auditors, ministries and authorities (agencies) are generated from the codes to create the sub-theme, Institutions of food supply chain collaboration for sustainability.

4.2.5.3 Sub-theme III: Smart partnership and relationship and supply chain contracts

In addition to collaboration activities and institutions promoting sustainable food supply, producers suggest that smart partnership and relationships, and supply chain contracts, constitute another sustainability impact (sub-theme) to consider. Producers emphasise that they utilise farming support, agreements, and relationships with smallholders, outgrowers, or other local farmers to facilitate this sustainability impact. This sub-theme is derived from two different codes: a) smart partnerships and relationship management; and b) supply-chain contracts. Some of the producers clarify that:

> *"Every exporter has his/her outgrowers or farmers he works with. It isn't like you just go to the wild and pick from there. So it's the negotiation between you and your farmer or you and your outgrowers. So when I sponsor you, this is the agreement; this is what I'm going to invest in your farm when your produce come, how much you agree to pay"* (from SR of FGD-SSP).
>
> *"Yes, we do. Like the outgrowers what I do with them. I plough the land for you, give you the input, then when I buy the things from you, we do the deduction"* (from FR of FGD-LSP).

"In terms of support for our outgrowers we do. Sometimes we help them in terms of cash anytime they need money to expand their farm, we help in terms of cash. Anytime they need money to expand their farm, we give them money and then sometimes too we buy fertiliser and other things and their chemicals that they need to farm. We do all these things to help our farmers to expand before we get" (from I-SSP).

Keywords identified: Negotiation, sponsorship, agreement, investment, support, calculation, expansion and other assistance generated from the codes to create the sub-theme, Smart partnership and relationship and supply chain contracts.

4.2.6 Tentative Theme VI—Producers' Complexities in Developing Sustainable Food Supply Chains

"Complexities" is the sixth sustainability dimension (theme) identified from the responses. The theme mainly captures challenges and concerns towards developing sustainable food supply chains. Producers' responses about complexities generated two sub-themes: a) complexities in developing sustainable food supply chains; and b) local producers' complexities. These sustainability impacts (sub-themes) are generated from different codes that are intertwined.

4.2.6.1 Subtheme I: Market Dynamics and Uncertainties

Producers discuss external challenges which constrain their contributions towards developing sustainable food supply chains. These external challenges are collated into a sub-theme as market dynamics and uncertainty. This sub-theme is generated from the codes, i.e., competitive market from overseas producers; COVID-19 challenges; and opportunities and logistical challenges. Although some of the implications from market dynamics and uncertainties can motivate productivity and innovations, such as COVID-19 opportunities, respondents, however, claim that this impact (sub-theme) usually causes difficulties that hinder their food production and supply chain, as well as their ability to compete in the global food market. Excerpts from producers' responses explain that:

"The reason why I am saying this, though it affected our work and it create opportunity for us, especially the UK belt. So some of the challenges … is because, I have to be brief …the logistic issue is a big challenging to us. … If I say logistic issue, freight cost is high … because of the lockdown, beginning up to now we are struggling, freight is high, something we normally pay 80 cents ...or 1 dollar we

are … paying double of that price now. … so it's a big challenges to us, so those are some of the issue affecting the export sector … So those are the challenges because our main destination […] is facing a big challenges in that sector now, in terms of logistics issue. … the other hand is that, since COVID some of the seed we normally use, you know in Ghana we don't produce seed. Some of the seed have to be imported, so those factories we get seed from through our suppliers in Ghana, the seed are not coming. Due to the COVID issue. So basically those are some of the big challenges we are having. […] The market is solid but produce is not available because of logistics. […] So basically that is what I want to say if my colleagues have something they can add " (from FR of FGD-LSP).

"During COVID, there was a lockdown in Ghana so they were not able to travel to their various farms to work on their farms. And also, in our warehouses, the labourers that we are working with, some of them are coming from other places and they also use public transport to the workplace and during the lockdown's time, they were not able to come to job. And also, there was a lockdown at the airport, passenger flight is not coming in, none is going so we were only having only one cargo flight, when it comes once a week. And this cargo flight, when it comes, if IAB finds in having produce like 5 tonnes, they only took at 1.5 tonnes. Because of that, we've lost our produce from the farm and even in the warehouse as well. Even if we have the produce, there's no flight so we … not able to export what we are supposed to do. So due to all that, our revenue has come down, let's say it has come down to 60%. So…. This is the way the COVID has affected our export" (from FR of FGD-SSP).

"Though we realise that[…]…. Those we have been competing with… they have been getting their flight cheaper than what we get" (from FTHR of FGD-LSP).

"So sometimes, it affects our exports industry like; getting more orders to export in volumes let's say from Dominica Republic to the UK. Sometimes, they charge 1 Dollar 10 cent and from Ghana to the UK, they are charging 2 Dollars, some charging 2.50 Dollars meanwhile from there to the UK is the same hour to the UK. So because of that, sometimes let's say when you take to vegetables, to vegetable, is coming from Dominica Republic to the UK because of our freight is expensive,

they reduce our order and give more order to the Dominica exporters" (from FR of FGD-SSP*).*

Keywords identified: Market opportunities and challenges, COVID, restrictions, transportation challenges, export challenges, competition, and high freight charges generated from the codes to create the sub-theme, Market Dynamics and Uncertainties.

4.2.6.2 Sub-theme II: Local producers' complexities

Responses also suggest another complexities sub-theme, such as local producers' complexities; in other words, challenges facing their production and supply chain locally. These cover inadequate credit facilities and financial support; inadequate government support and policy; lack of knowledge of food processing; limited knowledge of efficiency; and local challenges of complex food supply chains. Although producers advocate for support from the government, the third sector, and private FSC organisations to minimise the impacts associated with complexities (this sub-theme), evidence of these local complexities is clear and well-argued by their responses:

> *"Trap is very expensive and even we don't have that available so you have to struggle, the little that you get, you but it at a very price high cost. So on the field, all this thing goes on there. You produce and you do not get your yield that you want" (*from SR of FGD-SSP). Appendix 17 provided as evidence.

> *"From the support of … government or any funding agency, we don't receive anything for the last meetings. Also, it has affected well! well! well! on our, … due to the prices and cost of the … items like cost of the freight and had gone up and affect us a lot. So on the funding side we don't have any funding"* (from SR of FGD-LSP).

> *"Credit facility for the exporters on this challenging time, but we didn't get that support. The little one we have that is what we are turning around with it"* (from FR of FGD-LSP).

> *"One important thing is the input. The inputs are mostly expensive. They are very very expensive and you know, mostly, some of the certified insecticide we buy is very expensive, and sometime, we have to adjust ourselves because of the weather conditions to it"* (from SR of FGD-SSP).

Keywords identified: Expensive farm inputs, inadequate financial support, no credit facilities and weather conditions (production challenges) are generated from the codes to create the sub-theme, Local producers' complexities.

In summary, this study identifies six key sustainability dimensions and their associated impacts from the producers' experiences and responses (i.e., the interviews and focus group data). Based on producers' accounts, the themes and sub-themes are described and interpreted to provide explicit content of the text and its underlying meaning in the respondents' words. Table 4.2 presents descriptions of themes, sub-themes, and codes as well as references or sources of data that informed or linked to the themes. The significant number of references or sources of data obtained enhance saturation. It also explains the essence, intellectual content, and the fitness of the data in relation to the research question, according to producers' (respondents') experiences and opinions on sustainability implications of Ghana's fresh vegetable supply chain to the UK.

Table 4.2 Descriptions of themes, sub-themes, codes and sources

Themes	Sub-themes	Codes	Description/Explanation	References/Sources of Data informing Themes
Theme I: Environmental Aspects of Sustainability	CO_2 emissions related to logistical activities	Logistical activities CO_2 emissions	CO_2 emissions related to packaging, warehousing, and transportation of fresh vegetables.	50 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
	Environmental Concerns	Environmental awareness	Education, decisions, activities, and practices of producers that enhance environmental protection and sustainable development.	
		Environmental licensing	Practices and activities of institutions such as EPA that ensure that producers' operations are properly licensed, to enable them to follow protocols to minimise negative environmental impacts,	
		Inspections for environmental sustainability	Field inspections by environmental authorities, e.g., EPA, that foster environmental protection.	
	Promoting environmental sustainability	Farm sustainability	Includes activities that explain either sustainable value, value contribution or sustainable efficiency of the farm.	
		Reducing environmental Impact	Activities that contribute to reducing any environmental impact.	
		Sustainable agricultural Practices	Producers' practices and activities on their land considered safe, healthy, and sustainable practices.	

Theme II: Economic Aspects of Sustainability	FairTrade concerns	Lack of institutional proximity	Institutional proximity refers to the rules, norms, conventions, and regulations that govern relationships between actors	34 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
		Non-FairTrade market	Market where there is no existence of FairTrade, and at the introductory stage.	
	Food losses and food waste concerns	Food sorting	Activities of sorting out inedible food, either generally inedible or having deteriorated after harvesting.	
		Food waste concerns	Activities or concerns of decrease or discarding of food at all the stages of the food supply chain prior to final consumption.	
		Reducing food waste	Activities directed towards reducing food waste.	
Theme III: Social Aspects of Sustainability	Promoting transparency and traceability	Promoting traceability	Methods or approaches locally adopted to help all FSC actors trace the source of food. This includes the use of the Farm code.	13 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
		Promoting traceability and transparency	Methods or approaches locally adopted to help all FSC actors trace the source of food and what they are consuming. This includes the use of the Farm code and Food labelling .	
	Traceability of local producers	Traceability of local producers	Other approaches used by producers to enable FSC actors to trace food sources.	

Theme IV: Regulatory Aspects of Sustainability	External regulatory oversight	External regulatory checks	All activities, rules, and regulations put in place by external authorities rather than Ghana to oversee exports of vegetables.	17 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
	Internal regulatory oversight	Internal regulatory checks	All activities, rules, and regulations put in place by authorities in Ghana to oversee exports of vegetables.	
Theme VI: Promoting Sustainable Food Supply Chain Collaboration	Activities of food supply chain collaboration for sustainability	Activities of institutions overseeing environmental sustainability	Activities of institutions such as PPRSD overseeing environmental sustainability.	87 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
		Activities of institutions overseeing traceability	Activities of institutions such as EPA and Global G.A.P. overseeing traceability.	
		Activities of institutions promoting regulations	Activities of institutions such as PPRSD and the Ministry of Food and Agriculture (MOFA) overseeing environmental sustainability.	
		Activities of institutions promoting sustainable practices	Activities of institutions such as Global G.A.P., FAGE, and PPRSD overseeing environmental sustainability.	
	Institutions of food supply chain collaboration for sustainability	Institution overseeing traceability	Institutions such as PPRSD overseeing traceability (Farm code) activities and measures that can help consumers and other FSC actors trace sources of food.	

		Institutions promoting environmental sustainability	Institutions such as EPA and Global G.A.P. overseeing activities, protocols and procedures that enhance environmental sustainability.	
		Institutions promoting regulations	Institutions such as PPRSD and the Ministry of Food and Agriculture (MOFA) overseeing regulations of production and supply of vegetables.	
		Institutions promoting sustainable practices	Institutions such as Global G.A.P., FAGE, and PPRSD overseeing activities regarding sustainable practices.	
	Smart partnership and relationship, and supply chain contracts	Smart partnership and relationship management	Explains the financial and other innovative support exporters give to farmers to help them improve their productivity.	
		Supply chain contracts	Sets out the guide and agreement between both parties (farmers and exporters) with which they must comply.	

Theme VI: Producers' Complexities in Developing Sustainable Food Supply Chains	Market Dynamics and Uncertainties	Competitive market	Challenges and concerns for producers created or enabled by other markets internationally, including prices, technology, and other producers	43 sources include I-SSP, I-LSP, FGD-SSP and FGD-LSP
		COVID challenges and opportunities	Concerns and difficulties presented by COVID regarding producers' production and supply chain. And opportunities including collaborations, innovations, sales in other markets, extra funds, and ideals presented by COVID to enhance producers' production and supply chain.	
		Logistical challenges	Concerns or issues regarding airfreight or other transportation modes to the UK, as well as packaging and warehousing difficulties that producers face. These concerns are usually prompted by government policies, energy issues and some constraints from other FSC players.	
	Local producers' complexities	Inadequate credit facilities and financial support	Issues, concerns, or activities that indicate producers have less or no accessibility to funds, credit or any financial support.	
		Inadequate government support and policy	Measures, programmes, policies, and support initiatives that are readily available for producers or that indicate ineffectiveness of any of these support systems	

		lack of the knowledge of food processing	Issues and activities that indicate limited or lack of knowledge of food processing on the part of the producers.	
		limited knowledge of efficiency	Issues and activities that indicate limited or inadequate knowledge of efficiency in terms of producers’ operations.	
		local challenges of complex food supply chains	Other challenges facing local farmers in their production and supply chain, other than credit facilities, government support, food processing difficulties, and limited knowledge of efficiency.	

For purposes of generalisation, this study adopts the recommendations of Yin (2009), Polit and Beck (2010), and Maxwell and Chmiel (2014) on analytic generalisation, which enable the researcher to adopt the two-step process by first developing conceptualisation through scrutiny and identifying information that is relevant to the study. To demonstrate that, the case study findings revealed key themes, and the sequence of the identified themes was evidence from different sources of the data. Then, the researcher used and finalised the identified themes to imply the main themes obtained from the data. This helps the researcher to arrive at an insightful generalisation concerning the study through rigorous analysis and confirmatory strategies at the point of interpretation. Therefore, the sub-themes and codes are finalised by linking them to more appropriate concepts—i.e., sustainability impacts that are relevant to the study—to enable generalisation. Hence, Table 4.3 explains six sustainability dimensions identified and finalised from the analysis of the case study data, as well as identified sustainability impacts and generalised sustainability impacts, from the sub-themes and codes (identified sustainability impacts) for the furtherance of the study, especially for the development of the conceptual framework (SIA model).

Table 4.3 Six sustainability dimensions and their associated impacts—Finalised sustainability dimensions and generalised sustainability impacts

Respondents or Producers	Finalised Sustainability Dimensions	Identified Sustainability Impacts	Generalised Sustainability Impacts
Large Producers and Small Producers	Environmental Aspects	• Logistical activities CO_2 • Environmental awareness • Environmental licensing • Inspections for environmental sustainability • Farm sustainability • Reducing environmental impact • Sustainable agricultural practices	• Logistical activities CO_2 • Environmental awareness • Environmental licensing
	Economic Aspects	• Lack of Institutional proximity • Non-FairTrade Market • Food waste • Food loss • Reducing food waste	• Lack of Institutional proximity • Non-FairTrade Market • Food waste • Food loss
	Social Aspects	• Promoting traceability (Farm code) • Promoting traceability and transparency (Global G.A.P./Green Label and Farm code) • Traceability of local producers	• Global G.A.P./Green Label • Farm code
	Regulatory Aspects	• External regulatory checks (phytosanitary certification) • Internal regulatory checks (phytosanitary certification)	• Phytosanitary certification
	Collaboration	• SFSCC Institutions and Activities • Smart Partnerships and Relationship	• SFSCC Institutions and Activities • Smart Partnerships and Relationship

		• Supply Chain Contracts and Relationship	• Supply Chain Contracts and Relationship
	Complexities	• Competitive market • COVID-19 opportunities and challenges • Logistical challenges • Inadequate credit facilities and financial support • Inadequate government support and policy • Lack of the knowledge of food processing • Limited knowledge of efficiency • Local challenges of complex food supply chains	• Competitive market • COVID-19 opportunities and challenges • Logistical challenges • Inadequate credit facilities and financial support • Inadequate government support and policy • Lack of knowledge of food processing • Limited knowledge of efficiency • Local challenges of complex food supply chains

4.3 Relationship between sustainability dimensions among large- and small-scale producers

Matrix coding query suggested by NVivo 11 (Mortelmans, 2019; QSR International, 2020) is employed to provide relationship or interactions between the sustainability dimensions among large producers and small producers. The case interview and focus group were used to explore this relationship. This enables producers, other FSC players, policymakers, and researchers to appreciate the sustainability dimensions that are more important or require development. Matrix coding has the capacity to reveal a wide range of questions regarding the data to draw patterns and relationships (Hutchison et al., 2010). The study utilises the six sustainability dimensions drawn from the thematic analysis and explores further from the data the interactions or relationships that exist within responses or data (from the interviews and focus group of large- and small-scale producers). The results of matrix coding are presented in Table 4.4, demonstrating the interactions or relationship between sustainability dimensions from the perspective of large- and small-scale producers. Appendix 18 provides evidence of Matrix Coding from NVivo 11. The different relationship between sustainability dimensions among large- and small-scale producers can help align more realistic and relevant initiatives, measures, and approaches to enhance sustainable food supply chains for different classes of producer.

Table 4.4 shows the six main sustainability dimension interactions within the data captured from each producer perspective. These sustainability dimensions include economic and environmental aspects of sustainability; local producers' complexities in developing sustainable food supply chains; promoting sustainable food supply chain collaboration; regulatory aspects of sustainability; and social aspects of sustainability. Regarding the environmental aspects of sustainability, there is clear indication that data from both classes of producer reveal the theme that reflects environmental dimension of sustainability, with the significant number of 27 references from the large-scale producers and 23 references from the small-scale producers, although the large-scale producers are found to be more associated with environmental aspects compared to the small-scale producers. Initially, the interview data revealed more environmental aspects for large-scale producers than small-scale producers. Interestingly, the analysis of the focus group data otherwise claims that a collective group of either large- or small-scale producers are more concerned or associated with similar environmental aspects, therefore providing meaningful references related to environmental dimensions or aspects. One of the references or codes of environmental dimensions from the data clarify that:

> *"Before you even get it to the airport, there's no flight, or your load is even left behind and they will tell you it's going to go the next day before you realise, its left behind again. All these are issues that are bothering we, the exporters, and even the farmers as well"* (SR of FGD-SSP).

Further, matrix coding reveals that the sum of environmental aspects for the case of large-scale producers is likely to be higher than the case of small-scale producers. This result is consistent with Lee et al. (2014) who empirically concluded that environmental impacts of large-scale producers exceed those of small-scale producers.

Table 4.4 Relationship between sustainability dimensions from the perspective of large producers and small producers

Sustainability Dimensions	Large Producers			Small Producers		
	Interview	Focus Group Discussion	Sum of Interactions	Interview	Focus Group Discussion	Sum of Interactions
Environmental Aspects	13	14	27	9	14	23
Economic Aspects	8	7	15	7	12	19
Social Aspects	1	6	7	3	3	6
Regulatory Aspects	2	10	12	2	3	5
Collaboration	20	39	59	8	20	28
Complexities	8	19	27	5	11	16

Regarding the economic aspects of sustainability, the data reveal the economic dimension of sustainability from the data of both producers. The study further finds that small-scale producers are more involved in economic dimensions; thus, small-scale producers are likely to demonstrate a greater number of economic implications than large producers, both data revealing 19 and 15 references or interactions, respectively. This result is in line with Kuit and Waarts (2014) and Oya, Schaefer and Skalidou (2018), who report that small-scale producers demonstrate more economic-related issues including: prices for their produce are regularly negotiated; low productivity; and activities rarely lead to improved livelihood conditions. Even though the interactions for economic dimensions for both classes of producer are not so different in the interview data, the focus group data show a clear margin in the interactions or references. The reason may be drawn from the recent work of Grabs and Carodenuto (2021) on global food supply chains, who explain that reaching a large number of small-scale producers and involving them in sustainable practices can significantly scale up meaningful sustainability results. Otherwise, it is also widely argued that small-scale producers dominate food production and distribution in developing countries (Saavedra et al., 2014; Chapoto et al., 2018), so it is not surprising that the collective perspective of small-scale producers may seem to demonstrate more economic implications.

In terms of social aspects of sustainability, the sum interactions between large- and small-scale producers are almost synonymous (thus, seven references for large producers and six references for small producers). In fact, the researcher was expecting wider differences in social sustainability between large- and small-scale producers, as argued by Govindan et al. (2014), who suggest that barriers to any sustainable practices for small- or medium-scale producers are different to those for large-scale producers. However, the study's findings indicate otherwise. Interestingly, this study's results for social sustainability are consistent with those of Bourlakis et al. (2014), who explain that, despite large-scale producers reaping more benefits across supply chain networks, small-scale producers demonstrate outstanding sustainability performance as to flexibility. This can circumstantially substantiate that small-scale producers are likely to provide more trade openness, flexibility, and responsiveness through traceability and transparency, to enable them to gain acceptance and build a solid supply chain network. On the other hand, the results of the interviews between large- and small-scale producers differ significantly from the results of the focus groups between the two classes of producer. These results can be explained by the recent work of Ehrnström-Fuentes et al. (2019), who emphasise that the connection established between producers, input suppliers, and consumers has improved to foster community and cooperation, meaning that a collective connection between producers either small or large and other food supply chain actors is likely to yield results, such as cooperation and a sense of community. Circumstantial evidence revealed by the interview data from small-scale producers is consistent with (dos Santos and Guarnieri, 2020), who explain that artisanal (or small-scale) producers show a stronger relevance in social aspects than for other sustainability aspects. Their study further stressed that the artisanal or small-scale producers value the aspects related to social gains and satisfaction, but not to profits. Although both large- and small-scale producers are engaged in activities that ensure satisfaction, such as transparency and traceability, the small-scale producer is found to be more involved in these social aspects than the large-scale producer. Also, this finding is in line with the work of Hazell et al. (2010), who argue that small-scale farms are proven to use more remarkably resilient approaches that enable their activities and products to be more socially responsible. Despite fascinating evidence provided in support of small-scale producers in different journals regarding social sustainability, the outcomes of the interviews and focus group discussions about the social aspects of sustainability in this research are strongly aligned with the sustainable supply chain literature, such as Bourlakis et al. (2014) and Ehrnström-Fuentes et al. (2019). In other words, both small-scale and large-scale producers improve sustainability performance through cooperation and community-building approaches such as traceability and transparency.

Regarding regulatory aspects of sustainability, the interview data reveal that large-scale producers seem to experience similar regulatory implications to those of the small-scale producers while the focus group shows wider regulatory implications for large-scale than small-scale. The findings of similar regulatory implications for both classes of producer are in line with the assertions of the European Commission (2018) and Despoudi (2021), which stress that producers are encouraged to be well-informed and comply with the requirement of General Food Law Regulation in order to export, remain competitive and build a quality reputation ideal for trade. Food production either by large- or small-scale producers is regulated and enforced by designated authorities within the jurisdiction (Silvestre et al., 2018). Hence, producers need to follow internal and external regulations, especially when they want to export overseas. It implies that neither the large- nor the small-scale producer can escape the restrictive regulatory principles and procedures that need to be complied with to export to the UK. Hence, we see equal responsiveness to regulatory aspects. Despite this evidence, it is not surprising that this study's focus group data reveal more regulatory implications for large-scale producers. This result is consistent with Grazia, Hammoudi and Hamza, (2012) who argue that large-scale producers show more regulatory compliance probability than do small-scale producers. It is the case that, to be certified, a producer is required to follow standardised guidelines and procedures, and then be verified by regulatory auditors. It is also explained that implications of regulatory reinforcement and principles are not the same for both the small-scale and large-scale producers (Grazia, 2012; DeFries et al., 2017). Further, the totals of regulatory aspect interactions between large- and small-scale producers are twelve and five, respectively, indicating that the large-scale producers have a more intensive engagement with regulatory frameworks than do the small-scale ones. Discussing other food categories, Zhou, Pullman and Xu (2021) explain that the government regularly publishes regulatory checks on food safety and quality for large production businesses. to encourage local producers to adopt sustainable practices.

In terms of collaboration, the large-scale producers are found to be engaged in more collaboration to promote sustainable supply chain activities than small-scale producers. This is in line with León-Bravo et al. (2017), who explain that large-scale producers are more susceptible to collaboration for sustainability, especially involving joint planning, decision making, and tacit knowledge sharing. Data from both the interviews and focus groups reveal that large-scale producers exhibit more sustainable supply chain collaboration implications than the small-scale producers. From the study, while the large-scale producers show a total of 59 interactions or references, the small-scale producers record only 28. Similar significant disparities exist between the interview and survey data for both classes of producer. The large-scale producers record 20 interactions, against small-scale producers' eight interactions for the interview and, significantly, show 39 interactions against 20 for small-scale producers in focus group data. The substantial disparities in the sustainable food supply chain collaboration implications between large- and small-scale producers can be explained by the assertion of Pakdeechoho and Sukhotu (2018), who emphasise that different producers are incentivised by different sustainable supply chain collaboration (SSSC) practices, and that such opportunities can facilitate social and economic performance.

On the other hand, this study finds substantial complexities in developing sustainable food supply chains for both classes of producer. However, data from the interview and focus group reveal that large-scale producers encounter more challenges in their contribution towards sustainable food supply chains, even though significant complexities are equally found among small-scale producers in both datasets. The complexities broadly cover COVID-19 challenges and opportunities; knowledge of how to enhance efficiency in their operations and activities; limited knowledge of food processing; and other local challenges associated with complex food supply chains and developing sustainable food supply chains, such as inadequate credit facilities, inadequate government support, and policies. This finding chimes with those of Gamboa et al. (2016) and Fernández Campos et al. (2019), who assert that complexity is a major barrier to food supply chains, from production to retailing, and on to consumption; and both classes of producer face upstream and downstream elements of complexity in their food supply chains (Ilbery and Maye, 2005; Kirwan et al., 2017).

4.3.1 Visualisation of sustainability dimensions between large producers and small producers

This study utilises a polar diagram and word cloud (Figures 4.1 and 4.2, respectively) to visualise data and make further sense of the quality interview and focus group data, in order to distinguish between large- and small-scale producers. Despite the discussion of key relationships between both classes of producer, these charts provide more contextualisation and visualisation of the pattern of sustainability dimensions between the two groups. From Figure 4.1 (polar diagram), it is seen that producers show a significant relationship with the sustainability dimensions, indicating minimum of five interactions within the data. This can be explained as showing that both classes of producer consider the sustainability dimensions important. This supports Oosterveer and Sonnenfeld (2012) and Bollani, Bonadonna and Peira (2019), who emphasise that FSC players, including producers, are adopting various approaches, roles, and measures to foreground sustainability. The rectified sustainability approaches and roles employed include their use of renewable resources, minimising the use of land, reuse of waste, promotion of recycling, minimising the consumption of energy, reuse of packaging, and reduction of chemical additives as well as considering efficient transportation modes and sustainable organic farming.

Furthermore, the producers are more geared towards sustainable food supply chain collaborations than other dimensions of sustainability. From the polar diagram, data from both classes of producer reveal a shift towards collaboration, implying that there is a more significant relationship between small-scale and large-scale producers towards collaboration. Producers engage in more relevant initiatives, programmes, and activities with other FSC players, policymakers, researchers, and educators in order to enhance sustainable food supply chains. This supports the claims of Chen et al. (2017), Bustos and Moors (2018), and Krishnan et al. (2021), all of whom emphasise that FSC actors, including producers, are utilising collaborative initiatives to foster sustainable performance; and that the collaborations between FSC actors are enabling sustainable technologies, minimising waste, and improving FSC actors' sustainability performance (Niesten et al., 2017).

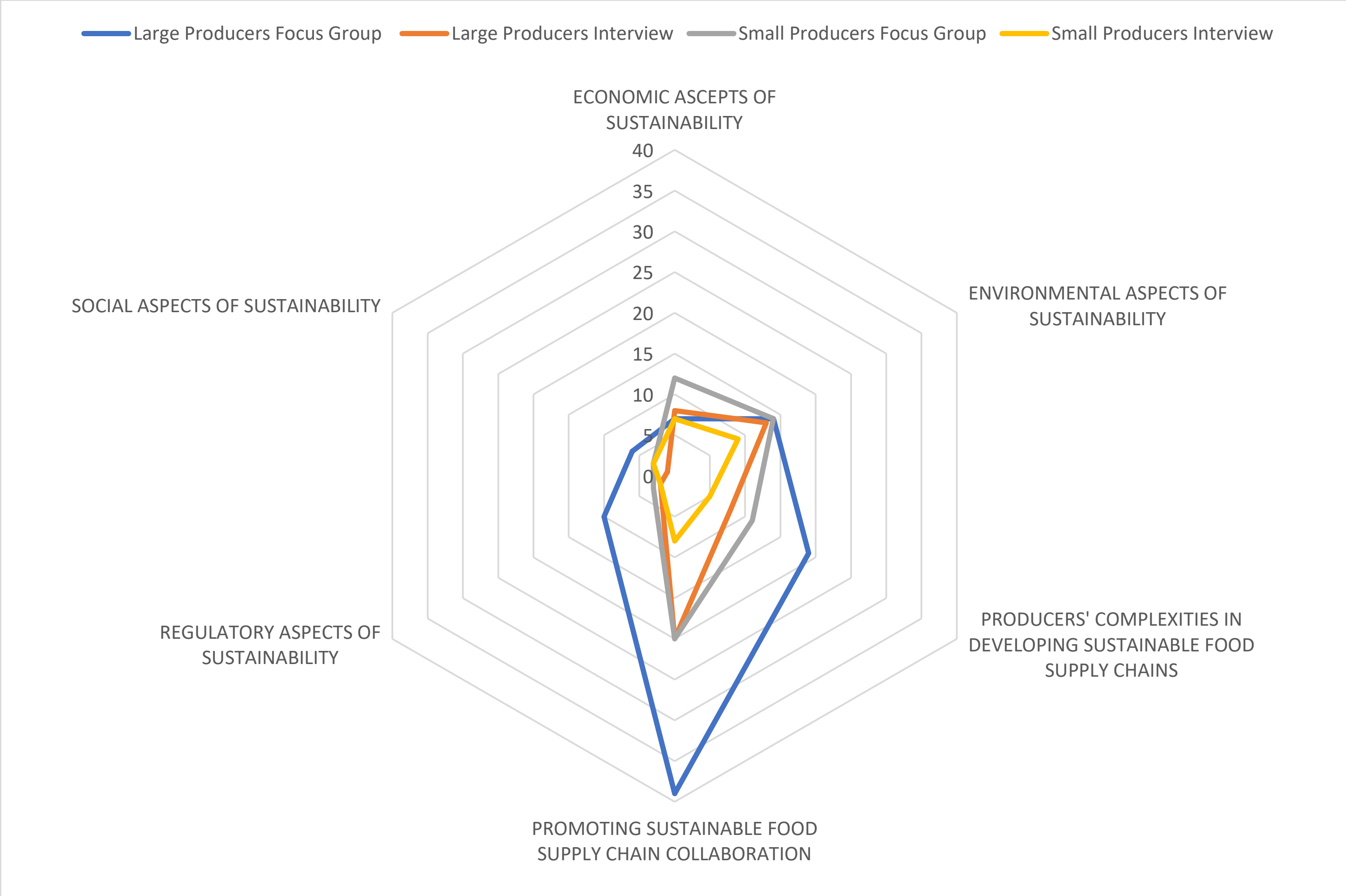


Figure 4.1 Relationship between large producers and small producers.

Another powerful visualisation tool is the word cloud, which can provide immediate context to the data by displaying frequently-appearing words from the data (Castleberry, 2014). It can also offer visual capabilities to display findings from both interview and focus group discussion data from the small- and large-scale producers on sustainable food supply chains (sustainability dimensions). To visualise the data, this study has used NVivo 11 software and adopted the word frequency function. To run a query for results, the study opted for display of the 100 most frequent words, with minimum quantity of five and grouping exact matches. The output from the large-scale producers' data (word cloud) clearly highlights words such as "think", "export", "pprsd", "traceability", "follow", "things", "measures", "produce", "system", "support", "reduce", "issue", "supply", "flight", "growers", "farmers", "carbon", and "price". Following the work of Chang (2002), which provides a guide to abilities and skills in combining words into novel sentences, the study has constructed three sentences from the captured or most-visualised words: 1) Farmers think about measures and export. 2) PPRSD supports system and traceability. 3) Growers produce, reduce carbon, and follow things to get prices and manage issues on supply (flight).

Figure 4.2 Word cloud of sustainable dimensions between small and large producers

First, sentence 1 reveals aspects of collaboration, economic, and environmental sustainability, where large-scale producers show concern about measures to minimise challenges, how to collaborate, and how to export more. Large-scale producers regularly look for alternative measures (approaches) to export more (Martincus and Carballo, 2008; Atkin, Khandelwal and Osman, 2017). This usually requires being environmentally-sensitised (environmental aspect), collaborative (collaboration), and having an ability to produce more, while reducing losses (waste) (economic aspect). Second, sentence 2 reveals collaboration, environmental, social, and regulatory sustainability practices among food producers. The PPRSD, an authorising body, ensures systems (protocols, processes, and procedures) are followed, as well as ensuring traceability activities through the invention and use of the Farm code. Third, sentence 3 demonstrates growers' (producers') contribution towards sustainable food supply chains. These contributions include production (economic aspect); adopting approaches and practices that minimise carbon emissions (environmental aspect); and partnering with FSC actors (e.g., wholesalers and distribution centres) to ensure a good price for their produce and consistent supply (collaboration).

Meanwhile, the study visualises "produce", "farmers", "export", "things", "something", "think", "exporters", "production", "government", "vegetables", "field", "ensure" and "supply" as key words from the small-scale producers' data. Similarly, meaningful sentences are constructed from these words by employing the suggestions of Chang (2002). Again, three sentences are constructed. Sentence 1 is: "Farmers work with exporters and government on production of vegetables." This could imply that small-scale producers are engaging in several activities and approaches that foster work with exporters and government agencies. These activities and approaches mainly involve economic aspects, environmental aspects and collaboration. Sentence 2 is: "Farmers think about produce and supply." This exposes the strength of small producers as dominant in vegetable production and their contributions towards sustainability dimensions are broadly collaboration, social, and economic aspects. Sentence 3 is: "Small producers (exporters) follow things or something to maximise field production." It is not surprising the study constructs this sentence from the key or most-visualised words. This sentence reveals that small producers regularly follow procedures or guidelines from authorising bodies (Saavedra et al., 2014), while buyers (or exporters) engage in collaborative activities with other FSC actors to enable them to produce more; thus displaying more collaboration, economic, regulatory, and complexities aspects of sustainability.

All things considered, zooming into the word cloud of both large- and small-scale producers' data interestingly reveals that, while the large-scale producers think more about exporting ("think export" - largely visible words), small-scale producers focus on production ("farmers produce" - more visible words). This supports the emphasis by Burnett and Murphy (2014): that small-scale producers would want to engage in exporting but are rather more focused on production in traditional forms. Nevertheless, it is also clear that there are several words shared by both classes of producer, including: "produce", "export", "ensure", "follow", "supply", "flight", "something", "think" and "farmers". Be that as it may, the context of the visualised large- and small-scale producers (Figure 4.2) can explain that producers are continuously championing measures and collaborative initiatives to produce more and export more and enhance their contribution to sustainability performance. Table 4.5 provides a summary of word-cloud interpretations of sustainability dimensions between large- and small-scale producers. Like the polar chart, collaboration is clearly seen as an important sustainability dimension among both classes of producer, even though each class has additional sustainability dimensions.

Table 4.5 Sustainability dimensions between large- and small-scale producers from word-cloud interpretations

Producers	**Sentences**	**Sustainability Dimensions**	**Sustainability Implications (Interpretations)**
Large Producers	Farmers think about measures and export.	• Economic • Environmental • Collaboration	Based on the references on the sustainability dimensions captured from the three sentences, large producers are more concerned about or associated with environmental aspects of sustainability and sustainable food supply chain collaboration. This visualised context from the data supports the
	PPRSD supports system and traceability.	• Collaboration • Environmental • Social • Regulatory	
	Growers produce, reduce carbon, and follow things to get price and manage issues on supply (flight).	• Collaboration • Environmental • Economic • Complexities	

			relationship or interactions between the sustainability dimensions among producers presented in Table 4.4.
Small Producers	Farmers work with exporters and government on production of vegetables.	• Collaboration • Environmental • Economic	Based on the references on the sustainability dimensions captured from the three sentences, small producers are more concerned or associated with economic aspects of sustainability and sustainable food supply chain collaboration. This visualised context from the data supports the relationship or interactions between the sustainability dimensions among producers presented in Table 4.4.
	Farmers think about produce and supply.	• Collaboration • Social • Economic	
	Small producers (exporters) follow things or something to maximise field production.	• Collaboration • Economic • Regulatory Complexities	

4.4 Developing and Testing the Conceptual Framework (SIA model)

Based on prior knowledge and the review of the literature from scholars and leading authors and institutions, such as DEFRA (2002), Audsley et al. (2010), Ehrenfeld and Hoffman (2013), Elkington (2013), Garnett (2013), Govindan (2018), and Anderson (2019), the researcher has designed the conceptual framework of the study, as discussed in section 2.8. This conceptual framework under development is shown as Figure 4.3 below, indicating all three traditional sustainability dimensions—environmental, economic, and social. Figure 4.3 further highlights various sustainability impacts of the food supply chain that encompass the production stage (sustainability impacts associated with farming); distribution stage (exporters' sustainability impacts); and the consumption stage (UK suppliers' sustainability impacts).

Before further developing and testing of the conceptual framework with the data, the study makes a novel modification to the conceptual framework by inclusion of the regulatory dimension. This is prompted by the reading of HM Government (2010), Stevens (2019) and European Commission (2019), which reveal the relevance of regulation frameworks and mechanisms in food supply chains. Therefore, the conceptual framework has been modified, and Figure 4.4 is the output before further developing and testing with data.

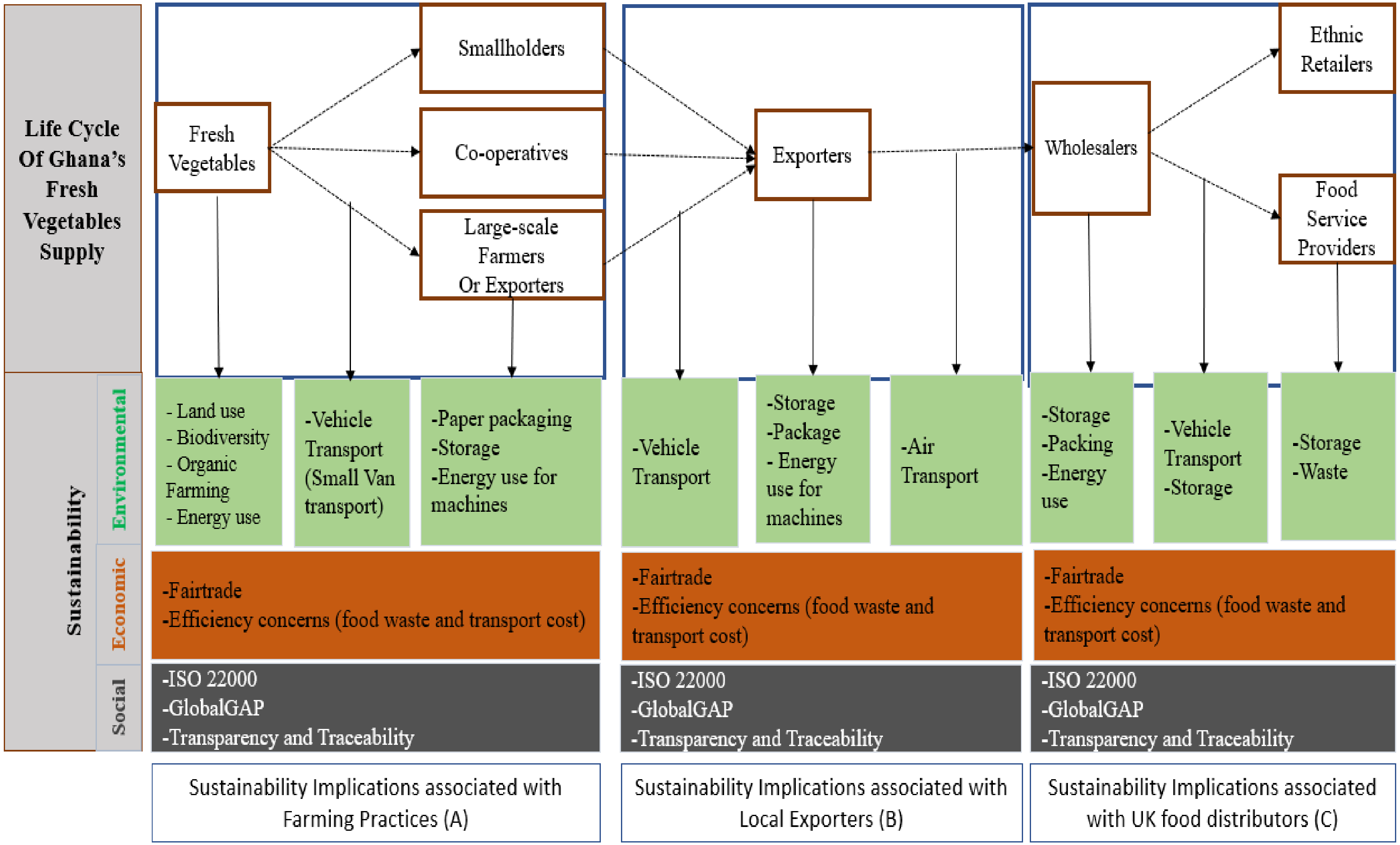


Figure 4.3 Conceptual Framework of the study

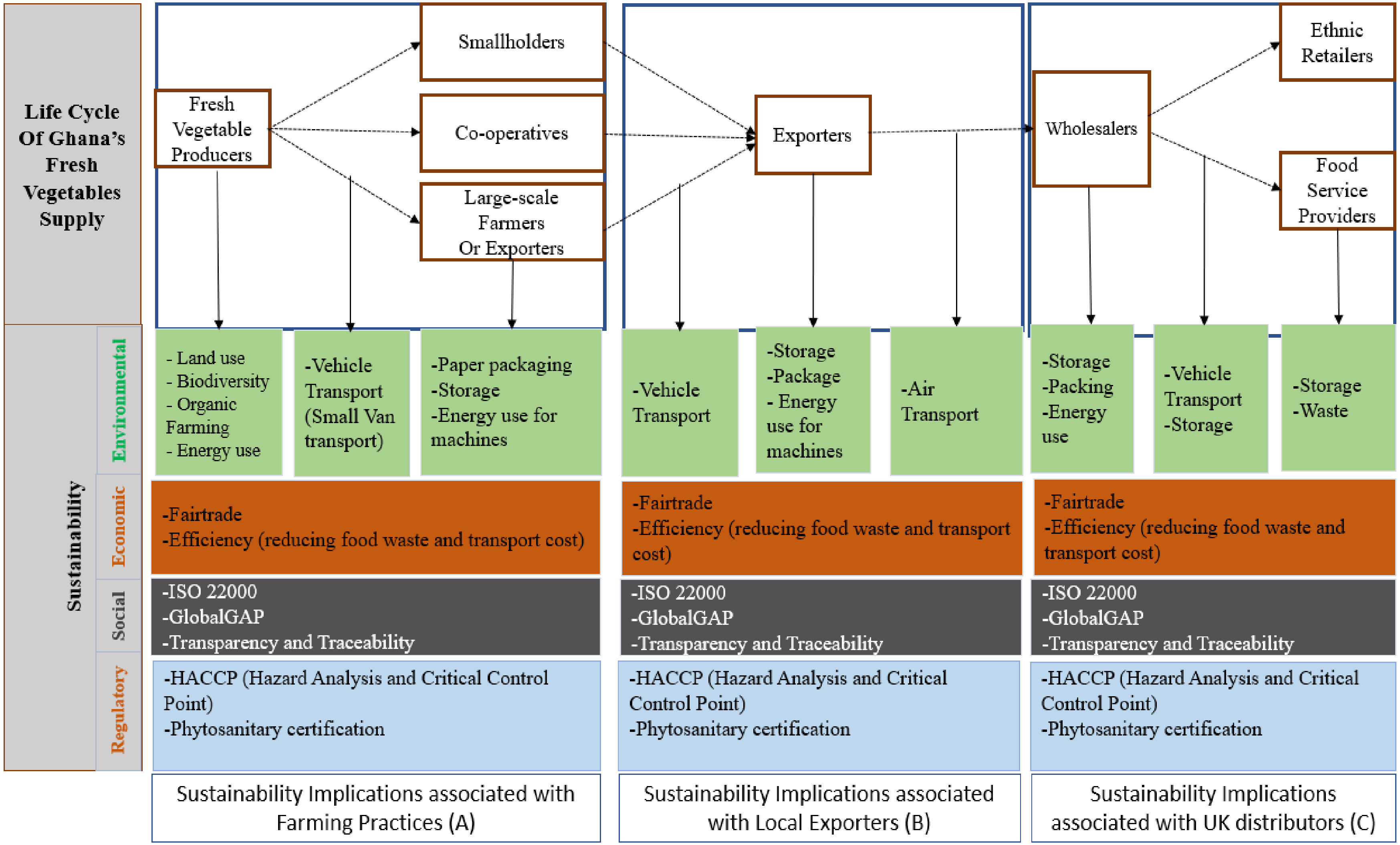


Figure 4.4 Modified Conceptual Framework.

In an attempt to consider further development and testing of the conceptual framework, the study utilises semi-structured interviews as a pilot study approach. The pilot study captured responses from five FSC actors: one large-scale producer, one small-scale producer, one local farmer, one exporter, and one ethnic retailer. Preliminary findings from the interviews enabled the researcher to modify and further develop the conceptual framework of the study. Figure 4.5 is the output (modified conceptual framework) after the pilot study. It is apparent that there are clear differences between the conceptual framework before the pilot study (Figure 4.4) and after (Figure 4.5). The preliminary findings from the pilot study revealed five key considerations or observations in support of the development and testing of the conceptual framework. First, the life cycle of the food supply chain was modified to more accurately capture actors and processes involved in the Ghanaian fresh vegetable supply chain to the UK. This involves the outstanding contributions of outgrowers in the production of the vegetables; producers' (mainly local farmers, also referred to as smallholders and outgrowers) relationship with exporters; and the various distribution channels and intermediaries at the consumption stage (sustainability implication associated with UK distributors).

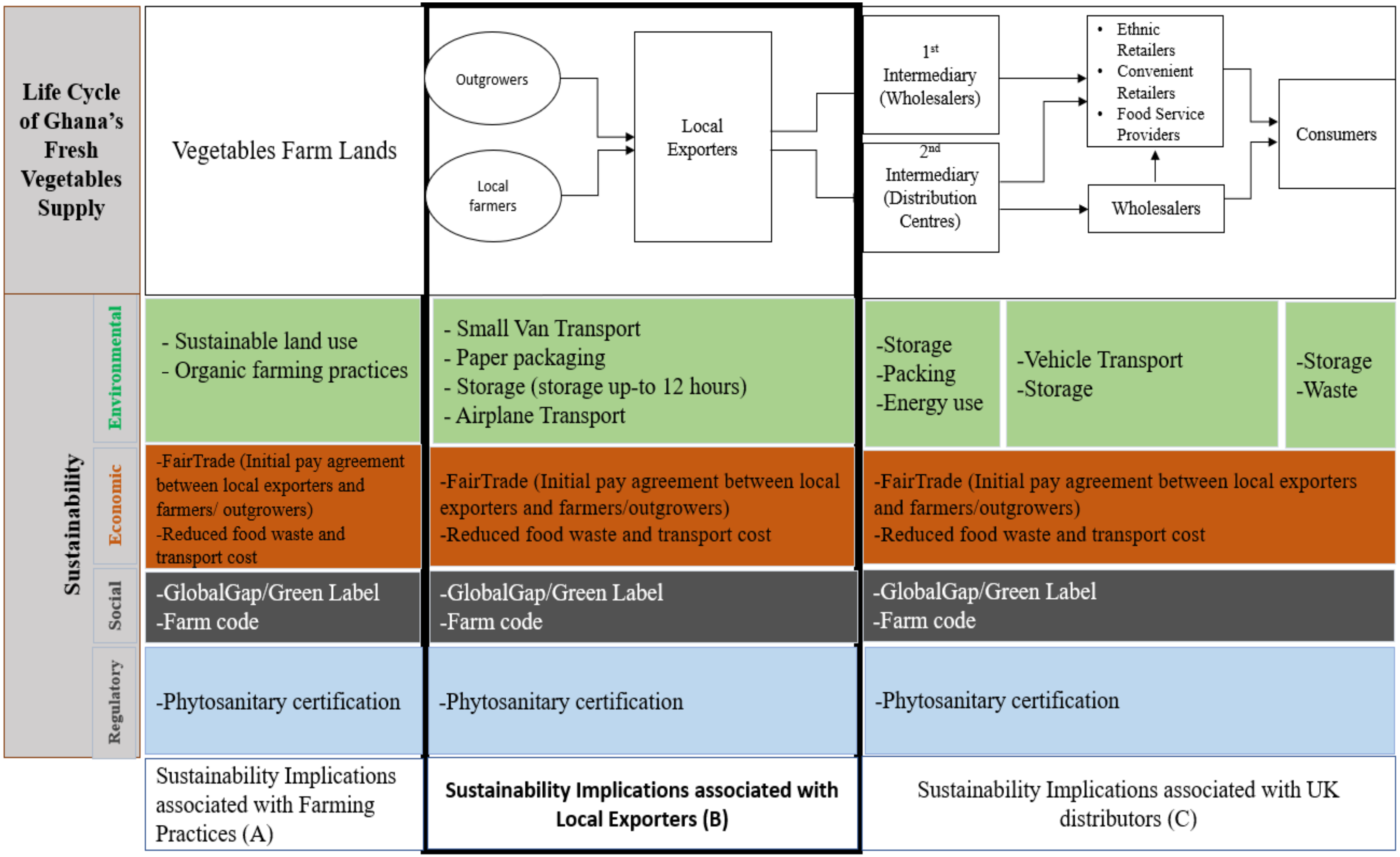


Figure 4.5 Modified Conceptual Framework (SIA model) after pilot study.

Second, the study identified various environmental dimensions (implications) for each stage, i.e., production stage (sustainability implications associated with farming practices); distribution stage (sustainability implications associated with local exporters); and the consumption stage (sustainability implications associated with UK distributors). While the literature review identifies the use of energy, packaging, biodiversity, storage, land use, organic farming, and transportation as the sustainability implications associated at the production stage, the preliminary findings reveal only sustainable land use and organic farming practices. At the distribution stage, the pilot study indicated small van transportation, paper packaging, storage, and air transport as the main sustainability implications, but prior knowledge from the literature included the use of energy. It is obvious that environmental implications at the consumption stage did not change, but the life cycle of FSC and actors involved was amplified. It is revealed that there are major wholesalers and distribution centres who act as first and second intermediaries, respectively. In addition, the study pointed to ethnic retailers, convenient retailers, food service providers, and other wholesalers who network with the two intermediaries to supply vegetables to the consumers. However, previous knowledge focused only on the network between wholesalers, ethnic retailers, and food service providers.

Third, unlike the environmental dimensions, the study identified economic dimensions for all three stages (production, distribution, and consumption) of the conceptual framework. Indicating FairTrade (initial pay agreement between local exporters and farmers/outgrowers) and reduced food waste and transport costs as the main sustainability implications associated with economic dimension of the conceptual framework. However, previous knowledge identified FairTrade and efficiency (reducing food waste and transport costs) as the economic sustainability implications associated with all three stages. Fourth, impacts associated with the social dimension for the three stages were minimised, according to the responses from the pilot study. The preliminary findings revealed Global G.A.P./Green Label and Farm code, whereas previous knowledge from the literature indicated ISO22000, Global G.A.P., and transparency and traceability. Although a new sustainability impact—.e., Farm code—is revealed from the data, responses refer to the Farm code as a system or approach for ensuring sources of the vegetable production, therefore enhancing transparency and traceability. Fifth, it was interesting to find that phytosanitary certification is recognised by the producers and all FSC actors within

Ghana's fresh vegetable supply chain. This revelation supports the previous knowledge adopted for the design of the conceptual framework. However, the study did not find circumstantial evidence for the HACCP (Hazard Analysis and Critical Control Point) discussed in the conceptual framework under development (which had been based on prior knowledge).

Due to the complexities and broad nature of the conceptual framework, taking into account the life cycle of the food supply chains and the sustainability impacts associated with it, the study focuses on the distribution stage (thus, sustainability implications associated with local exporters).

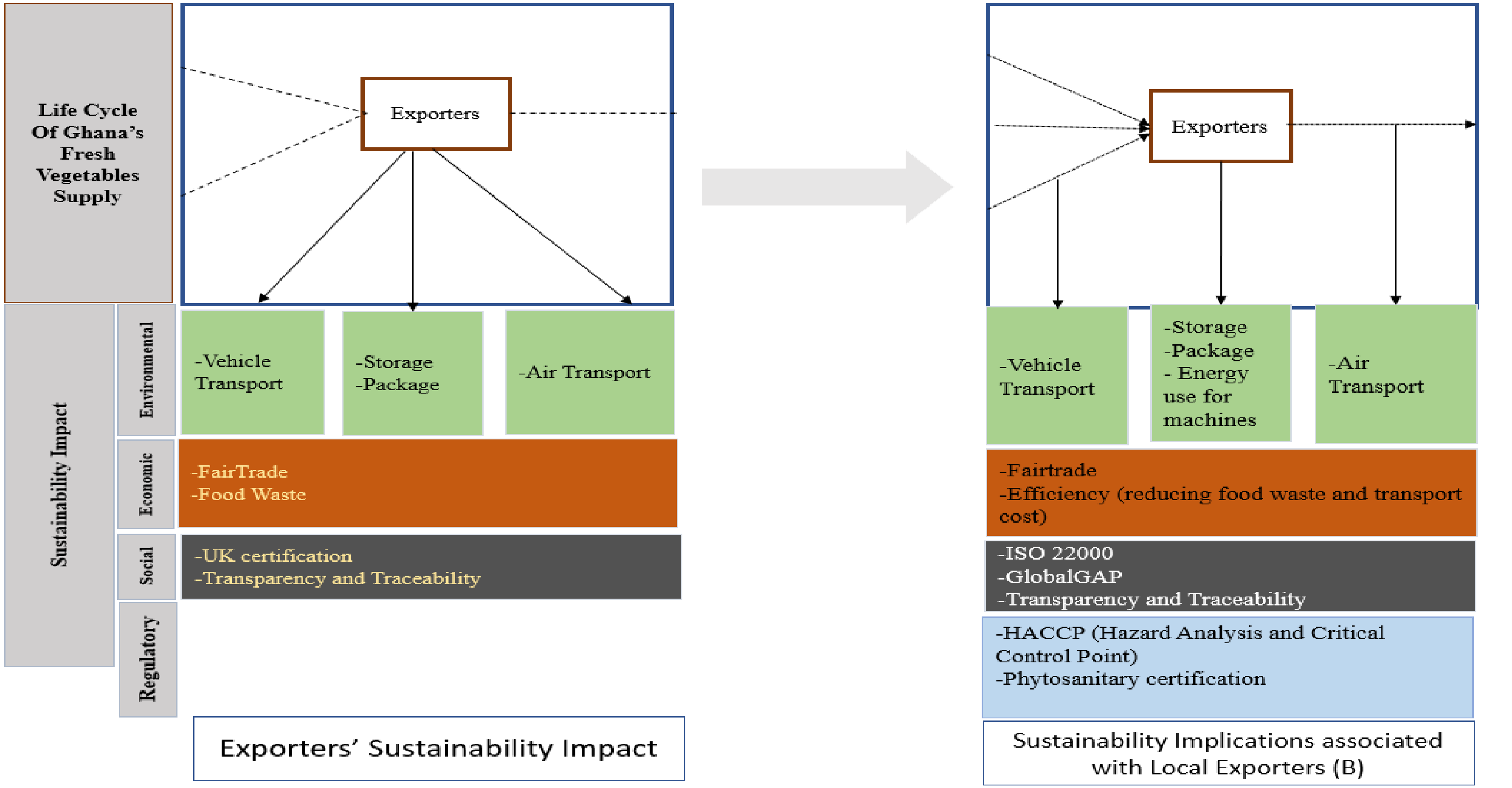


Figure 4.6 Difference between conceptual framework before and after pilot study (from the distribution stage).

It is important to mention that the semi-structured interviews revealed that exporters double as producers of fresh vegetables for the UK and continuously maintain networks and relationships with smallholders, outgrowers, local farmers, wholesalers, and distribution centres in the UK. This implies that a study of sustainability impact assessment focusing on this stage (producers/exporters) would reveal deep insights and prompt vital contributions, measures, and implications that can realistically and adequately enhance a sustainable food supply chain for all parties.

4.4.1 Finalising Development of the Conceptual Framework

To facilitate further development of the conceptual framework of the study, also known as the sustainability impact assessment (SIA) model, this study utilises case study data which involve semi-structured interviews of a large-scale producer and a small-scale producer, as well as focus group discussions of a group of small-scale producers and a group of large-scale producers. Two focus groups were conducted and the data collected were analysed using NVivo 11 (QSR International, 2020). Findings of the thematic analysis of the qualitative data suggested by Braun and Clarke (2006) and Nowell et al. (2017) were used to modify and finalise the development of the SIA model. The findings revealed additional sustainability dimensions and associated impacts that were not captured by the pilot study. The final output that considers current findings is presented as Figure 4.6, which demonstrates the changes or development of the conceptual framework from before the pilot study (based on prior knowledge of the literature and researcher’s thinking); after the pilot study (analysis of five semi-structured interviews); and after analysis of the case study data.

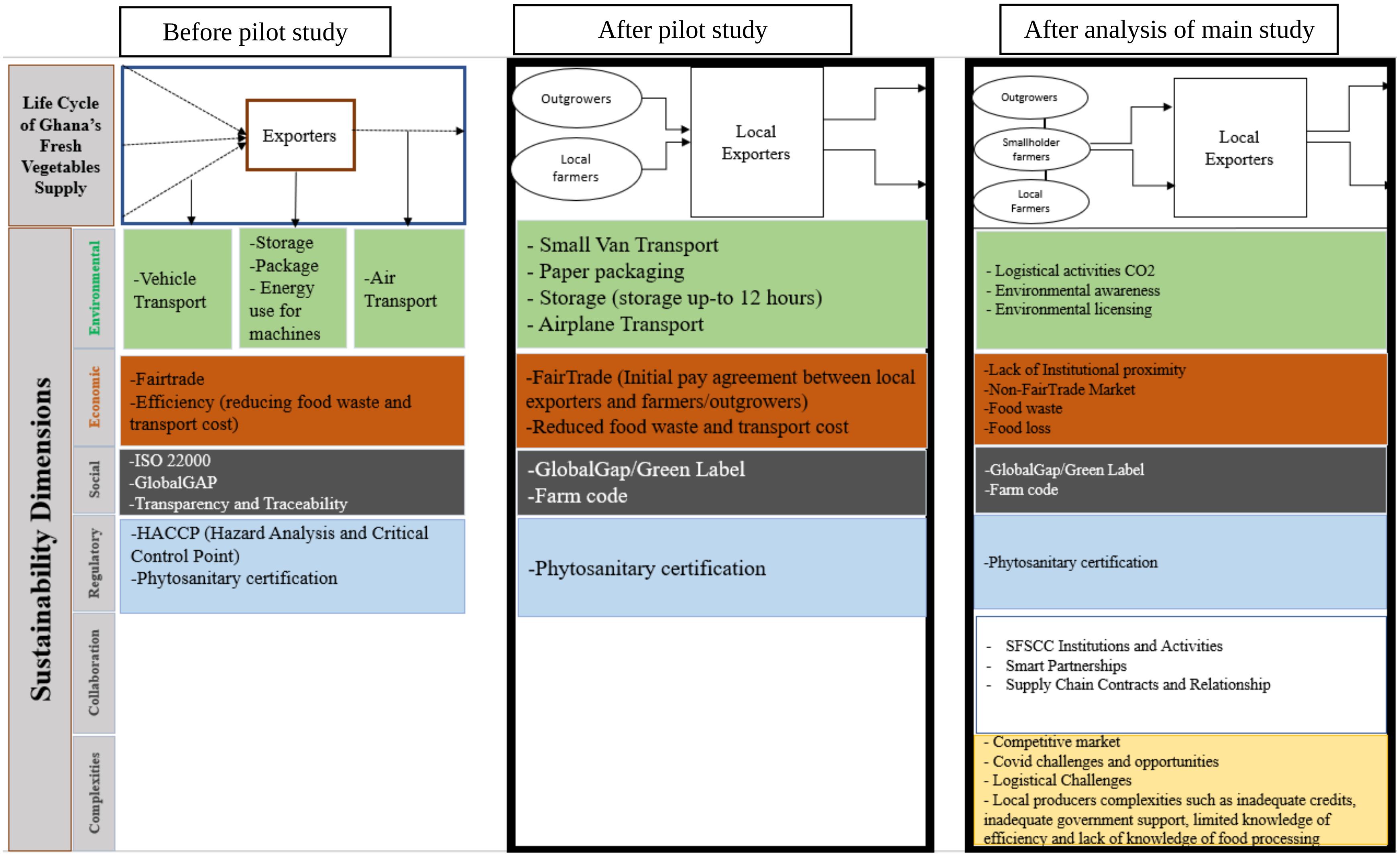


Figure 4.7 Changes or development of the conceptual framework before the pilot study, after the pilot study, and after analysis of the main study data.

From Figure 4.7, it is clear that key changes have been made to the conceptual framework, and the differences are easily noticed. These changes broadly cover the life cycle of the fresh vegetable supply chain and the environmental and economic dimensions, while new sustainability dimensions (i.e., collaboration and complexities) are captured. Regarding the life cycle of the fresh vegetable supply chain, the SIA model clarifies key producers involved in Ghana's fresh vegetables supply chain and the relationships among them. These are outgrowers, smallholders, local farmers, and local exporters. It is further discussed that local exporters who double as producers are either large- or small-scale producers. In terms of environmental aspects or dimension, the data specifically indicate the logistical activities CO_2 emissions, environmental awareness, and environmental licensing as specific sustainability impacts; rather than small van transportation, paper packaging, storage and air transportation, which were captured from the pilot study. The SIA model makes advanced changes in the economic dimension in its associated impacts while confirming evidence of the sustainability dimension. The pilot study highlights FairTrade (Initial pay agreement between local exporters and farmers/outgrowers) and reduced food waste, and transport costs as economic impacts, while the SIA model developed from the current data confirms lack of institutional proximity, non-FairTrade market, food waste, and food loss as the "correct" sustainability impacts of the economic dimension.

In terms of associated social impacts and regulatory dimension, the study did not find any changes for these sustainability dimensions, but rather supports their associated impacts. Surprisingly, two new sustainability dimensions emerge from the current data analysis. These are collaboration and complexities. The data further reveal that collaboration is usually associated with SFSCC institutions and activities, smart partnerships and supply chain contracts as respective sustainability impacts. Regarding complexities, its associated impacts are captured as competitive market, COVID challenges and opportunities, logistical challenges and local producers' complexities, such as inadequate credits, inadequate government support, limited knowledge of efficiency and lack of knowledge of food processing.

In summary, the SIA model is developed and presented as Figure 4.8. This SIA model indicates six sustainability dimensions related to local producers (exporters). Each sustainability dimension draws out relevant associated impacts that producers, other FSC actors, policymakers, researchers and educators should consider in their quest to contribute to sustainable food supply chain and sustainability development.

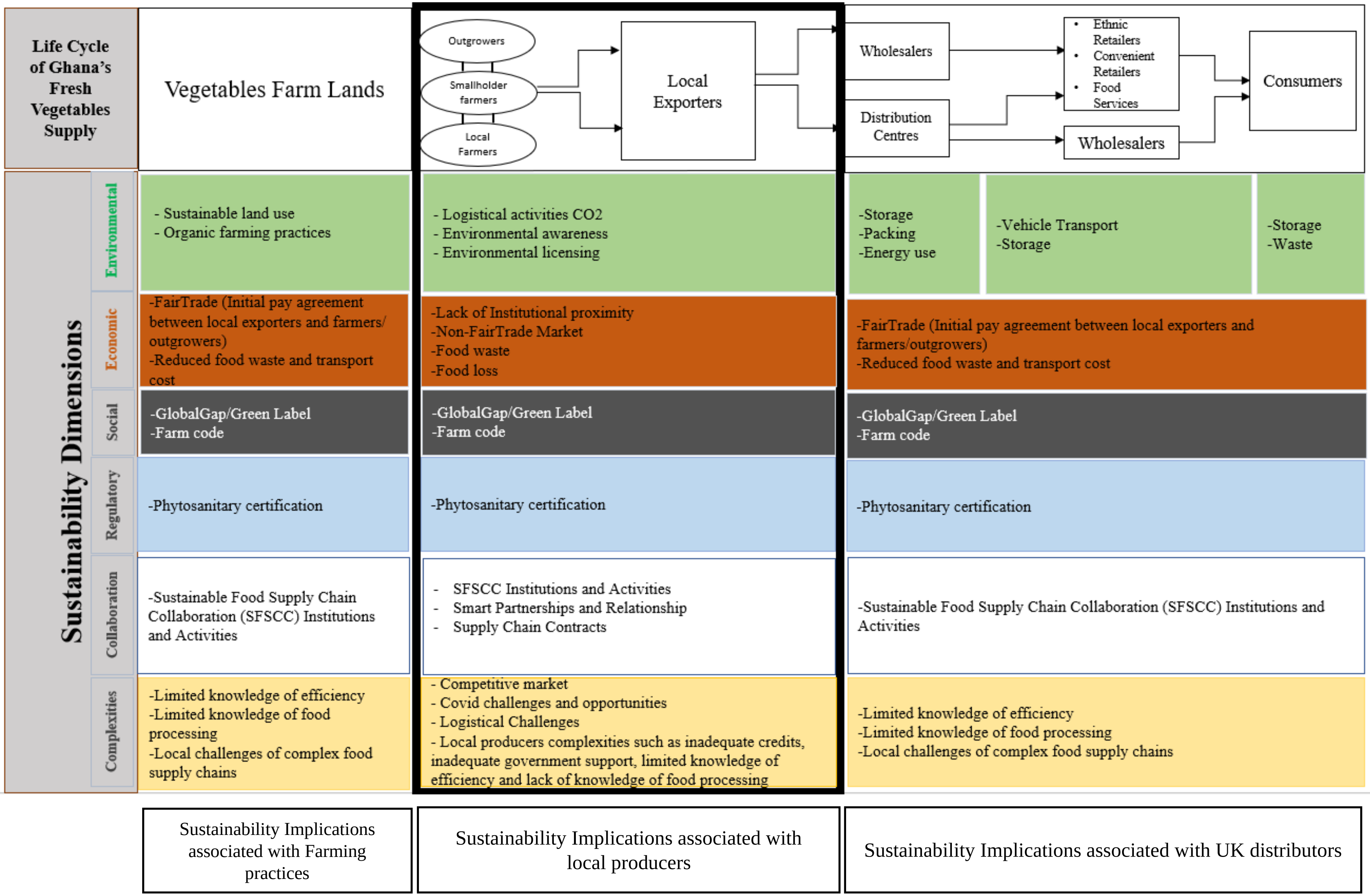


Figure 4.8 Developed SIA model

4.4.2 Testing the SIA model

To test the SIA model, this study makes use of a coding presence tool suggested by NVivo 11 (QSR International, 2020). Coding presence provides an exploratory, simple but powerful tool that can show existence or non-existence of a code within data. It demonstrates presence or absence of codes by employing Yes or No. Table 4.6 shows coding presence from the thematic analysis of the interviews and focus group data. This supports and confirms the various sustainability impacts of the six sustainability dimensions presented in the SIA model (Figure 4.8). First, it shows the coding presence for economic dimension and its associated impacts (lack of institutional proximity, non-FairTrade market, food waste and food loss) as Yes. Similarly, environmental dimension and its associated impacts (thus, logistical activities CO_2 emissions, environmental awareness and environmental licensing) captured by the SIA model is checked or presented as Yes. Furthermore, complexities and its associated impacts coding presence is Yes, although there is no evidence of presence for the complexities impact (COVID-19) regarding the column of interviews. This is due to the fact that, at the interview stage with both small-scale and large-scale producers, the researcher did not structure or have ready any questions on COVID-19. Nonetheless, coding presence provides Yes for collaboration and its associated impacts, e.g., SFSCC institutions and activities, smart partnerships and Relationship and Supply Chain Contracts. In addition, the regulatory dimensions and its associated impacts are supported and confirmed by the coding presence as Yes. This confirms the result that phytosanitary certification is a key requirement, and exporters or producers comply with protocols and procedures to obtain it. Last, coding presence for social dimension and its associated impacts is Yes, indicating the existence of Global G.A.P./Green Label, and Farm code within Ghana's fresh vegetable supply. Hence, the SIA model is tested, and the final output is presented as Figure 4.9.

Table 4.6 Coding presence from the thematic analysis of the interviews and focus group data.

Themes, Sub-themes and Codes (constructs)	Large Producers		Small Producers	
	Focus Group	Interviews	Focus Group	Interviews
ECONOMIC ASPECTS OF SUSTAINABILITY* **	Yes	Yes	Yes	Yes
FairTrade concerns**	Yes	Yes	Yes	Yes
• Lack of institutional proximity	Yes	Yes	Yes	Yes
• Non-FairTrade market	Yes	Yes	Yes	Yes
Food losses and food waste concerns**	Yes	Yes	Yes	Yes
• Food sorting	Yes	Yes	Yes	Yes
• Food waste concerns	Yes	Yes	Yes	Yes
• Reducing food waste	Yes	Yes	Yes	Yes
ENVIRONMENTAL ASPECTS OF SUSTAINABILITY* **	Yes	Yes	Yes	Yes
CO_2 emissions related to logistical activities**	Yes	Yes	Yes	Yes
• Logistical activities	Yes	Yes	Yes	Yes
Environmental Concerns**	Yes	Yes	Yes	Yes
• Environmental awareness	Yes	Yes	Yes	Yes
• Environmental licensing	Yes	Yes	Yes	Yes
• Inspections for environmental sustainability	Yes	Yes	Yes	Yes
Promoting environmental sustainability**	Yes	Yes	Yes	Yes
• Farm sustainability	Yes	Yes	Yes	Yes
• Reducing environmental impact	Yes	Yes	Yes	Yes
• Sustainable agricultural practices	Yes	Yes	Yes	Yes
PRODUCERS' COMPLEXITIES IN DEVELOPING SUSTAINABLE FOOD SUPPLY CHAINS* **	Yes	No	Yes	No
Market Dynamics and Uncertainties **	Yes	No	Yes	No
• Competitive market	Yes	No	Yes	No
COVID-19 challenges and opportunities**	Yes	No	Yes	No
• COVID-19 challenges	Yes	No	Yes	No
• COVID-19 opportunities	Yes	No	Yes	No
Logistical challenges**	Yes	Yes	Yes	Yes
Local producers complexities**	Yes	Yes	Yes	Yes

• Inadequate credit facilities and financial support	Yes	Yes	Yes	Yes
• Inadequate government support and policy	Yes	Yes	Yes	Yes
• Lack of the knowledge of food processing	Yes	Yes	Yes	Yes
• Limited knowledge of efficiency	Yes	Yes	Yes	Yes
• Local challenges of complex food supply chains	Yes	Yes	Yes	Yes
PROMOTING SUSTAINABLE FOOD SUPPLY CHAIN COLLABORATION* **	Yes	Yes	Yes	Yes
Activities of food supply chain collaboration for sustainability**	Yes	Yes	Yes	Yes
• Activities of institutions overseeing environmental sustainability	Yes	Yes	Yes	Yes
• Activities of institutions overseeing traceability	Yes	Yes	Yes	Yes
• Activities of institutions promoting regulations	Yes	Yes	Yes	Yes
• Activities of institutions promoting sustainable practices	Yes	Yes	Yes	Yes
Institutions of food supply chain for sustainability**	Yes	Yes	Yes	Yes
• Institution overseeing traceability	Yes	Yes	Yes	Yes
• Institutions promoting environmental sustainability	Yes	Yes	Yes	Yes
• Institutions promoting regulations	Yes	Yes	Yes	Yes
• Institutions promoting sustainable practices	Yes	Yes	Yes	Yes
Smart partnership, supply chain contracts and relationship	Yes	Yes	Yes	Yes
• Smart partnerships and relationship management	Yes	Yes	Yes	Yes
• Supply chain contracts	Yes	Yes	Yes	Yes
REGULATORY ASPECTS OF SUSTAINABILITY* **	Yes	Yes	Yes	Yes
External regulatory oversight**	Yes	Yes	Yes	Yes
• External regulatory checks	Yes	Yes	Yes	Yes
Internal regulatory oversight	Yes	Yes	Yes	Yes
• Internal regulatory checks	Yes	Yes	Yes	Yes
SOCIAL ASPECTS OF SUSTAINABILITY* **	Yes	Yes	Yes	Yes
Promoting transparency and traceability**	Yes	Yes	Yes	Yes
• Promoting traceability	Yes	Yes	Yes	Yes
• Promoting traceability and transparency	Yes	Yes	Yes	Yes
Traceability of local producers	Yes	Yes	Yes	Yes

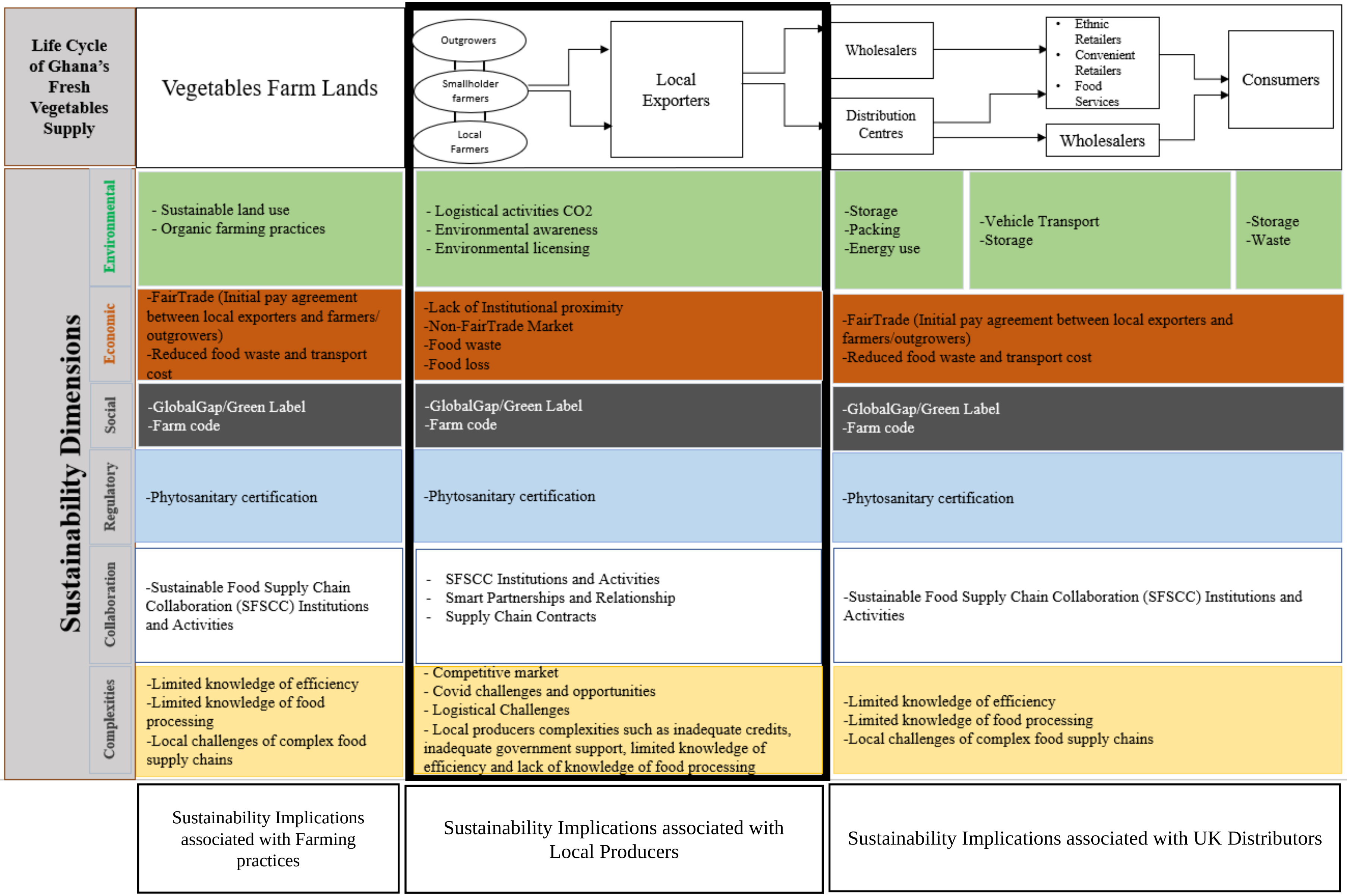


Figure 4.9 Tested SIA model.

4.5 Theoretical Support for and Justification of the Conceptual frameworks—SIA model

The development of the conceptual framework is grounded in stakeholder theory—businesses generate externalities that affect several individuals or parties, both external and internal to the businesses (de Camargo Fiorini et al., 2018), and a stakeholder is any individual or group who is affected by or can be affected by achievement of an organisation's purpose (Freeman, 1984). Starting with Figure 4.3, the life cycle of Ghana's fresh vegetable supply chain to the UK reveals the FSC actors (stakeholders) from fresh vegetable producers—outgrowers, local farmers, and large-scale farmers, to exporters and then to wholesales who are linked with ethnic retailers and food service providers. The framework then shows the capture of sustainability impacts under the environmental, economic, and social sustainability dimensions generated by the FSC actors—outgrowers, local farmers, and large-scale farmers—based on prior knowledge of the literature. The arrows show the interconnectedness of the sustainability impacts among the FSC actors (stakeholders). Value creation by interdependent stakeholders fundamentally considers the form solving collective action concerns and challenges (Bridoux and Stoelhorst, 2016). This framework extends the stakeholder theory approach, arguing that business ethics should cover a broader perspective and should capture the environmental, social, and economic impacts of business firms. This shaped the development of the conceptual framework (Figure 4.3)

Figure 4.4 provides the modification to Figure 4.3 by including the regulation dimension in the framework. The modified conceptual framework (Figure 4.4) is to ensure that all stakeholders benefit from sustainable food supply chains by enhancing sustainable practices within the chain. The development of the conceptual framework aligns with the logic of stakeholder theory—justifying that stakeholders' (FSC actors) contributions can reduce negative sustainability increase impacts and positive sustainability impacts (Sarkis et al., 2011; Freeman et al., 2017). It is built on the logic that FSC actors or businesses can improve on their sustainability development agenda by considering all sustainability impacts regarding environmental sustainability, economic sustainability, social sustainability, and regulatory mechanisms in a single framework or model connecting stakeholders and considering options for sustainability improvement.

Figure 4.5 provides the modifications made to the conceptual framework after conducting the pilot study. The life cycle of Ghana's fresh vegetable supply chain to the UK reveals more specific stakeholders and associated sustainability implications. Such revelations are accommodated and utilised to modify the conceptual framework (SIA model). The stakeholder theory approach encourages businesses to be more inclusive in identifying relevant stakeholders (FSC actors) and their interests (key activities and operations) and to develop the capability to connect and handle multiple stakeholders (activities of other relevant key stakeholders) (Freeman, Harrison and Zyglidopoulos, 2018). The capability in this context explains how businesses (FSC actors) can avoid making some strategic mistakes (negative sustainability impacts) and look for options for competing with other businesses (look for options to reduce negative sustainability impacts through assessment involving all key stakeholders). This approach and context of stakeholder theory shaped the modification of the framework (Figure 4.5) enabling the capture of all key stakeholders and sustainability impacts emerging from the food supply chain after the pilot. It is important to mention that, after the pilot study, this research decides to focus on the sustainability implications associated with local exporters. This aligns with Freeman and McVea's (2005) further work on stakeholder theory which stresses that, to be more pragmatic, the stakeholder framework must identify particular stakeholders and their associated interests. They emphasise that this encourages the business to adapt its actions, plans, and strategies around particular stakeholders to maximise value. Therefore, to ensure maximum contributions towards improving sustainability, the notion of Freeman and McVea (2005) and the case study research revelation were utilised—by focusing on local exporters.

Meanwhile, Figure 4.6 presents the difference between the conceptual framework before and after the pilot study. Although the FSC actor (stakeholder) does not change for the two frameworks, the sustainability implications associated with the framework after conducting the pilot reveal significant changes or inclusion. Harrison and Wicks' (2013) work on stakeholder theory suggests that it is naturally easier to measure outcome (sustainability impacts) when compared to other outcomes or value (other sustainability impacts) generated by other stakeholders (FSC actors). This ideal facilitates the need to compare the outcome of the pilot study's conceptual framework (SIA model) and the conceptual framework based on prior literature. It is possible to ignore the stakeholder's contribution (sustainability contributions) (Freeman, Harrison and Zyglidopoulos, 2018), hence, it is important to capture all contributions generated within the food supply chain by all key stakeholders (FSC actors) to enhance the firm's value-creating processes (SIA framework for the food supply chain). However, having identified one stakeholder (exporter) from the pilot study, the researcher made modifications to the sustainability implications generated which are different to the sustainability implications based on prior literature. Similar to Figure 4.6, Figure 4.7 presents the differences between the focus area of the framework after the main study (case study research) with those of prior literature and the pilot study's framework. It compares the sustainability implications associated with local exporters of the framework developed based on literature (Figure 4.4), after the pilot study (Figure 4.5) and after the case study research. This comparison reveals significant differences towards SIA framework development aligning with Harrison and Wicks (2013) and Freeman, Harrison and Zyglidopoulos's (2018) stakeholder theory approach on outcome compassion and individual stakeholder's contribution in enhancing the value-creating processes of the firm (thus, the SIA framework for the food supply chain). The FSC actors (stakeholders) and sustainability implications after the case study research are modified.

Figure 4.8 presents the developed SIA model after the case study research. This phase of the SIA model captures all relevant FSC actors (stakeholders) and their associated sustainability implications across the food supply chain. Freeman, Harrison and Zyglidopoulos (2018) argue that various stakeholders accept or do not accept unexpected interactions between different systems because some stakeholders have the ability to reduce the effectiveness of a particular system. They further argue that frequent interactions with key stakeholders are relevant to support the identifying of unexpected systems interactions. Following the emphasis of Freeman, Harrison and Zyglidopoulos (2018), likewise, stakeholders have ability to improve the effectiveness of a particular system. Hence, this leads to the capturing of all stakeholders (FSC actors) and sustainability implication identified within Ghana's fresh vegetable supply chain to the UK through case study research into a SIA framework. Further, early work of Brandenburger and Stuart (1996) stress that stakeholders simultaneously integrate to compete and create value. Therefore, it is important to utilise this theoretical foundation to develop SIA framework that demonstrates how all key stakeholders (FSC actors) of Ghana's fresh vegetable supply chain can be linked together to create sustainability and sustainable food supply chains. Figure 4.9 presents testing SIA model using the coding presence tool suggested by NVivo 11 (QSR International, 2020). This final stage of SIA model framework reveals captures all relevant FSC actors (stakeholders) and their associated sustainability implications within Ghana's fresh vegetable supply chain to the UK. This presents the final sustainability assessment framework for evaluation, development, and improvement of sustainability.

It is important to clarify that, based on the revelation of case studies data analysis, the stakeholder captured as "local exporters" from the development of the conceptual framework, i.e., Figure 4.3 to Figure 4.7, was then modified to a more specific stakeholder, "local producers", as revealed by the case study research. However, throughout the study, local exporters, exporters, and large producers are used interchangeably. This is due to the stakeholder (thus, FSC actor) performing the same activities and operations within the food supply chain—by producing and exporting vegetables from Ghana to the UK. The central idea of stakeholder theory is that framework, approach, or strategy is about building lasting relationships with a firm's stakeholders (the FSC actors) that are important to value creation (sustainable food supply chain) (Dmytriyev, Freeman and Hörisch, 2021). Further, stakeholder theory clearly incorporates a social dimension, a moral or ethical dimension, and an economic dimension (Bridoux and Stoelhorst, 2022). This study extends the idea of Bridoux and Stoelhorst (2022) to capture other relevant dimensions—such as environmental., regulatory, collaboration, and complexities dimensions—to enhance sustainability. Therefore, recommendations of the stakeholder theory of different authors are utilised and sometimes extended to underpin the development of the SIA model of the study. Hence, stakeholder theory is utilised to underpin the development of the SIA model.

4.6 Summary

This chapter thematically analysed the case study data from the interviews and focus groups using NVivo software 11. This helped the researcher to identify sustainability implications associated with Ghana's fresh vegetable supply chain to the UK. The results showed that environmental aspects, economic aspects, social aspects, regulatory frameworks, collaboration and complexities, and their associated impacts are the key sustainability implications that require attention. The chapter further analysed the relationship between the key sustainability implications among large-scale and small-scale producers. An SIA framework (model), forming the conceptual framework of the study, is modified and developed based on the revelations and findings from the thematic analysis of the interview and focus group data.

CHAPTER FIVE (5)
5.0 STATISTICAL ANALYSIS OF SURVEY DATA

5.1 Introduction

This chapter seeks to address two main aims. First, the study attempts to statistically estimate the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK, based on the findings from thematic analysis of the case study data. By so doing, this study addresses RQ 2: "How can the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK be estimated using available methods?" To facilitate that, producers' responses to a survey, designed with Likert-scale items and administered through Qualtrics, are extracted and analysed using IBM SPSS Statistics Version 27 (IBM Corporation, 2020). The survey design captures statement items (questions) about sustainable FSC and the six sustainability dimensions (environmental, economic, social, regulatory collaboration, and complexities) identified from the thematic analysis of the case study data (interviews and focus group). This lays the ground for an easy way of statistically summarising the relationship between sustainable FSC and sustainability dimensions using a multilinear regression (MLR) model. Hence, hypothesis (H1)—There is a significant relationship between the sustainable food supply chain (SFSC) and sustainability dimensions—is tested.

Second, the study utilises the statistical results of the sustainability dimensions to test and validate the SIA model developed from thematic analysis of the case study data. This enables the study to contribute to the global food supply chain and sustainability literature by inventing a novel SIA model, developed and tested using multiple research methods, which will be important for the capture and assessment of qualitative and quantitative sustainability data.

This chapter is divided into six sections. First, bias assessment for the survey-based research is conducted. Second, reliability and validity tests of the survey data are performed. In the third section, bias assessment for the survey is conducted. This is followed by descriptive statistics of the survey and then robustness checks (normality test and multicollinearity test). Fifth, model performance (regression estimations) is provided and, finally, SIA model validation is conducted using Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE).

5.2 Bias assessment of the survey

To ensure that the survey is free from bias and that the data can be utilised for further statistical analyses, the study conducts both common method bias and non-response bias assessment.

5.2.1 Common method bias

Common method bias occurs when both dependent and independent variables are captured by the same response instrument (method) (Kock, Berbekova and Assaf, 2021). Respondent-related sources (e.g., personality traits, lack of education, lack of experience or too much experience) and measurement-related sources (item complexity, item order in the survey, item labelling, and item ambiguity) are the main sources of common method bias (Podsakoff et al., 2003; Kock, Berbekova and Assaf, 2021). The consequence of this bias can affect the validity of the study. This study designed a survey instrument which captured the dependent variable (sustainable FSC) and the sustainability dimensions (environmental, economic, social, regulatory, collaboration, and complexities aspects of sustainability). This can create common method bias. Hence, the study adopted appropriate procedural and statistical controls to identify and prevent common method bias to ensure that the empirical results of the study are valid and reliable. To identify, control for, and prevent common method bias in the survey, the researcher employed the following approaches—procedural controls suggested by Podsakoff et al. (2003) and Viswanathan and Kayande (2012) and statistical controls (Harman's single factor test using Factor Analysis) suggested by Korsgaard and Roberson (1995) and Podsakoff et al. (2003):

(a) Procedural Controls

(i) The study ensures that the instrument instructions provided are clearly given without confusion and ambiguity. This was well ensured by a three-step proofreading of the instrument by a friend (with no background in the researcher's field of study), PhD colleagues (in the researcher's discipline and other disciplines) and, also, the supervisors of the project. The instrument was also pilot tested to 10 FSC actors (mainly local farmers, outgrowers, smallholder farmers, and exporters) based in Ghana who were recruited for the main study. A follow-up call was made to confirm that the instrument was clear and to avoid any confusion.

(ii) The study ensures the anonymity of participants. This was clearly detailed in the Ethics form, participant information sheet, and consent form. Hence, the researcher ensured that the instrument does not include any identifiable information.

(iii) The study avoids complex and ambiguous items. Ambiguous and complex items highlighted by the proofreaders and pilot testing were modified and removed (if necessary). For example, items (questions) regarding to age, sex, and other complex items e.g., “how much CO_2 emissions do you generate from your vegetable production activities” were removed.

(iv) The study ensures that the survey is concise. The study ensures that items were clear, easy to respond to, and straightforward. For example, “Your activities have environmental impacts” and “You have ideas about sustainability”.

(b) Statistical Controls—The study performs Harman’s single factor test using Factor Analysis along with SPSS. Common method bias is present if suggested by Korsgaard and Roberson (1995) and Podsakoff et al. (2003) with the help of SPSS. Common method bias is prevalent if all primary study variables included result in a single factor accounting for over 50% of the variance (Kock, Berbekova and Assaf, 2021). Using SPSS version 27, the study performs factor analysis (explanatory factor analysis) of the 45 items, assume dimension reduction – then assume extraction to fixed number of factors (factors to extract) to 1. The result for the percentage of variance from the total variance explained shows 25.3%. This implies that there is no existence of common method bias and the survey data collected are ready for further statistical analysis. Appendix 6 presents common method bias assessment – output from SPSS.

5.2.2 Non-response bias assessment

Non-response bias occurs when there are discrepancies between respondents and non-respondents to a survey (Bianchi et al., 2019). In other words, non-response bias can happen when respondents who decline to part take in a study or withdraw before completing the study are systematically different from the actual respondents of the study. This threatens the representativeness of a survey (Prince, 1998). Non-response bias can be created due to sensitive items, if the pre-test is not conducted appropriately, and other factors. The difference between respondents and non-respondents can be influencing factor(s) creating the lack of response. To ensure that a survey has low or reduced non-response bias, a study can utilise selective decisions by employing snowball, purposive, and convenience sampling (Patton, 2014; Bryman, 2016). However, selective decisions or sampling approaches can still affect the reliability and conclusions of a study (Duszynski et al., 2022). Hence, this study performs Levene's Homogeneity of Variance Test (Levene, 1960; Ogbonna, Idochi and Sylvia, 2019) for non-response bias assessment of the survey by comparing the first 50 respondents with the last 50 respondents in order to adjust or test the non-response bias. Thus, a robustness test is carried out to ensure the equality of variances. In survey studies, non-response bias can be assessed by comparing early respondents and late respondents as proxies (Lahaut et al., 2002). This study assumes that each set of 50 respondents represents a group. To test for non-response bias, SPSS 27 is utilised by Comparing Means assuming One Way ANOVA – then assume Options to Homogeneity of Variance Test. Table 5.1 presents Levene's Homogeneity of Variance Test.

5.1 Test of Homogeneity of Variances

Variable	Levene Statistic	Statistical Significance
Environment: Environmental Protection Agency (EPA) regularly visit my premises to carry out inspections.	4.011	0.047
Collaboration: You work with Green Label	9.607	0.002
Collaboration: You work with ISO 22000 (International Organisation for Standardisation).	4.963	0.028
Complexities: You have limited knowledge on how to improve efficiency in your food production and supply activities.	11.933	0.001

Out of the 45 items (variables), the study finds four variables with statistically significant differences. These are items (variables) that the two groups did not similarly respond to. Thus, there are different distributions to those items and, therefore, care must be taken when utilising these items for further statistical analysis. However, this study does not seek to individually analyse each item (variable). Nevertheless, the mean of specific items representing a construct can be taken to adjust or correct a non-response bias (Alfranca, 2022). Hence, to further correct any non-response bias, the study takes the aggregate of items representing a construct. More importantly, the biased items (variables) are statistically different, albeit quite small (four items out of 45 items), and generally may not affect the interpretation and reliability of the survey results. The study can conclude that non-response bias is not a threat for the sample and that participants' responses can actually reflect the views, opinions, and ideas of the FSC actors (the producers of Ghana's fresh vegetable supply chain to the UK).

5.3 Reliability and Validity Test of the Survey Data

Next, validity and reliability tests of the raw survey data are conducted to check usefulness, precision, and accuracy of the data for analysis. While the validity test explains whether the data measure that which they were intended to measure or the accuracy of the means of measurement, the reliability test determines the research instrument's internal consistency and replicability (Golafshani, 2003; Taherdoost, 2016). To test for validity, the sum of the items for each respondent was taken and the study performed bivariate correlations, assuming Pearson correlation coefficients and two-tailed test of significance using SPSS (Obilor and Amadi, 2018; IBM Corporation, 2020). It is important to know that the smaller significance level (p-value) implies a more significant relationship, whereas the larger the correlation, the stronger the relationship between the variables (items) (Obilor and Amadi, 2018). The validity test was conducted, and the results of the Pearson correlation coefficients of variables (items) with total N 133 show statistical significance at 0.05, implying that the null hypothesis that "there is no significant relationship between the sustainable food supply chain (SFSC) and sustainability dimensions items of the study" is rejected. In other words, the result shows that there is a significant relationship between the sustainable food supply chain (SFSC) and the sustainability dimensions captured by the study. It further implies that the questions or Likert-scale items designed for sustainable food supply chain (dependent variable) and sustainability dimensions (independent variables) are useful and accurate for statistical analysis.

To test the reliability of the survey data, the study assumed scale function to perform reliability analysis while assuming descriptives for item and scale if the item is deleted using SPSS (Franzen, 2011; IBM Corporation, 2020). Studies emphasise that the data are reliable when Cronbach's alpha is greater than 0.7, which is considered generally acceptable, as high alpha values indicate that the items are highly correlated (Shrestha, 2021). Further, this implies that alpha values of less than 0.6 mean that data sampling is inadequate, unreliable, and requires corrections (Shrestha, 2021). Interestingly, the reliability test for this study shows a Cronbach's alpha of 0.925 for the 45 items, implying that there is excellent strength of consistency in the survey data (Nawi et al., 2020). Hence, these results for validity and reliability test show the quality, rigour, and trustworthiness of the survey data. It is important to clarify that the validity test and reliability test are performed using Pearson correlation coefficients of variables (items) with total N 133 responses and Cronbach's alpha for the 45 items, respectively. Since the raw survey data are valid and reliable, this determines important variables from the large dataset reducing inter-correlation, and makes the constructs meaningful for statistical analysis. Hence, the study performs factor analysis.

5.3.1 Factor Analysis (Principal component analysis)

Factor analysis helps to extract meaningful factors from a large dataset involving several related variables (Shrestha, 2021). It is a statistical technique that a researcher can apply to determine "relevant" variables that are comparatively independent of one another (Tabachnick, Fidell and Ullman, 2007). In this study, factor analysis is used as a data-reduction technique with the help of IBM SPSS Statistics Version 27 (IBM Corporation, 2020) to reduce the large number of inter-correlated measures and to make the constructs or factors more meaningful for further statistical analysis (MacCallum et al., 1999; Ho, 2006; Shrestha, 2021). Factor analysis has an assumption that the dataset variables correlate to some degree. Hence, exploratory factor analysis is employed to investigate the survey dataset to identify complex interrelationships among group items and items that are included in the incorporated concepts (Shrestha, 2021). The study then considers both the dependent and independent variables for this exploratory factor analysis. This helps to identify the underlying variables (dependent and independent variables items) and to only consider the correlation matrix of the data. Further, factor analysis with the PCA approach is utilised to identify the items (question statements) that characterise identifiable factors associated with sustainable FSC and sustainability dimensions. Principal component analysis is a statistical technique that helps to underline variation and produce robust patterns in the dataset (Hair et al., 2006; Shrestha, 2021). This helps to enhance variability, thereby increasing interpretability while minimising heterogeneity and information loss. It has the capacity to provide new variables that support linear functions based on the initial dataset, resolving any eigenvalue problem (Jolliffe and Cadima, 2016). Following the model suggested by Deane (1992), Hair et al. *(*2006), and Shrestha (2021), the factor model with ‘n’ common factors is assumed as Eq. (3):

$$X = \mu + \lambda F + \varepsilon \qquad \text{Eq. (3)}$$

where X equals to X_1, X_2, X_3……. $X_{p,}$ is the random vector with mean vector μ; and the covariance matrix Σ; and λ equals to $\{\lambda_{jk}\}_{pxn}$ shows the factor loadings matrix. λ_{jk} is the loading of j^{th} variable on the k^{th} common factor, which equals to F_1, F_2, F_3……. F_n, representing the latent factor scores vector. The F_k is the score denoting the k^{th} common factor; and ε is the error terms which is equal to ε_1, ε_2, ε_3, …..ε_p representing the vector of latent error terms. Finally, ε_j is the j_{th} specific factor.

To estimate the model, this study utilises SPSS statistical software to identify constructs or factors for the dependent and independent variables, considering all the items and group items captured within the survey dataset. The dependent variable items are responses to sustainable FSC variables designed by the survey, and the independent variables are responses captured for sustainability dimensions involving environmental, economic, social, regulatory, collaboration, and complexities variables. To identify factors for further statistical analysis, the factor analysis (PCA) is estimated using dimension reduction and assuming descriptives with initial solution, coefficients, significance level, the Kaiser–Meyer–Olkin (KMO) test, and Bartlett’s test of sphericity (Hair et al., 2006; Yong and Pearce, 2013; Shrestha, 2021). On extraction, the study assumes correlation matrix, unrotated factor solution, and scree plot. The eigenvalues are left at default, which is usually greater than 1. The maximum iterations for convergence are increased to 75, since the survey dataset is small—below 300 observations—to help convergence of the variables. With a small sample or observation like 133, convergence can become increasingly different if the maximum iterations for convergence are not increased (Thompson, 2004; Yong and Pearce, 2013). On rotation, the study assumes varimax (Kaiser, 1958) and, also, the maximum iteration for convergence is increased to 75. This is applied to help reduce the number of variables that denote high loadings of an individual factor (Kaiser, 1958; Shrestha, 2021). The study then ignores the score options but, however, assumes the options of excluded cases listwise and coefficient display format sorted by size and suppresses small coefficients to 0.40. This will help avoid overestimation of the factors of the dependent and independent variables of the large dataset (Yong and Pearce, 2013: Boduszek, 2018). The Kaiser–Meyer–Olkin (KMO) test and Bartlett’s test of sphericity results from this model help to determine the factorability of the dataset (Shrestha, 2021). The KMO test measures the fitness of the dataset for statistical factor analysis, while testing the suitability of the sample size; whereas KMO values between 0.6 and 0.69 means that sampling is mediocre, KMO values between 0.8 and 1.0 show that the sample size is adequate for factor analysis. Bartlett's test of sphericity presents the null hypothesis (H_0) that the variables from the original correlation matrix, which is also the identity matrix, are unsuitable and unrelated for structure detection. Furthermore, the alternate hypothesis (H_1) explains that the variables are sufficiently related to show the original correlation matrix differs from the identity matrix. This implies that a significant value less than 0.05 shows that factor analysis is useful for the dataset (Van Truong, Pham and Vo, 2016; Shrestha, 2021).

The results (KMO and Bartlett's test of sphericity) of the factor analysis (PCA) estimated are presented in Table 5.2 below.

Table 5.2 KMO and Bartlett's Test

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.806
Bartlett's test of sphericity	Approx. Chi-Square	4725.907
	Df	990
	Sig.	0.000

The KMO value in Table 5.2 is 0.806, falling in the range of KMO adequacy value of 0.8 to 1.0. This implies that the sample size for factor analysis is suitable and adequate. On the other hand, the Bartlett's test of sphericity is statistically significant value < 0.05. This explains that conducting factor analysis for the survey dataset is useful or worthwhile. Having these significant and valuable results from the factor analysis (PCA), the study draws on the rotated component matrix output to determine the factors or constructs of the dependent and independent variables for further statistical analysis which is multilinear regression (MLR). So, an item (question statement) that loads on two or more factors is dropped, since such an item is not interpretable; is ill-defined (van der Gaag et al., 2006; Mathur, Jugdev and Fung, 2013); or the questions are jumbled. Hence, using Rotated Component Matrix (Factor Analysis—PCA) output from SPSS, cross-loading items for the sustainable FSC and sustainability dimension factors (items) are presented as Appendix 7. Appendix 7 presents the Rotated Component Matrix—PCA—showing cross-loading items. The remaining items are then factored as constructs or variables for the dependent (sustainable FSC) and independent (environmental, economic, social, regulatory, collaboration, and complexities) variables accordingly. Table 5.3 below presents items considered as constructs (factors) for further statistical analysis by MLR. These items or constructs are 34 in total. Meanwhile, Appendix 8 presents the items excluded after Factor Analysis (PCA). The 34 constructs (items in Table 5.3) determine the dependent and independent variables, i.e., sustainable SFC and sustainability dimensions variables after factor analysis (PCA).

Table 5.3 Items considered as constructs (factors) for further statistical analysis by MLR.

Variables	Items (Question statements)
Sustainable FSC	You have an idea about sustainability
	Your activities have economic impacts. For example, my activities generate income for myself, farmers, outgrowers or other workers.
	There are authorising institutions who supervise and regulate my activities.
	Your activities have environmental impacts.
Environmental	You work with a local institution or foreign institution that helps to conduct sustainable agricultural practices.
	You adopt farm practices or activities that enhance sustainability.
	You have a license from the Environmental Protection Agency (EPA) for your operations.
	Your activities produce a negative environmental impact.
	Your activities produce CO_2 emissions from transportation and other logistical activities.
	The Environmental Protection Agency (EPA) regularly visit my premises to carry out inspections.
	Your activities are regulated and guided by the Environmental Protection Agency (EPA).
Economic	Your activities are supported and guided by FairTrade.
	You are aware of FairTrade.
	Some vegetables can go waste (either by rotting, damage, or being discarded) before exporting to the UK.
	There is any form of rules or regulations that govern your relationship with a smallholder farmer or exporter.
Social	There are other better approaches to enhancing traceability and transparency apart from Farm code or your own labelling.
	Consumers and trade partners can trace the source of your product because of your labelling or packaging.
	Apart from Farm code, you adopt other methods that help traceability of products.
	You have a Farm code.
Regulatory	You work with a local institution that regulates your activities and guides the way you produce food.
	You have a certification to export overseas.
	You do have a phytosanitary certification.
	You work with a foreign institution (an overseas organisation) that regulates your activities and guides the way you produce food.
	You have a certification that enables you to produce locally.

Collaboration	You work with any other institution that helps you to enhance sustainable vegetables production and supply.
	Smallholders and local farmers have an agreement with exporters on how much of their produce to buy.
	You work with the Food and Drugs Authority (FDA).
	You work with the Ghana Standard Authority (GSA)
	You work with the Environmental Protection Agency (EPA).
	You provide some financial support and other innovative farm tools that help farmers to improve their productivity.
	You set out an agreement with farmers, smallholders, or exporters which they must comply with.
Complexities	With the current supports available from foreign institutions, local institutions (e.g., PPSRD) and government, developing sustainable food supply is still difficult?
	You have limited knowledge on how to improve efficiency in your food production and supply activities.
	You have limited knowledge on processing your food.

5.4 Descriptive statistics

The data collected are first analysed using descriptive statistics to explain minimum, maximum, mean, standard deviation, skewness, and kurtosis. Table 5.4 presents the results of the descriptive statistics of the variables (i.e., sustainable FSC, environmental, economic, social, regulatory, collaboration, and complexities) within the survey data. It is important to mention that the Likert scale for the responses to statement items (questions) is designed as being from 1 to 5, where 1 = "strongly disagree"; 2 = "disagree"; 3 = "neither disagree nor agree"; 4 = "agree"; and 5 = "strongly agree". The results can be read as showing that the average response for sustainable FSC is "agree" (i.e., 4.3816), implying that participants or respondents agree to engaging in, evidencing, and being informed about sustainable FSC activities. However, similar results are not clearly seen for environmental aspects, as average respondents reflect "neither agree nor disagree" with engaging, evidencing, and being informed about environmental aspects or activities. The study anticipated "agree" or "strongly agree" to environmental aspects in the descriptive statistics; however, the results could be due to unfamiliar terminologies used in the statement items (e.g., "CO_2 emissions" and "negative environmental impact"); question statements outweighing respondents understanding of environmental aspects; and some question statements capturing activities with regulatory authorities such as the Environmental Protection Agency (EPA), on the grounds that most small producers do not work with these authorising bodies. Even so, an average response of 3.5038 is weighted towards agreeing to the environmental aspects statements items (questions). Regarding economic aspects, the average of the responses is inconclusive (i.e., 3.3120) to engaging, evidencing, and being informed about economic aspects. In contrast, the average of social responses is weighted towards agreement (3.5470) to engaging, evidencing, and being informed about activities which reflect the social dimensions of sustainability, i.e., traceability and transparency.

In terms of the regulatory dimension, average responses do not agree or disagree (at 3.0090). The researcher had expected different results, based on the data related to the impact of regulatory authorities on producing and exporting vegetables to the UK, but the descriptive statistics led elsewhere. This result could be due to high responses from smallholders, outgrowers, and local farmers to the survey. These small producers usually sell their vegetables to the open markets, to large producers, and to exporters; and most of them may not have export certification (phytosanitary certification) and may not be regulated by authorising bodies, because of their rural location or area of production, which may have had a similar effect on the descriptive statistical results on collaboration. Average responses for food supply chain collaboration are not confirmatory and decisive (i.e., 3.2932). The results could be due to the number of question statements captured of which most small producers may not have an idea or do not have any collaboration with. These question statements include "You work with ISO 22000 (International Organisation for Standardization)", "You work with Green Label", "You work with the Ghana Standard Authority (GSA)", "You work with the Environmental Protection Agency (EPA)", and "You work with Global G.A.P.". Furthermore, it is perhaps surprising to observe from the survey data that average responses to complexities in developing sustainable food supply chains is not confirmatory or strongly agreeing (at 2.9323). Producers, whether small- or large-scale, encounter a significant number of challenges in production and supply, e.g., efficiency issues, lack of technological input, weak government policies, and limited credit facilities. Hence, the descriptive statistics results from the survey, i.e., neither disagree nor agree, could be because of honesty or uncertainty of response from participants. In other words, participants may not want to provide a confirmatory response to the question statement: "You have limited knowledge on processing your food".

In summary, the descriptive statistics of the survey data reveal important, and interesting predictions and observations of producers' or respondents' understanding, engagement, evidence, and activities related to sustainable FSC and the different sustainability dimensions.

Table 5.4 Descriptives of the Survey data

Variable	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Sustainable FSC	1.25	5.00	4.3816	.71349	-2.173	5.975
Environmental	1.00	5.00	3.5038	.85689	-.392	-.104
Economic	1.00	5.00	3.3120	1.04056	-.198	-.879
Social	1.00	5.00	3.5470	.86062	-1.404	2.258
Regulatory	1.00	5.00	3.0090	1.16564	.490	-.852
Collaboration	1.00	5.00	3.2932	.88419	-.194	-.269
Complexities	1.00	5.00	2.9323	.88929	.263	-.192

5.5 Robustness Checks—Normality and Multicollinearity Tests

Before estimating the regressions (multilinear regressions) to explain the relationship between sustainable FSC and sustainability dimensions, it is appropriate to check statistical procedures to enhance the robustness of the analysis. To facilitate this, the researcher investigated normality tests, scatterplots, and multicollinearity tests of the 34 constructs (items). These statistical procedures for robustness have the benefit of demonstrating that assumptions are met, the data are ideal for further statistical analysis, and the variables are not strongly correlated (Ghasemi and Zahediasl, 2012; Cohen, 2013; Park, 2015).

5.5.1 Normality Test and Scatterplot

This study has adopted the graphical method of assessing normality in the data. The normal probability–probability plot (Normal P–P plot) explains the statistical ability to distinguish a non-normal distribution of a variable from a normal distribution. When two distributions fit, the plotted points provide a linear pattern passing through the starting point of zero with a unit slope (Park, 2015; Kim and Park, 2019). The results from the normal p–p plot (Figure 5.1) of sustainable FSC (dependent variable) show a linear pattern and do not deviate from the horizontal line, showing a standard normal distribution (Ghasemi and Zahediasl, 2012; Park, 2015). Hence, the outcome variable (sustainable FSC) is normally distributed and there is a linear relationship between the predictor and outcome variables. Scatterplots also help to assess the normality in multivariate models (Jeon, 2015; Oppong and Agbedra, 2016). The study creates a residual scatterplot using the “z predictor” and “z residual”—i.e., the standardised scores—to check the normal distribution of the residual. To indicate normality, a pile of residuals should be centred on the residual scatterplot, showing a rectangular shape with the residuals partly moving away symmetrically in all four paths (directions) from the centre (Jeon, 2015).

Figure 5.1 below also shows the scatterplot indicating normality.

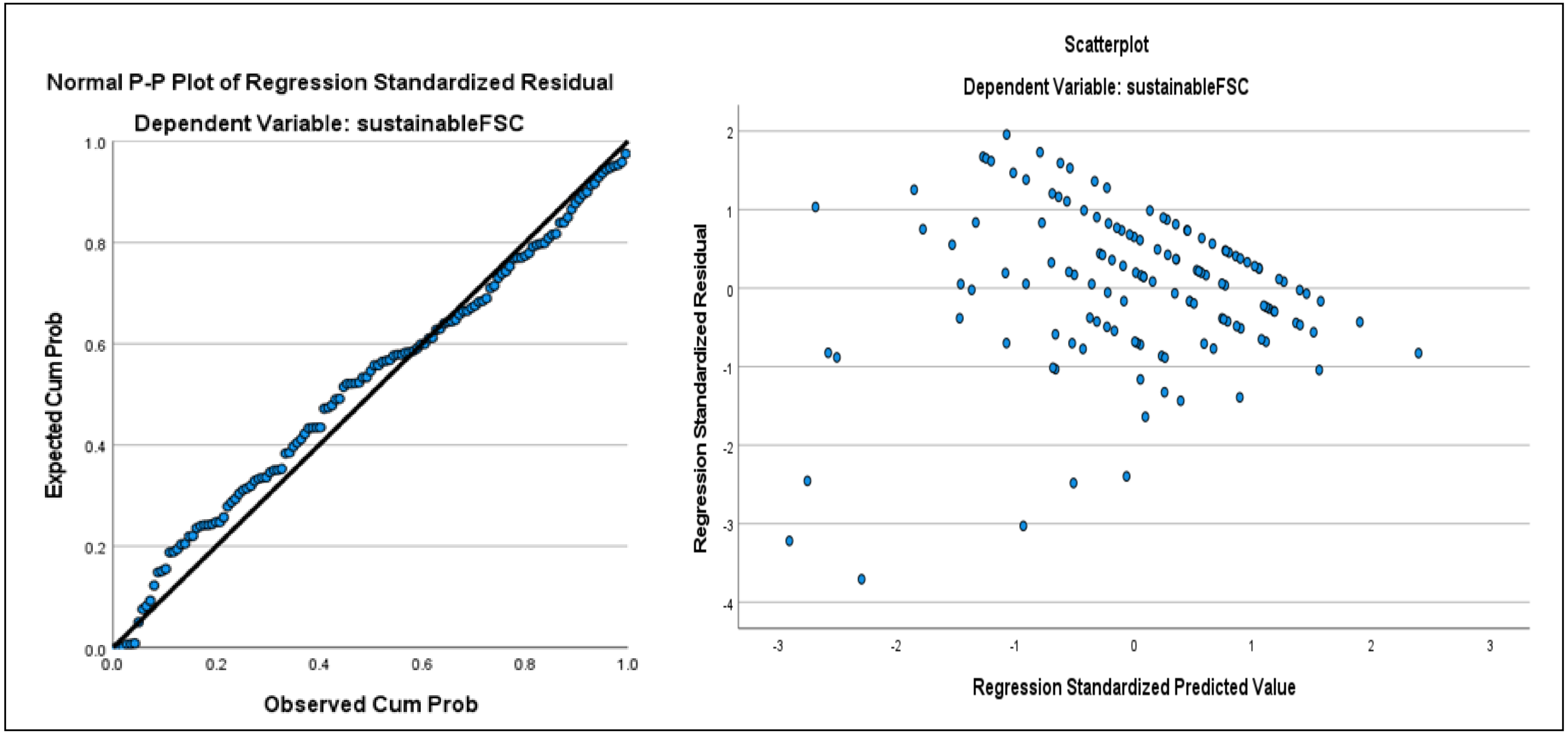


Figure 5.1 Normal P–P Plot and Scatterplot

5.5.2 Multicollinearity Test

Before MLR is tested, it is important to check whether the current data are suffering from multicollinearity. A multicollinearity test points to a statistical anomaly where two or more independent variables are highly correlated in a multilinear regression model (Daoud, 2017; Shrestha, 2020). This implies that its presence in the data means that the standard errors of the coefficients increase, causing change in the results of the statistical analysis (Shrestha, 2020). The two most common ways of testing for multicollinearity are using the correlations matrix and variance inflation factor (VIF) (Thompson et al., 2017; Abhyankar and Singla, 2021). To test for multicollinearity, correlation matrix output from the SPSS statistical analysis is utilised and presented in Table 5.2 (Correlation), where SFSC represents the dependent variable (sustainable SFC), and the independent variables are presented as: “Env” for environmental aspects; “Eco” for Economic aspects; “Soc” for Social aspects; “Reg” for Regulatory aspects; “Colla” for sustainable food supply chain collaboration; and “Compl” for Complexities in developing sustainable food supply chains. The general rule of thumb explains that there is multicollinearity if the Pearson correlation value between two different independent variables is greater than 0.70; and there is much greater multicollinearity if the Pearson correlation coefficient is greater than 0.8 (Ringim, Razalli and Hasnan, 2012; Dormann et al., 2013; Shrestha, 2020). Additionally, the independent variable should correlate with the outcome (dependent) variable at a value or coefficient greater than 0.30 to demonstrate a strong relationship between the variables (Dormann et al., 2013; Barton and Peat, 2014; Shrestha, 2020). The correlation in Table 5.5 reveals that all independent variables’ (environmental, economic, social, regulatory, collaboration) correlations with outcome variable (sustainable FSC) are greater than 0.30, except for complexities. However, according to Cohen (2013) and Son, Ha and Khuyen (2018), complexities can be explained as having a weak relationship with sustainable FSC and may be removed from the model. Notwithstanding, the correlations between any two independent variables (e.g., environmental and social aspects) is not greater than 0.70. Satisfying these two assumptions implies that there is no multicollinearity in the data and the regression model for sustainable SFC and sustainability dimensions can be estimated.

Table 5.5 Correlation

		SFSC	Env	Eco	Soc	Reg	Colla	Compl
SFSC	Pearson correlation	1	0.570***	.415***	0.521	.349***	.494***	.016
	Sig. (1-tailed)		0.000	0.000	0.000	0.000	0.000	0.427
Env	Pearson correlation		1	.646***	.629***	.675***	.664***	-.014
	Sig. (1-tailed)			0.000	0.000	0.000	0.000	.436
Eco	Pearson correlation			1	.437***	.623***	.633***	-0.92
	Sig. (1-tailed)				0.000	0.000	0.000	.147
Soc	Pearson correlation				1	.498***	.524***	0.056
	Sig. (1-tailed)					0.000	0.000	.260
Reg	Pearson correlation					1	.682***	-.183**
	Sig. (1-tailed)						0.000	0.017
Colla	Pearson correlation						1	-0.076
	Sig. (1-tailed)							0.192
Compl	Pearson correlation							1
	Sig. (1-tailed)							

Note(s): SFSC (Sustainable FSC), Env (Environmental), Eco (Economic), Soc (Social), Reg (Regulatory), Colla (Collaboration) and Compl (Complexities). *** means p<0.01 (thus, correlation is significant at 0.01 level); ** means p<0.**05** (thus, correlation is significant at 0.05 level)

5.6 Model Performance

5.6.1 Relationship between sustainable FSC and the sustainability dimensions

After investigation for normality and multicollinearity, hypothesis (H1)— There is a significant relationship between the sustainable food supply chain (SFSC) and sustainability dimensions—is tested using the multilinear regression (MLR) model. This is statistically presented as follows:

$$\text{Sustainable FSC} = \beta_0 + \beta_1\text{Environmental} + \beta_2\text{Economic} + \beta_3\text{Social} + \beta_4\text{Regulatory} + \beta_5\text{Collaboration} + \beta_6\text{Complexities} + \varepsilon_i \qquad \text{Eq. (2)}$$

where sustainable SFC is the dependent variable expressing factors of the sustainable food supply chain defined by actors, stakeholders, or producers; β_0 is the intercept; Environmental, Economic, Social, Regulatory, Collaboration, and Complexities are the independent variables that explain the different sustainability dimensions; β_1 through to β_6 are the coefficients of the regression; and ε is the error term. Obtaining a significant statistical relationship and relevance between sustainable FSC and sustainability dimensions using MLR can suggest a measurement or method for valuing the sustainability dimensions (or implications) associated with Ghana's fresh vegetable supply chain to the UK. In a broader context, it could suggest a robust and novel relationship and measurement between the identified sustainability dimensions (implications), based on the thematic analysis of the case study data and sustainable FSC.

Model Summary

The results of the model summary are presented in Table 5.6. From Table 5.6, R shows a positive correlation of 0.635 between the dependent variable (sustainable FSC) and the independent variables (sustainability dimensions). The value 0.56441 is the standard error of the estimate and explains the standard deviation of the residuals. However, R-square is 0.403, representing 40.4% of the variation in the sustainable FSC that can be explained by the regression model, while the adjusted R-square is 0.374, i.e., 37%. The results indicate that the model is a good fit, and the regression model has statistical significance lower than 0.01.

ANOVA

The F-test of ANOVA assesses the statistical significance of the regression model (Shrestha, 2020). Table 5.7 shows that the F-test (df=14.157) is statistically significant at 0.000 which is lower than the critical index (α) of 0.05, so this study rejects the null hypothesis (H_0) that the variables are heterogeneous and can agree that there is statistical significance between the dependent and independent variables. So, hypothesis (H_1) is accepted. Therefore, it can be emphasised that the results of the regression analysis are not a consequence of chance.

Table 5.6 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.635	.403	.374	.56441	.403	14.157	6	126	.000

Note(s): Predictors: (Constant); Environmental, Economic, Social, Regulatory, Collaboration and Complexities and Dependent Variable: Sustainable FSC

Table 5.7 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.058	6	4.510	14.157	.000
	Residual	40.139	126	.319		
	Total	67.197	132			

Note(s): Predictors: (Constant); Environmental, Economic, Social, Regulatory, Collaboration and Complexities and Dependent Variable: Sustainable FSC

5.6.1.1 Results of the relationship between sustainable FSC and the sustainability dimensions

Table 5.8 presents the results of multilinear regression estimating Eq. (3), the relationship between sustainable FSC and sustainability dimensions. The results show that variance inflation factor (VIF) is greater than 1 but less than 5, implying that there is a moderate correlation within the variables and there is no existence of collinearity in the regression model (Shrestha, 2020). Additionally, the constant (intercept) is 2.250, indicating the value of sustainable FSC (dependent variable) when the sustainability dimensions equal to zero. The study is not interested in the constant, since all the sustainability dimensions amounting to zero is not possible. The results of the standardised coefficients (Beta) help to compare the relative strength of the sustainability dimensions (independent variables) within the regression model (Imbens and Wooldridge, 2009). The standardised coefficients (Beta) for the sustainability dimensions show a positive relationship for some independent variables (environmental, social, and collaboration) and an inverse relationship for an independent variable (regulatory aspects). From these results, a one standard deviation increase in environmental aspects can lead to a 0.370 standard deviation increase in sustainable FSC. Also, a one standard deviation increases in social aspects leads to a 0.254 standard deviation increase in sustainable FSC. Even though collaboration shows a less positive standard deviation effect on sustainable FSC compared to environmental and social aspects, it is important to mention that a one standard deviation increase in collaboration results in a 0.229 standard deviation increase in sustainable FSC. On the other hand, the regulatory aspects standardised coefficient shows that an increase in standard deviation of regulatory aspects inversely leads to a 0.220 standard deviation increase in sustainable FSC.

Even so, interesting results can be read from the regression analysis. First, the findings of sustainability dimensions, economic aspects and complexities are not statistically significant. The insignificant result for the economic aspect may be due to constructs (question statements) designed for the sustainability dimension. The constructs (question statement items) mainly focused on FairTrade, food waste, and food loss. However, vegetables not certified for FairTrade (Opoku, Bannor and Oppong-Kyeremeh, 2020) and evidence from the case analysis of this study confirm this.

Table 5.8 Regression results

Variable	**Unstandardised Coefficients**		**Standardised Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
	B	Std. Error	Beta			Tolerance	VIF
Constant	2.250	0.287		7.833	0.000		
Environmental Aspects	0.308	0.095	0.370	3.226	0.002***	0.361	2.770
Economic Aspects	0.038	0.068	0.056	0.567	0.572	0.484	2.064
Social Aspects	0.211	0.075	0.254	2.800	0.006***	0.574	1.742
Regulatory Aspects	-0.135	0.066	-0.220	-2.039	0.044**	0.406	2.464
Collaboration	0.185	0.086	0.229	2.158	0.033**	0.420	2.381
Complexities	-0.009	0.057	-0.011	-0.151	0.881	0.930	1.075

Note(s): Dependent variable: Sustainable food supply chain (SFSC), *** means p<0.01, ** means p<0.05 and * means p<0.1

Complexities in developing sustainable food supply chains is not significant due to uncertainties in the data from respondents. In summary, the study finds statistical significance for Environmental Aspects, Social Aspects, Regulatory Aspects, and Collaboration; whereas Environmental and Social Aspects are statistically significant at 1%, Regulatory Aspects and Collaboration are statistically significant at 5%, indicating that Environmental and Social Aspects have a high significant relationship with sustainable FSC.

Regarding environmental aspects, the study further reveals that an additional increase in practices and activities focused on the environment can predict an increase in sustainable FSC by 30.8% of unit of measurement at a significance level of 1%. This result is due to producers' increasing awareness of environmental issues, adopting sustainable agricultural practices (such as green manuring, minimising the use of pesticides, and the use of approved farm inputs) and dominance of small-scale farming in the country. This is in line with Gatzweiler and Von Braun (2016), who stress that producers' approaches – including agricultural innovations—help them to make better decisions more sustainably and increase resilience. This is also consistent with Reklitis et al. (2021), who indicate that food supply chains connecting all partners including producers strengthen environmental sustainability orientation, thus inducing positive impacts on environmental performance and sustainable food supply chains. Other relevant empirical studies, such as that of Poore and Nemecek (2018), can confirm this contribution of the study: that producers adopting substantial opportunities in their operations can help reduce environmental impacts.

In terms of social aspects, the study finds a positive relationship between social aspects and sustainable FSC. The results can be explained as showing that an increase in practices and activities that are related to social aspects of sustainability can predict an increase in sustainable FSC by 21.1% of the unit of measurement, at a significance level of 1%. This circumstantial evidence can suggest that producers are becoming better decision makers, minimising health and environment risks, as well as ensuring safe and traceable food items for consumers and other FSC players. This result is akin to that of Ruiz-Torres et al. (2021), whose regression estimations of social constructs for sustainability are statistically significant and can explain the possibility of an incremental performance in the sustainability of food systems. The discussion of previous studies by Nichols and Hilmi (2009) supports these results, arguing that on-farm production, post-harvest, and producers' interconnected activities involve healthy and safe approaches that foster social sustainability and ultimately lead to building trust among consumers and other FSC actors. In addition, the study results are consistent with the assertions of Buzby et al. (2011) and Principato, Secondi and Pratesi (2015): that producers providing meaningful information to consumers and information about food miles can precipitate more sustainable outcomes.

Importantly, the study reveals collaboration that has a positive relationship with sustainable FSC. The results indicate that an increase in collaborative activities with other FSC actors or collaboration practices between FSC players can increase sustainable FSC by 18.5% of the unit of measurement at a significance level of 5%. This result is due to collaborative activities in the sector more focused on enhancing sustainable food supply chains, e.g., increasingly using organic farm inputs and maintaining sustainable production practices. Also, collaborative institutions' activities are directed towards safe, healthy, and sustainable agricultural practices, as well as providing necessary support and resources to facilitate sustainable production and supply chains. This empirical and circumstantial evidence is consistent with that from Smith et al. (2017), who emphasise that collaboration practices for sustainability have positive and innovative effects on sustainability performance. They further argue that collaborative initiatives between FSC actors such as farmers and researchers have the potential to increase food production while enhancing other sustainability dimensions, such as economic, social, and environmental sustainability. Again, this result is consistent with the emphasis of Chen et al. (2017): that collaboration activities engaging different actors, such as producers, suppliers, and other supporting organisations enhances sustainability performance. In addition, Govindan (2018) clearly indicates that collaboration involving coordination of FSC actors can help achieve sustainable production and consumption.

Furthermore, it is noteworthy that the study reveals an inverse relationship between regulatory and sustainable FSC. The results show that an increase in regulatory mechanisms and checks can decrease sustainable FSC by 13.5% of the unit of measurement at a significance level of 5%. The study anticipated a positive relationship, because it has strongly argued that regulations positively improve marketability of farm produce, producer and consumer safety, as well as inducing innovations due to the impetus of market competitiveness (Porter and Van der Linde, 1995; Bynoe, 2004; Hidayat et al., 2018). This result of the study may be due to high responses captured from small-scale producers, centralised regulatory mechanisms in Ghana, and poor regulatory oversight. Ghana's vegetable supply chains are mainly dominated by small-scale producers who are outgrowers, smallholders, and local farmers widely dispersed across the country. These producers' activities are rarely regulated, and most of them are unaware of many of the regulations regarding their production and supply chain activities. Nonetheless, the result is consistent with the work of Bynoe (2004), whose work in food production showed that regulations can increase agricultural inefficiencies, hence, affecting sustainable practices. Similarly, it confirms the discussion of Hurley (2006) to the effect that regulations negatively affect producers' bottom line and any attempts to estimate a country's regulation cost for producers or FSC actors are likely to skew downward. Increasing regulatory frameworks may disincentivise producers, especially smallholders and local farmers, and they may look for alternative options instead of increasing vegetable production and supply activities and contributing to vegetable exports to the UK.

5.6.2 Multilinear regressions: Relationship between producers and the sustainability dimensions

The study further explores the relationship between large- and small-scale producers, sustainable FSC, and sustainability dimensions. Therefore, the following hypotheses are tested:

> H_{2a}: The relationship between large producers and sustainability dimensions influences the sustainable food supply chain (sustainable FSC)
>
> H_{2b}: The relationship between small producers and sustainability dimensions influences the sustainable food supply chain (sustainable FSC).

In this case, the relevance of the sustainability dimensions and producers to predicting sustainable FSC is estimated and tested. It is important to mention that large producers and small producers presented in the regression equations below are used as dummy variables. Understanding the statistical relationship and significance between FSC actors (mainly producers), sustainable FSC, and the sustainability dimensions (implications) can enable producers, FSC professionals, other FSC actors, regulators, and policymakers to draw on more specific measures and approaches to enhancing food sustainability from the grassroots and food sources. This implies that policies, measures, and approaches can be properly aligned with various food supply chains, knowing the sustainability implications which matter. Additionally, it can demonstrate the significant contributions of large-scale producers towards sustainable food supply chains, helping to focus in on sustainability implications that require rectification or development and strengthen positive implications for the furtherance of all food trade partners' and FSC actors' interests. To estimate the relationship between producers, sustainable FSC, and sustainability dimensions, two separate equations are employed. Hypothesis (H_{2a}) explained by Eq. (4) is estimated for large producers as:

$$\text{Sustainable FSC for large producers} = \beta_1 + \beta_2\text{Environmental} + \beta_3\text{Economic} + B_4\text{Social} + \beta_5\text{Regulatory} + \beta_6\text{Collaboration} + \beta_7\text{Complexities} + \beta_8\text{Large Producers} + \varepsilon_i \qquad \text{Eq. (4)}$$

where sustainable SFC is the dependent variable expressing factors of sustainable food supply chain defined by actors, stakeholders, or producers. β_1 is the intercept; Environmental, Economic, Social, Regulatory, Collaboration, and Complexities are the independent variables that explain the different sustainability dimensions; β_2 through to β_8 are the coefficients of the regression; and ε is the error term. Large producers is the dummy variable and ε is the error term. Further, hypothesis (H_{2b}) explained by Eq. (5) is estimated for small producers as:

$$\text{Sustainable FSC for small producers} = \beta_2 + \beta_3\text{Environmental} + \beta_4\text{Economic} + \beta_5\text{Social} + \beta_6\text{Regulatory} + \beta_7\text{Collaboration} + \beta_8\text{Complexities} + \beta_9\text{Small Producers} + \varepsilon_i \qquad \text{Eq. (5)}$$

where small producers is the dummy variable; β_2 is the intercept; β_3 through to β_9 are the coefficients of the regression; and ε is the error term. Similar to the relevance and objectives of the estimation with large-scale producers in Eq. (4), this study considers small-scale producers' relationship with sustainable FSC and sustainability dimension. Since small-scale producers are highly dominant in food production and supply chains, it is vital to estimate the statistical significance and relevance of their relationship between sustainable FSC and sustainability. As increasing numbers of FSC actors, policymakers, and third sector organisations expand their activities, programmes, policies, and resources to support small-scale producers (Chemnitz, Grethe and Kleinwechter, 2007; Aung et al., 2021), the results of this estimation can guide benefactors and governments to balance inputs (policies, measures, resources, and programmes) with outcomes (sustainable FSC results). Hence, the relationship between small-scale producers, sustainable FSC, and the sustainability dimensions is estimated, and the results are presented in Table 5.9, comparing producers, sustainability dimensions, and sustainable FSC).

Table 5.9 Regression results—Comparing producers, sustainability dimensions, and sustainable FSC.

Variable	Eq. (2)—Sustainable SFC and sustainability dimensions (Coefficients)	Eq. (4)—Sustainable SFC and sustainability dimensions for large-scale producers (Coefficients)	Eq. (5)—Sustainable SFC and sustainability dimensions for small-scale producers (Coefficients)
Environmental Aspects	0.308***	0.300***	0.300***
Economic Aspects	0.038	0.036	0.036
Social Aspects	0.211***	0.215***	0.215***
Regulatory Aspects	-0.135	-0.139	-0.139
Collaboration	0.185**	0.186**	0.186**
Complexities	-0.009	-0.006	-0.006

Note(s): *** means p<0.01, ** means p<0.05 and * means p<0.1

Table 5.9 presents the summary of results of the regression model derived from Eq. (2), (4), and (5). The results of the regression analysis show important reflections and revelations that a sole FSC actor does not holistically influence sustainable food supply chain outcomes. For food supply chains to be more sustainable, collaborative activities and inputs of various FSC actors are required. Global food supply chains are complex, involving many actors, decision makers, roles, factors and challenges. Hence, one group of actors, e.g., small-scale producers, cannot determine the value of measurement or unit of estimate that can influence how sustainable food supply chains can be enhanced. Hence, robust statistical measurement of sustainable food supply chains, policymakers, researchers, and educators can be determined using existing methods such as a regression model (Eq. (3)) which equates sustainable FSC to all sustainability dimensions considered while ignoring the group of FSC that responded to the data or sources of the data. This is because the capture of any sustainability dimension data, to some extent, includes the engagement or activities of FSC actors other than the data provider or respondent. Therefore, FSC professionals, authorising bodies, and researchers can consider broader capture of sustainability data by accommodating all the sustainability dimensions and multiple sources. The findings of this study have revealed that survey data can produce robust statistical results by utilising PCA to extract meaningful constructs and by estimating a multilinear regression model. It is important to stress that key variables such as environmental, social, regulatory, and collaboration aspects (activities) of sustainability should not be overlooked and should be integral to any sustainability impact assessment.

5.7 Sustainability Impact Assessment (SIA) model—Validation

To validate the SIA model (Figure 5.2), the study utilises that survey design based on the results from the thematic analysis of the case study data and runs reliability and validity assessment of the 34 constructs (items) based on Cronbach’s Alpha, CR, and AVE values of the items. This study also adds the descriptive statistics for the Likert-scale items covering the sustainability dimensions and their associated impacts (34 constructs).

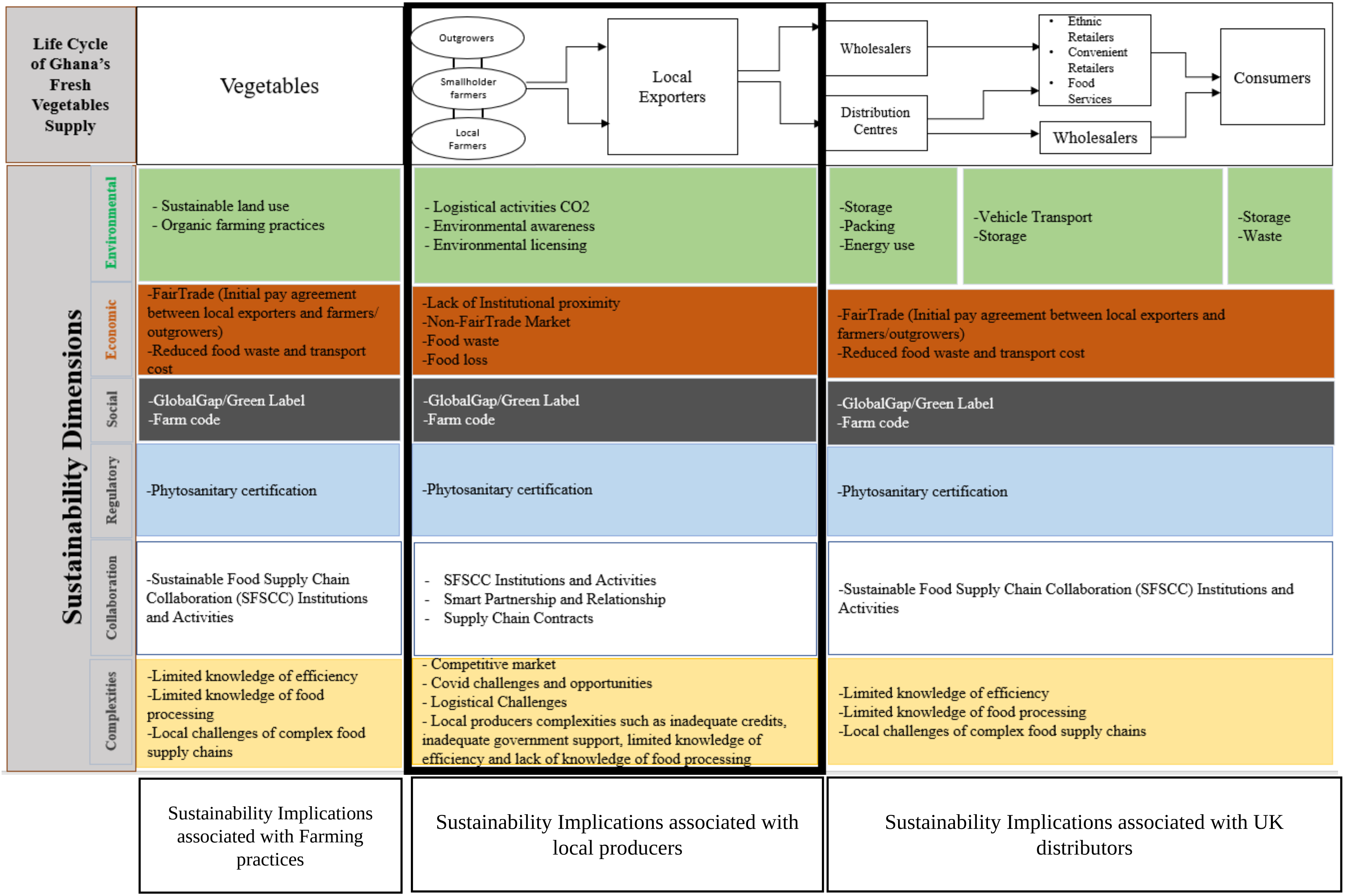


Figure 5.2 SIA model to be validated.

Among the 34 items covering the sustainability implications (sustainability dimensions and their associated impacts) captured in the SIA model, it is important to mention that the Likert scale is rated as 1 = “strongly disagree”; 2 = “disagree”; 3 = “neither disagree nor agree”; 4 = “agree”; and 5 = “strongly disagree”. First, the Cronbach’s Alpha result for the survey data is 0.925 for 34 items, implying that there is excellent strength of consistency in the survey data. Hence, the result for the reliability test show the quality, rigour, and trustworthiness of the survey data.

Further, the study tabulates the results reliability test (Cronbach’s Alpha if item deleted), mean, CR, AVE and standard deviation for all constructs (items) for each sustainability dimension and utilises these results to validate sustainability implications (sustainability dimensions and their associated impacts) captured in the SIA model. For a sustainability dimension and an impact to be established or validated (i.e., included in the SIA model), its Cronbach’s Alpha (Cronbach’s Alpha if item deleted) should be greater than .70 (thus, $\alpha \geq 0.70$), but not more than 0.925; and mean (i.e., average of the sum of mean of the items designed for that sustainability impact) should be more than 3.0 (thus, neither disagree nor agree, agree, or strongly agree).

5.7.1 Composite reliability (CR)

Composite reliability (CR) determines the reliability and internal consistency of the constructs. Some studies use Cronbach’s alpha (e.g., Shrestha, 2021) to determine a construct reliability. However, the limitation of Cronbach’s alpha prioritising all items according to their individual reliability (Nguyen, Nguyen and Ba Le, 2022), this study uses composite reliability taking into account different outer loading of the items explaining the construct. Hence, the composite reliability equation is defined as:

$$\mathrm{Pc} = \frac{(\Sigma_{i=1}^{n} L_i)^2}{(\Sigma_{i=1}^{n} L_i)^2 + (\Sigma_{i=1}^{n} var(ei)^2} \quad \dots\dots\dots\dots Eq.(6)$$

Where L_i represents the standardised outer loading of the item i of a construct, var(e_i) depicts the variance of measurement error which is explained as ($1\text{-}L_i^2$), while e_i represents the measurement error of the item i. Hence, the composite is calculated using the factor loading of the 34 items assuming varimax rotation. CR values range from 0 to 1. The higher the level of reliability, the higher the composite reliability. It is important to note that that acceptable CR values are greater than 0.60 (Hair et al., 2009; Pallant, 2020; Nguyen,

Nguyen and Ba Le, 2022). CR values less than 0.70 mean that the item lacks internal consistency reliability.

5.7.2 Average variance extracted (AVE)

The assessment of CR values, thus, outer loading of the items and AVE can determine convergent validity; that is, how an item positively correlates with alternate items of the same construct (Cowin et al., 2008; Hair et al., 2009; Pallant, 2020; Nguyen, Nguyen and Ba Le, 2022). AVE explains the mean value of the squared loadings of the items related to a particular construct. Thus, it estimates the total of the squared loadings divided by the number of items in a construct (Nguyen, Nguyen and Ba Le, 2022). Hence, the AVE formula is defined as:

$$\text{AVE} = \frac{\sum_{i=1}^{n} {L_i}^2}{n} \;\ldots\ldots\ldots\ldots Eq. (7)$$

where L_i represents the standardised factor loading, and i is the number of the items. It is important to highlight an acceptable AVE of 0.5 or higher is adequate convergence – showing validity of the construct (Hair et al., 2009; Pallant, 2020; Nguyen, Nguyen and Ba Le, 2022). To determine the CR and AVE, factor analysis is conducted of the 34 items using SPSS version 27. First, dimension reduction is performed assuming varimax rotation. The output (rotation component matrix) is further utilised to calculate CR and AVE with the help of Excel.

Table 5.10 presents the results of the environmental dimension. If the item is deleted for the variable, the Cronbach’s Alpha for environmental aspect is 0.922 and the mean is 3.5038, confirming that environmental dimension of sustainability should be captured. In addition, composite reliability (CR) and AVE for the constructs—environmental awareness, environmental licensing and logistics activities CO_2 emissions show acceptable, reliable, and satisfactory scores. Two items generating the environmental awareness construct indicate CR of 0.778 and AVE of 0.683 with Cronbach’s alpha if item deleted as 0.923 and 0.924, respectively. Also, three items generating the environmental licensing construct indicate CR of 0.812 and AVE of 0.612 with Cronbach’s alpha if item deleted as 0.921, 0.922 and 0.922, respectively. Further, two items generating logistical activities CO_2 emissions construct indicate CR of 0.798 and AVE of 0.541 with Cronbach’s alpha if item deleted as 0.922 and 0.924, respectively. Hence, these results confirm that environmental awareness, environmental licensing, and logistical activities CO_2 emissions should be included in the SIA model.

On validating the economic dimension presented in Table 5.11, the Cronbach's Alpha if item deleted for the variable is 0.922 and the mean is 3.915, confirming that the economic dimension should be included in the SIA model. However, two items generating the non-FairTrade market construct indicate CR of 0.779 and AVE of 0.589 with Cronbach's alpha if item deleted as 0.922 and 0.924, respectively. Lack of institutional proximity and Food waste constructs are individually generated by a single item, so CR and AVE could not be estimated. Literature suggests that a single item can be increased by including a criterion measure item to enable CR and AVE assessment or use test–retest reliability for a single item (Hair et al., 2009; Polit, 2014; Shrestha, 2021). However, the survey was not administered more than once to the same group to enable test–retest reliability. . Hence, lack of institutional proximity and food waste are excluded from the framework while non-Fairtrade market is included due to its acceptable and satisfactory CR and AVE values.

Regarding the social dimension presented in Table 5.12, Cronbach's Alpha if item deleted is 0.922 and the mean is 3.5470, confirming that the sustainability dimension should be included. Global G.A.P./Green Label generated by two items produce CR and AVE values of 0.567 and 0.448, respectively. This shows that there is a lack of internal consistency reliability and no adequate validity of the construct—Global G.A.P/Green Label. Meanwhile, Cronbach's Alpha if item deleted for two items is 1 and 2 is 0.923 and 0.923, respectively. Furthermore, the two items generating the Farm code construct produce CR and AVE values of 0.841 and 0.622, respectively, and Cronbach's Alpha if item deleted for the two items 3 and 4 is 0.923 and 0.924, respectively. This shows strong internal consistency reliability and validity of the construct—Farm code.

Regarding the regulatory dimension presented in Table 5.13, the Cronbach's Alpha if item deleted for item as 0.921 and a mean of 3.0090, confirming the inclusion of the sustainability dimension in the framework. Further, phytosanitary certification represented by items 1–4, and 5 has Cronbach's Alpha if item deleted as 0.921, 0.922, 0.922, 0.922, and 0.925, respectively. More importantly, the CR and AVE values explain that the internal consistency reliability and validity of the construct is acceptable and satisfactory. This confirms that phytosanitary certification should be included.

Furthermore, the collaboration dimension is presented in Table 5.14 and confirms that the sustainability dimension is included due to its 0.922 as Cronbach's Alpha if item deleted and a mean of 3.2932. Moreover, the four items generating the construct SFSCC Institutions and Activities produce CR and AVE values of 0.814 and 0.622, respectively. The Cronbach's Alpha if item deleted, items 1–4 are 0.925, 0.923, 0.925, and 0.921 respectively. The Cronbach's alpha, CR, and AVE values show that the construct, SFSCC institutions and activities should be captured in the framework depicting the reliability and validity of the construct. Meanwhile, the construct, supply chain contracts, is generated by a single item, so CR and AVE could not be estimated. Interestingly, smart partnerships and relationship generated by two items produce CR and AVE value of 0.763 and 0.551 respectively. The two items, 5 and 7, show Cronbach's Alpha if item deleted to be 0.924 and 0.923, respectively. The Cronbach's alpha, CR, and AVE values show that the construct, smart partnerships, and relationship should be included in the framework.

Nevertheless, the complexities dimension presented in Table 5.15 is not confirmed due to the mean of 2.923, which is lower than 3.0. Meanwhile, if the item is deleted, the Cronbach's alpha is 0.926. Further, the three constructs—inadequate credits and inadequate government support; limited knowledge of efficiency; and lack of knowledge of food processing—are generated by a single item. Therefore, the CR and AVE values of the single items cannot be calculated and, thus, the sustainability dimensions as well as associated constructs (impacts) are removed from the model.

Hence, considering the results and analysis of the survey data, the SIA model is validated by capturing all confirmed sustainability dimensions, and their associated confirmed impacts(constructs), whereas the sustainability dimension (complexities), its associated impacts and other sustainability impacts (constructs) which are not confirmed—i.e., food loss, food waste, GlobalGap/ Green Label, lack of institutional proximity, and supply chain contracts—are excluded from the SIA model. Therefore, the SIA model is validated and presented as Figure 5.3.

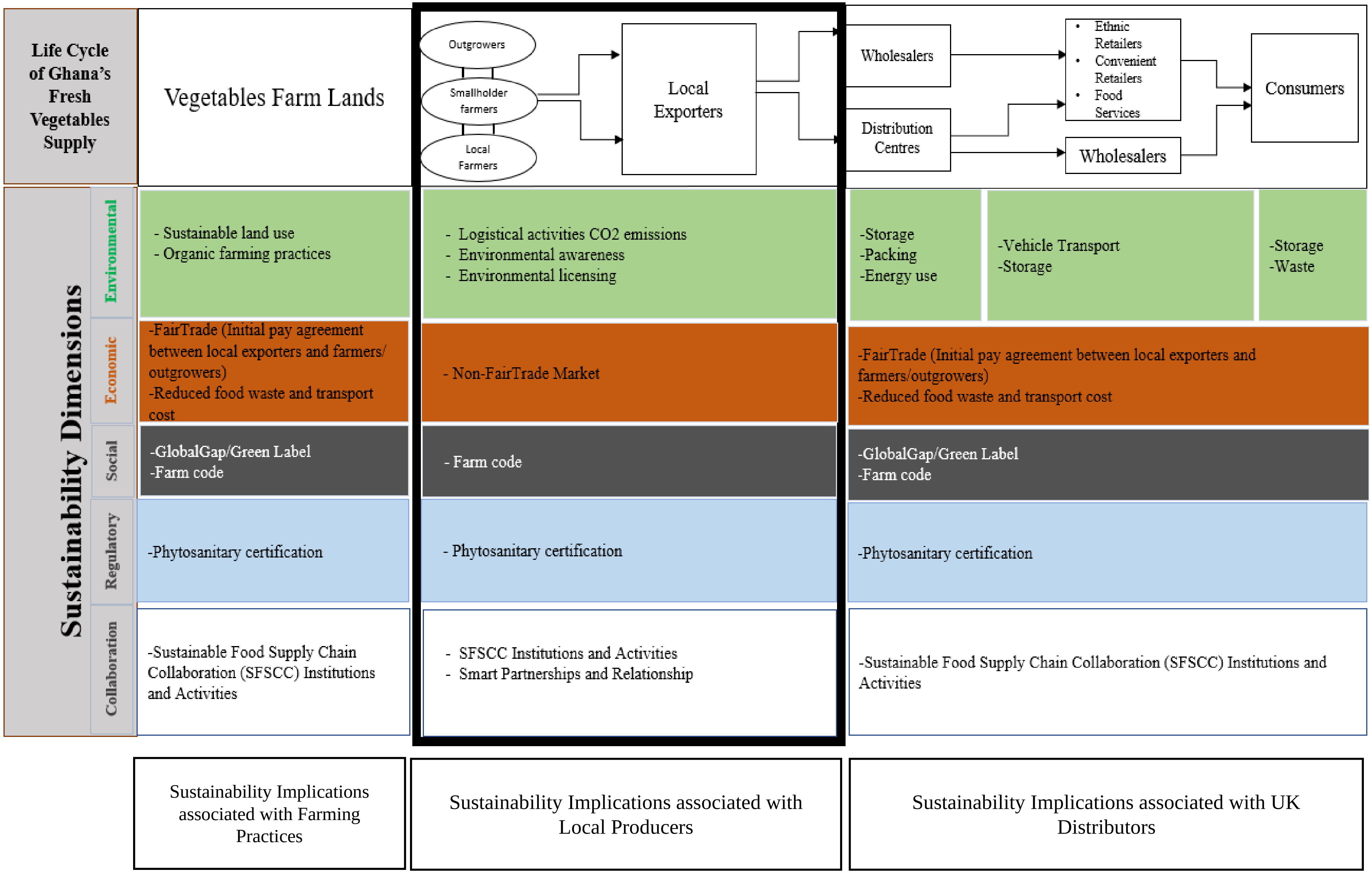


Figure 5.3 Validated SIA model.

Table 5.10 Validating the SIA Model—Environmental Dimension

Variable	CR	Mean	Items	Cronbach's alpha	CR	AVE	Items link with SIA model - implications	Interpreta-tions
Environmental	.922	3.5038	1. You work with a local institution or foreign institution that helps to conduct sustainable agricultural practices.	.923	0.778	0.583	Environmental awareness	Confirmed and should be included in the SIA model
			2. You adopt farm practices or activities that enhance sustainability.	.924				
			3. You have a licence from the Environmental Protection Agency (EPA) for my operations.	.921	0.812	0.612	Environmental licensing	Confirmed and should be included in the SIA model
			4. The Environmental Protection Agency (EPA) regularly visits my premises to carry out inspections.	.922				
			5. Your activities are regulated and guided by the Environmental Protection Agency (EPA).	.922				
			6. Your activities produce CO_2 emissions from transportation and other logistical activities.	.922	0.798	0.541	Logistical Activities CO_2 emissions	Confirmed and should be included in the SIA model
			7. My activities produce a negative environmental impact.	.924				

Table 5.11 Validating the SIA Model—Economic Dimension

Variable	CR	Mean	Items	Cronbach's alpha	CR	AVE	Items link with SIA model (implications)	Interpretations
Economic	.922	3.915	1. Your activities are supported and guided by FairTrade.	.922	0.779	0.589	Non-FairTrade Market	Confirmed and should be included in the SIA model
			2. You are aware of FairTrade.	.924				
			3. There is any form of rules or regulations that govern your relationship with a smallholder farmer or exporter.	.922	-	-	Lack of Institutional proximity	Not confirmed and should not be included in the SIA model.
			4. Some vegetables can go waste (either by rotting, damage, or are discarded) before exporting to the UK.	.927	-	-	Food waste	Not confirmed and should not be included in the SIA model.

Table 5.12 Validating the SIA Model—Social Dimension

Variable	CR	Mean	Items	Cronbach's alpha	CR	AVE	Items link with SIA model (implications)	Interpretations
Social	.922	3.5470	1. There are other better approaches to enhancing traceability and transparency apart from the Farm code or your own labelling.	.923	0.567	0.448	Global G.A.P./Green Label	Not confirmed and should not be included in the SIA model
			2. Apart from the Farm code, you adopt other methods that help traceability of products.	.923				
			3. Consumers and trade partners can trace the source of your product because of your labelling or packaging.	.923	0.841	0.622	Farm code	Confirmed and should be included in the SIA model
			4. You have a Farm code.	.924				

Table 5.13 Validating the SIA Model—Regulatory Dimension

Variable	CR	Mean	Items	Cronbach's alpha	CR	AVE	Item link with SIA model (implications)	Interpretations
Regulatory	.921	3.0090	1. You have a certification to export overseas.	.921	0.790	0.677	Phytosanitary certification	Confirmed and should be included in the SIA model
			2. You do have a phytosanitary certification.	.922				
			3. You work with a foreign institution (an overseas organisation) that regulates your activities and guides the way you produce food.	.922				
			4. You have a certification that enables you to produce locally.	.922				
			5. You work with a local institution that regulates my activities and guides the way I produce food.	.925				

Table 5.14 Validating the SIA Model—Collaboration

Variable	**CR**	**Mean**	**Items**	**Cronbach's alpha**	**CR**	**AVE**	**Items link with SIA model (implications)**	**Interpre-tations**
Collaboration	.922	3.2932	1. You work with any other institution that helps you to enhance sustainable vegetables production and supply.	.925	0.814	0.622	SFSCC Institutions and Activities	Confirmed and should be included in the SIA model
			2. You work with the Food and Drugs Authority (FDA).	.923				
			3. You work with Ghana Standard Authority (GSA)	.925				
			4. You work with the Environmental Protection Agency (EPA).	.921				
			5. You set out an agreement with farmers, smallholders, or exporters which they must comply with.	.922	-	-	Supply Chain Contracts	Not confirmed and should not be included in the SIA model
			6. Smallholders and local farmers have an agreement with exporters on how much to buy their produce.	.924	0.763	0.551	Smart Partnerships and Relationship	Confirmed and should be included in the SIA model
			7. You provide some financial support and other innovative farm tools that help farmers to improve their productivity.	.923				

Table 5.15 Validating the SIA Model—Complexities

Variable	CR	Mean	Items	Cronbach's alpha	CR	AVE	Items link with SIA model (implications)	Interpre-tations
Complexities	.926	2.9323	1. With the current supports available from foreign institutions, local institutions (e.g., PPSRD) and government, developing sustainable food supply is still difficult?	.925	-	-	Inadequate credits Inadequate government support	Not confirmed and should not be included in the SIA model
								Not confirmed and should not be included in the SIA model
			2. You have limited knowledge on how to improve efficiency in your food production and supply activities.	.928	-	-	Limited knowledge of efficiency	Not confirmed and should not be included in the SIA model
			3. You have limited knowledge on processing your food.	.925	-	-	Lack of knowledge of food processing	Not confirmed and should not be included in the SIA model

5.8 Chapter Summary

The chapter utilised survey data sourced from different producers of Ghana's fresh vegetables for two main purposes: first, to statistically estimate the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK using available methods and, second, to validate the conceptual framework of the study (SIA model). The survey is designed based on the findings obtained from thematic analysis of the case study data. Multilinear regression is estimated to explain the relationship between sustainable food supply chain (FSC) and the identified sustainability dimension (implications) from the thematic analysis of the case study data which are Environmental, Economic, Social, Regulatory, Collaboration, and Complexities. While the study found statistical significance for Environmental, Social, Regulatory, and Collaboration; the Economic dimension (aspects) and Complexities are found not statistically significant. Interesting results from the study showed that an increase in Environmental, Social, and Collaboration activities are likely to enhance sustainable food supply chain while an increase in the regulatory dimension (checks) would decrease sustainable food supply chains. Increasing regulatory frameworks may disincentivise producers, especially smallholders and local farmers, and they may look for alternative options instead of increasing vegetable production and supply activities and contributing to vegetable exports to the UK.

Further, a comparative analysis among small-scale producers and large-scale producers on sustainable FSC show important revelations that a sole FSC actor does not holistically influence sustainable food supply chain outcomes. Hence, one group of actors—e.g., small-scale producers—cannot determine the value of measurement or unit of estimate that can influence enhancing sustainable food supply chains.

Finally, the SIA model is validated by estimating the Cronbach's alpha, CR, and AVE values for the constructs (the sustainability impacts). Five sustainability dimensions (environmental, economic, social, collaboration, and regulatory frameworks) that are confirmed by applying the assumptions are captured in the SIA model; however, one sustainability dimension (complexities) and its associated impacts (constructs) which are not confirmed for not meeting the assumptions are excluded. Further, the constructs (sustainability impacts) relating to the five sustainability dimensions which are found to be reliable and valid due to the Cronbach's alpha, CR, and AVE values are captured by the SIA model.

CHAPTER SIX (6)

6.0 DISCUSSIONS AND IMPLICATIONS

6.1 Introduction

The main objective of this study is to identify the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK and suggest a robust method for statistical estimation of the sustainability implications. This would help create more realistic, practical and innovative strategies and measures to enhance sustainable food supply chains for the UK, for Ghana and for global food supply chains. The findings from the thematic analysis of interviews and focus groups (i.e., Phases 3 and 4 of the study) reveal that six sustainability dimensions and their associated impacts influence sustainable food supply chains starting from global sources—namely, the environmental, social, and economic dimensions, regulatory aspects of sustainability, sustainable food supply chain collaboration, and producers' complexities in developing sustainable food supply chains. Interestingly, findings from the survey (i.e., Phase 5 of the study) suggest that four of the sustainability dimensions are significant in statistically determining measures or values to enhance sustainable food supply chains. The four sustainability dimensions are environmental, social, regulatory, and collaboration. In addition, more interactions among and attention towards environmental, social, and collaboration are likely to positively enhance sustainable food supply chains, whereas strengthening regulatory frameworks would produce inverse outcomes.

Additionally, the study results reveal a considerable number of sustainability impacts associated with individual sustainability dimensions that require attention and practical measures in the furtherance of sustainable food supply chains. Moreover, findings of further statistical analysis of the survey data, which attempts to explore the relevance and influence of large- and small-scale producers on the identified sustainability dimensions and sustainability, reveal important reflections and revelations that one FSC actor (either large- or small-scale producer) cannot alone holistically influence sustainable food supply chain outcomes; meaning that, for food supply chains to be more sustainable, collaborative activities and inputs of various FSC actors are required.

Hence, the revelations from the thematic analysis of case studies data and statistical analysis of the survey are utilised to modify, develop, and test the conceptual framework (Figure 2.6based on prior knowledge of the literature. This helps the development of novel

SIA frameworks (theoretical frameworks) addressing the RQ 1 and 2. The SIA frameworks (theoretical frameworks) are presented in Section 6.3.2 explaining the theoretical contributions of the study, elaborating on how industrial players, policymakers, and decision makers can leverage the SIA framework to enhance sustainability development agendas.

In addition, this study mind-maps all-inclusive sustainability implications identified from the thematic analysis of the case studies data and presented in Figure 6.1. Figure 6.1 shows the sustainability implications (thus, sustainability dimensions and impacts) associated with Ghana's fresh vegetable supply chain to the UK, highlighting the interconnectedness between the sustainability dimensions and their associated impacts. It also provides easy visualisation of all sustainability implications within food supply chains to prompt its incorporation into existing sustainability performance plans and goals. The thick lines indicate core relationships between all sustainability dimensions.

Importantly, the chapter further discusses various sustainability implications identified in an attempt to address RQ 3. Rich and valuable insights, recommendations, lessons, and ideas are provided as theoretical, managerial, and policy implications to offer in-depth understanding, appropriate assessment, development, and a new contribution to the literature in the context of sustainable food supply chains, global food trade and sustainability impact assessment. The rest of this chapter is organised as follows: Section 6.2 presents a discussion of the results that cover promoting environmental sustainability, economic sustainability, social sustainability, regulatory frameworks, sustainable food supply collaboration, and complexities in developing sustainable food supply chains. Section 6.3 presents the implications of the research findings which entail theoretical, managerial, and policy implications.

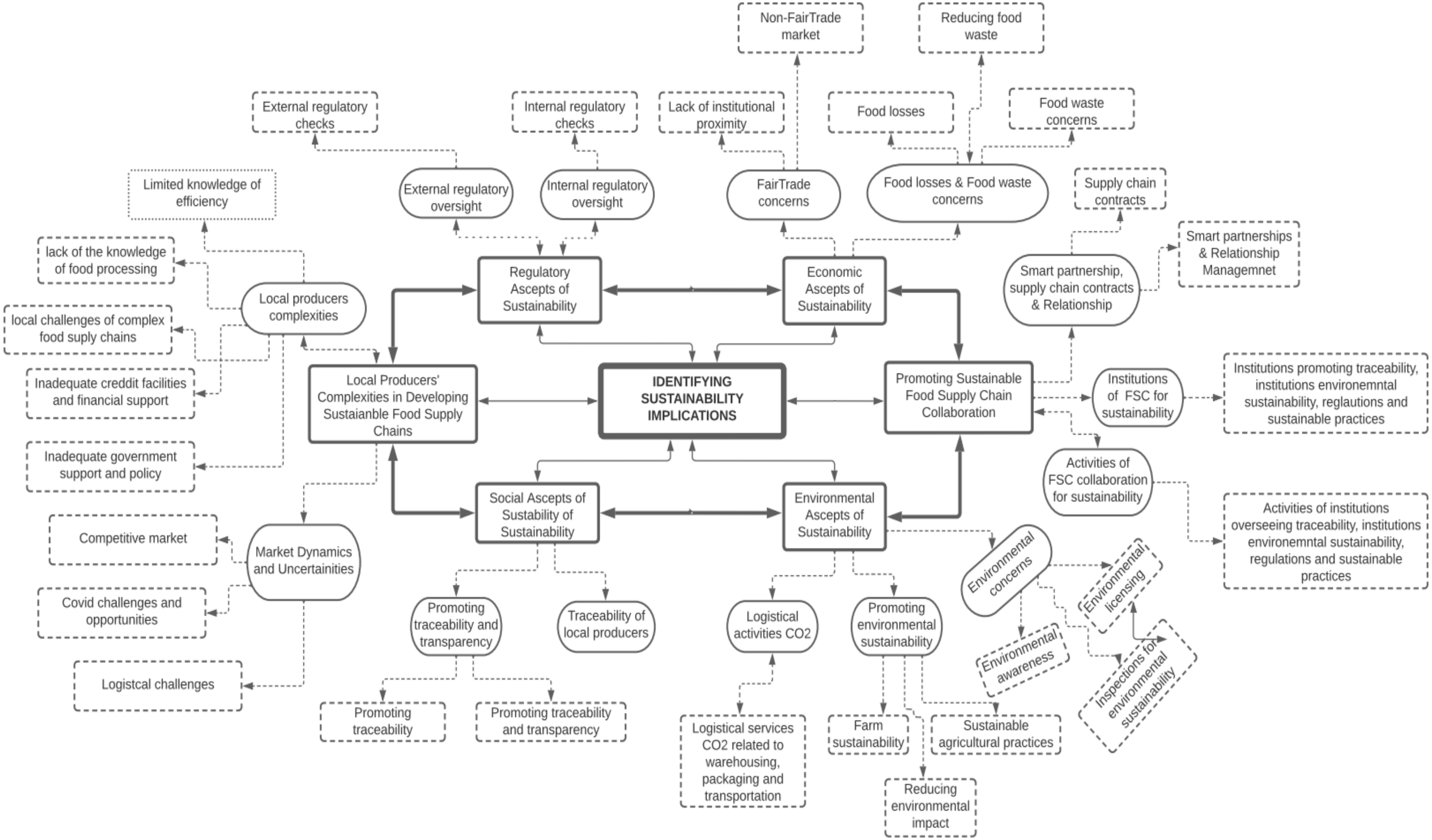


Figure 6.1 Mapping of Sustainability Implications within food supply chains.

6.2 Discussion of Results

This section discusses the findings of the study, clearly highlighting its contributions to the body of knowledge in the context of sustainable food supply chains, sustainability impact assessment (SIA), and global food trade. It also aligns the results of the study with existing literature and conducts a distinctive and critical discussion of the theoretical contribution and development of sustainability dimensions, sustainable food supply chains, sustainability impact assessment (SIA), and global food supply. The thematic analysis findings (interview and focus group results) that revealed the six key sustainability dimensions and their associated impacts are also discussed. Further, statistical analysis of the survey that revealed some fascinating results (a mixture of synonymous and opposing results to the thematic analysis findings) are discussed, drawing on some important factors, literature discussion, and valuable ideals for promoting sustainable food supply chains for FSC actors and food trade partners in both developing and developing countries.

6.2.1 Environmental aspects and sustainable food supply chains

The results of the qualitative thematic analysis revealed that the environmental aspects of sustainability play a key role for FSC actors, clearly indicating that the latter are engaging with a significant number of environmental activities, practices, and procedures both directly and indirectly. It is acknowledged that there is a clear relationship between environmental concerns and FSC actors. For producers, lands are cleared for farming, organic fertilisers are used, mechanical tools and machines are used on farms, farm produce is transported, and storage and warehousing activities are evident, but only for a limited number of days. For food regulators and government agencies, sustainable activities, programmes, and policies are championed to engage producers and foster food production and consumption activities. For third sector and other FSC actors, they are taking responsible actions and initiatives that are promoting sustainable agricultural practices and environmental sustainability as a whole. This finding is aligned with Batista et al’s. (2021) argument that adopting more pragmatic alternatives can improve the sustainability of food supply chains, including environmental aspects. Gatzweiler and Von Braun (2016) reiterate that global food supply chains and some FSC actors are adopting more sustainable and agricultural innovations, enabling them to facilitate sustainable food supply chains. Early work by Smith (2009) emphasised that producers are engaged with and driven towards adopting more sustainable practices, thus having positive viewpoints towards environmental sustainability. Importantly, promoting sustainable food production practices is vital to mitigate negative environmental impacts and can increase the food systems' efficiency and quality (Killebrew and Wolff, 2010; Tuomisto et al., 2012; Adegbeye et al., 2020). Adegbeye et al. (2020) identify a need to shift from "dirty" production practices to sustainable methods, suggesting that embracing globalised sustainable intensification and localised technology improvement have significant positive impacts for the environment. Some of the suggested methods of achieving high positive environmental impact include a shift in agricultural management systems, resource-use efficiency, and the implementation of integrated farming systems.

The result of this study also implies that empowering overseas sources with more pragmatic environmental sustainability initiatives—rather than allowing the continuation of unfriendly environmental practices, such as chemical fertilisers and herbicides, and poor farming practices (e.g., land rotations)—can stimulate sustainable food supply chains and possibly produce fewer negative environmental impacts. The results follow the pattern of arguments of some authors, e.g., Majewski et al. (2020), which suggest that lower negative environmental impacts than those of short food supply chains can be generated. Contrastingly, according to Krishnan et al. (2020), food production and other food supply chains generate negative environmental impacts, irrespective of the sources. This study addresses the concerns of much of the literature about environmental impacts, including those of Notarnicola et al. (2017), Krishnan et al. (2020), and Ritchie and Roser (2020). The results of this study reveal that fostering more sustainable, environmentally-friendly activities can be undertaken by FSC actors to produce favourable and positive environmental impacts. These include farm sustainability practices, sustainable agricultural activities, using environmental impact reduction activities, and increasing environmental sustainability monitoring and evaluation. Ahearn, Armbruster and Young (2016) and Clark and Tilman (2017) argue resoundingly for opportunities for environmental sustainability, including using agricultural production systems, Big Data, and "precision" agriculture.

Furthermore, this circumstantial evidence from the survey data analysis (Phase 5 of the study) affirms that environmental aspects show a positive relationship with sustainable food supply chains and there are significant statistical measures and relevance that contribute to them. The results are in contrast to the evidence from empirical studies by Parajuli, Thoma and Matlock (2019) that assess the environmental sustainability of fresh fruits and vegetables. Their studies reported significant environmental impacts characterised according to particular farming systems when different agro-ecological and farming systems were considered, including conventional and organic farming systems. It is important to mention that the strength of their work is its assessment of life-cycle environmental footprints of fruits and vegetables. However, this current study identified all activities relating to environmental impacts and assessed their relevance and influence for sustainable food supply chains. Hence, the strength of this study goes beyond the work of Parajuli and colleagues because all relevant environmental issues and impacts are identified and assessed in the furtherance of sustainable food supply chains. Similarly, this study's results make further contributions to the interesting work of Frankowska, Jeswani and Azapagic (2019). They examined the environmental impacts of vegetables air-transported to and consumed in the UK; their findings showed that environmental impacts of fresh vegetables airfreighted to the UK are about five times greater than those of locally-produced fresh vegetables, and they deplete sustainable supply chains by 20.3Mt CO_2-equivalent. The survey analysis result is synonymous with enhancing environmental sustainability and sustainable food supply chains by 30.8% of unit of measurement. This implies that the UK can both benefit from and contribute to positive environmental sustainability and sustainable food supply chains by "pushing" and advocating producers (exporters) to adopt minimised and low environmental impact activities, sustainable agricultural practices and farm sustainability activities. However, this study did not consider the assessment of quantitative values of airfreighted fresh vegetables, unlike Frankowska et al. (2019), but rather used qualitative variables which represent producers' engagement and involvement with air transportation or logistical services, enabling holistic assessment of the environmental dimension and impacts in one common unit.

Nevertheless, the evidence from this study is in line with the findings and argument of Poore and Nemecek (2018), who assessed the environmental impacts of producers, and their findings provided support for the idea that producers can adopt different practical approaches to achieve environmental targets. This implies that overseas food suppliers have opportunities and can shift to more environmentally friendly approaches to enable them to contribute to sustainable food supply. Distinctively, the results of the study (qualitative thematic analysis) reveal that environmental awareness, environmental licensing, and CO_2 emissions from logistic activities are the main sustainability impacts that need critical attention, and they can be fed into development agendas to help facilitate environmental sustainability and sustainable food supply chains. Hence, section 6.2.1.1

discusses environmental awareness and licensing, while section 6.2.1.2 analyses the CO_2 emissions of logistical activities.

6.2.1.1 Environmental awareness and environmental licensing

The study further explored the impacts that originate from the environmental dimension of sustainability within food supply chains. The results reveal that environmental awareness and environmental licensing are important impacts identified with environmental sustainability. Identifying sustainability impacts or factors associated with each dimension, including environmental sustainability, is core to finding problem areas of the food supply chain and to the development of practical alternatives that can enhance environmental sustainability and sustainable food supply chains. Hence, producers' and FSC actors' responses revealing these two environmental impacts (i.e., environmental awareness and environmental licensing), which can positively facilitate environmentally friendly and sustainable practices, explain the existence of environmental mechanisms and structures that need to be recommended and utilised to enhance sustainable food supply chains. The findings reflect the emphasis of Ponte and Gibbon (2005), White and Hunter (2009), Despoudi (2021), and Mohseni, Baghizadeh and Pahl (2022). However, increasing awareness of environmental issues instigates producers and other FSC actors to contribute more to sustainability. For instance, Despoudi (2021) points out that environmental awareness is increasingly forcing businesses to turn their supply chain model into a circular one.

In addition, Ponte and Gibbon (2005) and White and Hunter (2009) stress that growing public awareness of environmental impacts is playing a key role in pushing producers and other businesses to adopt or establish sustainability. More currently, Mohseni et al. (2022) evaluated barriers and drivers to sustainable food supply, and one of their key conclusions was that environmental impact awareness is driving food supply chains towards sustainability goals. Life-cycle Assessment (LCA) has been one of the main tools for creating environmental awareness (McCarthy, Matopoulos and Davies, 2015). Further, Younis (2015) advocates for environmental education increasing awareness, while Shokri, Oglethorpe and Nabhani (2014) propose sustainability awareness measures that can be utilised through collaborative initiatives, instead of building competitive supply networks. These include regular staff training, delivery efficiency, minimising food packaging, and improving food labelling (traceability). Many developed countries are benefitting from increased awareness of environmental externalities, inducing advanced technologies and improved innovations in various parts of the food supply chain, including operations and logistical services (Beitzen-Heineke, Balta-Ozkan and Reefke, 2017; Zilberman and Reardon, 2019). On the other hand, limited knowledge, perceptions, lack of government support, training, and the state of the economy are listed as the factors hindering awareness and reaping the benefits of harnessing environmental sustainability in developing countries (Younis, 2015).

Furthermore, environmental licensing is also identified as one of the key environmental impacts within the food supply chains. The results are consistent with studies in Brazil (Bezerra, Vieiraand de Rezende, 2019; Nascimento, Abreu and Fonseca, 2020) and the Netherlands (Grekova et al., 2014). Environmental licensing is one of the strategies and tools that are improving business environmental management (Bezerra, Vieiraand de Rezende, 2019) as it aims to reduce a firm's environmental impact. Environmental licensing serves as a legal and administrative certification for producers' activities, processes, and procedures. It can be used as an environmental management tool that can boost environmental performance for producers and other FSC actors, but its structures and functions in relation to food supply chains are underdeveloped, especially in developing countries. These findings imply that existing authorising bodies and "watchdog" organisations should intensify advocacy and campaigns to encourage FSC actors—mainly food producers, exporters, distributors and logistics companies—to be fully aware of environmental demands of food supply chains. The contributions of FSC professionals and actors in the supply chain process cannot be underestimated. Hence, it is important to mention that adequate training and supervision programmes can generate immeasurable contributions towards environmental sustainability. Environmental agencies, pressure groups, and environmental licensing authorities need to ensure that a wider pool of food producers, exporters, distributors, and other FSC actors is engaged, informed, and regularly trained on environmental management, conversation, and protection. This should include increasing environmental awareness across areas and sectors, more frequent inspections for environmental sustainability, promotion of farm sustainability, education of producers and other FSC actors on measures of reducing environmental impact, as well as encouraging sustainable agricultural practices. Scholarly research clearly shows that environmental licensing can be used as "command and control" measures to restrict potential environmental damage (Bajay, 2004). Hence, continuous initiatives and advocacy are needed to speed up environmental awareness and environmental licensing in order to facilitate environmental best practice and sustainable food supply chains.

6.2.1.2 Logistical activities' CO_2 emissions

The study finds that the CO_2 emissions caused by logistical activities are another key environmental impact in addition to environmental licensing and environmental awareness. "Logistical activities' CO_2 emissions" refers to the CO_2 emissions generated by packaging, warehousing, and transportation of fresh vegetables from farmland to warehouses (storage facilities), from storage facilities to the airport and from the airport to the final destination (the UK). The results are consistent with studies in Sweden (Jofred and Öster, 2011); the USA (O'Donnell et al., 2009; Wakeland, Cholette and Venkat, 2012); the UK (Coley, Howard and Winter, 2009; de Ruiter et al., 2016; Frankowska, Jeswani and Azapagic, 2019; Aikins and Ramanathan, 2020); Australia (Estrada-Flores and Larsen, 2010; Eady et al., 2011); Southeast Asia (Mubarak and Zainal, 2018; Mubarak and Rahman, 2020); and the Netherlands (van der Vorst, Peeters and Bloemhof, 2013). Logistics services' CO_2 emissions have been one of the major challenges facing FSC companies (Mubarak and Zainal, 2018). Logistics is the science of movement and storage of services, goods, and information and consists of inventory management, transportation, reverse logistics, and packaging. Producers' and FSC actors' activities in these areas can generate significant negative environmental impacts (i.e., CO_2 emissions). In a food supply chain, four different kinds of logistics processes usually take place—i.e., inbound logistics, production logistics, outbound (distribution) logistics, and reverse logistics (Haass et al., 2015). Hence, there is a need for holistic measurement of logistics services starting from overseas sources, to enable policymakers and FSC actors to draw up more realistic and sustainable measures to mitigate the enormous associated CO_2 emissions. Sbihi and Eglese (2007) point to "green logistics" as an effort to estimate businesses' CO_2 emissions from logistics and transport, in order to enable the development of adequate measures for carbon emissions reduction. However, multiple calculation tools, frameworks, models, and methodologies have been suggested and used to estimate CO_2 emissions. Greene and Lewis (2016) argue that there is lack of a global method specific to logistics operations among these tools or approaches.

Despite logistics' carbon emissions damage to the environment, few businesses are implementing improvements and initiatives to address the environmental impacts of transportation (Golicic, Boerstler and Ellram, 2010). Food supply from overseas sources is airfreighted; and airfreighted food generates enormous CO_2 emissions that are around 50 times those of sea-transported foods (Ritchie and Roser, 2020). Nevertheless, the findings of this study are not in line with those of Barthelmie (2022), who argues that logistics (transportation) accounts for lower carbon emissions within the food supply chains than does land use. Barthelmie's study, coupled with that of Ritchie (2020), asserts that food products and supply chains such as meat products, farming, land use, and feeds generate greater CO_2 emissions than logistics-related CO_2 emissions. Although there are a few studies that have focused on sustainability in the transportation of perishable products (Vrat et al., 2018), Ramanathan et al. (2014) and Chen et al. (2017) stress that cooperative or collaborative logistics can contribute to reducing CO_2 emissions and improve supply-chain sustainability. Moreover, Ballot and Fontane (2010) argue that FSC actors operating a pooled network system can save about 25% of CO_2 emissions. Nonetheless, there should be bold steps to make logistics activities greener; and the first step can be measuring all logistics activities or processes within the food supply chains.

6.2.2 Economic aspects and sustainable food supply chains

The study examined other sustainability dimensions and the results of the qualitative thematic analysis revealed economic aspects of food supply chain as one sustainability dimension that plays a major role in producers' quest for fostering fresh vegetable exports to the UK and enhancing sustainable food supply chains. The findings are akin to those of Stein and Santini (2021) in emphasising that economic aspects of food systems are essential in a sustainability context. Stein and Santini further argue that, in the context of economic sustainability, trading food in local markets or through short food supply chains may benefit some producers, while selling food in the international markets or across borders may also benefit others. Economic sustainability promotes regional and local development, contributing to job creation (Mundler and Laughrea, 2016; Aguiar, DelGrossi and Thomé, 2018). Economic sustainability also has specific positive multiplier effects and offers opportunities that drive change, development, and improvement for producers and other FSC actors. Hence, the study identified specific economic sustainability elements within food supply chains that are of concern to the producers and FSC actors. These economic aspects are made up of food waste, food loss, and non-FairTrade concerns. The findings are consistent with those of Kusumowardani et al. (2022): that food waste and food loss within agri-food supply chains in the developing countries still pose a persistent challenge. This can be attributed to lack of agri-business operations knowledge to enable the handling of food waste and food loss issues. Drawing on the evidence and argument of Dragusanu, Giovannucci and Nunn (2014), who show that FairTrade appears to be of great importance to producers, as it boosts their profitability and incomes, this study's results do not find its impact in the fresh vegetable sector, but it is a factor in the cocoa sector (Nelson et al., 2013; Djokoto, 2016). This implies that, although economic aspects are corroborative in Ghana's vegetable supply chains, producers are losing out, since identified economic sustainability elements are posing challenges rather than offering benefits.

Furthermore, the findings of the survey analysis indicate that economic aspects are not statistically significant. The results may be due to the variables (question statements) designed to ascertain the economic elements of sustainability, which may not be of valuable concern to the producers as they may not be fully aware of the key variables (questions) relating to the economic aspects. For instance, Opoku, Bannor and Oppong-Kyeremeh (2020) assert that vegetables are not certified for FairTrade in Ghana, and including such a variable in determining economic aspects of sustainability can induce undesirable insignificant results. Similarly, the study did not capture other economic elements, such as price, profitability, and competition. These present worthwhile research opportunities in the capture and statistical estimation of economic aspects in food supply chains starting from overseas sources (global suppliers). It is important to mention that measuring economic sustainability fosters the planning and development of sustainable food supply chains (Accorsi et al., 2016), and considering holistic assessment of key economic sustainability elements would be a fascinating contribution. To summarise the economic aspects of sustainability, sub-sections 6.2.2.1 and 6.2.2.2 discuss food waste and food losses, and FairTrade concerns which emerged from the qualitative analysis of the interview and survey data as the economic impacts associated with fresh vegetable supply from Ghana to the UK.

6.2.2.2 Food waste and food loss

The study reveals that food waste and food loss are other important economic impacts within food supply chains. The findings of this study are consistent with those of Lundqvist, De Fraiture and Molden, (2008), Venkat (2011), Gustavsson et al. (2011), Papargyropoulou et al. (2014), Konstantas, Stamford and Azapagic (2019), Ellison and Kalaitzandonakes (2020), Minor et al. (2020), and Kusumowardani et al. (2022). These studies confirm that economic value is associated with the food throughout the food supply chains and that food waste and food loss have direct, significant, and negative economic impacts for producers on their incomes. Unlike COVID-19, waste is not a novelty in our food system. The disruptions, complexities, and activities of the global food supply chain, or food miles, are likely to generate significant food waste and food loss, which may cause enormous economic effects such as cost, and loss of income and investment to producers and FSC actors (such as distributors, food service operators, food processors, retailers, and even households). Although many studies have shown the negative impact of food waste on the environment (Pullman, Fenske and Wakeland, 2010; Scherhaufer et al., 2018; Tonini, Albizzati and Astrup, 2018; Skaf et al., 2021), the economic impacts of food waste and food loss throughout FSC are massive (Papargyropoulou et al., 2014). In other words, most producers and businesses prioritise reducing food waste based on financial considerations rather than social, ethical, or environmental concerns. As a result, only "visible" food waste with an economic impact on outcomes is reduced. Nonetheless, true waste is frequently hidden. Food waste reduction opportunities come by enhancing the visibility of abandoned food and addressing plate waste (Derqui, Fayos and Fernandez, 2016). Critically, the impacts of food waste and food loss stimulate other environmental impacts. Emissions, energy consumption and water use, as well as food and packaging waste, are all factors that have an impact on the environment, and also have economic impacts. Food safety, nutrition, and ethical trading are some of the social consequences. Since food waste and food loss are the FSC's most significant negative external effect, the key benefit FSC actors can bring is to reduce food waste at the supplier, retail, and consumer levels (Beitzen-Heineke, Balta-Ozkan and Reefke, 2017). Food waste and food loss may be caused by pests, weather, labour issues, price, product quality, and other market conditions (Minor et al., 2020), but developing countries have high food waste and food loss levels during the post-harvest and food processing stages arising from a lack of or poor storage infrastructure and transportation (Venkat, 2011), while developed countries encounter significant food waste and food loss at the consumption stage (Katsarova, 2016).This result empirically adds to the body of literature that identifies food waste and food loss as economic impacts specifically from the developing country context. Although quantitative assessment is not considered by this study, it is a valuable contribution to literature to reiterate that food waste and food loss are still current challenges for producers from global sources, despite shipping or transporting most of their produce overseas.

6.2.2.3 FairTrade concerns

The study explored economic impacts within fresh vegetable supply to the UK and identified FairTrade concerns as one of the key economic sustainability impacts within the supply chains which require attention. FairTrade concerns of the study indicate that there is lack of instructional proximity and a non-FairTrade market for the vegetable sector in Ghana. Producers are not benefitting from FairTrade and are deprived of proper regulations and conventions governing their business with other FSC actors, as well as widely acceptable price and value for vegetable producers. The findings of the study are congruent with those of Griffiths (2012), whose work emphasised that there is no sufficient evidence that some producers benefit from FairTrade. Ghana, a leading actor in vegetable production and supply in the West Africa sub-region, needs FairTrade that has economic advantages in providing fair prices for producers, builds producers' capacity, and improves agricultural services. FairTrade Africa promotes the fact that HPW Fresh and Dry Limited enjoys FairTrade for their mangoes, pineapples, and coconuts; Bormats Farms Limited benefits from FairTrade for their mangoes, pineapples, bananas, and coconuts; the Acopps and Amoppa cooperative enjoys FairTrade in organic pineapples; the Aiyinase Coconut Society enjoys FairTrade for its organic coconuts; Nyameakwan Citrus Farmers Association benefits from FairTrade in citrus; and Akoma multipurpose cooperative benefits from FairTrade in its shea nuts (FairTrade Africa, 2022). These producers are large-scale producers and the non-existence of FairTrade for vegetable producers implies that significant producers occupying the vegetable sector—predominantly small-scale producers—are not benefiting from FairTrade advantages. Although Griffiths (2012) further argued that there is no clear evidence showing that FairTrade producers get higher, better, or fairer prices than non-FairTrade, the economic benefits of improving farmers welfare, training opportunities, pre-financing for farmers, positive income impacts, investment in socio-economic projects, and market access associated with FairTrade is vital for producers, especially for small-scale producers (Nelson et al., 2013; Krumbiegel, Maertens and Wolini 2018; Donovan, Blare and Peña, 2020). Even though FairTrade products have only a small share of the market (Dammert and Mohan, 2015), there is need for organisational support from multinational firms, governments, and other major FSC actors to help engineer the transition of vegetable producers and non-FairTrade farmers to become FairTrade producers.

6.2.3 Social aspects and sustainable food supply chains

The study explored the social dimension of sustainability and the findings from the qualitative thematic analysis revealed that social aspects are important to producers and FSC actors within the vegetable supply chain to the UK. This implies that producers and other FSC actors are utilising social sustainability approaches and methods that are promoting sustainable food supply chains. The findings are in line with the emphasis of Sarkis, Helms and Hervani (2010), Klassen and Vereecke (2012) and Govindan et al. (2021). The purpose of social sustainability addresses three main issues: these are the well-being of society, the well-being of humans, and the safety of consumers (Govindan et al., 2021). Traceability and transparency approaches identified by the study and categorised under social sustainability serve these objectives. The implementation of social practices in developing countries and by vegetable producers are driving social sustainability. Klassen and Vereecke (2012) stressed that activities relating to consumer safety are important and a core part of social sustainability. A recent study by Mani, Gunasekaran and Delgado (2018) pointed out that producers in developing countries adopting social sustainability practices are achieving better food quality, increased product reliability, and improved producers' and buyers' performance as well as driving a positive relationship between producers and buyers. However, the importance of social sustainability practices is overlooked, if social aspects within the supply chain are ignored or not given suitable attention. Moreover, there is a need to understand that social sustainability relevance overlaps with corporate social responsibility (Sarkis et al., 2010; Govindan et al., 2021) and facilitates social sustainability practices. Earlier work on social sustainability by Galuppo et al. (2014) emphasised that social sustainability implementation by any producing company requires the involvement of all other stakeholders, but the reality is that stakeholders have different priorities which may hinder ambitions and goals aimed at social sustainability. In this case, government, the third sector and managers should also prioritise social sustainability practices, just as more priority has been given to environmental sustainability. Additionally, Golicic, Boerstler. and Ellram (2019) have stressed that consistent pressure from governments, communities, and consumers can promote the implementation of more social sustainability practices.

Furthermore, the findings from the survey analysis support the qualitative results that social aspects of sustainability (social sustainability) are statistically significant to enhancing sustainable food supply chains. The results further revealed that improving social aspects would increasingly benefit sustainable food supply chains. The findings are similar to the arguments, emphasis, and results of Nichols and Hilmi (2009), Buzby et al. (2011), Principato, Secondi and Pratesi (2015), and Ruiz-Torres et al. (2021). At the same time, the findings of the study address the concerns of Taticchi, Tonelli and Pasqualino (2013), Ajmal et al. (2018), Staniškienė and Stankevičiūtė (2018), and Govindan et al. (2021), all of whom argue that measuring social sustainability is difficult compared to other sustainability dimensions, such as environmental and economic. Given that, many studies have resorted to developing frameworks instead of attempting a statistical estimation of social sustainability. This study provides the solution to such concerns while suggesting a robust SIA framework in addition. The social impacts or aspects identified as enhancing sustainable food supply chains are promoting traceability and transparency of food items, and the traceability of local producers. The two sub-sections below expand the discussion on the identified social impacts for sustainable food supply chains.

6.2.3.1 Promoting traceability and transparency

The results from the qualitative analysis revealed that producers are promoting traceability and transparency by utilising Farm code and food labelling. The social aspects or impacts such as traceability and transparency identified by the study indicate that producers and FSC actors are using practices and initiatives that enhance sustainable food supply chains. The results are in line with studies and discussion by Wognum et al. (2011), Tai (2018) and Zhou, Pullman and Xu (2021). Tai (2018) emphasised that traceability and transparency are key levers, tools, and mechanisms within global food supply chains, whereas the study by Zhou, Pullman and Xu (2021) concluded that traceability practice has a significant impact on sustainable performance. Wognum et al. (2011) suggested that traceability and transparency are more likely to foster social sustainability, although they may have less effect on environmental sustainability. This study's findings are in congruence with existing studies highlighted, clearly showing that vegetable producers have adopted proactive and widely acceptable methods or approaches locally that provide traceability and transparency of the food they produce and supply to the UK and the rest of the world, thus contributing to sustainable food supply chains. The methods of traceability and transparency adopted by Ghana's producers are the use of Farm code and food labelling. The relevance of adopting a social sustainability element or impact such as traceability and transparency is clearly pointed out by Song and Morgan (2019) and Cousins et al. (2019), the latter stressing that traceability has a significant positive impact on environmental performance and improvement, while Song and Morgan have explained that producers and FSC actors adopting traceability approaches are able to obtain sufficient return on their investment. This explains that producers are now enjoying an open market, wider market access, some goodwill, and a better negotiating position for their produce since the vegetables can be well-regulated and traceable and the processes of their production and supply well-communicated to consumers and other FSC actors.

Moreover, transparency promotes leveraging sustainable changes within global food supply chains, whereas traceability supports an appropriate assessment of sustainability performance of the food supply chains (Mao et al., 2018; Tai, 2018). These social impacts are enabling strong relationships between the food value chain and sustainable practices. Previous studies conducted by Kimathi (2017) stressed that traceability requirements are increasingly significant for small-scale vegetable producers, since food markets are more concentrated, globalised and internationalised. Increasing pressures are coming from different stakeholders that are enforcing producers and businesses to integrate the social aspects of sustainability into their activities or businesses. Popovic et al. (2017) clearly point out that lack of information leaves gaps in social sustainability. Hence, it is important and appropriate that producers work out approaches to share information about their produce with consumers and other FSC actors.

6.2.3.2 Traceability of local producers

The results from the qualitative analysis revealed that producers are promoting traceability and transparency by utilising their own methods of food labelling and traceability. The difference between promoting traceability and transparency and the concept of the traceability of local producers is that the latter provides information about the food sources which may be best known to the producers and the importer, whereas the former are widely known and acceptable to the food importer and other FSC actors, including other producers, regulators, logistics providers, distributors, and retailers. Producers have adopted their own approach to enable other FSC actors to trace the sources of their food. It is important to explain that a unique identification is allocated to individual batches of produce which separate them from others harvested or produced from different sources or other agricultural lands belonging to the same farmer. In the event of detection of food bacteria or contamination, the producer or importer can destroy only the batch of produce belonging to the same source, instead of the entire consignment shipped from Ghana to the UK. This finding is similar to that of Fonsah (2006), whose research explored how producers are equipped with standard operating procedures to step up their own traceability systems, and that fresh food producers are using all forms of methods—for example, rubber stamps—to enable consumers and other FSC actors to trace their produce.

The findings are congruent with the emphasis of Bosona and Gebresenbet (2013): that producers, especially small-scale producers, find it difficult to develop a well-detailed traceability method; instead, a range of different approaches are opted for. It is difficult to put a barcode on food produced by small-scale producers, which is usually sold in the streets, in stores or kiosks (Chrysochou, Chryssochoidis and Kehagia, 2009). However, without a barcode or appropriate method of traceability, traditional methods employed by small-scale producers offer only limited information and knowledge for consumers and other FSC actors (Kher et al., 2010). Despite the uniqueness of local producers' traceability, the method can be improved to be widely recognisable and acceptable, adding to existing Farm code and food labelling used by other producers. Otherwise, Manikas et al. (2010) suggest that a central database can be provided to accommodate small-scale producers' information, so that consumers and all other FSC actors can access and share their information using internet and high-tech devices. Regulators, government organisations, and other FSC professionals should not enforce or introduce expensive traceability systems but, instead, champion a cost-effective traceability system in addition to providing training for both small-scale and large-scale producers.

6.2.4 Regulatory frameworks and sustainable food supply chains

The regulatory aspect of sustainability is examined, and the findings of the qualitative thematic analysis revealed that regulatory frameworks are an important sustainability dimension that can enhance sustainable food supply chains. The findings are similar to the results and emphasis of Bynoe (2004), Smith (2009), Hidayat, Offermans and Glasbergen (2018), and Parrot (2022). Various regulatory frameworks are available to protect consumers' safety and health as well as to ensure FairTrade (Aruoma, 2006; Smith, 2009; Mokrejšová, Filipová and Zeman, 2018; Food Standards Agency, 2020). Consumers desire a healthy, safe, and sanitary food supply. Hence, governments across the globe have contributed to regulating food supply, facilitating enforcement, providing education programmes, and assisting producers with supportive initiatives and policies to supply safe food. These have strengthened producers in adopting measures, practices, and initiatives that comply with the regulations of government and international markets on food supply. The findings clearly indicated that producers and FSC actors are working with several regulatory guidelines and laws that enable them to supply to the UK and other overseas countries. In contrast to the findings, Hidayat et al. (2018) concluded that the recognition and existence of regulations can induce more sustainable production and supply activities. Increasingly, small producers believe, however, that regulatory frameworks are political positions taken up by governments. Nevertheless, the practices of producers—if not regulated and guided—can cause serious effects for consumers' wellbeing and other FSC actors. Be that as it may, it is important to mention that regulatory frameworks have the advantages of safeguarding consumers, increasing market efficiency, and responding to market failures and information challenges (Smith, 2009).

Further statistical analysis of the survey data revealed that regulatory frameworks may have an inverse relationship with sustainable food supply chains. These circumstantial results indicate that the stricter or tougher regulatory frameworks are, the more producers are unlikely to comply with sustainability measures. The findings are similar to the emphasis and findings of Grimonprez (2016) and Kapala (2022). The latter researcher pointed out that complying with regulatory frameworks within FSC requires extra efforts, including costs, and producers may not be interested in taking on such costs. Earlier, the work of Grimonprez (2016) stressed that regulations are yet to provide ideal frameworks as a guidance for development of global agri-business and FSC. Moreover, Smith (2009) stated that producers would comply with food regulations if it made economic sense (i.e., was profitable) or if they are compelled to do so. Nonetheless, regulatory frameworks covering long and short food supply chains are not well-established or stated in one single global law. Rather, there is a multiplicity of different regulations drawn from local governmental policies, national laws, international laws, and markets (Kapala, 2022). These may be very confusing and unattractive for producers, especially small-scale producers in developing countries. The main issues confronting developing countries' producers trying to comply with stringent regulatory frameworks are set out by Parrot et al. (2022). They emphasise that African exporting countries are restrained by poor infrastructure, capital endowments, and extension services in addition to a lack of authorising institutions and policies to regulate effectively and to protect smallholders. Despite these findings, the regulatory framework—such as phytosanitary measures and certifications—are enabling producers to supply safe food and expand markets, while facilitating innovations (Mokrejšová et al., 2018; Affum and Wang, 2019). The study provides further discussion on internal and external regulatory frameworks within the food supply chain in section 6.2.5.1, which looks at regulatory impacts.

6.2.5.1 Internal and external regulatory checks

The results of the qualitative thematic analysis showed that there are internal and external regulatory checks within the vegetable supply chains. This indicates that internal and external regulations are detailing producers' responsibilities to ensure that vegetable production and supply are safe, secure, and healthy for consumers and other FSC actors. Some of these regulations include producers providing traceability of their produce, which can be linked directly and clearly to the producer (Kapala, 2022). The findings are consistent with Hurley and Noel (2006), Smith (2009), and Affum and Wang (2019), who emphasised the relevance of regulatory frameworks in food supply chains and that producers and other FSC actors are complying with different regulatory checks, both at the national and international level, to improve competitive advantage while supplying safe, healthy, and sustainable food. The results support the work of Saavedra et al. (2014), of Osei-Assibey (2015), and Asselt, Masias and Kolavalli (2018) by revealing that the role of regulatory mechanisms should not be overlooked in studies regarding the Ghanaian vegetable supply across borders and to the UK; and that studies should focus not only on economic, environmental, and social impacts, but should also capture regulatory impacts, which are shown to be of equal relevance and benefit to producers and other FSC actors. Interestingly, the World Trade Organisation (WTO), of which Ghana is a member, prescribes a number of measures and regulations governing food production and supply. Smith (2009) states that:

> "With the creation of the WTO and Sanitary and Photo Sanitary (SPS) and Technical Barriers to Trade (TBT) Agreements establishing clear rules on the applications of standards by member countries to minimise any negative trade effects, governments now face increased scrutiny to ensure that standards are not introduced for the purpose of trade protection" (Smith 2009, p.4).

Governments now utilise different mechanisms, systems, and checks through local agencies or authorising bodies to ensure compliance with laws and regulations regarding food production and supply, for the safety of consumers and other FSC actors. International or external regulatory checks include HACCP, Green Label, British Retail Consortium (BRC), ISO 22000, Good Manufacturing Practices (GMPs), Sanitary and Phytosanitary certifications, and Safe Quality Food (SQF) certification. Some of these regulatory checks, e.g., HACCP and SQF, are acknowledged as background tools for assessing and managing food quality (Affum and Wang, 2019), Sanitary and Phytosanitary certifications stand for safe, quality, and healthy food for export, whereas Global G.A.P. is recognised for sustainable agricultural practices (Sansawat and Muliyil, 2012; Global G.A.P., 2021). The internal (i.e., Ghanaian) regulatory checks are certifications from the Food and Drugs Authority, Ghana Standards Authority, and the Environmental Protection Agency (Affum and Wang, 2019). These internal regulatory checks ensure the implementation of appropriate regulatory mechanisms to obtain the utmost standards of quality, efficacy, and safety of food locally produced, exported, imported, distributed, used, and sold to ensure consumers' protection according to the regulations and laws governing food production and supply in Ghana. Despite several regulations on food supply chains, however, Sumberg (2005) and Parrot et al. (2022) bemoan lack of proper oversight of these regulatory frameworks, whereby one can appreciate the weaknesses of enforcement of these regulations. The outcomes of this ineffectiveness of regulations and strict formal regulatory checks pose a threat to consumers' safety and sometimes result in food waste or cost to producers, since the products may not be duly certified or regulated throughout the production and supply process. Hence, governments have the powers to establish, implement, and impose compliance with regulations and laws, not simply for facilitating consumers' safety, but also for producers' socio-economic benefit.

6.2.5 Collaboration and sustainable food supply chains

Producers and other FSC actors are engaged with collaborative institutions and practices that oversee traceability, environmental sustainability, regulation, and sustainable practices. These have created platforms for addressing sustainability concerns, while propagating sustainable food supply chains. The results of the qualitative study revealed that collaboration is important for producers and FSC actors within Ghana's vegetable supply chain. It can further be explained that collaborative practices, initiatives, and networks among producers and FSC players are promoting sustainable food supply chains. The findings are consistent with the emphasis and studies of Lozano (2008), Fawcett et al. (2016), León-Bravo et al. (2017), Blackmar et al. (2018), Lozano (2018), and Fobbe (2020). The latter researcher has clearly stressed that collaboration is increasing interactions among businesses and FSC actors that promote sustainability activities beyond their regular operations, and on to technology and resources, as well as transfer knowledge among producers and other FSC actors.

Moreover, the work of Lozano (2018) adds that an increasing number of businesses and FSC players are rapidly engaging in sustainability activities that tackle issues of different sustainability dimensions, such as social, environmental, and economic issues.

Furthermore, the findings of their study address the gap in the literature highlighted by Murray, Haynes and Hudson (2010), who pointed out that there is limited knowledge about collaboration practices of businesses that facilitate sustainability agendas, beyond the hoped-for economic gains. This study shows that collaboration practices among producers and other FSC actors are increasingly driving environmental, social, and economic sustainability, as well as regulatory frameworks. Collaboration practices entail a regulatory framework and the environmental, economic, and social aspects of the food supply chain. The findings also indicate that the collaboration between the stakeholders is increasingly becoming indispensable and practical. This is giving rise to sustainability awareness, innovative initiatives, creativity, and smart partnerships. Interestingly, collaboration for sustainability increases competitive advantage and provides benefits to enhance the survival and growth of businesses (Foley et al., 2017).

Additionally, the results of the survey analysis showed that collaboration activities and initiatives by producers are promoting sustainable food supply chains. This implies that increasing collaborative initiatives are likely to yield more sustainable outcomes within the food supply chains. To the best of the researcher's knowledge, this study makes a novel contribution to the body of literature on supply chains and food sustainability. Studies are yet to consider the quantitative analysis of collaboration contributions towards sustainable food supply chains. Hence, the results are similar to the emphasis of Smith et al. (2017), Chen et al. (2017), and Govindan (2018). These studies argue that collaboration activities between FSC actors—including producers, agronomists, processors, logistics providers, distributors, retailers, regulators, and governmental agencies—are promoting sustainability dimensions at different levels, thus enhancing sustainability performance. The results also address the concerns of Ramanathan, Gunasekaran and Subramanian (2011), who emphasised that estimating the benefits of collaboration is a big problem. This study has shown that collaboration practices can be measured to inform stakeholders of the attention and intensity required to promote sustainability, thus providing innovative and robust ways of enhancing sustainability; these address the concerns of Ghomashchi (2012), who calls for innovative approaches to resolve unsustainable situations. More recently, this study strongly provides support for the work of Ramanathan et al. (2021), which confirms the importance of collaborating organisations and commitment from collaborating partners to foster sustainability in global supply chains. Two sections are raised to discuss the impacts associated with collaboration—i) section 6.2.4.1:

collaborative institutions and practices and ii) section 6.2.4.2: smart partnerships, supply chain contracts, and relationships.

6.2.4.1 Collaborative institutions and practices (Institutions and practices for sustainable food supply chain collaboration – SFSCC)

Integrated collaboration institutions and activities have been fostering sustainability. All producers and FSC actors in the study are engaged with one or more collaboration practices, enabling them to enhance sustainable food supply chains. Producers have sufficient experience with different stakeholders, such as regulators, environmental protection agencies, and other producers, following their guidelines and playing different roles to address sustainability issues while championing collaboration for sustainability. The findings indicate that producers and FSC actors perceive collaboration as the most important dimension contributing to sustainability within Ghana's fresh vegetable supply chain. The results provide support for arguments put forward by Smith (2008), Ghomashchi (2012), Ali (2018), and Ramanathan et al. (2021). This could be due to the similar SC actors that are involved in the study, e.g., producers, SC partners, and authorising bodies. Smith (2008) stressed that collaboration among farmers, food manufacturers, retailers, NGOs, and governmental organisations is vital in order to raise standards for supply chains and to enable farmers to adopt more sustainable agricultural practices. Also, the findings support the analysis and emphasis of studies in Brazil (e.g., do Canto et al., 2020); Australia (e.g., Gloet and Samson, 2019); Belgium (e.g., Hubeau, Marchand and Van Huylenbroeck 2017); Spain (e.g., Pérez-Mesa et al., 2021); the UK (e.g., Ramanathan et al., 2014); Italy (e.g,. León-Bravo et al., 2017); and the USA (e.g., Miller and McCole, 2014; Foley et al., 2017). These collaborative institutions and practices encompass traceability, environmental sustainability, regulation, and sustainable practices. Thus, there are collaboration practices involving different institutions, such as PPRSD, GSA, FDA, MOFA, and GEPA, together with producers championing sustainability through their performance and goals. In addition to this positive impact of collaborative institutions, producers, regulators and other FSC actors are undertaking practices that are promoting sustainable food supply chains. Hence, collaborative institutions and practices, although synonymously related, are promoting sustainability for the vegetable supply from Ghana to the UK.

The collaborative sustainability approach requires the participation of all stakeholders to create a shared sustainability agenda and promote common ground for spearheading sustainable practices (Ghomashchi, 2012). Suppliers’ collaborations are promoting different sustainability goals, including socially responsible and environmentally friendly practices (Ali, 2018). Such suppliers’ or producers’ collaborations are allowing actors to learn from the positive and negative outcomes and take actions and initiatives to improve their sustainability strategies through increasing numbers of solid collaboration practices for future possibilities. Achieving this sustainability agenda is a complex challenge; however, this study supports the emphasis that multi-actor collaboration can help provide systematic change and solutions (Borg and Yström, 2018). Although performance benefits are mainly aligned with downstream collaboration and upstream are sustainability-related (Blome, Paulraj. and Schuetz, 2014), this analysis shows that collaboration practices in the different streams are yielding positive sustainable outcomes. Although this analysis reveals the importance of collaborative institutions and practices, the study fails to perform individual statistical analysis of the positive impacts (thus, collaborative institutions and practices relating to traceability, environmental sustainability, regulations, and sustainability practices). Further studies could consider statistical analysis of collaborative institutions and practices to enable stakeholders (collaborating members) to completely appreciate the attention, commitments, and contributions required to enhance sustainability.

6.2.4.2 Smart partnerships, Supply chain contracts, and Relationship

In supply chain collaboration relationships, actors benefit from and share valuable resources and information, which can improve their economic performance. Producers and other FSC actors within Ghana’s fresh vegetable supply chain are capitalising on collaboration opportunities to create and re-design smart partnerships, contracts, and relationships to boost operational activities as well as sustainable food supply chains. The qualitative analysis revealed and strongly supports smart partnerships, supply chain contracts, and relationship relevance within food supply chains. The findings are similar to and provide support for the emphasis and analysis of Ramanathan and Gunasekaran (2014), Hubeau, Marchand and Van Huylenbroeck (2017), and Ordonez-Ponce, Clarke and Colbert (2021). The success of collaboration lies in the planning, decision making, and execution of collaborating partners (Ramanathan and Gunasekaran, 2014) and these initiatives from collaborating partners are resulting in smart decisions, contracts, and relationships that facilitate sustainability. Moreover, collaborating members are generating meaningful partnerships to build intangible sustainability, contributing to sustainability progress (Ordonez-Ponce, Clarke and Colbert, 2021). This analysis also provides qualitative support for the empirical work of Vereecke and Muylle (2006), who found and emphasised that there is a meaningful relationship between collaboration partners and performance improvement, and this improvement entails quality and cost-effectiveness. Through these collaborative outcomes, conflicts among stakeholders are minimised and each stakeholder is able to contribute to or foster sustainability (Pomeroy et al., 2007; Dania, Xing and Amer, 2018). The analysis suggests that collaboration between actors is developing, facilitating, and establishing new practices and innovative ideas, such as smart partnerships and SC contracts, that are closely linked to sustainability of the food system. Producers, other FSC actors and those organisations outside the chain, such as NGOs, credit providers, and regulators, are also utilising these positive impacts (i.e., smart partnerships, supply chain contracts, and relationships) to tackle sustainability challenges while exploiting more opportunities.

Due to the enormous contributions from emerging food supply chain collaboration, retailers are increasingly creating and using partnerships with producers and other FSC actors to maximise sustainability-focused innovation and performance (Riandita, 2022). Clarke and Crane (2018) pointed out that the increase in business collaborations through partnerships, relationships and SC contracts with other FSC actors is helping to address sustainability issues. It is important to emphasise that producers have established networking and some form of collaborations with input suppliers, other producers (outgrowers and smallholders in remote areas), logistics providers, distributors, retailers, regulators, NGOs, unions and associations, governmental agencies, and other actors within and outside the chain. These networks, connections, and associations create new ideas, innovations, and opportunities in the form of SC contracts, smart partnerships, and relationships that contribute to sustainability issues. Although these positive impacts (i.e., the smart partnerships, relationships and SC contracts) are difficult to measure and manage, due to the difficulties regarding when and with whom to collaborate, how to establish collaboration and for what purpose (León-Bravo et al., 2017), it is necessary to focus on such collaboration existing within food supply chains that is able to provide sustainable outcomes.

6.2.6 Complexities and Sustainable food supply chains

The qualitative analysis of the interviews and focus groups revealed that producers and other FSC actors are dealing with complexities within their vegetable food supply chains. These consist of several challenges, disruptions, and inefficiencies hindering producers' drive towards developing and achieving sustainable food supply chains. The complexities identified by this study are mainly categorised into two: 1) market dynamics and uncertainties and 2) local producers' complexities. The findings are similar to the work and discussions of Robinson and Carson (2015), Gamboa et al. (2016), Tai (2018), Nasereldin et al. (2020), Abideen et al. (2021), and Loring and Sanyal (2021). Global food systems are developing and growing and are mostly characterised by stochastic disruptions and inefficiencies, such as overuse of plastics, social inequalities, food waste, and transport and energy costs (Loring and Sanyal, 2021). Tai (2018) queries the approach and drive towards attaining sustainability in the modern age of complex global food supply chains, as they display several features that make it inherently difficult for producers and FSC actors at different stages of the supply chain. This study has shown that these complexities include: a competitive market; COVID-19 opportunities and challenges; logistical challenges; inadequate credit facilities and financial support; inadequate government support and policy; lack of knowledge of food processing; limited knowledge of efficiency; and local challenges of complex food supply chains. The COVID-19 pandemic presented a new era in food supply chains, raising concerns about food production, processing, distribution, and even demand (Aday and Aday; 2020; Abideen et al., 2021). It also resulted in the closure of food production facilities, restricted movement of farm workers and food trade, and created financial pressures and difficulties for producers and FSC actors (Deconinck, Avery and Jackson, 2020). In the UK, Garnett, Doherty and Heron (2020) stressed that the country's food system suffered from weakened Just-In-Time (JIT) supply chains, labour issues, and insufficient local production and called for resilience. In the light of these bottlenecks and COVID-19 pandemic challenges, many smallholders and producers in developing countries were left in difficult situations (FAO. 2020), not being able to comply with sustainable practices in food production, distribution, and consumption. Nonetheless, all complexities have equal importance to producers and FSC actors and there is a need for more pragmatic, collaborative, and modern approaches to minimise or eliminate the food supply complexities endangering sustainable food supply chains.

Global food supply chains face multiple complex systems that encompass international market concerns; logistical challenges regarding shipping or airfreight of their produce; and other local challenges that hamper their food production and supply, e.g., lack of credit facilities, insufficient government support, and lack of knowledge and technologies to improve on efficiencies. Vegetable producers call for support from governments, the third sector (NGOs) and international organisations to minimise or remove these complexities. To resolve this global issue, Goldenberg et al. (2003) suggested innovation by subtraction, i.e., removing the challenge through innovation, but not adding any further complexity. For instance, using digital systems and smart supply chains to remove global food supply complexities, such as food safety and food waste, according to Abideen et al. (2021), who argued strongly that producers and the FSC should consider utilising technology to help eliminate global food catastrophes. Moreover, rapid COVID-19 recovery strategies and practical policy decisions are needed to minimise border waiting times, foster food trade, streamline food trade certification procedures, and relax food trade regulations.

On the other hand, the findings from the survey analysis showed that complexities are statistically not significant. This result may be due to respondents' uncertainties in clearly outlining their specific challenges and producers being discouraged and resistant to detailing their challenges, since such bottlenecks have been in existence for a while without any support from the government or any other organisation. Further studies could suggest that producers and FSC actors prioritise those complexities that are specific to their food production and supply chain, to avoid participants listing all bottlenecks and complexities on the survey.

6.3 Implications

This study provides a novel opportunity for governments, policymakers, FSC professionals, other FSC actors, NGOs, food regulators, researchers, and academics to identify and measure key sustainability dimensions and their associated impacts within food supply chains. Previous studies focused on individual assessment of sustainability dimension and domestic sources of food supply, and a few sustainability impacts of the food supply chains. This study, however, extends existing studies to capture sustainability implications from global food sources; assess all the various sustainability dimensions; and highlight a considerable number of impacts connected with sustainable food supply chains. Moreover, this study suggests a Sustainability Impact Assessment (SIA) model that simply captures all sustainability dimensions and their related impacts within the food supply chains. This study offers a valuable and rich model or framework for development and a thorough assessment of the topic; and it makes contributions towards enhancing sustainability performance and achieving sustainable development goals. The study contributes a better understanding of the sustainability dimensions resulting from global food supply chains. Most notably, the scale of the study's data indicates that robust findings and recommendations are provided in terms of theoretical, practical, and policy implications. In order to strengthen the development and actualisation of global food supply chains, food sustainability, and the sustainability development agenda, the study takes a closer look at theoretical implications, followed by the implied practicalities. A section is further created to discuss policy implications. This is also with a view to scrutinising, addressing, and reducing all sustainability impacts in the furtherance of sustainable performance across different sectors as well as increasing productivity.

6.3.1 Theoretical Implications

6.3.1.1 Sustainability Impact Assessment (SIA) framework

The study presents theoretical frameworks (novel SIA frameworks or models) that diagrammatically capture all relevant sustainability dimensions. In contributing to the growing literature on sustainability, this model shows that the understanding of a broader perspective of sustainability can easily be integrated into a theoretical model (SIA framework) to allow new insights into the development and assessment of the stream of sustainability development. In that regard, it is easier to explore relevant sustainability dimensions and their performance, contribution, and development in a more in-depth way; test the relationship between them and FSC stakeholders to expand knowledge; and provide research conclusions based on current studies. Moreover, the SIA framework of this study carries more significant theoretical implications. First, the SIA framework considers all-inclusive sustainability dimensions, primarily focusing on the environmental, economic, social, regulatory, collaboration, and complexities of food supply chains. The existing body of knowledge seemingly examined only the three traditional sustainability dimensions—environmental, economic, and social (Smith, 2008; Schmutz et al., 2018; Tsolakis, Anastasiadis and Srai, 2018; Hendiani, Liao and Jabbour, 2022)—leaving out some important sustainability dimensions that can promote sustainable food supply chains. This study addresses not only the crucial concern and gap raised by Hendiani et al. (2022) regarding the lack of an integrated approach to assess sustainability but also extends their contribution by providing a comprehensive, integrated framework for measurement of sustainability that is simpler, robust, and novel. Hence, it contributes to the discussion of sustainability impact assessments in management and business literature which, for more than two decades, has focused on environmental, social, and economic dimensions while ignoring regulatory frameworks, collaboration, and other development and complexities' approaches from global sources (i.e., overseas food suppliers). Therefore, the theoretical frameworks (SIA models) that were designed, developed, tested, and validated in this study are presented in Figure 6.2, Figure 6.3, and Figure 6.4.

Figure 6.2 below presents the initial theoretical framework—the conceptual framework of the study designed and modified based on prior knowledge of the study. The design of this theoretical framework depicts the capture of all relevant sustainability dimensions and their associated impacts on Ghana's fresh vegetable supply to the UK as discussed in the literature. Literature has long utilised the three traditional sustainability dimensions to enhance sustainability impacts, e.g., Schmutz et al. (2018). This demonstrates contextual usage of the traditional sustainability dimensions as sustainability impact assessment (SIA) approach as explained by OECD (2010) and Gibson (2013). However, the framework of this study provides a broader and more innovative perspective, along with clarity on the usage of sustainability impact assessment (SIA) approach, by re-designing and re-structuring the SIA as a diagrammatic tool that can capture all contextual, observational, and evaluative sustainability implications associated with global food supply chains. Interestingly, the framework demonstrates and enforces that the capture of sustainability implications by this innovative SIA approach should start from overseas sources. In other words, this SIA approach is holistically enabling the capture and assessment of sustainability implications of food supply chains, starting from sustainability concerns associated with the activities and operations of overseas food producers and other related FSC actors. This can facilitate the evaluation of the sustainability of global food supply chains to instigate more pragmatic measures and strategies to enhance sustainability development agendas. It is important to highlight that the framework is aligned with stakeholder theory as a theoretical contextualisation of the framework. Hence, the initial framework can encourage FSC stakeholders, policymakers, and other FSC professionals to rethink the capture of sustainability implications through a broader lens that considers the environmental, economic, social, and regulatory aspects of sustainability. However, to ensure more robust SIA models (theoretical frameworks), the initial framework (Figure 6.2) is further developed, tested, and validated. The final

SIA models (theoretical frameworks) developed, tested, and validated by the study are Figure 6.3 (SIA model developed and tested by case studies data analysis) and Figure 6.4 (SIA model validated by survey data analysis).

The developed and tested SIA framework (Figure 6.3) shows a broader perspective of the SIA tool proposed. This framework captures wider relevant sustainability dimensions and their associated impacts; namely, collaboration and complexities aspects of sustainability in addition to the environmental, economic, social, and regulatory components (which were initially captured based on literature). This SIA model was developed and tested using case studies data collected through interviews and focus groups. While some studies present final sustainability frameworks based on extant literature, e.g., Govindan (2018), other studies e.g., Gupta et al. (2020) collect data from researchers and other professionals which are not directly involved in the supply chain to develop sustainability framework. This study collects data directly from key actors of the food supply chain (mainly smallholder farmers, outgrowers, local farmers, and exporters) to develop and create a novel and broader approach for sustainability assessment—the SIA model. This advanced sustainability assessment framework has the capability of capturing all relevant sustainability implications ranging from environmental, economic, social, regulatory, collaboration, and complexities aspects of sustainability. This SIA framework also affirms that there is the need to assess sustainability considering the activities and operations of overseas' food suppliers, whereby data are collected from key FSC actors outside the UK. Further, the initial framework (Figure 6.2) considers the generic capture of sustainability implications associated with global food supply chains, while the developed and tested SIA framework (Figure 6.3) focused on sustainability implications associated with Ghana's fresh vegetable supply chain to the UK. This framework (SIA model) supported by stakeholder theory provides a much broader perspective of the capture and assessment of sustainability. Sustainability impacts generated by an individual stakeholder (FSC actor) within the supply chain are carefully examined and aligned with the stakeholder theory to inform and support the development of the SIA model. Further, sustainability concerns such as Fairtade, uncertainties, food waste, environmental licensing, and collaborations that are mostly associated with global food supply chains but ignored are well captured in this framework. The ideal of evaluation, rectification, and improvement of sustainability is made easier due to the simpler, capture capability, and practical nature of this SIA model. Policymakers, FSC actors and professionals, researchers, educationists, NGOs, and other related stakeholders can utilise this novel SIA framework for their various projects, strategies, activities, and operations in order to enhance sustainability and sustainable food supply chains.

Furthermore, Figure 6.4 presents an additional SIA model which is tested using the survey data analysis. After the development of the SIA model based on the thematic analysis of the case studies data, this study assesses the reliability and validity of the theoretical constructs (both sustainability dimensions and their associated impacts) of the SIA model (Figure 6.3). The results facilitated the modification of the SIA model and, hence, the tested SIA model (Figure 6.4) produced. This framework has the capacity to equally capture all contextual, observational, and evaluative sustainability implications associated with global food supply chains. It further reveals more important sustainability dimensions and their impacts that FSC stakeholders should pay critical attention to in order to enhance their sustainability development agendas and sustainability performance. Finally, the conceptualisation of an SIA framework can further research interests in sustainability assessment. Although some disciplines and a body of literature have grown in developing and evaluating sustainability with different approaches and frameworks, the SIA models (Figure 6.2, Figure 6.3, and Figure 6.4) provide different and innovative perspectives addressing ignored sustainability dimensions. Here, research may find the conceptual frameworks (SIA models) a useful approach to enrich discussion, assessment, and development in the literature of sustainable food supply chains and global food trade, as well as of supply chains. Table 6.1 briefly distinguishes between the frameworks (Figure 6.2, Figure 6.3, and Figure 6.4).

Table 6.1 Differences and similarities between the SIA models (theoretical frameworks) of the study.

Framework Description	Modified Conceptual Framework (Figure 6.2).	Developed and Tested SIA model (Figure 6.3)	Validated SIA model (Figure 6.4)
Development	Developed based on prior knowledge of the literature.	Developed based on case studies data analysis.	Modified SIA model based on survey data analysis.
Sustainability Dimensions	Shows four (4) sustainability dimensions associated with limited and generic sustainability impacts.	Shows six (6) sustainability dimensions associated with broader perspective, specific and data-guided	Shows five (5) sustainability dimensions associated with limited, specific and tested sustainability impacts.

		sustainability impacts.	
Theoretical Underpinning/Support	Stakeholder theory	Stakeholder theory	-
Users	Policymakers, FSC actors and professionals, researchers, educationists, NGOs and other related stakeholders.	Policymakers, FSC actors and professionals, researchers, educationists, NGOs and other related stakeholders.	Policymakers, FSC actors and professionals, researchers, educationists, NGOs and other related stakeholders.
Relevance	As a model, framework, a tool, strategy and approach for identification, evaluation and improvement of sustainability and sustainable food supply chains.	As a model, framework, a tool, strategy and approach for identification, evaluation and improvement of sustainability and sustainable food supply chains.	As a model, framework, a tool, strategy and approach for identification, evaluation and improvement of sustainability and sustainable food supply chains.
Scope and stream of sustainability assessment	Demonstrates that sustainability impact assessment should consider activities and operations of all key FSC actors starting from those in overseas countries.	Demonstrates that sustainability impact assessment should consider activities and operations of all key FSC actors starting from those in overseas countries.	Demonstrates that sustainability impact assessment should consider activities and operations of all key FSC actors starting from those in overseas countries.
Limitations	Lacks data support	Developed and tested only by interviews and focus group data collected from one overseas' food-supplying country.	Dwells on already developed SIA model (Figure 6.3) to make further contribution using survey data analysis. Survey data collected from only food producers from one overseas' food-supplying country.

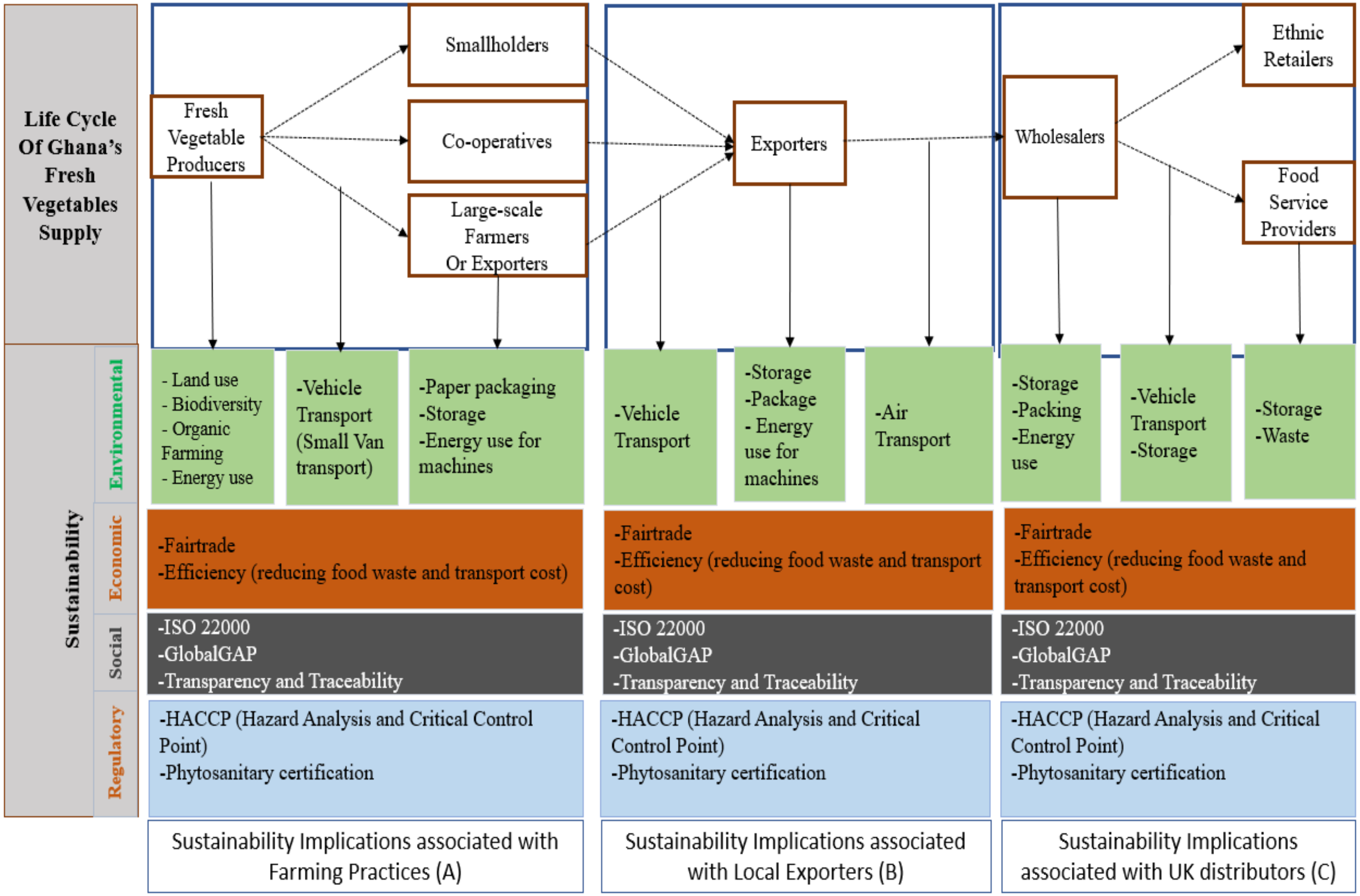


Figure 6.2 Modified Conceptual Framework.

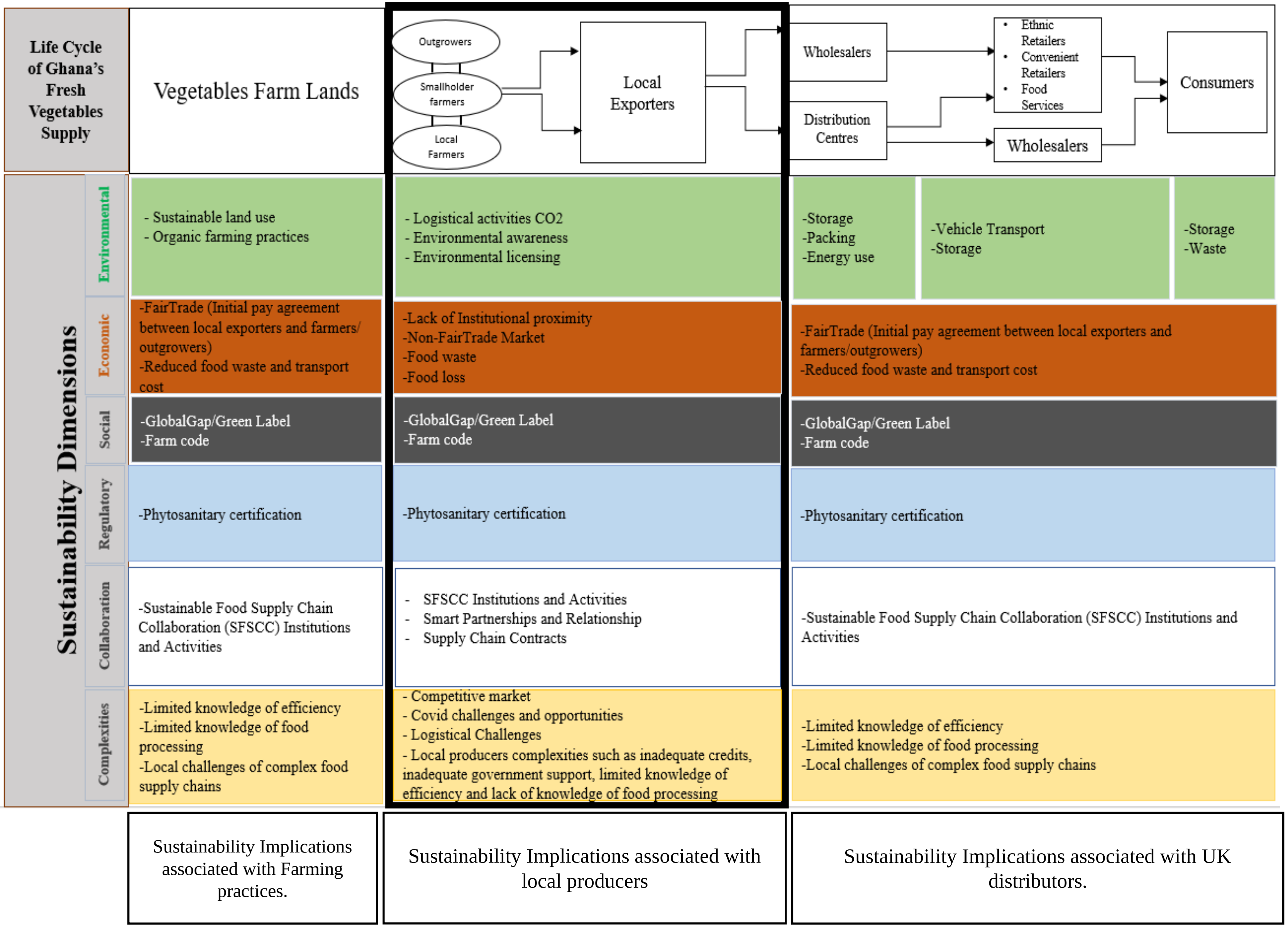


Figure 6.3 Tested SIA model - from the thematic analysis of case studies data

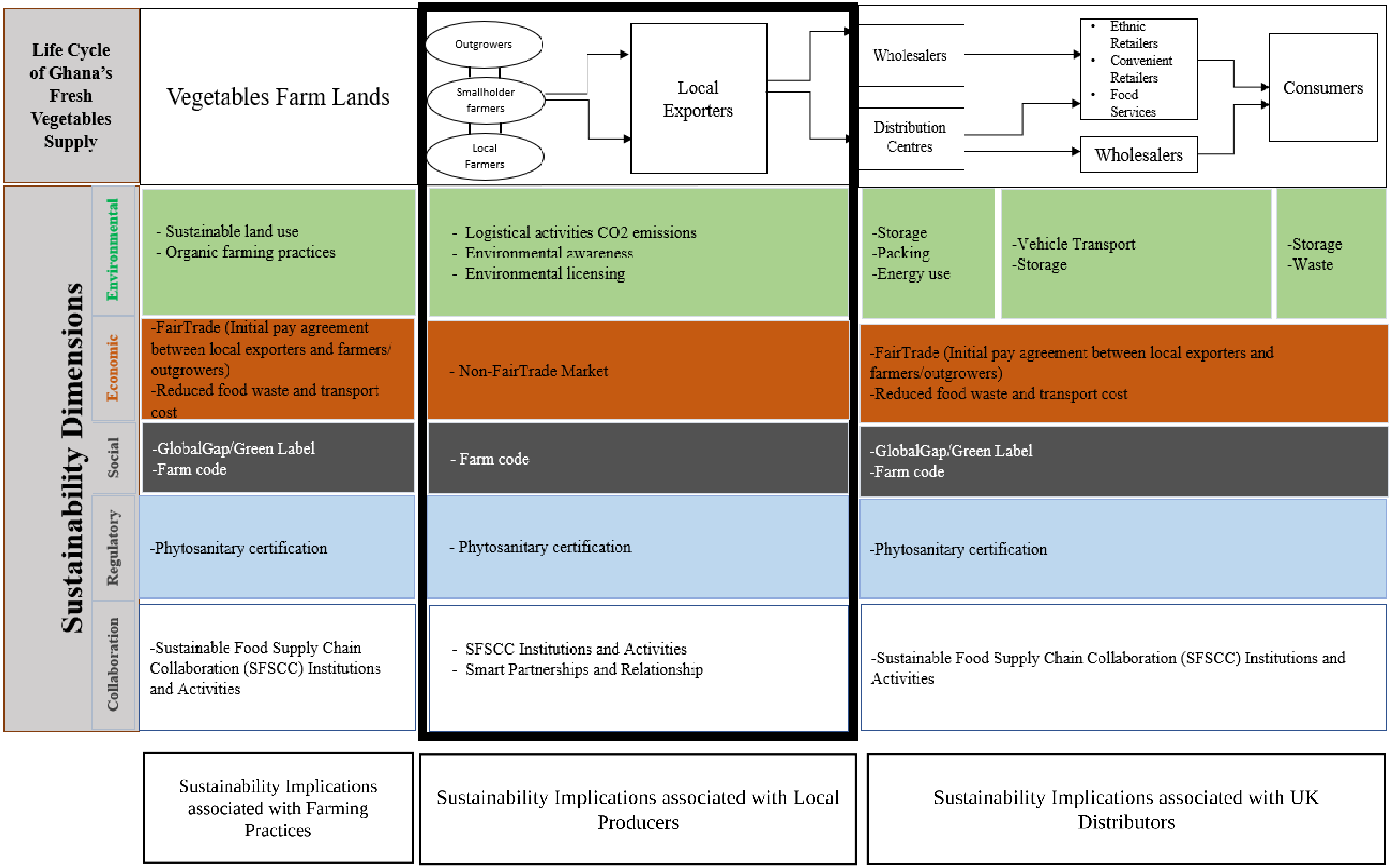


Figure 6.4 The validated SIA model from the survey data analysis.

6.3.1.2 The capture, measurement, and development of sustainability data

In the sustainability literature, the capture of sustainability data has not previously been holistically established. A wide range of different variables or constructs have been used for the measurement of sustainability elements. More particularly, a great amount of literature—and still growing—has considered many different sustainability variables (e.g., Yakovleva, 2007; Schmutz et al., 2018; León-Bravo et al., 2021) that are associated with domestic, in-country, or region-based activities, without taking into account the practices and activities of overseas and outsourced food suppliers. This study establishes a novel alternative for the capture, measurement, and development of sustainability data. Its generalised applicability is demonstrated based on the use of qualitative and quantitative data to emphasise that the evaluation and improvement for sustainability should take into account data from actors contributing to the food supply chains from overseas. This makes a theoretical contribution to sustainable supply chains research by establishing that an appropriate and holistic assessment of sustainability must also examine the practices of overseas players. In the context of food supply chains, this study illustrates what overseas activities, practices, factors, and sustainability elements must be considered for the improvement and evaluation of sustainability. Most noteworthy of all, this study reveals that observational, contextual, and evaluative sustainability data can be captured and are important to facilitate the appropriate, realistic and holistic examination and evaluation of sustainability.

6.3.1.3 Improvement and contributions of sustainability dimensions

This study contributes to a broader perspective and holistic understanding of sustainability dimensions as decisive actors to look for in developing and achieving sustainable development targets. Social sustainability and the regulatory dimension of sustainability are thoroughly considered, examined, and evaluated to explore their relevance towards sustainability development in supply chains and food sustainability. This theoretical contribution addresses the concerns of Ahmadi, Kusi-Sarpong and Rezaei (2017) and Desiderio et al. (2021), who stress the need for exploring social sustainability issues which are almost ignored. Existing studies of social sustainability arguably focus on qualitative discussion. This study opens fresh discussion on the quantitative contribution of social sustainability, leading to a practical approach to enhancing social sustainability-related matters of food supply chains and other contexts. Furthermore, the study puts forward regulatory frameworks as an essential dimension to strengthen sustainability within the food supply chains. The inclusion of this regulatory dimension in itself raises a novel discussion for the development of regulatory sustainability.

Although complexities and collaboration are important considerations for developing sustainable food supply chains (Gamboa et al., 2016; Blackmar et al., 2018; Fobbe, 2020; Abideen et al., 2021), this study establishes that these dimensions should not be distinctively separated from the traditional sustainability dimensions (i.e., environmental, social, and economic) but, rather, should be integrated into sustainability frameworks, projects, objectives, and agendas. Prior studies with the emphasis on supply chains have individually examined complexities and collaboration contributions towards sustainability. Theoretically, this study contributes to the broader understanding of supply chain sustainability by highlighting environmental, social, and collaboration factors as possible constructs to determine the improvement for sustainability.

6.3.2 Managerial Implications

The results of the study and the SIA framework as an output have implications for managerial and professional practices. Literature suggests different sustainability frameworks that can facilitate the identification and measurement of sustainability implications, e.g., Manzini and Accorsi (2013) and Latino et al. (2022). However, existing frameworks are mostly not elaborative on the sustainability dimensions; focus on one sustainability dimension; are generated with limited sustainability impacts; and are centred on the capture of sustainability implications of the local supply chains. This SIA framework provides food organisations, logistical services businesses, producers, and other FSC leaders with a greater degree of clarity about identifying, measuring, and resolving sustainability matters. It offers a holistic diagrammatic model for sustainable food supply chains that governments, businesses, and FSC professionals can adopt to fashion more proactive, pragmatic, and realistic approaches in shaping their supply chains with achievable sustainability targets. Existing studies e.g., Schmutz et al. (2018) have only adopted SIA as an approach but not as a model. With the aid of this model, all sustainability objectives, protocols, and targets can easily be mapped and communicated to all stakeholders, partners, and other contributors within the supply chains, thereby providing a clear direction, visualised platform, and blockchain-like framework for sustainable performance and development. Nevertheless, further managerial or practical implications are highlighted as follows:

6.3.2.1 Smart food production and training

Industry players and producers can utilise smart technologies to reduce negative sustainability impacts identified within the supply chain. Even though producers in developing countries are faced with poor technological development in food production, supply and consumption activities (Affum and Wang, 2019), the findings and framework of the study, however, clearly highlight where available technologies can be directed to enhance development of food systems. Hence, smart farming can be instigated from the use of small, simple, less expensive technological devices to highly advanced, expensive technological devices. Smart farming has the ability to improve and develop sustainable food production and consumption (Walter et al., 2017; Moysiadis et al., 2021). It transforms the traditional approaches to innovative solutions using information communication technologies (ICT). Evidentially, technologies such as Image Processing, Big Data, Unmanned Aerial Vehicles (UAVs), Wireless Sensor Networks (WSNs), Cloud Computing, and Unmanned Ground Vehicles (UGVs) bring the advantages of increasing production, reducing labour efforts, and reducing farm input costs, e.g., for fertilisers, fuel and pesticides. Smart farming ensures production improvements, resulting in nutritious and healthier products with fewer or no food chemicals or pesticides. Outsourcers or overseas producers should be encouraged and supported to switch to smart farming approaches. Food trade partners, retailers, and wholesalers in importing countries can provide financial and equipment support towards promoting smart technologies in food production. Sensors and Internet of Things (IoT) devices can be distributed to smallholders and installed, leading to the evolution of modern agriculture in outsourcing and developing countries. Furthermore, seed drills, sprayers, spreaders, drones, and satellite imaging devices for producers can significantly contribute to sustainable agriculture. In other words, producers can be encouraged to shift toward “precision farming”, which utilises information technologies in agriculture, minimising environmental burdens and farm input costs and encouraging the increased flow of farm information (Auernhammer, 2001; Finger et al., 2019). Industry players and producers adopting smart farming and farming precision are likely to rapidly improve on their sustainability performance with this SIA model. From the capture of the sustainability impacts by this framework, smart farmers can visually see areas that require further attention, and their positive sustainability impacts generated from their food production practices. Further, smart producers are also able to contribute to the SIA framework by capturing all relevant sustainability implications associated with farming practices in order to facilitate the full development of the SIA model that can be utilised by other food producers and FSC actors.

In addition, food producers' training needs must be analysed and satisfied. Through application of the SIA framework, sustainability concerns that require skilled attention would instigate more appropriate training needs for food producers and other FSC actors. In this case, producers and FSC major stakeholders would not be engaged in generic training but, rather, in more tailored training with a focus on improving sustainability and ensuring a sustainable food supply chain. This would help retail managers and other FSC professionals to capture and incorporate producers' sustainability growth and development plans into their businesses' frameworks, operations, and objectives, thereby facilitating continuous improvement for producers in modern agriculture, consumer-driven products, the use of farm technologies, and collaboration practices.

6.3.2.2 Collaboration-driven FSCs and responsible production

The results from both analyses reveal that collaboration enhances sustainability and sustainable food supply chains. With such a revelation, it is important for industry players and FSC actors in different countries to champion collaboration-driven FSCs and responsible production despite the food miles. The existing literature argues that localisation or local food is more sustainable (e.g., Brunori et al., 2016; Cvijanović et al., 2020). However, recent work by Stein and Santini (2021) refutes the idea that local food simply means sustainable food, because much local food may not have a lower environmental impact and may indeed have other sustainability issues. Further, a body of authors, including Rohm et al. (2017) and Taghikhah, Voinov and Shukla (2019), has emphasised that consumers (consumer-driven food supply chains) drive the sustainability implications, ensuring that food sources are highly embedded with environmental initiatives. Utilising this SIA framework between two FSC businesses would create shared sustainability responsibility. In other words, the major industry players and FSC managers can champion measures and strategies to mitigate negative sustainability impacts captured by an individual FSC actor's SIA. Collaboration instigates the share of information (thus, sustainability impacts captured by the framework), knowledge, and responsibilities and such opportunities can be utilised to spearhead sustainability within the supply chains.

Importantly, most sustainability approaches and innovations do not connect directly with smallholders and local producers in overseas countries (Asuming-Brempong et al., 2016). Due to the amount involved in the food trade, smallholders and local producers are marginalised, creating lucrative opportunities for exporters, food export agencies, and large-scale producers. This study's SIA proposes that large FSC actors (e.g., retailers, wholesalers, food trade partners, and large food service providers) in importing countries should adopt collaboration-driven FSCs. This approach creates all-inclusiveness, enabling the capture of sustainability concerns of all small food producers to properly and holistically evaluate sustainability of the business supply chain. Utilising SIA frameworks with more collaborative practices—which integrate all relevant FSC actors and stakeholders outside FSC contributions and activities starting from overseas sources—will drive sustainable food supply chains.

Additionally, this study contributes to responsible production and consumption in the context of collaboration and regulatory mechanisms. The SIA model encourages industry players and food supply decision makers to guide their strategies, operations, and projects with sustainable collaboration and regulatory impacts which have benefit of spearheading responsible production and consumption. Regulation influences competitiveness and trade-offs and, consequently, other sustainability dimensions and resilience of food supply chains. Assessment of trade-offs among the sustainability dimensions (Schader et al., 2016) requires in-depth improvement and analysis of agricultural practices, economic issues, and food consumption statistics. However, the analyses in this study suggest that policymakers, donors, and FSC professionals can identify where to invest to promote sustainable food supply chains. The utilising of the SIA framework and the findings of the study instigate equal and overarching sustainability development, solving the problem of trade-offs among sustainability impacts to enhance sustainability development agendas. Moreover, industry players and FSC managers can benefit from such further assessments of collaboration and regulatory frameworks to predict future complications and incentivise constructs linked to collaboration and regulatory mechanisms. From the perspective of global food supply chains, comparative studies regarding various sustainability dimensions of FSCs can provide more reliable direction and support for international donors and food trade partners for a genuinely sustainable development agenda.

6.3.2.3 The use of transportation optimisation and technology-enabled transport systems

Industry players and FSC managers should consider alternate means of reducing CO_2 emissions in logistical activities and improving sustainability. The SIA reveals strong environmental concerns including significant amount of CO_2 emissions associated with the food supply chains. Therefore, industry players and FSC managers can adopt transportation optimisation in food supply chains (Haass et al., 2015) to reduce waste in post-harvest processes and encourage improvement in in-country and export transport activities. As the dominant environmental impact generated by global food supply chains, CO_2 emissions (Poore and Nemecek, 2018; Frankowska, Jeswani and Azapagic, 2019) have been a major challenge for industry players and FSC managers. The effects of CO_2 emissions associated with transportation and other logistical activities is extremely high, and is implicated in climate change. However, using the SIA framework has the capacity to capture CO_2 emissions associated with the supply chain. This framework of capturing and evaluating critical environmental impacts such as CO_2 emissions can enable industry players and FSC managers to achieve improved sustainability by minimising carbon emissions within in-country transportation and transportation for export by using energy-efficient refrigerated vehicles and practising logistically effective routing and re-routing of vehicles.

It is important to mention that the impact of sustainability on the global food supply chain is simply enormous, and consumers are contributing to such change because they desire healthier and more sustainable food that is environmentally friendly (Yadav, Luthra and Garg, 2011). However, industry players and FSC managers can resort to technological tools, devices, and systems to enhance performance, improve sustainability, and reduce food waste and CO_2 emissions after the SIA framework has revealed its negative contribution to the food supply chains. To address this, FSC managers and industry players can utilise the option of deploying of the Internet of Things (IoT), Blockchain (BC), Big Data, Artificial Intelligence (AI), Machine Learning, and Digital Twins (DT). These tools have the capability to contribute to reducing CO_2 emissions and addressing global food supply chain challenges and sustainability issues (Zilberman and Reardon, 2019). Therefore, industry players and FSC professionals can systematise their operations with the help of the SIA framework which can enable them to employ more appropriate technological tools and promote research endeavours to establish and produce reliable options for improving sustainability performance.

6.3.2.4 Organisations' and FSC actors' leadership in sustainability development

Every development, goal, strategy, or project that needs to be achieved in an organisation requires leadership. Deploying this SIA model requires leadership from industry players and FSC managers alike to affect its contribution towards sustainability development, since the application of the SIA framework and the options for improving sustainability after identifying sustainability implications lie in the hands of the FSC managers and decisions managers. Interestingly, recent literature has argued that, to enhance sustainability performance, organisation leadership is required (Iqbal, Ahmad and Halim, 2020). Business organisations, FSC stakeholders, and the third sector in developing countries can utilise the SIA model, thereby demonstrating leadership in strengthening sustainability development and implementation objectives.

Sustainable leadership creates an environment for economic growth (McCann and Holt, 2010). Businesses and government agencies need to show leadership by applying the SIA model , integrating sustainability goals facilitated by the use of the SIA framework and the study's findings into their structural and performance objectives, as well as grounding their culture on sustainability. Organisations can lead SC with robust, effective, and pragmatic sustainability agendas. By doing so, they can promote a new dynamic of innovations, long-term success, sustained competitive advantage, and continuous improvement (McCann and Holt, 2010; Iqbal, Ahmad and Halim, 2020).

Food supply chain managers should continuously adopt sustainable approaches by utilising the SIA framework for operational and process improvements and also promote business strategies that are firmly embedded with sustainability values, behaviours, and attitudes which, to the best of the researcher's knowledge, to date no sustainability framework has been able to facilitate these features. Furthermore, businesses and industry players can concentrate on the impacts associated with sustainability dimensions that require more attention—as identified by the SIA framework and the study's findings—while developing and re-configuring their models and strategies to meet their organisations' ambitions for sustainability and sustainable business practices.

6.3.3 Policy Implications

6.3.3.1 Agricultural and Sustainable Food Supply Policy

The EU Common Agriculture Policy (CAP) reforms seek to increase social and environmental sustainability by striving towards protecting biodiversity and water resources and enhancing rural development. Following its departure from the EU, the UK is no longer participating in the CAP, and has instead adopted the Agricultural Act 2020 as a transition approach from the CAP. This Act sets out to wind down direct payments to producers by 2027 and replace them with environmental land management (ELM), which encompasses the current set of environmental schemes (Agriculture and Horticulture Development Board, 2021; Thomsen Reuters, 2022). Despite the UK's eco-schemes and transition plan, which offer more commitment towards environmental sustainability (promoting environmental and climate friendly practices) and social sustainability (promoting producer welfare and fair dealing with producers and other FSC actors), the Act does not say much about global food sources. While measures are adopted to strengthen local producers, there is a need to consider sustainability implications associated with global food producers, since the UK is by no means self-sufficient in food production. In the meantime, government policies and measures should entail aid, provisions, and collaboration initiatives for overseas producers. This would enable the UK to significantly minimise the negative environmental impacts associated with global sources, while extending the fair dealings, welfare, and innovations to producers from their food trade partners. Arguably, the UK Food 2030 vision details strategies for enhancing sustainable food supply, but this policy fails to consider or include global sources. The UK has ambitions to be a global leader in food sustainability, but it first needs to consider the main sources of its food supply chains. As many countries are yet to achieve self-sufficiency in food production, food policymakers and strategists need to ensure that agricultural development and food sustainability are embedded in the sustainability implications originating from food trade partners. Specifics of these areas that can be captured are biodiversity, logistics and operations, producers' welfare, and food waste.

6.3.3.2 Revisiting Ghanaian and UK food policies

The results of the study suggest that food policies, guidelines, and strategic projects should be amended or revisited. These include Ghana's L'Aquila Food Security Initiative, Accelerated Agricultural Growth and Development Strategy (AAGDS), Planting for Food and Jobs, Food and Agriculture Sector Development Policy, Ghana Food and Nutrition Policy, and Agriculture Policy Support Project (APSP) (Al-Hassan, 2018; Coomson, 2022). These policies are more focused on encouraging agricultural growth and the use of food safety information and education mechanisms, strengthening existing regulatory frameworks, and facilitating food trade. However, silence is maintained on how collaboration among food industry players or food supply chain actors can be redirected to champion sustainability. The policies and strategies are also quiet on integrating all sustainability dimensions as overarching policy objectives that need to be achieved. Again, other food policies, such as the Global Food Security Strategy (GFSS) Country Plan for Ghana, are focused on nutrition and food security to address issues of poverty, malnutrition, and food insecurity. Even though the GFSS Country Plan considered consultation with industry players and major stakeholders on socio-economic impacts of food security and nutrition (Feed the Future, 2018)—and despite the food policy drive to maximise investments, promote agriculture-led growth and food production resilience, and tackle emerging problems and opportunities—the approaches to enhance collaboration practices among food industry players are not clarified. Also, it does not stretch itself to capture the overarching idea of sustainability. The government, policymakers, and all the concerned stakeholders should ensure that similar food policy is composed of clear approaches to and objectives of enhancing all sustainable practices, including the environmental, social, regulatory, and collaborative components. Unlike Ghana's food policy (such as GFSS), UK food policies including Food 2030, the Food and Farming Policy, the Government Food Strategy, and the National Food Strategy, as well as other frameworks like the Environment Act (2020) and the Agriculture Act (2020), capture initiatives and measures for attaining more sustainable practices and objectives. However, these UK food policies also fail to include strong collaboration and regulatory blueprints that can strengthen the sustainability agenda. Moreover, what is also missing in the food policies and strategies is measures tailored to addressing existing and current complexities in the food supply chains. Most strategies and measures focus on localisation (increasing local production), improving farmers' capacity, influencing consumers' choices, and advocating for local industry players' collaboration. However, the UK's food policies and strategies are yet to consider overseas food suppliers' activities to understand sustainability challenges and create collaborative practices and sustainable initiatives that can support a sustainable food supply chain, which might then culminate in the UK achieving its stated aim of achieving global leadership in food sustainability. Therefore, UK food policies should be revisited and capture clear regulatory frameworks and collaboration initiatives considering overseas food suppliers in order to boost sustainability practices while aligning measures and strategies to address complexities in global food supply chains. During the COVID-19 pandemic, food supply chains suffered from supply shortages, logistical activity restrictions, food price hikes, food waste, and unemployment. Governments and policymakers should re-design policies and strategies, providing guidelines and mechanisms to ensure that food supply chains are more resilient and sustainable. More strategic policies and measures should consider overseas food supply chain processes and challenges.

6.3.3.3 Incorporating Regulatory frameworks into Food Policy mechanisms

It is important to recognise that increasing regulatory frameworks can minimise food exports from developing to advanced countries, thereby minimising any strategic approaches towards sustainable food supply chains, not only their economic dimensions, but also other dimensions of sustainability. This means that governments and policymakers should champion policies, measures, and strategies that regulate and strengthen governance of producers' production and distribution activities while, in addition, initiating active participation to influence food production, agricultural production, and trade policy and intervening to improve food processing and utilisation of foods to minimise food waste. Policies also need to be developed in response to the latest world pandemic crisis (COVID-19) in order to minimise food waste and enhance sustainable food production and supply rather than looking for a comprehensive strategy for agri-business and food trade. Also, greater importance needs to be attached to enhancing environmental sustainability. Further, there is a need for the promotion of environmental policies, protocols, and activities that can enhance sustainable food supply chains, such as food production intensification aligned with sustainability requirements, smart production and usage of smart technologies, and advocacy of precision farming which minimises negative environmental impacts. Moreover, regulations should not be inflexible, expensive or complex, so as to encourage producers to carry out more voluntary and simpler sustainable actions.

Government agencies, along with agri-food producers, processors, and farmers, must be ready to change their current agricultural practices by adopting new approaches. For example, Trujillo-Barrera, Pennings and Hofenk (2016) reiterate the need for policymakers to understand the motives that encourage producers to adopt sustainable practices which would enable them to re-design and improve on such incentives for sustainable performance. Sustainable practices (such as labelling or traceability) would be welcomed by producers if the regulatory initiatives behind them can also increase their profitability through efficient processes.

6.3.3.4 FairTrade and economic incentives

Regulating and guiding the vegetable sector of Ghana with FairTrade is vital. With the compelling and absolute advantages for producers or farmers, providing fair prices and decent welfare for farmers would make a significant contribution toward economic development. FairTrade for vegetable producers would increase vegetable production and supply, as well as fostering sustainable food supply chains. Policymakers, FairTrade organisations, and all the concerned stakeholders should ensure that the vegetable market is guided by FairTrade and fair prices. Also, the government and policymakers can utilise economic incentives—such as tax holidays, tax benefits, and farm input subsidies—to support vegetable producers in the promotion of sustainable food production and consumption. The government of the Netherlands already offers tax benefits to producers who are certified for sustainable livestock practices, as part of its Maatlat Duurzame Veehouderij programme. To enjoy tax benefits and other related leverages, producers are compelled to obtain a sustainable practice certificate which requires them to maintain strict standards on energy use, emissions, and a range of other activities (Trujillo-Barrera, Pennings and Hofenk, 2016). Similar policies or strategies can be established for vegetable producers to enable more substantial contributions towards environmental and social sustainability, regulatory frameworks, and collaboration to enhance sustainable food supply chains.

6.4. Summary

This chapter presented discussions and implications of the study. Key findings and revelations from both thematic analysis of case study and survey data are discussed to demonstrate how the results contribute to the existing body of knowledge. Results relating to environmental aspects of sustainability, economic aspects of sustainability, social aspects of sustainability, regulatory frameworks, collaboration, and complexities are explained to provide a broader understanding and aligned with the literature. The chapter further provided implications from theoretical, managerial, and policy perspectives to suggest the different strategies, measures, and options available for policymakers, FSC professionals, academics, researchers, the third sector, and other stakeholders to improve sustainability and enhance sustainable food supply chains.

CHAPTER SEVEN (7)
7.0 SUMMARY, OVERALL CONCLUSIONS, AND OPPORTUNITIES FOR FURTHER RESEARCH

7.1 Introduction

The global food supply chain has improved agricultural productivity, created enormous employment, and stimulated innovations and new technologies but, nonetheless, it does generate major sustainability implications. These are exacerbated by world population growth and increased human consumption. Both developed and developing countries are continuously importing a range of food items from sources all over the globe to supplement their domestic production. The UK relies on global sources for many food items to match domestic food consumption. However, the UK's food policy, Food 2030, and the food policies of overseas food suppliers are almost silent on the sustainability implications associated with global food supply chains and food trade. Hence, there is a need for a practical examination of the holistic sustainability impacts associated with the food supply chain starting from overseas or global sources in order to help re-design frameworks and networks, and put in place pragmatic measures that foster sustainable food supply chains.

This thesis explored the opportunities for reducing the sustainability implications of the UK's global food supply chain by analysing Ghana's fresh vegetable export, using case research and survey. To facilitate this, the study set out four research objectives and followed five methodological phases to address the three Research Questions. The methodological phases adopted combined both qualitative and quantitative research approaches (mixed methods) to explore the phenomenon and contribute to the body of knowledge. The methodological phases utilised to achieve the research objectives and address research questions are: i) reviewing of literature; ii) conducting a pilot study; iii) conducting interviews; iv) focus group discussions; and v) a survey.

The first two phases, i.e., the review of literature and the pilot study, provided the theoretical background and support for the study, explored the feasibility of the main study, and drew on preliminary observations for more rigorous investigation to address the study's Research Questions. The two phases further enabled the development of the SIA framework. First, enabling the capture of various sustainability dimensions and impacts to help the diagrammatic design and construction of a conceptual framework (SIA model) of the study. The outcome of the review of the literature contributed an additional sustainability dimension, i.e., the regulatory dimension, to the framework, based on a new understanding of current literature and the relevance of regulatory mechanisms in global food supply chains. Further, the pilot study facilitated work-in-progress development of the framework (SIA model), refining the sustainability impacts captured for each dimension. This phase prepared the conceptual framework for further development, testing, and validation by the main study.

The interviews and focus discussions (Phases three and four) were utilised to identify tentative sustainability dimensions and impacts. Based on the responses from both small- and large-scale producers, the explicit and underlying meaning were produced for each dimension and impact, i.e., appropriately explained or described. The sustainability dimensions and impacts were, however, finalised through rigorous analysis and confirmatory strategies to allow for generalisation. The conclusive sustainability dimensions and impacts were further utilised for finalising the development and testing of the conceptual framework (SIA model) of the study. Moreover, the interviews and focus groups provided the variables (sustainability dimensions) for statistical estimation of the relationship between sustainable food supply chains and sustainability implications (dimensions). The final phase, the survey, was used to statistically estimate the sustainability implications associated with Ghana's fresh vegetable supply chain to the UK, based on the findings from thematic analysis of the interviews and focus groups. In addition, the survey (phase five) was used to test and validate the SIA model developed from the thematic analysis of the interview and focus group data.

Each of the five phases addressed the three Research Questions, formulating enquiry into different aspects of the research objectives. This chapter, therefore, summarises the research findings as aligned objectives and demonstrates how the four research objectives were achieved within the process and context of this project.

The rest of this chapter is organised as follows: a summary of research findings and implications is presented in section 7.2. Section 7.3 explains contributions to knowledge; section 7.4 discusses the limitations and directions for future research; further research opportunities is presented in section 7.5; and a concluding statement of the thesis is provided in section 7.6.

7.2 Summary of research findings and implications

As mentioned in section 3.4, this study adopted five phases comprised of both qualitative and quantitative methods (i.e., mixed methods research), used to address the Research Questions, while meeting the research objectives stated in section 1.5. Phases 1 and 2 (i.e., literature review and pilot study) provided the background understanding of the topic, prior knowledge for the development of the conceptual framework, and preliminary observations for the main study. Analysis and discussion of the findings of Phases 3 and 4 (i.e., the use of interview and focus group) and Phase 5 (the use of survey) provided intriguing and fascinating revelations that adequately aligned with and achieved the research objectives of the study. Hence, section 7.3 provides a summary of the findings and implications of the research, demonstrating how each research objective has been achieved throughout the phases of the study.

Research Objective I: Identify the sustainability gaps in Ghana's fresh vegetable exports to the UK.

The results of the study showed circumstantial evidence that six sustainability dimensions and their associated impacts are important sustainability implications or gaps in Ghana's fresh vegetable exports to the UK. First, the six sustainability dimensions are environmental, social, and economic, plus regulatory frameworks, collaboration, and complexities. While traditional food supply chain research has revealed three sustainability gaps associated with the environmental, social, and economic dimensions (Yakovleva, 2007; Govindan, 2018; Kumar, Mangla and Kumar, 2022), the study can conclude that measures and approaches are required to tackle additional sustainability dimensions, such as regulation, collaboration and complexities. The study further identified sustainability impacts or elements associated with the sustainability dimensions which highlight clearly the sustainability issues and concerns related to Ghana's fresh vegetable exports to the UK. For the environmental dimension, the study showed that CO_2 emissions generated by logistical activities, environmental awareness, and environmental licensing are environmental sustainability concerns. For the economic dimension, the study revealed a lack of institutional proximity, Non-FairTrade Market (i.e., lack of access to FairTrade benefits), food waste, and food loss. The Global G.A.P. or Green Label and Farm code schemes, representing the potential for promoting traceability and transparency, and traceability of local producers, were identified as social sustainability concerns that need to be fed into policy development. It requires pragmatic measures and purposeful attention to help facilitate sustainable food supply chains. For regulatory frameworks, the study showed that phytosanitary certification plays a key role. Sustainability concerns associated with collaboration were grouped into three sets: 1) institutions of food supply chain for sustainability; 2) activities of food supply chain collaboration for sustainability; and 3) smart partnership and relationship, and supply chain contracts. For complexities, the study revealed major concerns which covered market dynamics and uncertainties related to local producers' challenges. The complexities that sustainability concerns identified include a competitive market, COVID-19 opportunities and challenges, logistical challenges, inadequate credit facilities and financial support, inadequate government support and policy, lack of knowledge of food processing, limited knowledge of efficiency, and local challenges presented by complex food supply chains.

The sustainability concerns related to Ghana's fresh vegetable exports to the UK were identified through the first four phases, i.e., the review of literature (Phase 1), pilot study (Phase 2), interviews, and focus groups (Phases 3 and 4). While the review of literature provided ideas of sustainability gaps associated with Ghana's fresh vegetable export based on the environmental, social, economic, and regulatory dimensions, the pilot study revealed actual and crucial insights into the sustainability gaps. The interviews and focus groups helped to capture concerns about collaboration and complexities while developing and testing the overall sustainability dimensions and impacts. Meanwhile, the survey (Phase 5) was utilised to validate the identified sustainability dimensions (gaps) from the four previous phases.

As a result, the sustainability dimensions and their associated impacts emerging from this research indicate sustainability gaps that require practical attention from all FSC players, policymakers, the third sector, and other stakeholders in order to facilitate holistic contributions towards improving sustainability and sustainable food supply chains.

Research Objective II: Explore the alternative practices of reducing the sustainability impact associated with Ghana's fresh vegetable supply chain to the UK.

The study explored the alternative practical approach to reducing the sustainability implications by developing an SIA framework or model to explain the key sustainability impacts, illustrate relationships, and provide a roadmap visualising all sustainability dimensions and impacts for effective and practical approaches to improve sustainability. The literature has long stressed that SIA captures three integrated sustainability dimensions—social, environmental and economic. This study argues that this is not generalisable and considers modification to capture other sustainability dimensions. This SIA model is the result of circumstantial evidence found by the study, objectively presenting ideas in a diagrammatic and visualised fashion, to spark views, practices, approaches, and measures to achieve balance while reducing negative sustainability impacts and promoting sustainable food supply chains. The SIA model was systematically developed with illustrations establishing vigour and rigour to enable the study to provide a reliable framework, without bias, that could visually relate the sustainability dimensions and impacts, so as to intuitively instigate sustainability impact reduction approaches from stakeholders. Policymakers, FSC managers, academic researchers, and the third sector are now potentially equipped with research knowledge and alternative practice (the SIA framework) to enable them to handle the daily sustainability challenges from various perspectives.

Phase 1 (literature review) and Phase 2 (pilot study) provided a background and work-in-progress view of the conceptual framework. The results from Phases 1 and 2 are presented in Figures 2.5, 2.6, and 4.5. Phases 3 and 4 (interviews and focus group) revealed all the important sustainability dimensions and impacts for development, finalising and testing the SIA model. Phase 5 (the survey) validated and finalised the SIA model developed through Phases 1, 2, 3, and 4. The conceptual framework of the study (SIA model) is presented as a simple tool, not only for identification, but also for measurement and evaluation to foster sustainable performance and development. Hence, FSC professionals, policymakers, academics, researchers, the third sector, and other stakeholders can employ this model to visualise sustainability impacts enabling them to allocate reliable and practical measures to help reduce sustainability impacts while enhancing sustainability.

Research Objective III: Suggest a robust method for measuring and valuing the sustainability implications associated with fresh food exports (fresh vegetables) to the UK, taking account of the sustainability impact assessment (SIA) and life-cycle analysis of the food supply chain.

The study found out that regression analysis of sustainability data provides an important measurement and valuation approach for estimating sustainability implications. It further suggested that a multiple linear regression between the sustainable food supply chain and the identified sustainability dimensions showed a robust, applicable, and commendable method for assessing the food supply chain drawing from global sources and the life cycle of the chain. Prior to establishing that the regression estimation between sustainable supply chains and the identified sustainability dimensions offered an ideal model for determining the relationship between sustainable supply chains and sustainability implications, this study trialled other statistical models and approaches, such as logistic regression, multinominal logistic regression, and ordinal logistic regression. It is worth noting that these models could not provide reliable and relevant results or make meaningful sense of the data. The main reason was due to the nature of the data themselves and the selected model. It is important to mention that the model or estimation method was utilised to survey the data of this study.

Phase 1 and Phase 2 provided an understanding of the relevant sustainability dimensions associated with Ghana's fresh vegetable exports to the UK. These sustainability dimensions were further revised or modified following the revelations from Phase 3 (interviews) and Phase 4 (focus groups). Based on the finalised sustainability dimensions from the thematic analysis of the interviews and focus groups, Phase 5 (survey analysis) was utilised to estimate the relationship between sustainable supply chains and the identified sustainability dimensions in order to suggest an appropriate and robust method of measuring sustainability implications.

This regression estimation (i.e., of equating sustainable supply chains to sustainability dimensions) has the power to reveal which sustainability dimensions require more efforts, measures, and approaches to minimise the associated sustainability impacts and promote positive sustainability impacts. Policymakers, academic researchers, FSC professionals, and other stakeholders can now estimate the value of each sustainability dimension contribution towards any sustainability agenda or project. Moreover, researchers can now consider a broader capture of sustainability data accommodating all the sustainability dimensions and from multiple sources. Furthermore, it is vital to stress that key sustainability dimensions, such as environmental, social, regulatory, and collaboration aspects (activities) of sustainability, should not be overlooked, but rather should be integral dimensions considered for any sustainability impact assessment.

Research Objective IV. Provide recommendations to enhance sustainable food supply chains for the UK and Ghana.

Based on the findings of the study, theoretical, managerial, and policy implications are presented as recommendations for the enhancement of sustainable food supply chains. First, theoretical implications suggested that the sustainability impact assessment (SIA) framework of the study would provide different perspectives for addressing the ignored sustainability dimensions. Additionally, SIA depicts a comprehensive integrated framework for identification and measurement of sustainability that is simpler, robust, and novel. Further, FSC professionals, policymakers, and other stakeholders are provided with alternative approaches to the capture, measurement, and development of sustainability data. The study also explained that a holistic capture and measurement of sustainability should consider overseas sources. Moreover, whereas existing literature has focused on the traditional sustainability dimensions, this study did not expand on these, but conducted a novel discussion on the regulatory, collaboration, and complexities aspects of sustainability.

Second, the managerial implications of the study suggested the use of smart food production approaches, training and transportation optimisation, and technology-enabled transport systems to foster sustainable performance. FSC actors are advised to take the lead in sustainability development by adopting collaboration-driven FSCs and responsible production approaches. These professional and practical approaches have the benefits of reducing the cost to the environment and the economy while stimulating innovations and productivity.

Third, on policy implications, governments and major stakeholders are advised to reform and re-design their food policies and strategies to capture sustainability concerns from global sources. In addition, regulatory frameworks and initiatives should encourage producers and FSC actors to actively participate and conform in ways which promote food trade.

Phase 1 (review of the literature) and 2 (the pilot study) revealed preliminary sustainability concerns of Ghana’s fresh vegetable exports to the UK, highlighting relevant sustainability implications. However, Phases 3, 4, and 5 provided underlying sustainability dimensions and impacts, expanding and validating the observations of Phases 1 and 2, as well as revealing important sustainability implications which require attention from all stakeholders.

Hence, recommendations are drawn for FSC professionals, academics, researchers, policymakers, and other stakeholders to utilise the ideas, measures, and approaches in various practices to help improve sustainability and sustainable food supply chains.

7.3 Contributions to knowledge

This study contributes to the body of knowledge in several ways. First, the study provides understanding of the sustainability dimensions and impacts from food supply chains starting from global sources, highlighting different sustainability elements that need transforming into policies, action plans, projects, operations, and activities of FSC actors and those outside the chain, in order to enhance sustainability. Importantly, the research makes significant contributions in three main areas: policy, theoretical, and managerial

First, this study makes theoretical contributions to the discourse on the need to consider sustainability impact assessment starting from overseas sources. It identifies, explains, and provides understanding of different sustainability implications associated with food supply chains from the producers' perspective based in a global source (Ghana) ending up in an advanced world (the UK). Both qualitative and quantitative analyses of data suggest that environmental, social, collaboration, and regulatory dimensions and their related impacts are key sustainability implications of fresh food supply chains. In addition, the qualitative analysis revealed that economic and complexities sustainability dimensions and issues are also important to food producers and global food supply chains. To this end, the study utilised the revelations from qualitative analysis (thematic analysis of the interviews and focus groups)—see Chapter 4; and quantitative analysis (regression analysis of the survey) —see Chapter 5; to develop, test, and validate the conceptual framework (SIA model) of the study. This SIA model makes a novel contribution to the body of knowledge about supply chains and global food supply chain sustainability by providing an all-inclusive diagrammatic sustainability impact assessment (SIA) model for easy capture, examination, and evaluation of all relevant sustainability impacts associated with environmental, economic, social, regulatory, collaboration, and complexities dimensions. Moreover, the study provides the lead and a novel alternative for the capture, measurement, and development of sustainability data that should facilitate holistic examination and evaluation of sustainability. While the study reveals the important contribution of regulatory factors of food sustainability and global supply chains, it further suggests that promoting environmental, social, and collaboration factors can positively improve sustainability.

Second, the study provides managerial implications for FSC professionals and other stakeholders. The study suggests an SIA framework for easy and holistic capture, identification, and evaluation of sustainability impacts. This is because it opens up options for capturing all sustainability impacts under one framework and instigates assessment of the strength of each impact towards sustainability. In the final analysis, the SIA framework presents itself as a simple diagrammatic model to enable managers and professionals to map all sustainability issues into a visualised and blockchain-like framework to enhance sustainable development. Further, producers and FSC managers should utilise smart technologies such as the Internet of Things (IoT) and Big Data that have the potential to facilitate sustainable food production and distribution. Furthermore, producers are encouraged to adopt smart technologies, which has the benefit of minimising economic and environmental cost. One important fact is that there is a need for FSC managers to promote collaboration-driven FSCs and responsible production; and adopting training programmes can enormously encourage producers and FSC actors in overseas sources to contribute adequately to sustainability. Moreover, FSC managers can achieve improved sustainability by using transportation optimisation and technology-enabled transport systems. These can serve as smart approaches to CO_2 emissions reduction in logistical activities.

Third, this study informs the need for policy changes by first scrutinising the UK and Ghana food policies and strategies to reveal that the sustainability concerns of global food partners are either ignored or neglected in food policy development and strategy. To enable food trade partners to show global leadership in food sustainability, this study suggests that increasing collaborative initiatives and measures should be embedded in food policies and strategies in order to enhance sustainable food supply chains. Moreover, governments, policymakers, and all stakeholders concerned should ensure that policies, strategies, and measures are captured with clear approaches and objectives on environmental, collaborative, social, regulatory, economic, and complexities issues relating to food supply chains. Policies also need to be developed in response to the latest world pandemic crisis (COVID-19), to minimise food waste and enhance sustainable food production and supply, rather than looking for a comprehensive strategy for agri-business and food trade. Moreover, regulatory mechanisms and initiatives should be designed to enhance food trade, profitability, and conformity of FSC actors and those outside the chain. Furthermore, FairTrade offers enormous economic incentives for producers and local communities.

Hence, the study suggests that fresh food production and supply should be guided and regulated by FairTrade principles.

7.4 Limitations and directions for future research

This study is home-country-based and the data were collected only from FSC actors in Ghana (one geographical area), a fact that may affect generalisation of the results to the broader context, even though the study's conceptual framework is generalisable. Nevertheless, sourcing data from one geographical context to represent a global perspective can be controversial. Also, in Ghana, vegetable producers are scattered across the country, mainly in the southern and northern parts of the country. Mobilising producers across the country was difficult particularly from areas in the northern sector due to transportation, accommodation, and access to the internet. Hence, the study focused on data collection from producers with the southern sector, mainly in Accra, Nsawam, Dodowa, Koforidua, Volta, and Ashanti regions. The data were collected from multiple actors of the food supply chains and those outside the chain—e.g., smallholders, local farmers, exporters, large-scale producers, farm operations officers, regulators, and authorising agencies associated with food production and distribution. Be that as it may, a country-specific study embraces particularisation (Wikfeldt, 2016), but does not necessarily imply generalisability (Fendler, 2006) to other food categories. Analysis of multiple geographical areas, i.e., investigating more global food supply chains (overseas sources) and involving importers' countries, as well as considering other food categories, would provide more generalisable findings.

Second, this study does not align the data and findings with particular organisational theories, e.g., agency theory or institutional theory data, to facilitate theoretical development and contribution. Small-scale producers (e.g., smallholders, outgrowers, and local farmers) and large-scale producers (as agents) have important relationships with food wholesalers and distributors (as principals), which offer some insights into the challenges and solutions of Ghana's vegetable supply chains. However, it is important to mention that stakeholder theory is utilised to underpin the development of the conceptual framework of the study (SIA model). Notwithstanding that, future studies can consider such important relationships to make theoretical development and contribution. Moreover, there is a significant number of authorising bodies locally and internationally admonishing producers to conform to certain practices and protocols for the betterment of society, the environment, and humankind. These institutional pressures on producers can be aligned with some organisational theories, such as institutional theory (Suddaby, 2010; Peters, 2022), to make some institutional theoretical development and contribution. Theorists, therefore, could expand this study for the development and contribution towards relevant organisational theories.

Third, attempts were made by the researcher to test and estimate different mathematical and statistical models with the survey data, e.g., Logistic Regression, Multinominal Logistic Regression, and Ordinal Logistic Regression. However, the study finds that these models are not applicable to the data, but it also did not test other mathematical and statistical models, which may have the power to explore and make wider sense of the data and create a better understanding of that phenomenon, such as differential equations, stochastic functions, probability models, Fuzzy Inference Systems (FIS) models, Generalised Linear Model (GLM), decision trees, and Generalised Method of Moments (GMM). Therefore, this study establishes only that using a multiple linear model can simply explain the relationship between sustainable FSC and sustainability dimensions, while other models were not tested. Empirical researchers can test the survey data with various statistical models to establish other ideal and robust models and methods for determining a relationship between sustainable food supply chains and sustainability implications. Further, it can be observed that the study estimated the sustainability dimensions (economic, social, regulatory, environmental, complexities, and collaboration) without investigating sustainability impacts, e.g., food waste, CO_2 from logistics activities, environmental awareness, fairtrade concerns, traceability and smart partnerships. Future research should consider analysing and estimating the sustainability impacts' and elements' contributions towards the overall sustainable supply chain. Moreover, this study analyses the interview and focus group data with NVivo 11, and the survey data with SPSS; fuzzy-set qualitative comparative analysis (fsQCA) (Kraus, Ribeiro-Soriano and Schüssler, 2018) could provide rich analysis of set relations, narrowing down on the problems and coming out with the solutions.

Fourth, this study initially planned to recruit 10 case studies involving local producers and UK food distributors, wholesalers, and retailers to enable the capture of sufficient sustainability implications across the chain. However, due to the COVID-19 pandemic, recruiting participants became very difficult as a result of lockdown restrictions and the breakdown of supply chains, which led to many producers and FSC businesses temporarily closing down. Consequently, two producers (cases) were recruited for the main studies, and it was not possible to recruit a significant number of cases (businesses) for the study. Although this case study's data were complemented by a survey, future research should consider a greater number of cases for similar supply chain studies, to ascertain more functional perspectives from producers and FSC actors in order to feed into the development of resilient and sustainable supply chains and sustainable development.

7.5 Further Research

This study provides wider options and opportunities for future research and further corroboration of the findings of this research project. As clearly highlighted in the limitations section, this research can be expanded, taking into account other outsourcing countries (geographical contexts) and different food items, for a more robust comparative analysis to augment this study's findings. Investigating other global food supply chains in SSA countries and other regions would not only reveal the commonalities of food producers' sustainability dimensions and contributions but would also clearly highlight the wider capture of sustainability impacts within global supply chains for furtherance of the generalisation of the SIA model and statistical estimations of sustainability implications influencing supply chains.

Further studies could expand this study by collecting data, whether primary or secondary, to test for the statistical measure or value of the identified sustainability impacts associated with the individual sustainability dimension. This would enable policymakers and FSC stakeholders to appropriately align more realistic measures and approaches to minimise negative sustainability impacts and strengthen other impacts that significantly contribute to the sustainability of the global supply chain. In addition, researchers can utilise alternative methods, such as field observation visits and document reviews, and can also utilise multiple secondary data sources to measure sustainability implications using different mathematical and statistical models, to test and validate the SIA model. This will contribute additional empirical insights and enhance theoretical contributions and development in sustainable supply chains.

Researchers and academics can explore the SIA model (the conceptual framework proposed for this study) for various forms of assessment, evaluation, education, and future practice. Multiple propositions can be aligned with the SIA model to provide several alternatives and insights into the development of sustainable food supply chains. Researchers can explore the SIA model to look into the sustainability implications of disparities between perishable and non-perishable food supply chains. Additionally, the SIA model can stimulate distinctive studies between projects and policies and can be explored as an ex-post and ex ante framework that can utilise the sustainability implications of policies and projects. Information communication technologies (ICT), such as artificial intelligence, Big Data, and business intelligence can facilitate and transform collaboration and other sustainability dimensions (Perez-Mesa et al., 2021). Future research can look into digitalisation and utilisation of ICT in the supply chain, to expand the analysis, improve decision making, and champion intelligent supply chain strategies and management, while making use of this SIA model as an intelligent supply chain framework.

This study captures a significant number of stakeholders or actors in FSC whose collaborations and partnerships foster sustainability. The results of the study clearly highlight the need of the FSC actors to encourage and strengthen collaboration practices to spearhead sustainability. Not only that, but the study also suggests that collaboration among producers and other FSC actors offers the potential for greater sustainable performance within the food supply chains. Policymakers and the research community should encourage a collaborative environment and promote collaborative research in the supply chain, to enhance sustainable performance in the food systems. Research can be conducted into different collaborations to examine how they might contribute to and affect sustainable supply chains with regards to the drivers and FSC actors. In addition, further research could examine the relationship or collaboration between different FSC actors, as well as other regional food producers, to re-construct sustainability partnership design for achieving the highest sustainable goals. Moreover, future research should consider digging in depth into the complexities of the food supply chains, factoring in all current challenges and other issues emerging from outsourcing and overseas food suppliers. This would help the identification of substantial challenges, prioritise their complexification, and develop alternate ways of measuring, generalising, and resolving them for the furtherance of sustainable global food supply chains. It would also facilitate the development of rapid correction approaches and measures to minimise complexities in global food systems.

Finally, this study mainly focuses on the sustainability dimensions across the food supply chains by looking at the local producers' perspective in Ghana, a developing country in the SSA region. Careful consideration is needed before finalising and generalising the findings of this study to FSC stakeholders of different regions and different scales. Future research can be conducted into different FSC stakeholders or other aspects of the SIA model, such as Sustainability Implications associated with Farming Practices, and Sustainability Implications associated with UK distributors, to assess the differences of the sustainability impacts and implementation measures required to enhance overall sustainability in any holistic supply chain network. The researcher expects that future research can examine sustainability-oriented dimensions and impacts of different FSC stakeholders given their geographical contexts and the relationship between them.

7.6 Concluding statement

This study explores the opportunities to reduce the sustainability implications of the UK's global food supply chain by analysing Ghana's fresh vegetable export using case research and survey. The study was divided into five phases, starting with a review of existing literature and then a pilot study. Based on the preliminary observations, interviews and focus groups were conducted as Phases 3 and 4 of the study. The results of thematic analysis of the interview and focus group motivated a survey as Phase 5 of the study.

This research emphasises that there are six sustainability dimensions and their associated impacts are important sustainability implications associated with Ghana's fresh vegetable exports to the UK. These are the environmental, social, and economic dimensions, regulatory frameworks of food supply chains, collaboration, and producers' complexities in developing sustainable food supply chains (sustainable FSC). To minimise the sustainability implications arising from global food supply chains, this study suggested a novel SIA framework (conceptual framework of the study), which can easily facilitate the capture, examination, and evaluation of all relevant sustainability implications while also enabling new insights into the development and assessment of sustainability development.

It is also important to stress that promoting FairTrade for producers in developing countries, utilising transportation optimisation and technology-enabled transport systems would help producers and FSC actors to improve sustainability. Moreover, there is also need for the UK, Ghana and all food trade countries to revisit their food policies and strategies, to ensure that overseas sources' sustainability concerns are considered in their overarching food policy and strategy. Furthermore, regulatory frameworks and mechanisms should be complemented with economic incentives to promote conformity with food supply regulations and food trade. Governments, FSC professionals, and the third sector should encourage smart strategies and technologies to enhance improved logistics that minimise food waste and energy consumption while boosting producers' welfare. To contribute practically to the reduction of negative sustainability implications related to complexities, collaboration, social, economic, environmental, and regulatory factors, producers and exporters should switch to sustainable production and distribution practices. While there are some limitations with regard to restricted data collection and model consideration, this study provides other future research opportunities.

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APPENDICES

Appendix 1: Transcript: Interview – Large Producer (I-LSP)

PI: CO_2, I think you've heard about CO_2, right?
FR: Yeah
PI: CO_2 is a major concern in which you will refer to pollution but in… emissions from your vehicles, emission from your operations or any machines that you use that… The CO_2 is a major concern in
food production what are you doing to help reduce this CO_2? Within your production, within your storage or on the farm or in transportation.
FR: Okay, thank you! … Basically, on our farm, what we do is to yes! even though we have been using irrigation equipment on the field to irrigate and then … all those things. After it, … we harvest the produce, then transport it from the farm to the packhouse … and then after sorting everything, we transport it again to the … the airport for the goods to arrive to its destination. Now, what we are doing to…I mean reduce the impact of the CO_2 is this… Moving forward, we plan of having an enclosed van… like a cold van which can convey the thing from the farm to the packhouse and then same convey it to the packhouse to the … to the airport and that aspect I think … there would not be any impact in the form of CO_2 to the produce.
PI: Oh okay, welcome … Are working with any agency or institution or NGO it can be agency an institution or NGO which is helping you to reduce CO_2?
FR: No, not yet.
PI: Are you also following any government regulation that are helping you to reduce the CO_2 … emission?
FR: Yes! Government regulation that are helping us is the PPRSD – Plant and Plough Regulation Services which they which they are more into … they are regulating our vegetable sections and then giving us a fair idea what we have to make our regular market and all those kinds of things but all those things come up which financial … even though they have given us the clear indication but we still need… money that we can go implement what they have taught us.
PI: Do you think there should be any measurement to be implemented to help you reduce CO_2? Do you think there should be any measurement to be implemented to help you reduce CO_2? Do you think apart from financial, do you think there should be any other thing that should be done to help you reduce the CO_2?
FR: Yes!... I think … still there should be a measurement when it happened may be to get any other organization which can give us another briefing. In addition to what we have learnt from the government agencies, I think that will also be… fine.
PI: Okay! On your own, do you plan to use any other measure …. to
transport your vegetables apart from Air Freight? Are you planning in future to use apart from using air, are you planning to do process your product here or do anything apart from … transport or are you trying to sell locally in future? What … apart from that, what or how do you plan to supply your vegetables or transport vegetables to the UK?
FR: … vegetable transporting to the UK because it is a perishable product, it has to be transported by … an air freight because of the Perishability. Now, in the future my other plan is to … do processing in fruits; fruits like mango pawpaw, pineapple by the fruits in a way than can also… I mean add some value.
PI: What about vegetables?
FR: Vegetable, what we do ancient vegetable … what we do… I mean I don't have an idea of … doing any processing for now…

PI: Oh okay. In what way do you support your farmers and up growers? In what way do you support your farmers?
FR: The farmers and up growers I do support them by … giving them seeds, giving them some money for … for them to do very well on field. Apart from that I buy them traps, pheromone traps they set on the field so that those insects … they can control the insects. Yes …so these are the support I can mainly give to my outgrowers and farmers.
PI: Are they any regulation or a policy that ensure that farmers and up growers are paid fairly?
FR: Yes! Farmers and up growers are paid fairly in my opinion. Because farmer when you pay him, definitely you wouldn't expect him to do what is expected on the field especially by keeping the filed very neat … good agricultural practices that have to be done on the field and all those things … needs money and all those things so when the farmer gives you the produce or sell the produce to you, you definitely have to pay him fairly… without doing that, it means that farmer cannot be given by any produce any longer. Yeah, that's the whole idea.
PI:… How do you ensure that your food waste is reduced? Do you have food waste? What percentage of food waste do you see on your farm after harvesting or during harvesting and at storage and how do you plan to reduce it?
FR: Yeah… Before! Before that, before we started, you know EU put a on ban … our export produced, in 2015-2017 and that really reform us in a new way of doing our business, so since then because of … what our regulator. PPRSD taught us, by selling traps and then doing good agricultural practices and then doing our spraying very well. In fact, the amount of spoilage on the field is not so…it is minimal.
PI: About what percentage?
FR: Let's say about, I can say about 2 to 3%. Yeah! Yeah! It's very minimal as compared to … this thing so, when you pick the produce even from the field you bring it to the packhouse you see that we don't really take off to get a lot of reject from this thing.
PI: Is there any other … Do you think there should be any other measurement or policies to help you more to reduce more of your waste?
FR: Oh yeah! If if there's … a way that … somebody can or an organization can come on board to I mean give us any briefing in regard to that, I think that that …
PI: Do you think they can … can you tell me maybe what you think it should or can be suggested? Can you suggest anyway that you might need help that can help you to reduce waste?
FR: Maybe if technology… can be implemented on the field… In a way of a… yes there are some of the things that we think…Yes, you may not be able to see… On every plant, definitely what you plant it... when you plant something today though you plant every like you plant about 1000 (thousand) plant … of chilly pepper of whatever it is. Automatically, 1 (one) or 2 (two) or 3 (three) will start fruiting earlier than… Do you understand?
PI: Yeah!
FR: So, when you don't observe that very well, you will see that those ones will go waste. Do you understand?
PI: Yeah!
FR: So if there's any technology that can be implemented on the field in a way that…when it happens that way, you will get to know on time then that helps you to I mean…
PI: Do you…Do you… Do you think your activities or your supply chain is efficient enough? Do you follow any approach that is making you more efficient in your work?
FR: Yeah! Yeah! Supply chain Yes!. That is for now, that is what we are doing is what we know.
PI: Do you think it is very efficient enough?

FR: …Not! Not too efficient, yes but … to the best of my knowledge, what we are doing is what we are limited to. So, if there's any… briefing elsewhere that can … expand what we are doing I think we are…

PI: What measure do you follow to ensure that consumers know what they are consuming and how they are being produced? Do you follow to ensure that your food… your vegetables are traceable?

FR: Yeah…Measures that we do follow for the consumers to do that they are safe in terms of what they are consuming is… a lot of training have been done… to the farmers and then we those who export also … For instance, APC has been training us in so many ways how we can handle those kinds of produce from the farmers and then farmers need to understand what they are doing and the kind of chemicals that are harmful and those that are not harmful. The same way for us to understand … what will not harm the consumers, that is how come we normally use more of trapping to trap the insects troup into the farm and all those things. So, there are certain chemicals that… or maybe baits can be sprayed on the crop that would not cause any harm to the customers, So in our own way, tracing to that way helps us to know very well that the consumer is very safe in terms of what he/she consumes. Yeah!

PI: …Apart from the Farm code, do you use any other information on the product for farmers to know that they are consuming?

FR: Apart from the Farm code, what happen is … the Farm code helps you to trace to the farm what we have been doing because, whatever we have information that is sent to…PPRSD, our regulators knowing because they always visit the field to check what you are doing and all those things and then making sure that you are doing the right thing on it. That is how come they can give a code and even not just giving you the code…they will have to pick some of your produce to incubate it to the lab to check at the lab after it, then they will give you when you pass the lab, they they will give you when you … a sheet like this indicating what you have done on the field. Based on it, you should continue using doing the same thing on the field. After that, when you harvest the produce ready for export, doing your packaging at the packhouse ready for export, you take it to the… airport during…inspection is being done, you make sure that what you are sending… there's no problem with it and… the produce is very safe. So, this is how we do it.

PI: Do you think … there should be other measures or approaches which should be implemented to ensure that… there can be more…there can be more transparent and also your food can be more traceable?

FR: Yeah… what I think is … Yes! We are in a global would and then … whatever can just come out help for us to do what we can be doing to do the right things or whatever it is, we embrace it. Yes … we do not know a lot of things that will happen just like that… but I think … we will only have to embrace any form of or anything that will help the industry to grow and then the consumers see that yes! they are safe with their life.

PI: Two or more questions and we are done. Thank you!... Are you working with any institution… that is helping you to be more sustainable? Are you working with an agency… that is helping you to be more sustainable in terms of your produce? Your fresh produce, apart from PPRSD are you working with any agency that is making more…

FR: Yeah! …that is what I mentioned earlier… we have been having some few training with ACP … yeah Coleacp …so this are the the people who train you also and I mean give us a lot of awareness of how we can train the farmers and all those kind of things goes on which the farmers and then ourselves knowing understanding what we are to do…

PI: Okay, do you follow any regulations… Is there any regulation you must follow in order to produce and export to the UK?

FR: Yes, there are regulations.

PI: Can you tell me those regulation? Do you have any? Can you share come of them?

FR: Yes! I think I said something earlier mainly when you … the first thing that you have to tackle is how you can keep good agricultural practices on the field. Then after it you then look at your pest management, low you can manage your pest. Managing the pest… is what I said earlier … by what we currently known for now to do more of trapping on the field… So that, and then… Certain chemicals that are not harmful like … we have been using Neem oil so much which is we do spray on the field and this Neem oil is nor harmful. We can spray it today and then harvest it the same day…it's not harmful. So, all those things, are what is helping us to understand actually what we are doing and then think we are doing the right thing. Yeah!
PI: What measures lastly, what measures … to ensure that you are following sustainable practices…. Do you think there should be measure that should be implemented to ensure that producers are following sustainable practices in the fresh produce or fresh supply?
FR: I don't understand. What measures? Because…
PI: Do you think there can, there should be other way you can you can be helped so that you will be more sustainable in your work?...
FR: Yeah! I mean like we are saying… we embrace anything that… will help … for us to be in business to be sustainable in the sector.

Appendix 2: Transcript – Small Producers Focus Group Discussion (FGD-SSP)

PI: How has COVID affected your work? How has COVID affected your affected your supply chain and… if you can all share how COVID has affected your work, the supply chain of vegetables to the U?
FR: So the COVID has really affected our business from the farm gate to the warehouse and also Airport. First of all, because of the COVID, some farmers who take …public transport before they go to their farm. During COVID, there was a lockdown in Ghana so they were not able to travel to their various farms to work on their farms. And also, in our warehouses, the labourers that we are working with, some of them are coming from other places and they also use public transport to the workplace and during the lockdown's time, they were not able to come to job. And also, there was a lockdown at the airport, passenger flight is not coming in, none is going so we were only having only one cargo flight, when it comes once a week. And this cargo flight, when it comes, if IAB finds in having produce like 5tonnes, they only took at 1.5tonnes. Because of that, we've lost our produce from the farm and even in the warehouse as well. Even if we have the produce, there's no flight so we … not able to export what we are supposed to do. So due to all that, our revenue has come down, let's say it has come down to 60%. So…. This is the way the COVID has affected our export.

PI: Mr. SR, do you have something to add or I should go to the next question?
SR: …Yeah, so like Mr. FR just said, prior to the COVID, a lot the outgrowers and some of the farmers had to produce on their farms but because of the lockdown some of them had to abandon their farms and even some of the exporters. So, due to that insecurity as to whether there will be market or not which we weren't sure most of the farms were abandoned and some of the produce had to go rotten, some had to discharge theirs off even abandon their families not to go there again. So, those things have affected the outgrowers, exporters and the export industry as a whole. So, I think that's what to add up.
PI: …Okay that's very terrifying. THR, would you like to add something?... THR, you are muted.
PI:…my second question is … What approaches are you adopting … to ensure that you continue the supply chain? I understand that the COVID has created a lot of waste … created a lot of … lost revenue but what approach have you now adopted to ensure that you continue with the supply chain?
FR: Okay… After the lockdown, the airport was opening, so the farmers, most of the farmers had lost their capital so though they've lifted the ban at the airport but most of the farmers do have the money to go back to their production, so the few farmers that maybe we the exporters can support through … donors. You know we have some donors in the country which we work with some of them. So, after the COVID, they asked us what are the challenges and then we tell them. So they give us something small, some small input to help the farmers to come to work. So, we just… some people who are back on the field cultivating the vegetables. But I can say most of them…those who did not get the support are still there, they are not producing because they don't have lost their capital.
PI: Mr. SR, do you have any other approach that you take to enhance or to continue the supply chain whiles in the lockdown or … after the lockdown?
SR: Yeah…just after the lockdown, we had to go into sensitise the farmers and we had to motivate: a lot of motivation was done through investing into them. Like Mr. FR said "giving them a lot of input and some of the exporters also started their own farm as to be very sure if we can continue without any other lockdown. So that one also helped a lot, yeah.
FR: So Mr. SR, can I know where you work or you speak from?

PI: He cannot disclose that on this meeting because of confidentiality.
SR: So I will see you later.
FR: No, but… I will not agree with this; I have to know him...
PI: That is… that is the purpose of this meeting … you know he also, so at the end of the day, it's for this purpose so afterwards and you guys want to contact…THR from PPRSD to know yourselves, that's also fine. But it's unacceptable, Mr. FR.
FR: Okay! No problem … go ahead, okay.
PI: …THR, are you here? I can't hear you, we can't hear you. I'm sure all of us. Okay, now my next question is … do you think there are environmental effects? We've talked about the COVID, what about the environmental effects? Are you concerned about …what kind of ways, pollution…? Are there any environmental effects your activity is having?
FR: … like you know... based on that we've developed small protocols that we follow ourselves… You know we have to get the workers protected
In the warehouse, we have to get their face mask and then … most of them we have to get them like two uniforms… you know same as how we help the few farmers to come back to business is the same thing we do with worker… In the warehouse.
PI: … oh okay Mr. SP, have you identified any environmental effects or impact your activities have or made or generation… and how do you handle them?
SR: …Actually I think … Our production is rather being affected and not having impact on the environment because you know the climate change now is something else we couldn't even follow as to know this is the dry season, this is the rainy season. But when the dry season sets in, you know you have to spend more in terms of fumigating and other stuff. And during the dry season, too a lot of pest infestations also happens which you need to spend very much on pest control and other protocols that you need to follow. So, combining all this loses during the COVID, after the COVID and working together to ensure you get a pest free, the sun also destroying crops during this time which you need to do a lot of irrigation all those things have affected the production which we are not getting the maximum yield that we should get as previous time.
PI: Oh okay… So you don't… you use organic? Do you use organic farming? Or Do you do land rotation? Or do you actually pollute the environment because of some machine you use?
SR: Yeah! We do land rotation; we do crop rotation also but also use pumping machine so definitely. But…is like I say the smoke of the pumping machine affect the environment though. We also do spraying …pesticide application … so …
PI: Oh okay. Do you have any measures to do that? Do you put in any measures so that you can reduce such effects? Or are there any measures we can do to reduce such effect?
SR: With some of these things we have the protocol for pest control which we minimise the pesticide. So we have traps that we use to control the insects on the field so that one minimises the use of insecticide on the field.
PI: Oh Okay.
SR: Then with the irrigating too, even though there are new inventions that are coming like the solar that you connect it on the field that will give you a uniform irrigation on your field, we also have some pumping machines that… In terms of the fuse, it's not that high.
PI: Oh okay! That's very good. Thank you … Mr. FR can I please ask you that does your organization work with any institution, agency to ensure that your production, your supply chain is very sustainable? Are you working with any agency, company helping you that you will be sustainable either environmentally, socially … economically?
FR: Yes! We are working with PPRSD.
PI: Ohhhhh okay! Oh okay! THR, this is where I ask you; can you unmute? How does your office … help the farmers? …. Mr. SR, is there anyway the organizations, what actually do the organization do to help…farmers to ensure that their exercises or activities are sustainable?

SR: Okay… an organization like PPRSD do monitoring and evaluations on our fields. Before we do planting, they come to inspect first where we are going to plant wherever is conducive, whether you have a water source and they also, in fact, they implement the protocol, so they follow up and monitor whatever we are doing on the field to make sure we are out with the right thing and how it is supposed to be done. So before you can even export, they have to certify your crop so you send your field to their lab, test it and when it is free from pest, then you are free to go. So they have offices visit the field, every exporter's field. They come for inspection make sure you have the right produce; you follow the right protocol or you are doing the right farming practices. When they come and everything is okay, and they will now certify your crop to be harvested in their lab. When you go to the lab, they test and see if it's free from pest or if it is the quality is free for export. When they find out that you are good to go, then they then certify you. So this is how they also help in making sure we give out quality.

PI: Mr. FR, do you agree with that or you have something to add?

FR: Yes....I have something to add. So with all these, when you get to the export too, they inspect the things back and make sure whatever you are sending is up to the standard.

PI: Oh okay, that's good! Thank you for that. So apart from PPRSD, is there any other company which are helping you in any way? May be financially, economically, socially, are there any other companies?

FR: Yeah! As I mentioned, I work with some groups.

PI: Yeah! Is EPA helping you? Is GPA also helping you?

FR: GPA? No! No! No! I don't! I don't work; they don't help me with anything.

PI: Oh Okay!

FR: But recently... I'm doing a project with "GICAIF" which is called Priamba Project. They also support the farmers with irrigation and inputs. And also, they also... help us to get us... some equipment in the warehouse. And we also have partnership with Hortifresh as well. Yeah! Can you hear me?

PI: I can hear you very much Mr. FR. Thank you so much for your input. I want to mention that... Carbon Emission is very significant in your supply chain because...Food which are supported from Ghana...To the UK by...Air freight creates Significant amount of emissions... Can I please ask, have you identified any other means that you see that... Carbon emissions I created within your supply chain? Either your vegetable production or storage or the transportation to the airport ... What vehicle do you use? Or the refrigerators you use, do you think it generates certain amount of emissions?

FR: Yes, we use refrigerator, ...car from the warehouse to the airport.

PI: Oh Okay! Mr. SP, do you have something to add?

SR: ...It, I don't know if it's fortunate or unfortunate but normally, our produce that we send it's, we harvest a day and leave it the same day so we don't normally pre-store them here if we send them and exempt other vegetables.

PI: Oh okay

SR:...So the only thing we can talk about is our vehicle which they use the oil, diesel and petrol so definitely on our way...

PI: Are the vehicles in a very good conditions?

SR: Oh yes! Yeah.

PI: Oh okay, Mr. SR what about you? Are the vehicles the smoky types or they are in a very good conditions?

SR: The vehicles are in very good conditions

PI: Mr. FR what about you? Are your vehicles in good conditions or the smoky type?

FR: Yes, my vehicle that I'm using is in good condition but if you are able to help us to get a new vehicle, I will like it.

PI: Thank you so much ... So are you thinking about ... Do you think there's any other way we can reduce the emissions?... that is produced for your activity? I'm sure you use

machines; you use certain machines. Do you think we need to look at something like precision farming or a highly standard... technological equipment that help us reduce the emissions within the production section?
FR: When you say mission, what is mission?
PI: Come again
FR: Please when you say mission, what is a mission?
PI: Emission like carbon emission let me put it
SR: ....Okay, let me come in ... Pertaining to, pertaining to.... emissions we are looking at right now, the only source of our emissions our pumping machines and with that one like I was saying, there are new inventions that are coming in like using the solar. So is a way; is another form of irrigation whereby you connect it a solar machine that you get your source of power from the solar so it run through unto the farm or we also have the green net and the green house production that you can use the green irrigation. That one is just by getting a poly tank behind your greenhouse then it flows by gravity so these are also new forms by which you can adopt to reduce the emissions by using the pumping machine.
PI: Oh okay! Mr. FR, I was asking that, do your production of vegetable, do you generate any pollution? That is what I'm referring to as emissions.
FR: Oh okay! Okay!
PI:...Have you thought of any way to reduce the pollution that is generated please?
FR: ....Yes! That is what my brother just said ... that's what we are also planning to do but by doing the solar... Irrigation, what he just mentioned, it is very expensive so most of us are not doing that. What we use is the pump machine.
PI: Oh good! I like that point, that the solar is very expensive so we hope to... Thank you for making that comment. Again, is there any regulation that you follow, you export ... the vegetables to the UK? Do you have to comply with any regulation before you... ship all your vegetable to the UK?
FR: Yes! Yes!
PI: Can you express it?
FR: Yes...before you become an exporter... as I mentioned, we have an institution called PPRSD Ghana. So before we export for ... when you go to them, they will tell you to register their company from there, you also have to register with GIPA. And then, they also like to know your farm, they visit your farm, and then from your farm, you know we have protocol developed by PPRSD, you have to follow that protocol for your production. And also from there, they also ensure that you have a pack house; a standard pack house it's not just a place pack house but they will come and check if everything is fine. And also they will check the vehicles the you will be using to carry the things, transporting the things from the warehouse to the airport so when they check and all these things are working before they will give you the green light to export. And also, your produce from the farm, they will pick samples to the lab and test and if your produce is okay, they will issue a certificate based on that you can use, there's a code on it. You send that certificate you use the code on all your produce and send the certificate to the airport before you will be allowed to export. That is how our system works if you want to be an export here in Ghana if you want to be an exporter.
PI: Oh okay, thank you! Mr. SR, would you want to add something to that?
SR: Oh okay, it seems he has said it all but one thing too is that the EU also have their regulation that the PPRSD is also depending on. So, everything that Mr. FR said is being extracted from the EU regulations so that we meet their demands. So, if it happens that we do not meet the demands from the EU regulations so that we meet their demands. So, if it happens that we do not meet the demands from the EU, it means that our produce can't go. This came in because of the ban so now, there are vegetables that are being restricted there that before they can get to their market, it has to meet all their regulation that they've given us. Alright, thank you!

PI: Can I please ask; can we do or what do you think can be done so that it can help you supply or export more vegetables to the UK?
FR: Are you asking me?
PI: Yes! Mr. FR.
FR: Okay so what can be done to export more vegetables to the UK, that is it... you know as we were banned. Now, before you produce a vegetable for exportation, you need to do a lot of things. You know you need to buy traps, you have to get a correct seeds and then I think it's... all is they have to support, we need inputs like seeds, traps, fertilisers, the approved chemicals that we use on the field and all that. This is what if we get all these things, I think it will make ... it will expand our company so that we will be able to export more vegetables to the UK market.
PI: Oh okay, great! Mr. SR, would you want to add something?
SR: Yes! So it's like all the regulations, the bodies have to work hand-in-hand
to help the exporter or the farmer and also, we have to also adopt the new technologies that are coming in using of these certified seeds, mechanising our fields, you know when the labourer, when the work becomes easier, it helps you to produce more and it becomes too difficult too, your production can't be maximised so when we try to put in some of these things, it can help to produce more; just that they are expensive.
PI:...oh okay... can I please ask that, Mr. FR, can I please ask? Are you paid fairly or are you paying your workers fairly? Your farmers, are you paying your farmers fairly? Or are you also being paid fairly?
FR: Yeah! For me, I have been paid fairly and also, I pay the farmers fairly... I pay them in two weeks' basis when we take the produce, within two weeks, you have to give your money.
PI: Oh okay! What about you Mr. SR?
SR: Yeah! It is fair because, the farmers give the price. The prices come from them.
PI: Thank you! Thank you!
SR: Price comes from the farmers so ...
PI: So the price comes from the farmers not you. Mr. FR, do you agree? Does the price come from the farmer, Mr. FR?
FR: You know the whole issue is; price can never come from a farmer. Because, we are exporting the produce so per what we are selling over there is what will also measure to buy the produce from the farmers. And in Ghana, it looks like we have a fixed price with our farmers.
PI: Oh okay
FR: Since I started export, over 10 years now, I can say we have a fixed price with the farmers because, in UK, they don't normally increase their   things or reducing it like that.
PI: Oh okay
FR: Yes
PI: THR, do you have idea about that? Our farmers....
FR: Please can I land and then...?
PI: Oh sorry! Sorry! I thought you've landed Mr. FR.
FR: So I can say when you take a produce like Turia, since we started, we buy Turia for 10 Ghana cedis in the dry season and in rainy season, we buy it for 8 Ghana cedis. It's like if it is scarce, it is not there. So, since as I started export till now, it's the same price we are still buying. It does not go up it does not come down.
PI: Oh Okay
FR: Yes! Yes! And the farmers are okay with that and even in produce, we actually know the production cost. So it is not like if we are buying 10gh from the farmers or 8gh from the farmers, they will lose the money. No, they will not lose the money...
PI: Mr. SR, can I get this from you again? Thank you! Mr. SR, do   you know the production cost? How do you also think you pay fairly? But you said...for you, it is the

farmers that determine the price. But you shared it different view with Mr. FR. Can you express with yours? Mr. SR...
SR: Yeah! Hello! Can you hear me?
PI: Yeah, we can hear you.
SR: So… every exporter has his/her outgrowers or farmers he works with. It isn't like you just go to the wild and pick from there. So it's the negotiation between you and your farmer or you and your outgrowers. So when I sponsor you, this is the agreement; this is what I'm going to invest in your farm when your produce come, how much you agree to pay. I don't know if you are getting me?
PI: I got your point. Thank you very much. ...THR, do you, do you agree with them? ... or do you have different view with what Mr. SR and Mr. FR have said? THR, you are still muted.
THR: Yeah, I have unmuted now.
PI: Yes! Do you have any idea...?
THR: I went off shortly so... But …from what I've heard, ... will agree with SR in the sense that, as he said, "Every exporter has his/her outgrowers". So, it is based on the kind of... the agreement you have with the outgrower. From what I know, some exporters provide support to their outgrowers during the season. So, and then at the end of the day, the agreement is that; at the end of every season, he is going to sell to him at a certain price. Some also may not provide support but then would enlist the person outgrow will produce for him so at the season, he comes, he buys. So, it's based on the exporter actually. So between the exporter and the farmer.
PI: Oh okay, I think from, thank you so much. From what Mr. FR said is a very solid point because, he seems to have worked with the farmers for long years and knows the input and then has some level of understanding with them over the years. But all the we want to know is that if the farmers are paid very well? Are there any regulations or government policy or framework that or any organization that ensure you pay your farmers well? Mr. FR, is there any organization, any government check or framework that ensures that you pay your farmers well?
FR: Yeah! You know as a business man, you shouldn't even wait for any organization to come and tell you to pay your farmers well before you do. Because, if you are buying produce from your farmers and you are not giving them, paying them on time or giving them a good price for the produce, I think they cannot make more produce for you enough. So, that is why I said from the beginning that as an exporter, I know the production cost of all the items. So, I always make sure the farmers make profit with whatever I'm paying you. You will be able to make to expand your farm because, I also need produce to export in volume. By the way, currently, I'm doing a Priamba Project... there, they have a business manager whom will be given the money to when we go for the produce from the farmers, the money has been paid to the Business Manager and then he pays the farmers. So I can say that fix that person there to make sure that whatever produce they come and pick it is paid.
PI: Mr. SR, do you? Have you found any organization... any sector and government policy that ensures that you pay government fairly?
FR: Pay any government?
PI: Yes! sorry pay your farmers, Mr. SR. I want the view from Mr. SR.
SR: Oh okay! Actually, with the private sector, the government has no much policies in terms of that. But like you are saying, it all depends on the farmer and the exporter and even the farmers themselves will even guide you to pay them well. Because, if you don't pay him well, the next time you come, you cannot get the produce early for export and here lies the case you have your demand if you came to the farmer, he will just promise you and he will come and tell you that there's no good. It means they are not happy with how you

are going about with things. So, they themselves will even check you to pay them well from their actions.
PI: Mr. FR, do you agree with that? Has it been something that has come up to your attention?
SR: He has muted himself.
PI: Yes, I'm trying to unmute but... okay, thank you for that.
FR: Sorry, sorry. hello?
PI: Can we, can we, how can we ensure that farmers are paid well? How can we, How can we all of us; Government, to the farmers. How can we ensure that farmers are paid well?
FR: You know what, you know Ghana is very big and that is going to be a big problem, a big challenge to everybody in the country if we say government should make sure farmers are paid well. What we do is; you know, I'm an exporter and I know that without a farmer, I will not be able to get a produce to export and I always need produce from the farmers. So, when I go and buy produce from the farmers and I'm not able to pay them well, they also will not be happy with the work and even if I don't pay them well as I mentioned, they will not get money to produce for me back. As .... Mr. SR also mentioned, if you are not paying them well, they will call different exporter because I'm not the only exporter they know. They know a lot of exporters. So, what I'm paying to them if it is not good, they will divert the produce and give it to another person. When I go to the farm, I will not get the produce to export. So, I can say, the farmers, they themselves always will make sure that they are paid. That is, it.
PI: THR, thank you so much! Mr. FR. THR, can you elaborate on that? Do you think there can be a way out to help farmers ... by paying them fairly? How do you ensure that we pay farmers fairly?
THR: ...this is a dicey issue. I think for Ghana, some roots and some produce ... and I believe you are aware of fair trade?
PI: Yes
THR: That is what we don't have in the vegetable sector. So, if it is possible to have something like this. But then it's going to take time and then a lot of resources, research need to be done to be able to come out with a clear-cut criteria or whatever we have. So, that might take a while but it is possible I'm sure it's possible but it might take a while.
PI: Okay! Mr. SR, would you want to add something?
SR: Hello, yeah! I agree with THR with what she said.
PI: Apart from that is a very ... splendid input and suggestions from Mr, FR, THR and SR... Apart from the income... what other benefits do your work provide to these farmers? Any other benefit you are providing for the farmers apart from the money paid? Do you give them any support?
SR: For instance, our farmers, we engage them in a lot of capacity building. Some of them are ...with other organizations. This kind of certifications can even help you. We also give them a lot of education on farming and other stuff.
PI: Mr. FR
FR: Yes, sir
PI: Would you want to say something on that? Apart from the money paid for? Do you give any other support?
FR: Yes, we give support, we normally give them input and we give them training which they don't pay for that. We give them free training which they don't pay for that we give some of the seed, traps that we set from the farm and all that and you can be there.... (the network got interrupted)
PI: Mr. FR, your mic is a .... muted and again your sound was lagging so if you can unmute yourself and come back... But I will move on with the next question. Which is... THR, have you seen measures, have you seen measures that have been put in place that ensures

that consumers know what they are consuming from the exporters or from the farmers? And how are the processes?

SR: Please come again? The network was lagging.

PI: Yes ... is there any measures that you have seen? Are there any measures that you have put in place to ensure that consumers know what they are consuming and how is it process shown? And how the food they are consuming is produced? Is there any measure that consumers know? Is there a signal any information consumers know in the UK that whatever they are consuming is from is from farm or this farmer?

SR: Yes ...yes, there's a regulation that went on initially. It was regulated by PPRSD whereby the exporters send data to PPRSD. They collate it from the start of the produce to the end of the produce.

PI: Oh okay

FR: Hello?

PI: Hello! Mr. FR, welcome

FR: Thank you Sir, sorry.

PI: Alright! THR, is there any process that consumers know what they are consuming from these farmers?

THR: Hello?

PI: Yes! We can hear you.

THR: Yeah so currently, we are ... running something we are to call ... our GH Trace. It's something we are piloting so it's more or less the traceability system... where at the end of the day, when the produce gets to the UK and then the person or the consumer is able to...take the code that is given and then enter it into the system, the consumer will then have access to all details that took place during production so it's something that we are working on.

PI: What is the name for the, what is the name please?

THR: ... is a whole system, what we call GH trace

PI: Oh okay! GH Trace. So this is done by PPRSD right? Not the farmers or the exporters.

THR: Well, it's a whole system and the system is such that input, the input will be done from the farm. So let say ... at the beginning of production the farmer, the exporter, it will start with the exporter and list its farmers his/her outgrower. And them, we will then go in and do the necessary checks and then follow the production till it's harvested where we have to do with take our samples and go through our lab tests and everything. And then, the produce when it gets to the airport. Also go through our certification and finally if it's passed, its exported. So, it's a traceability system that we are putting in place.

PI: Oh okay! Mr. FR, are you aware of this? Is anybody contributing to this?

FR: No please, I'm not aware of this.

PI: (Adwoa), sorry THR, is the company, any farmer, exporter having their part working with this process? This system?

THR: Not yet, we did run some... we did, we piloted with just a few companies. Yes, and this year, we are going to train exporters on how to use it. We just had a training on...with some of even our staff, just last year. So, the COVID also dragged us a bit because of restrictions. So, this year, we are going to train exporters on how to use the system so that we can all start using. It is a gradual process. We are trying to start it gradually and see how it goes but the system not ready for use. That, I can say!

PI: Thank you! Mr. FR, how are your food or your vegetables you produce? How are they being traceable and transparent to the consumer?

FR: So as I mentioned, we have a protocol developed by PPRSD and I believe when you follow the protocol to for your production, everything is okay. Because whatever you've mentioned in the protocol, that is what we use for our production so we always make sure that whatever we produce, it is good for the consumers.

PI: Oh, thank you so much... Mr. SR, do you have something to add on traceability and transparency of your production?
SR: ...you know, even the goods produce that gets to the UK, I think they do this MRL test over there. So, it even makes we the exporters conscious of what we are using in terms of the chemical application. Then, we have this agency, that is the Ghana Standard Authority. With with some of the agencies that come around, sometimes they do ask you or if you want to renew FDA certificate, they check and see whether you’ve done MRL test on your produce before they can certify you again. So as time goes on, we do this kind of test or we do this kind of certification which we have to this test before the certificate will be renewed for us. So, all this activity makes us conscious of whatever we do for the input we use on the field so that when we get to the market in the UK, we might not have problems over there in terms of chemical...residues.
PI: Oh okay... thank you so much. Now, this brings us to my last three (3) questions and then that will be all. Do you think ... what measures, what do you think should be the measures or approaches that should be implemented to ensure that your supply of vegetables to the UK are more sustainable or what should be done?... Mr. SR first, how do you we ensure that we continue to be more sustainable or what should be done…earlier, you did mention about... some technologies what are other things can be done that you think you can do or produce or contribute to the supply chain in a more sustainable way?
SR: Okay…I think when we talk of sustainability, the government also have to come in to help the exporters and the farmers. The input that we use most of them are expensive and if the government even subsidise the input for us, it will motivate the farmers because when they look at the cost involved, and the stress they are going to go through the produce, to come out with the produce, it sometimes discourages some of them. But when the government should also come in with policies that can help or to protect we the exporter and the farmers, we realise that most of them will be motivated and even grow more for export. Looking at the rate at the airport, the taxes and all stuff, it the government should come in, it will minimise some of these cost for the exporters and also the farmers to realise help us sustain our production.
PI: Oh okay, Mr. FR, do you want to add something?
FR: ...as he mentioned, our freight cost is also high. So sometimes, it affects our exports industry like; getting more orders to export in volumes let’s say from Dominica Republic to the UK. Sometimes, they charge 1 Dollar 10 cent and from Ghana to the UK, they are charging 2 Dollars, some charging 2.50 Dollars meanwhile from there to the UK is the same hour to the UK. So because of that, sometimes let’s say when you take to Turia, to Turia, is coming from Dominica Republic to the UK because of our freight is expensive, they reduce our order and give more order to the Dominica exporters. So, if the government can also take a look at that to. I don’t know what that they can do but if they can do something to reduce the freight cost, it will help us a lot as exporters.
PI: THR, would you want to add something to that?
THR: Okay, I think this is something their association should take up. This is why they have their associations and they can then...hold ...this is... something that we PPRSD cannot help with so I think they should have some sort of deliberation with... people in the higher level. They can help...
PI: Oh okay, I want to go back to this question and then: Mr. FR, do you use Farm code? It’s part of the traceability I have mentioned. Do you use Farm code?
FR: We have Farm code and all our outgrowers are having it
PI: Oh okay, what about Mr. SR? Do you use the Farm code?
SR: We have them
PI: Oh okay, okay! ... I want to...
THR: Can I say something?
PI: Yes!

THR: ....So when I was referring to the traceability, what the, the code that they have now, that is you know it's done manually. So, it's this whole system that we are speaking to ... we are trying to make the computerised system out of ... these are the old system that we are changing into a computerised system.
PI: Oh okay
THR: So, this is something we are already doing but then like you are saying, for the consumers to also have ... some Farm code for their produce they are consuming. That is why we are also having this, trying to put the computerised system so that when consumer is able to the long run maybe have the QR code, he scans it and he's able to have all the data access all the data, information that he needs.
PI: Ohhhh good!... I have to go back to this question... that's the last question I beg your pardon for this discussion. …I know that ... flying ... your produce to the UK cause a lot of emissions. Yeah, is anyone or have you met? Are you thinking of... are you thinking of finding alternative means of... supplying to the UK either by processing your vegetables? Are you finding alternative means to air transport or shipping? I think you do air transport? Do you want to find alternative means to that? Are you thinking of processing your produce?
SR: .... currently the vegetables we export ... developing them into processing or processing them in a way will be a bit difficult except the chilly. Which is now a bit difficult to export the chili paste of it. But the other ones like Turia, Ravayah, Marrow; those ones too have to go as it is. As you harvested, that's how it has to go. You can't process it in anyway except the chili. And even with the chili, we export the green not the red. So with that one, I think unless some of the exporters are thinking of doing something else apart from the fresh vegetables.
PI: Mr. FR, when you use air freight, it causes a lot of emissions. Are you thinking of any other alternative of supply to the world or to the UK?
FR: …to add up mine, I think Mr. SR just said something. You know, exporting the chili is not a problem at all. So there's no way. …the people over there, they need the green chili not the powdered one. So I don't think there's a way of processing the chili. Because, the chili when you freeze it and send it to them, they don't like it that way. They like it fresh. So, as I mentioned, if we get the input, like you know in this country, we can say now FCL, how do we call it, the FCL is disturbing us a lot. If we get the greenhouse and we produce the chili the greenhouse, it will go. So, if we get support to do all these things, exporting chili will be very easy in this country; it wouldn't be any problem. For me, I'm not looking at… any other country now. Because…I'm getting a lot of demands from the UK which I cannot even fulfil it. So, unless I finish with them before I can look other places to ship to.
PI: Oh okay, thank you so much… Of all the things we've said, what do you think is a very important issue that you would want to stress on? Or are there any other important things you would want to stress on THR?
THR: Okay, thank you… I think you've said it all and I don't know during the time I was off; I don't know the kind of questions so I can't really say much on that. But I think in the nutshell, I've said much, if there's any other thing you think I need to answer.
PI: Mr. FR, is there any important thing about your supply chain or your production or something we discussed that you would want us to stress on?
FR: So, as I said about the freight, the freight is very important. It's affecting our business in Ghana a lot. And also, we are not getting the cargo flight which can pick our things from here direct to the UK. We are working with the passenger flight. As we are discussing now, what I loaded yesterday is still at the airport and they said they are going to send it today and I don't even know what will happen today. So we don't have flights; direct flights, a cargo flight which is moving from here to the UK. Meanwhile, I can say…
PI: You don't use British Airways?

FR: British Airways is a passenger flight. If they get more luggage and they get more passengers, they do drop our cargos.
PI: Does it happen the same way with you Mr. SR?...Mr. FR, continue please.
FR: So, we are having a challenge. Our main challenge as exporters in Ghana, our challenge is flight. And secondly, how they handle our things at the airport too is not good. The laborers at the airport are not trained on how to handle vegetables. Sometimes, when they offload the things from your car and they pack it on the container or on the palette, they force some of the boxes and they break the produce. Before your things gets there, your client will call you 10 boxes,15 boxes damped. So, these are the physical challenge we are having especially the flight. We don't have flights; we need cargo flight which can take out things from here directly to the UK. Which because, I can say almost all of our produce come to the UK, just a few we are shipping to other countries so we will need a flight and also we will need input for expansion like we need seeds, chemicals, some small financial support to identify outgrowers who are doing very well to expand their farm so that we can also export volumes from Ghana. But all I'm saying is, without flight, you cannot export. So we need a cargo flight which will be there for we the exporters at least if it is going 3 times in a week, we will like it. Our main challenge in the export industry in Ghana now is the flight. Because, this… passenger flight which is coming to Ghana, its handled by private people so they are charging us what they like but if there's a flight organised by the government, I think they will not charge us like that and they will also, we will get more space for whatever volumes you have can be exported. These are the areas…
PI: Can I ask a further question on that? Yes! Like, does the way they handle the things, does it create a kind of waste or waste or damage to some of the vegetables?
FR: Yes! As I said, some loaders at the airport are not trained. The loaders, those who offload the things and load it on the palette are not trained. Sometimes, they damage our produce. When they are loading it in the container or the palette in Ghana here at our Airport. And also, we are not getting space to export our produce. We have a company here in Ghana called Blue skies. Let's assume today, if the flight has, maybe, only 20tonnes, Blue Skies alone can load like maybe 18tonnes. So, it will be left with 2tonnes to space. If they have 20tonnes, Blue Skies alone maybe can take 10tonnes and it will be left with 10tonnes. And I don't think …British Airways can take more that 15-16tonnes of their highest, what they normally take I think… 18-20tonnes something like that. So, we need a cargo flight if it's a cargo flight, whatever volume you have can be exported, that's fine.
PI: Oh okay, Mr. SR, would you want to add something? I'm sure he is muted and he is…
SR: Yeah!
PI: Finally, would you want to add something to … what's the most important issue you would want to stress on?
SR: I think…Mr. FR has said it all. And also, our major concern how is the sustainability of our work or the industry which has to start from the field right to the destination. So, if from our field everything is going to go on well, right to the airport which is said most of produce are even mishandled there before they get to their destination. If we are going to work towards all this with some government agencies coming in, you would realise that we can sustain our industry or the export business and the supply chain will always be effective. So, it's something that we the farmers and agencies and any other stakeholder can work hand-in we need to ensure. Because, if you are good to them, revenue we get there, the government also get part or its share so as we are also growing, the country also keeps growing. I think the sustainability … is very very important…
PI: Okay, thank you! On the field, what is going on there, that is not appropriate that is not sustainable sorry? On the field, what do you think should be done …that will make your work more sustainable on the field?

SR: One important thing is the input. The inputs are, mostly expensive. They are very very expensive and you know mostly, some of the certified insecticide we buy are very expensive and sometimes, we have to adjust ourselves because of the weather conditions to it. So if you go and import the seed which is very very expensive and later on after production maybe the weather isn't that good, for it and you are not getting the yield, you will realise that you have run at a loss and with this seeds, you have to get fertiliser, pesticide and all of those stuff. So if there are agencies like the government agencies that can even subsidise some of the prices of the fertilisers which they do, but it's not all that effective, the chemicals they use some of the traps. You know the traps sometimes will minimise the use of pesticide but the trap is very expensive and even we don't have that available so you have to struggle, the little that you get, you but it at a very price high cost. So on the field, all this thing goes on there. You produce and you do not get your yield that you want. Before, you even get it to the airport, there's no flight, or your load is even left behind and they will tell you it's going to go the next day before you realise, it left behind again. All these are issues that are bothering we the exporters and even the farmers as well. So, if the field is good to go and at least we are able to make maximum and even able to maximise profit on the field before even…it will help us.
PI: Okay… Thank you so much for your participation.

Appendix 3: Interview Schedule Protocol

SECTION 1: Opening and Introduction

I. (**Establish Rapport**) [Greetings/Shake hands] My name is Emmanuel Ferguson Aikins. I am a student of Nottingham Trent University and I would like to interview you for a research study.

II. (**Purpose**) I would like to ask you some questions about your roles and experiences in the supply of food specifically fresh fruits and vegetables from Ghana to the UK. This will enable me to learn about the possibilities of identifying sustainability gaps in Ghana's fresh vegetables to the UK. It will also help explore alternative practices of reducing the sustainability impact associated with Ghana's fresh vegetables supply chain to the UK. Furthermore, I will be able to come out with recommendations to enhance sustainable food supply chains for the UK and Ghana.

C. (**Ethical Consideration**) This interview follows ethical practice and all information including recoding and transcript will be handled in confidence and anonymity. If you take part in this research study, the data collected will be kept by authorised persons from the Nottingham Trent University and will not be attributed to you either by name, your position or company.

D. (**Time**) The interview will take up to 40 minutes. Will you please be available to respond to some questions? The interview will cover five topics: environmental, economic, social regulatory dimension of sustainability and sustainable food supply.

E. (**Option**) If you did not agree to recording of the interview, note-taking will be used.

(**Transition**: Before we start this interview, can I ask you to take a couple of minutes to reflect on experience of supplying vegetables to the UK, the challenges, sustainability issues and how to enhance sustainability)

SECTION 2: Environmental Aspects

I. How are you reducing CO_2 emissions from your agricultural practices, storage and transportation?
II. How are available institution supporting you to reduce CO_2 emissions?
III. What other supports do you require to reduce CO_2 emissions?

(Transition to the next topic: ____)

SECTION 3: Economic Aspects

I. Are they any regulation or a policy that ensure that farmers and up growers are paid fairly?
II. Do you have food waste?
III. How do you ensure that your food waste is reduced?
IV. What percentage of food waste do you see on your farm after harvesting or during harvesting and at storage and how do you plan to reduce it?
V. Do you think there should be any other measurement or policies to help you more to reduce your waste?
VI. Can you suggest anyway that you might need help that can help you to reduce waste?
VII. Do you think your activities or your supply chain is efficient enough? Do you follow any approach that is making you more efficient in your work?

(Transition to the next topic:____)

SECTION 4: Social Aspects

I. What measure do you follow to ensure that consumers know what they are consuming and how they are being produced?
II. Apart from the Farm code, do you use any other information on the product for farmers to know that they are consuming?
III. Are other measures or approaches that should be implemented to ensure that there (food supply) can be more transparent and also your food can be more traceable?

(Transition to the next topic: ____)

SECTION 5: Regulatory

I. Is there any regulation you must follow in order to produce and export to the UK?
II. Can you tell me those regulations?

(Transition to the next topic: ____)

SECTION 6: Sustainable food supply

I. Do you think there should be measures that should be implemented to ensure that producers are following sustainable practices in the fresh produce or fresh supply?
II. Do you think there can, there are other ways you can be helped so that you will be more sustainable in your work?

(Transition to the next topic: ____)

(Transition: Well, thank you for your time and it is good insight for me from the information obtained through this interview. Let me briefly summarise the information that I recorded during our interview.)

SECTION 7: Closing

A. (**Summarise**) I started by introducing myself, the purpose of the study and explained the ethical consideration concerning your participation. I later asked you questions about four main topics of my research. environmental, economic, social and regulatory dimension of sustainability. Your responses provided for the questions under each topic was intriguing and very useful.

B. (**Maintain Rapport**) I appreciate the time you took for this interview. I say thank you. If there is anything else you think would be helpful for me to know, please let me know. Thank you again.

C. (**Final Comments)** With these questions well-answered by you, I should have all the information I need. Would it be alright to contact you again if I have any additional questions? Thank you so much. I look forward to meeting you.

Appendix 4: Focus Group Discussion Guide

1) INTRODUCTION

Hello, my name is Emmanuel. Thank you for agreeing to take part in this focus group interview (online). Before we start, I would like to remind everyone that I am looking at opinions about sustainable food and impacts associated with fresh vegetables supply chain from Ghana to the UK.

This focus group is an interactive group discussion where we can obtain several perspectives about a topic and participants can think about and comment on what others have said in the discussion.

In a minute, can we please introduce ourselves – first names only.

[PARTICIPANTS WILL BE BRIEFED ON THE CONSENT FORM AND A COPY OF THE CONSENT FORM IS SIGNED BY THE PARTICIPANTS].

2) **Confidentiality**: **-** Before we begin our discussion, I would like to spend few moments to talk about confidentiality and basic ground rules for our focus group discussion today: a. Everyone's views are welcomed and important.

b. The information which we will collect today will be treated as a group.
c. We will not identify quotes or ideas with *any one person* of this group.
d. We *are* assuming that when we learn about one another's views, they remain confidential.
e. Having said this, and having made these requests, you know that we cannot guarantee that the request will be honoured by everyone in the room.
f. So we are asking you to make only those comments that you would be comfortable making in a public setting; and to hold back making comments that you would not say publicly.
g. If you want to stop being in the focus group you can you can leave or stay and simply stop talking, but it will not be possible for you to pull out your data from the flow of the conversation because of the interconnected nature of the group discussion where one person's comments can stimulate the sharing of comments made by others in the group.
h. Anything heard in the room should stay in the room.
i. All voices are to be heard, so I will step in if too many people are speaking at once or to make sure that everyone has a chance to speak.
j. I may also step in if I feel the conversation is straying off topic.
k. You can expect this discussion group to last about 45minutes
l. We will follow ethical practice and all information including recoding and transcript will be handled in confidence and anonymity. If you take part in this focus group, the data collected will be kept by authorised persons from the Nottingham Trent University. Hard copies of research notes are kept in locked filing cabinets, and the electronic files are kept on password protected computers which are not accessible to any other university staff.

3) USE OF TAPE RECORDER

a. This focus group will be recorded to increase accuracy and to reduce the chance of misinterpreting what anyone says.
b. All tapes and transcripts will be kept by authorised persons from the Nottingham Trent University.
c. Names will be removed from transcripts. We will exercise all possible care to ensure that you and the transcripts are kept anonymous and confidential.
d. I will also ask that when using abbreviations or acronyms, you say the full name at least once to aid transcription.
e. We may also use a "flip chart" to write down key points during the focus group and take notes.

[AT THIS POINT, MATERIALS INCLUDING PENS, SCRAP PAPER, NOTE PAD AND FLIP CHART THAT PARTICIPANTS WILL NEED DURING THE FOCUS GROUP ARE PROVIDED]

4). Interview

A. GUIDING RULES

The following are the ground rules for this focus group:

- The most important rule is that only one person speaks at a time. There may be a temptation to jump in when someone is talking but please wait until they have finished.
- There are no right or wrong answers
- You do not have to speak in any particular order
- When you do have something to say, please do so. There are many of you in the group and it is important that I obtain the views of each of you
- You do not have to agree with the views of other people in the group
- Does anyone have any questions?
- If there is no question, then let's begin

B. GUIDING QUESTIONS

I. How has COVID affected your work? Has COVID affected your supply chain in any way?
II. Is there any approaches you are taking to ensure that you are continuing the supply chain? Have you adopted any approaches that will help you continue your supply, your production and your supply?
III. Do you think your work has any effect (impact) on the environment? What are these effects?
IV. What have been doing to reduce the effect of your activities on the environment?
V. What other supports or measures should be implemented to help reduce the impacts?

VI. Are you working with any institution or agency to be sustainable in vegetable supply? What actually do you do with the institution or agency? How often do you comply with their procedures/measures?

VII. If you are concerned about CO_2 emissions generated in your supply chain, are you undertaking measure to help reduce CO_2 emissions either within your vegetable production, storage or transportation?

VIII. What other supports should be implemented to help reduce CO2emissions?

IX. Are there regulations you must follow to export vegetables to the UK? How well do you comply with these regulations?

X. What do you think should be done to enable more vegetable exports to the UK?

XI. Are farmers paid fairly for their yield? Are there government regulations/recognised framework to ensure that farmers are paid fairly?

XII. How can we ensure farmers are paid fairly?

XIII. Apart from income, what other benefit does your work provides? How do you plan to enhance these benefits you work provide?

XIV. What measures do you follow to ensure consumers know what they are consuming and how are produced?

XV. What measures or approaches should be implemented to ensure vegetables produced are traceable and transparent?

XVI. What other measures or approaches should be implemented to ensure vegetable supply to the UK are sustainable?

Final question: Of all the things we have discusses today, what would you say are the most important issues you would want to stress on? Are there any other important issues you think we did not cover (discuss)?

5). CONCLUSION

a. At the beginning of this meeting, you were briefed on the consent form to understand what the study is about, what is expected of you and you gave your consent to part take this study. The confidentiality of the focus group was discussed before I explained that the interview we will be recorded.

   The focus group gained your perspectives on environmental, economic and social concerns associated with fresh vegetables supply chains from Ghana to the UK as well as gathering views on sustainable food and how to enhance sustainable food supply.

b. Your views are highly appreciated and THANK You for participating in this focus group meeting.

Appendix 5: Survey Instrument

Sustainability impact study of Ghana's fresh vegetables export to the UK

Start of Block: Consent

Q1 **Dear Participant,**
Thank you in advance for your participation in this research survey. Before proceeding further, please read carefully the information provided below to help you understand the purpose of the research and what will be required of you regarding participation. If you have any question, feel free to contact the principal investigator (researcher) by email, emmanuel.aikins@ntu.ac.uk

What is the purpose of this study?
The UK rely on global food suppliers (food exporting countries) to balance domestic food consumption. Fresh food imported from across the globe generate sustainability impacts. The sustainability impacts can be categorised into three dimensions—environmental, economic and social. Therefore, the research will seek to identify and explore the sustainability impact of fresh vegetables from a global food supplier to the UK to enable stakeholders tackle the implications while encouraging sustainable food supply. To facilitate this, the research focuses on Ghana's fresh vegetables export to the UK.

What are we asking you?
We would like to invite you to take part in a research study. Before you decide to participate, you need to understand why the research study is being done and what it would involve for you. Please take time to read the following information provided on this document carefully. Ask questions if anything you read is not clear or would like more information. Take time to decide whether or not to participate in the research.

How we would like to use the information provided?
The data from the survey will be analysed and feed into our research study findings. At the end, the research report will be deposited at the research archive of Nottingham Trent University who is organising and funding the research. Your information will be kept anonymous. Any information that points to your identity, the company you work for will be removed. The study findings will be converted to report and will be published as academic articles and book.

Compliance with the Research Data Management Policy Nottingham Trent University is committed to respecting the ethical codes of conduct of the United Kingdom Research Councils (RCUK) and EU GDPR. Thus, in accordance with procedures for transparency and scientific verification, the University will conserve all information and data collected during your survey in line with University Policy, consistent with both RCUK, and the EU GDPR, (https://www.ukri.org/about-us/policies-and-standards/gdpr-and-research-an-overview-for-researchers/). Normally all data will be anonymised unless a reasonable request is made by the participant and made available to be re-used in this form where appropriate and under appropriate safeguards.

What are the possible risks or discomforts?
Your participation does not involve any risks other than what you would encounter in daily life. If you are uncomfortable with any of the questions and topics, you are free not to answer and/or withdraw from the study.

What about my Confidentiality and Privacy Rights?
Unless required by law, only the research investigator, members of NTU staff and the sponsoring organisation [Nottingham Trent University] have the authority to review your records. They are required to maintain confidentiality regarding your identity. Results of this study may be used for teaching, research, publications and presentations at professional meetings. If your individual results are discussed, then a code number or a pseudonym will be used to protect your identity.

What are my rights as a research participant?
You have the right to withdraw your consent and participation at any moment: before, during and after the interview. If you do wish to withdraw your consent please contact me using my contact details as below. You have right to withdraw within a period of 30 days after your participation. Withdrawing from the study will not have any effect on you. If you withdraw from the study, we will not retain the information you have provided.

- You have the right to remain anonymous in any write-up (published or not) of the information generated during this interview.
- You have the right to refuse to answer to any or all of the questions you will be asked.
- You also have the right to specify the terms and limits of use (i.e., full or partial) of the information generated during the survey.
- You have the opportunity to ask questions about this research and these should be answered to your satisfaction.

If you want to speak with someone who is not directly involved in this research, or if you have questions about your rights as a research subject, contact Professor Michael White, Chair for the College Research Ethics Committee (CREC) for the College of Art Architecture Design and Humanities (CAADH) at Nottingham Trent University. You can call him at 0115 848 2069 or send an e-mail to michael.white@ntu.ac.uk.

Any expenses and payments involve in taking part?
Participants will not be paid an allowance to take part in the study. However, your participation in this online survey participation will be awarded with £5 gift voucher.

Who should I call if I have questions or concerns about this research study?
First, contact the principal investigator Emmanuel Ferguson Aikins (emmanuel.aikins@ntu.ac.uk). Otherwise, you can contact the supervisors: Prof Usha Ramanathan (usha.ramanathan@ntu.ac.uk) or Dr Roy Stratton (roy.stratton@ntu.ac.uk).

Finally, confirm that you have read this consent information sheet (spelt above) and you understand each part of the document. And you freely and voluntarily choose to participate in this study.

○ Yes, I Consent

○ No, I do NOT Consent

End of Block: Consent

Start of Block: Background

Q2 How do you want to be referred (what is your professional role)? You may pick more than one which applies to you.

▢ Smallholder farmer (1)

▢ Outgrower (2)

▢ Farmer (3)

▢ Exporter (4)

▢ If any other, please specify (5) ____

Q3 How many hectares (acres) of land do you work on?

- ○ Less than 2 hectares (5 acres) (1)
- ○ Between 2 and 5 hectares (thus, between 5 acres and 12.5 acres) (2)
- ○ Between 5 and 20 hectares (thus, between 12.5 acres and 50 acres) (3)
- ○ Between 20 and 50 hectares (thus, between 50 acres and 124 acres) (4)
- ○ Between 50 and 100 hectares (thus, between 124 acres and 248 acres) (5)
- ○ Over 100 hectares (over 248 acres) (6)

End of Block: Background

START OF BLOCK: SUSTAINABILITY

Q4 -Q9 Food Sustainability (Question 4 to 11)
To what extent do you agree or disagree with the following statements about Food sustainability?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly Agree (5)
4. Your activities have environmental impacts.	○	○	○	○	○
5. Your activities have social impacts. For example, my activities ensure consumer safety and health by informing them about what they eat.	○	○	○	○	○
6. Your activities have economic impacts. For example, my activities generate income for myself, farmers, outgrowers or other workers.	○	○	○	○	○
7. There are authorising institutions who supervise and regulate my activities.	○	○	○	○	○
8. You face some challenges regarding my vegetable production and supply.	○	○	○	○	○
9. You have idea about sustainability	○	○	○	○	○

End of Block: Sustainability

Start of Block: Environment

Q10-Q17 Environmental Aspects of Your Activities (Question 4 to 11)
To what extent do you agree or disagree with the following statements about environmental aspects of your activities?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly Agree (5)
10. Your activities produce a negative environmental impact.	○	○	○	○	○
11. Your activities produce CO_2 emissions from transportation and other logistical activities.	○	○	○	○	○
12. Your activities are regulated and guided by the Environmental Protection Agency (EPA).	○	○	○	○	○
13. The Environmental Protection Agency (EPA) regularly visit my premises to carry out inspections.	○	○	○	○	○
14. You have a license from the Environmental Protection Agency (EPA) for my operations.	○	○	○	○	○
15. You carry out organic farming practices.	○	○	○	○	○
16. You adopt farm practices or activities that enhance sustainability.	○	○	○	○	○
17. You work with a local institution or foreign institution that helps to conduct sustainable agricultural practices.	○	○	○	○	○

End of Block: Environment

Start of Block: Economic

Q18-Q24 Economic Aspects of Your Activities (Question 12 to 18)
To what extent do you agree or disagree with the following statements about economic aspects of your activities?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly agree (5)
18. There is any form of rules or regulations that govern your relationship with a smallholder farmer or exporter.	○	○	○	○	○
19. You are aware of FairTrade.	○	○	○	○	○
20. Your activities are supported and guided by FairTrade.	○	○	○	○	○
21. Some vegetables can go waste (either by rotting, damage, or are discarded) before exporting to the UK.	○	○	○	○	○
22. You carry out food sorting after harvesting.	○	○	○	○	○
23. Vegetables sorted are used for other purposes e.g., sold to the local market or used for manures.	○	○	○	○	○
24. You have adopted approaches that help to reduce food loss. (7)	○	○	○	○	○

End of Block: Economic

Q25-Q28 Social Aspects of Your Activities (Question 18 to 22)
To what extent do you agree or disagree with the following statements about social aspects of your activities?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly Agree (5)
25. You have a Farm code.	○	○	○	○	○
26. Apart from Farm code, You adopt other methods that help traceability of products.	○	○	○	○	○
27. Consumers and trade partners can trace the source of your product because of your labelling or packaging.	○	○	○	○	○
28. There are other better approaches to enhancing traceability and transparency apart from Farm code or your own labelling.	○	○	○	○	○

End of Block: Social

Start of Block: Regulatory

Q29-Q33 Regulatory Aspects of Your Activities (Question 23 to 27)
To what extent do you agree or disagree with the following statements about regulatory aspects of your activities?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly Agree (5)
29. You have a certification that enables you to produce locally.	○	○	○	○	○
30. You have a certification to export overseas.	○	○	○	○	○
31. You do have a phytosanitary certification.	○	○	○	○	○
32. You work with a local institution that regulates my activities and guides the way you produce food.	○	○	○	○	○
33. You work with a foreign institution (an overseas organisation) that regulates my activities and guides the way you produce food.	○	○	○	○	○

End of Block: Regulatory

Start of Block: Collaboration

Q34-Q44 Sustainable Food Supply Chain Collaboration (Question 28 to 38)
To what extent do you agree or disagree with the following statements about your collaborations with institutions and food supply chain partners?

	Strongly Disagree (1)	Disagree (2)	Neither disagree nor agree (3)	Agree (4)	Strongly agree (5)
34. You provide some financial support and other innovative farm tools that help farmers to improve their productivity.	○	○	○	○	○
35. You set out an agreement with farmers, smallholders or exporters which they must comply with.	○	○	○	○	○
36. Smallholders and local farmers have an agreement with exporters on how much to buy their produce.	○	○	○	○	○
37. You work with Plant Protection and Regulatory Services Directorate (PPRSD)	○	○	○	○	○
38. You work with Ghana Standard Authority (GSA)	○	○	○	○	○
39. You work with the Environmental Protection Agency (EPA).	○	○	○	○	○
40. You work with the Food and Drugs Authority (FDA).	○	○	○	○	○
41. You work with Green Label. (8)	○	○	○	○	○
42. You work with GlobalGap	○	○	○	○	○

43. You work with ISO 22000 (International Organisation for Standardization).	○	○	○	○	○
44. You work with any other institution that helps you to enhance sustainable vegetables production and supply.	○	○	○	○	○

End of Block: Collaboration

Start of Block: Complex Food Supply Chains and Challenges

Q45-Q48 Complex Food Supply Chains and Its challenges (Question 38 to 42): To what extent do you agree or disagree with the following statements about the challenges you face in food production and supply?

	Strongly Disagree (1)	Disagree (2)	Neither Disagree nor Agree (3)	Agree (4)	Strongly Agree (5)
45. You have limited knowledge on processing your food.	○	○	○	○	○
46. You have limited knowledge on how to improve efficiency in your food production and supply activities.	○	○	○	○	○
47. With the current supports available from foreign institutions, local institutions (e.g., PPSRD) and government, developing sustainable food supply is still difficult?	○	○	○	○	○
48. There are other major challenges faced in your sustainable food production and supply.	○	○	○	○	○

Q49 Please indicate which of the following you consider major challenge you face in your sustainable food production and supply? You may tick more than one which applies to you.

- ▢ Limited government support in policy (1)
- ▢ Lack of smart technology (2)
- ▢ Lack of training on efficiency (3)
- ▢ Lack of training on processing food (4)
- ▢ Lack of farming machines and farm inputs (5)
- ▢ Lack of storage facilities (6)
- ▢ Limited financial support and loans (7)
- ▢ Lack of food processing machines (8)
- ▢ If any other, please specify (9) ____

End of Block: Complex Food Supply Chains and Challenges

Start of Block: Export

Q50 How long do you store your vegetables before export to the UK? Please, provide your response either in **hours** or **days**.

Q51 In one business year (particularly in 2019), how many kilograms or tonnes of vegetables do you produce in altogether? Please, provide your response either in **kilograms** or **tonnes**.

Q52 In one business year (particularly in 2019), how many kilograms or tonnes of vegetables do you export to the UK? Please, provide your response either in **kilograms** or **tonnes**.

End of Block: Export

Appendix 6: Common method bias – Harman single factor test (SPSS output)

Total Variance Explained						
Comp-onent	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.388	25.307	25.307	11.388	25.307	25.307
2	8.527	18.949	44.256			
3	2.942	6.538	50.794			
4	2.519	5.599	56.393			
5	1.726	3.836	60.229			
6	1.452	3.227	63.456			
7	1.328	2.951	66.407			
8	1.252	2.783	69.190			
9	1.043	2.318	71.508			
10	.988	2.195	73.703			
11	.934	2.075	75.778			
12	.887	1.972	77.750			
13	.814	1.810	79.560			
14	.727	1.615	81.175			
15	.645	1.433	82.608			
16	.604	1.342	83.950			
17	.557	1.238	85.188			
18	.517	1.150	86.337			
19	.511	1.136	87.473			
20	.489	1.087	88.561			
21	.465	1.033	89.594			
22	.399	.886	90.480			
23	.374	.832	91.312			
24	.336	.747	92.059			
25	.316	.701	92.760			

26	.312	.694	93.454			
27	.294	.654	94.108			
28	.267	.593	94.701			
29	.258	.573	95.274			
30	.226	.502	95.777			
31	.218	.485	96.262			
32	.213	.474	96.736			
33	.196	.436	97.172			
34	.184	.409	97.580			
35	.163	.363	97.943			
36	.151	.335	98.278			
37	.133	.296	98.574			
38	.121	.268	98.842			
39	.114	.253	99.095			
40	.108	.239	99.335			
41	.092	.204	99.539			
42	.071	.157	99.696			
43	.054	.121	99.817			
44	.047	.105	99.921			
45	.035	.079	100.000			
Extraction Method: Principal Component Analysis.						

Appendix 7: Rotated Component Matrix (Factor Analysis – PCA)

	Component								
	1	2	3	4	5	6	7	8	9
ENVIRONMENTAL – You work with a local institution or foreign institution that helps to conduct sustainable agricultural practices.	0.861								
SOCIAL - There are other better approaches to enhancing traceability and transparency apart from Farm code or your own labelling.	0.786								
ECONOMIC - You have adopted approaches that help to reduce food loss.	0.742			0.407					
COMPLEXITIES -With the current supports available from foreign institutions, local institutions (e.g., PPSRD) and government, developing sustainable food supply is still difficult?	0.729								
SFSC - You have idea about sustainability	0.727								
SOCIAL - Consumers and trade partners can trace the source of your product because of your labelling or packaging.	0.717								
ENVIRONMENTAL - You adopt farm practices or activities that enhance sustainability.	0.707								
SOCIAL - Apart from Farm code, you adopt other methods that help the traceability of products.	0.693								

COMPLEXITIES - There are other major challenges faced in your sus	0.674								0.420
COLLABORATION - You work with any other institution that helps you to enhance sustainable vegetables production and supply.	0.629								
REGULATORY- You work with a local institution that regulates my activities and guides the way You produce food.	0.627								
SFSC - Your activities have social impacts. For example, your activities ensure consumer safety and health by informing them about what they eat.	0.594			0.453					
ECONOMIC - Vegetables sorted are used for other purposes e.g., sold to the local market or used for manures.	0.551			0.489					
ECONOMIC- You carry out food sorting after harvesting.	0.526					0.432			
SFSC - There are authorising institutions who supervise and regulate my activities.	0.514								
COLLABORATION - Smallholders and local farmers have an agreement with exporters on how much to buy their produce.	0.502								
REGULATORY – You have a certification to export overseas.		0.899							
REGULATORY - You do have a phytosanitary certification.		0.894							
REGULATORY - You work with a foreign institution (an overseas organisation) that regulates your activities and guides the way you produce food.		0.884							

ECONOMIC - Your activities are supported and guided by FairTrade.		0.791							
ENVIRONMENTAL - You have a license from the Environmental Protection Agency (EPA) for my operations.		0.726							
COLLABORATION - You work with the Food and Drugs Authority (FDA).		0.709							
ENVIRONMENTAL – the Environmental Protection Agency (EPA) regularly visit my premises to carry out inspections.		0.689							
COLLABORATION - You work with Ghana Standard Authority (GSA)		0.609							
COLLABORATION - You work with ISO 22000 (International Organisation for Standardization).		0.566			0.551				
SOCIAL - You have a Farm code.		0.564							
COLLABORATION - You work with GlobalGAP.		0.549			0.514				
COLLA - You work with Green Label.		0.510			0.418				
ENVIRONMENTAL - Your activities are regulated and guided by the Environmental Protection Agency (EPA).			0.830						
COLLABORATION - You work with the Environmental Protection Agency (EPA).			0.772						
COLLA - You work with the Plant Protection and Regulatory Services Directorate (PPRSD)	0.421		0.697						
ECONOMIC - You are aware of FairTrade.			0.599						

REGULATORY - You have a certification that enables you to produce locally.			0.544						
SFSC - Your activities have economic impacts. For example, my activities generate income for myself, farmers, outgrowers or other workers.				0.752					
COLLABORATION - You provide some financial support and other innovative farm tools that help farmers to improve their productivity.				0.604					
ECONOMIC - There is any form of rules or regulations that govern your relationship with a smallholder farmer or exporter.				0.601					
COLLABORATION - You set out an agreement with farmers, smallholders or exporters which they must comply with.				0.559					
COMPLEXITIES - You have limited knowledge on how to improve efficiency in your food production and supply activities.					0.849				
COMPLEXITIES - You have limited knowledge on processing your food.					0.785				
ENVIRONMENTAL - Your activities produce CO_2 emissions from transportation and other logistical activities.						0.851			
ENVIRONMENTAL - Your activities produce a negative environmental impact.						0.783			
SFSC - You face some challenges regarding my vegetable production and supply.						0.551	-0.436		
SFSC - Your activities have environmental impacts.							0.641		

ECONOMICS- Some vegetables can go waste (either by rotting, damage, or are discarded) before exporting to the UK.								0.863	
ENVIRONMENTAL - You carry out organic farming practices.		0.403						0.420	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization (Rotation converged in 12 iterations).

Appendix 8. Items excluded after Factor Analysis (Principal Component Analysis)

Variable	Sustainability & Sustainability Implications/Dimensions	Question/Data
Dependent	Sustainable Food Supply Chain	Your activities have social impacts. For example, your activities ensure consumer safety and health by informing them about what they eat.
		You face some challenges regarding my vegetable production and supply.
Independent	Environmental	You carry out organic farming practices.
	Economic	You have adopted approaches that help to reduce food loss.
		You carry out food sorting after harvesting.
		Vegetables sorted are used for other purposes, e.g., sold to the local market or recycled for manure.
	Collaboration	You work with ISO 22000 (International Organisation for Standardization).
		You work with Global G.A.P.
		You work with Green Label
		You work with Plant Protection and Regulatory Services Directorate (PPRSD)
	Complexities	There are other major challenges faced in your sustainable food production and supply.

Appendix 9: Participant Information Sheet (PIS)

Protocol Title	UK food sustainability and Global food supply chains: Sustainability impact study of Ghana's fresh vegetables export industry to the UK
Principal Investigator	Emmanuel Ferguson Aikins
Project Group	
Supported By	Prof Usha Ramanathan and Dr Roy Stratton
What is the purpose of this study?	
The purpose of this research to explore the opportunities of reducing sustainability impact of the global food supply chain to the UK by analysing Ghana's fresh vegetables export industry, highlighting the sustainability implications and providing practical strategies to enhance sustainable food supply chain for both the UK and Ghana.	
What are we asking you?	
We would like to invite you to take part in a research study. Before you decide to participate, you need to understand why the research study is being done and what it would involve for you. Please take time to read the following information provided on this document carefully. Ask questions if anything you read is not clear or would like more information. Take time to decide whether or not to participate in the research.	
How we would like to use the information provided	
The tape of the interview will be transcribed. The transcript will be analysed and feed into our research study findings. At the end, the transcript will be deposited at the research archive of Nottingham Trent University who is organising and funding the research. This transcripts will be kept anonymous. Any information that points to your identity, the company you work for will be removed be archived. The study findings will be converted to report and will be published as academic articles and book.	
Compliance with the Research Data Management Policy	
Nottingham Trent University is committed to respecting the ethical codes of conduct of the United Kingdom Research Councils (RCUK) and EU GDPR. Thus, in accordance with procedures for transparency and scientific verification, the University will conserve all information and data collected during your interview in line with University Policy, consistent with both RCUK, and the EU GDPR, (https://www.ukri.org/about-us/policies-and-standards/gdpr-and-research-an-overview-for-researchers/). Normally all data will be anonymised unless a reasonable request is made by the participant and made available to be re-used in this form where appropriate and under appropriate safeguards.	
What are the possible risks or discomforts?	
Your participation does not involve any risks other than what you would encounter in daily life. If you are uncomfortable with any of the questions and topics, you are free not to answer and ~~not~~ /or withdraw from the study.	
What are my rights as a research participant?	

- You have the right to withdraw your consent and participation at any moment: before, during and after the interview. If you do wish to withdraw your consent please contact me using my contact details as below. You have right to withdraw within a period of 30 days after your participation. Withdrawing from the study will not have any effect on you. If you withdraw from the study, we will not retain the information you have provided.

- You have the right to remain anonymous in any write-up (published or not) of the information generated during this interview.
- You have the right to refuse to answer to any or all of the questions you will be asked.
- You also have the right to specify the terms and limits of use (i.e., full or partial) of the information generated during the interview.
- You have the opportunity to ask questions about this research and these should be answered to your satisfaction.

If you want to speak with someone who is not directly involved in this research, or if you have questions about your rights as a research subject, contact Professor Michael White, Chair for the College Research Ethics Committee (CREC) for the College of Art Architecture Design and Humanities (CAADH) at Nottingham Trent University. You can call him at 0115 848 2069 or send an e-mail to michael.white@ntu.ac.uk.

ANY EXPENSES AND PAYMENTS INVOLVE IN TAKING PART?

Participants will not be paid an allowance to take part in the study. However, your participation in a focus group discussion (online) will be rewarded with a £20 gift voucher. Also, online survey participation will be awarded with £5 gift voucher.

What about my Confidentiality and Privacy Rights?

Unless required by law, only the study investigator, members of NTU staff and the sponsoring organisation [Nottingham Trent University] have the authority to review your records. They are required to maintain confidentiality regarding your identity.

Results of this study may be used for teaching, research, publications and presentations at professional meetings. If your individual results are discussed, then a code number or a pseudonym will be used to protect your identity.

Audio/visual recordings

Permission to use audio or visual recordings of your participation, for presentations at professional meetings or in publications, is requested below, as this may be necessary to understand and communicate the results.

Any recorded data will be kept confidential and in a secure place in line with the Research Data Management Policy and destroyed in line with the current RCUK/University/GDPR Guidelines.

Who should I call if I have questions or concerns about this research study?

Contact Emmanuel Ferguson Aikins (*emmanuel.aikins@ntu.ac.uk*), Prof Usha Ramanathan (*usha.ramanathan@ntu.ac.uk*) or Dr Roy Stratton (*roy.stratton@ntu.ac.uk*)

Appendix 10: CONSENT FORM PROFORMA

Dear Research Participant

The UK rely on global food suppliers (food exporting countries) to balance domestic food consumption. Fresh food imported from across the globe generate sustainability impacts. The sustainability impacts can be categorised into three dimensions—environmental, economic, and social. Therefore, the research will seek to identify and explore the sustainability impact of fresh vegetables from a global food supplier to the UK to enable stakeholders tackle the implications while encouraging sustainable food supply. To facilitate this, the research will focus on Ghana's fresh vegetables export to the UK. This research uses Ghana's fresh vegetables export industry due to trade increasing UK consumption, quality standards, regular supply to the UK and the level of food safety associated with the industry.

There are several questions we would like to discuss with you. However, you only need to respond to the ones which you want to. There is no time limit on this interview it may be as long or as short as you wish. Most interviews last around [45minutes]. All interviews may be recorded and transcribed into text form with identifying features removed (e.g., names and places). Relevant quotations may then be included in the final report. All recordings will be stored securely and remain confidential.

All participation in the project is voluntary. However, your participation in a focus group discussion (online) will be rewarded with £20 gift voucher and online survey will be awarded with £5 gift voucher. If do you agree to be part of the project, we would like to use the information to develop a report; but your name and identity will remain anonymous. If you decide at any stage, you no longer want to be part of the project, just let us know and we will make sure any information you have given us is destroyed.

This project has been reviewed by, and received ethics clearance through, the Nottingham Trent University College of Art, Architecture, Design and Humanities Research Ethics Committee

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Please read the following statements:

I have read the above project description, and had an opportunity to ask questions about the research and received satisfactory answers to any questions.
I have had sufficient information to decide whether or not you wish to take part in the study.
I understand that I am free to withdraw from the research at any time by informing the researcher of this decision.
I understand that the information I give will be treated in the strictest confidence.
I agree to take part in the study.
I agree that this interview can be recorded.
I understand that quotations, which will be made anonymous, from this interview may be included in material published from this research.
I am willing to participate in an interview as part of this research project.
I understand that anonymised data may be used in other studies in line with the University Research Data Management Policy

I confirm that data obtained from the study can be used in the final research report. I understand that the data will be used anonymously: names, places and identifying details will be changed.

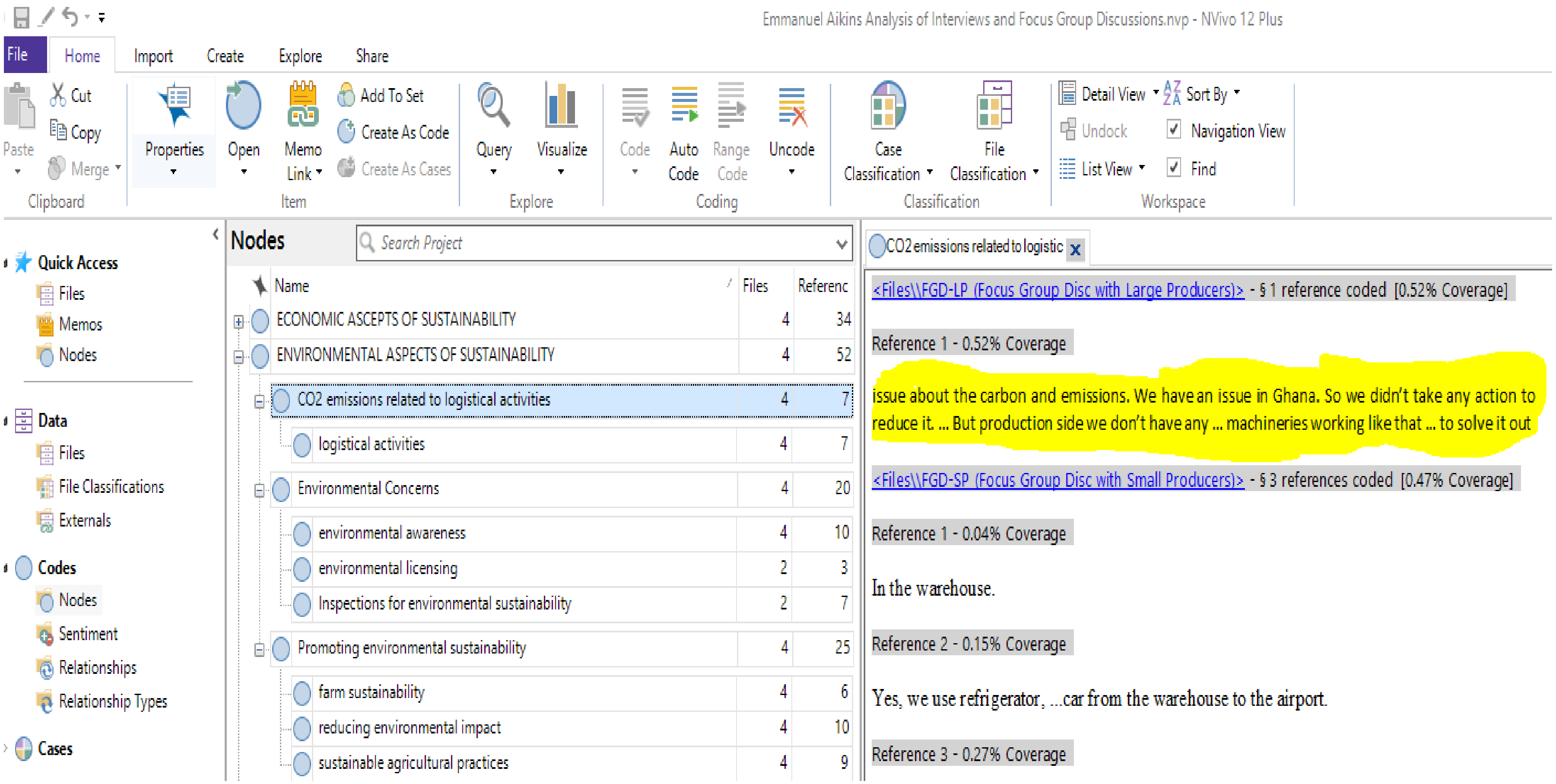
Full Name ____

Date ____

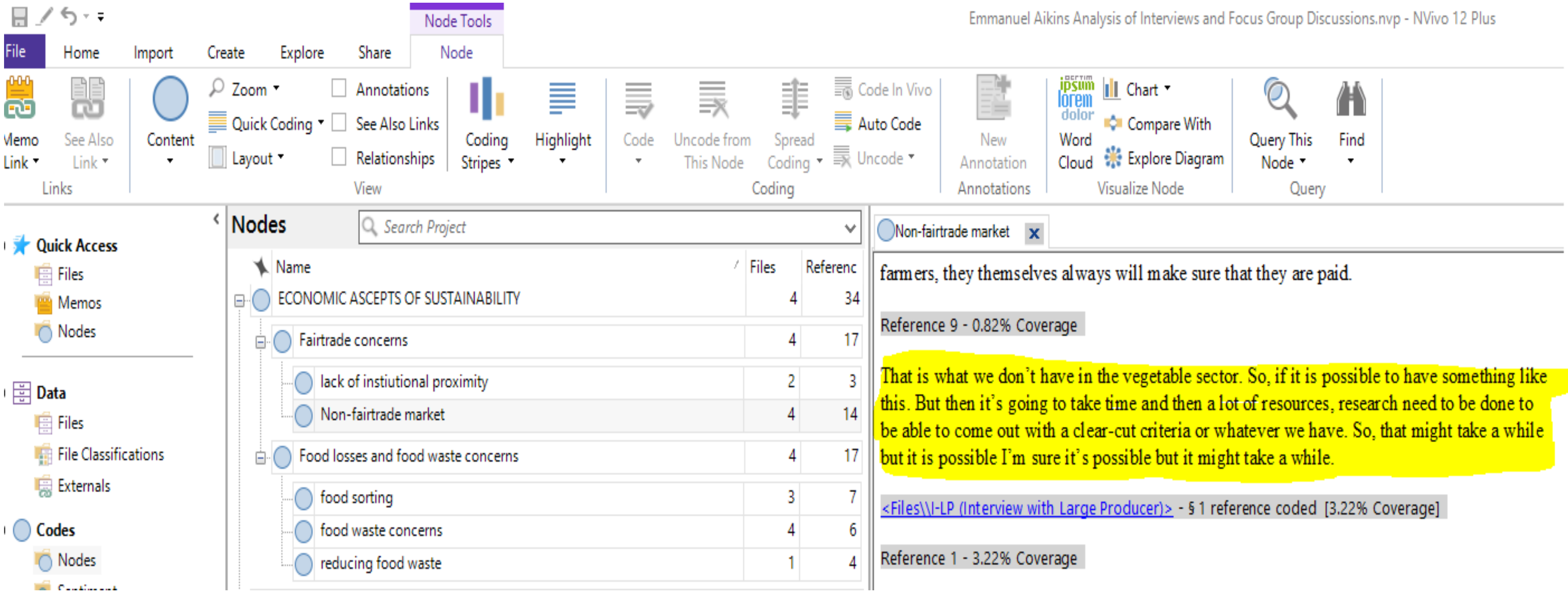
If you have any questions please contact Emmanuel Ferguson Aikins (*emmanuel.aikins@ntu.ac.uk*), Prof Usha Ramanathan (*usha.ramanathan@ntu.ac.uk*) or Dr Roy Stratton *(roy.stratton@ntu.ac.uk*)

In line with the Research Data Management Policy, requests may be made to use data from this study for other projects. If you do not wish your anonymised data to be used for future studies please tick here ☐

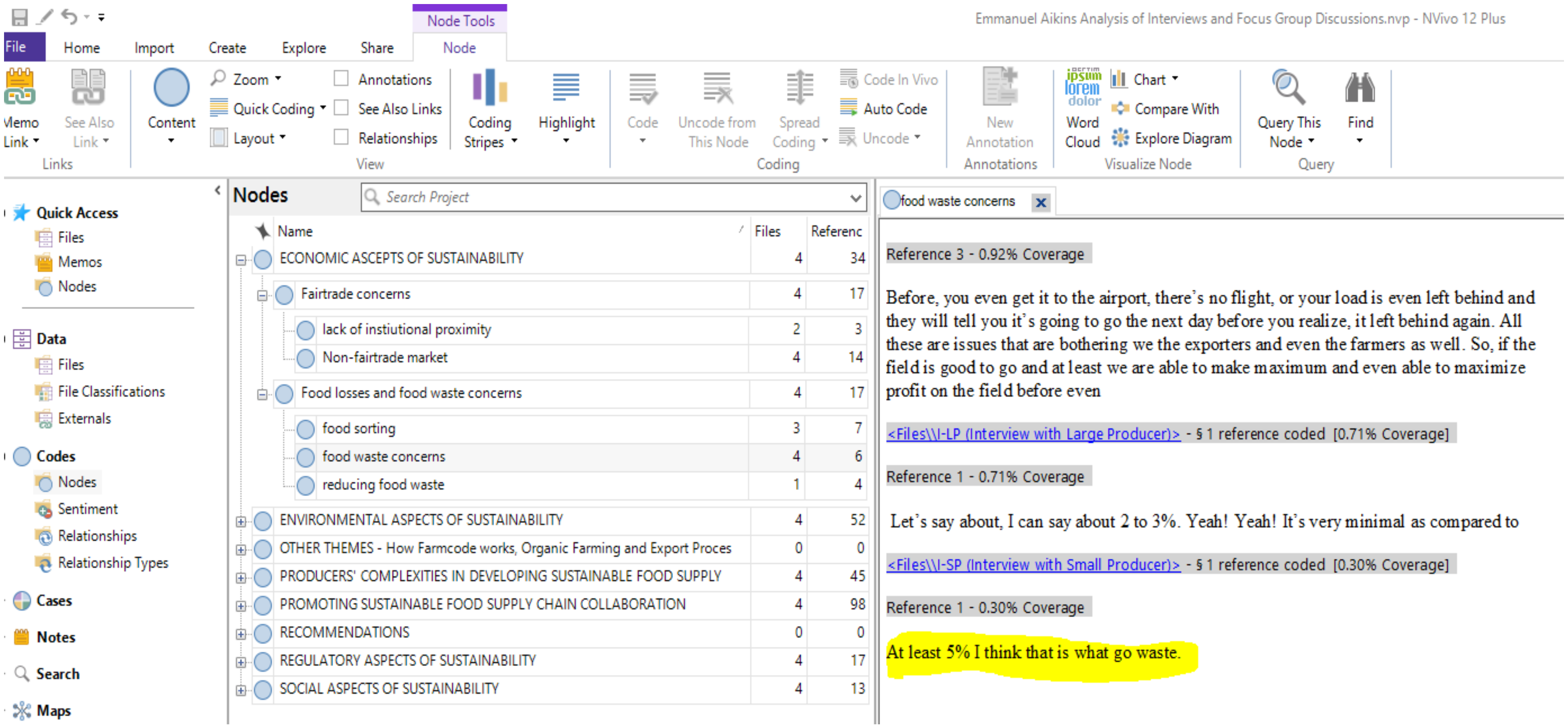
Appendix 11: Code for the Sub-theme I: CO_2 emissions related to logistical activities under Envrionemental Aspects of Sustainability (from SR of FGD-LSP)



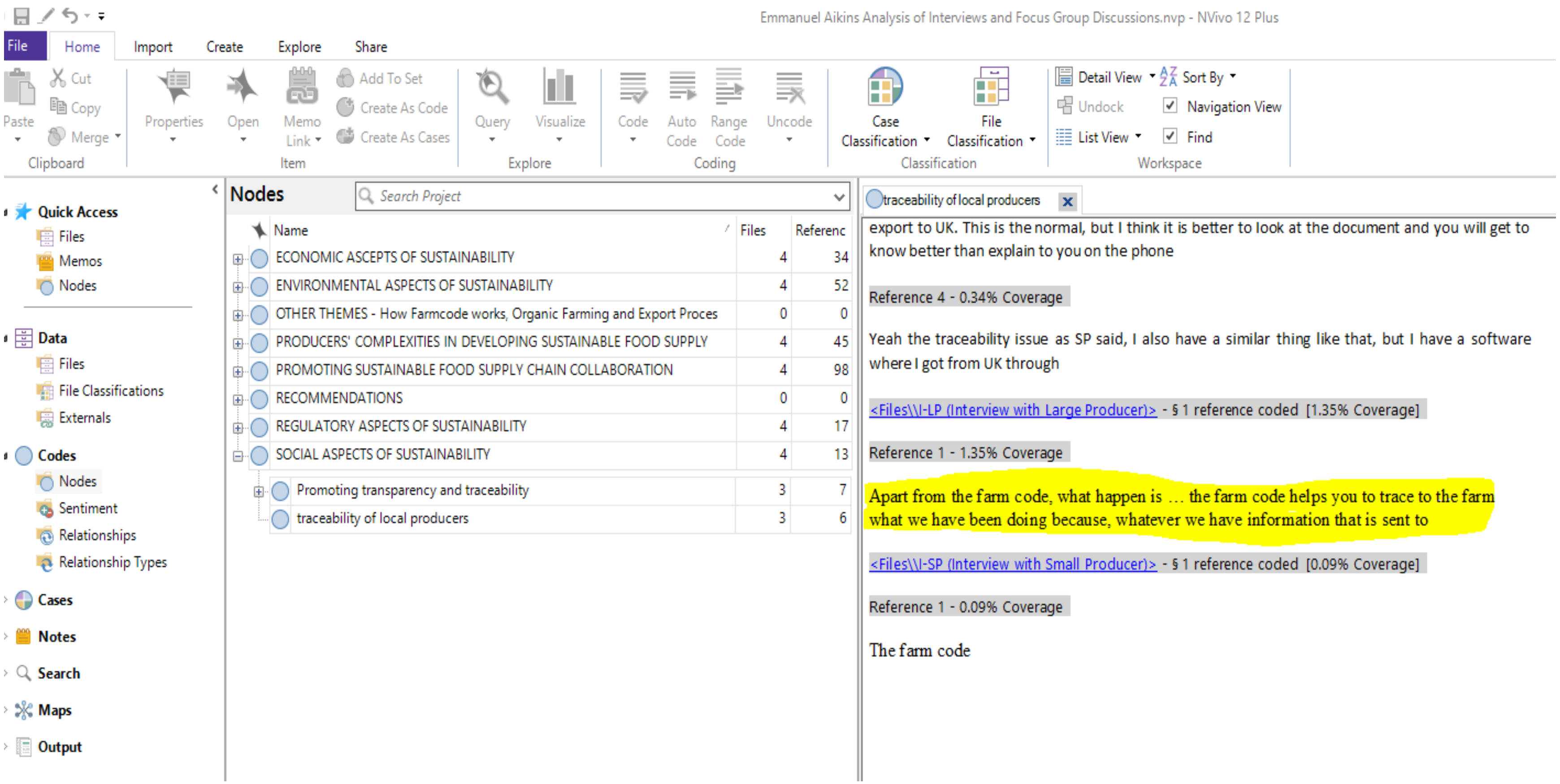
Appendix 12: Code for Sub-theme I: FairTrade concerns under Economic Aspects of Sustainability (from THR of FGD-SSP)



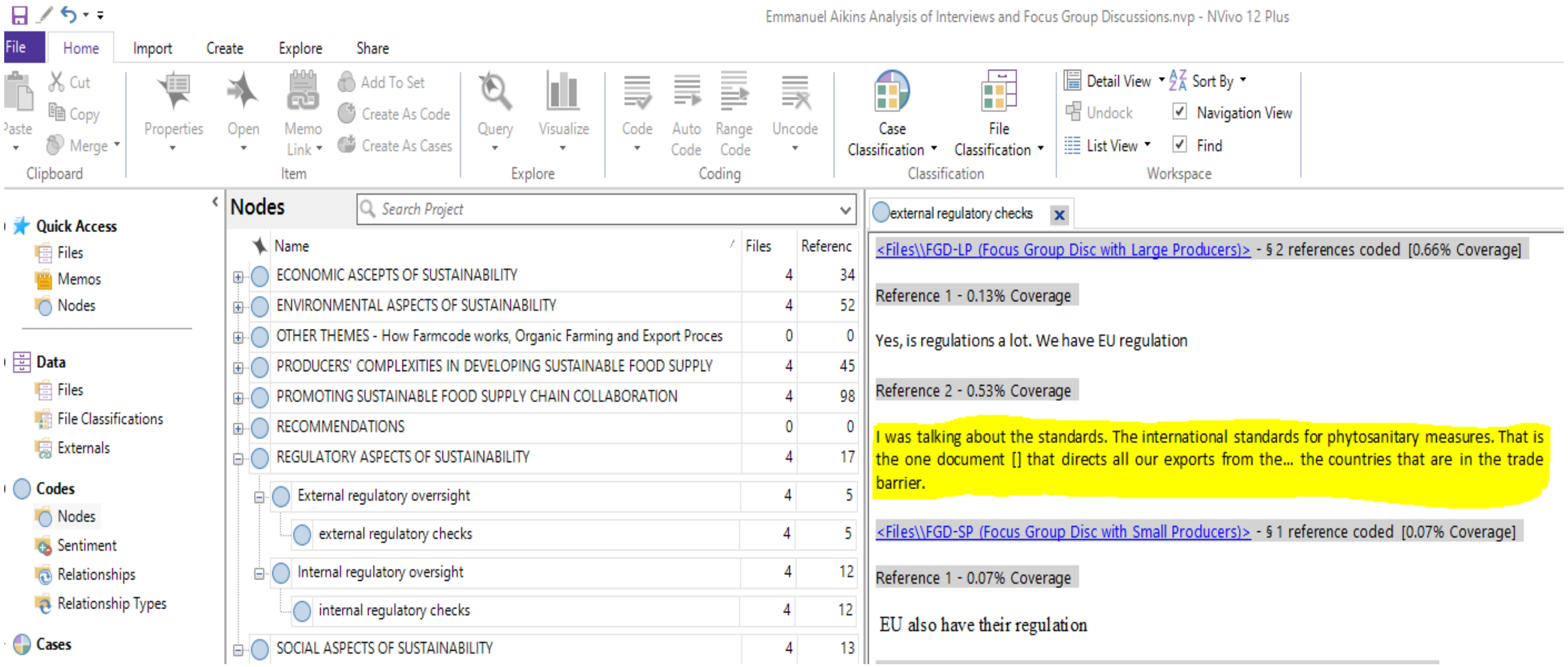
Appendix 13: Code for Sub-theme II: Food losses and food waste concerns under Economic Aspects of Sustainability (from I-SSP)



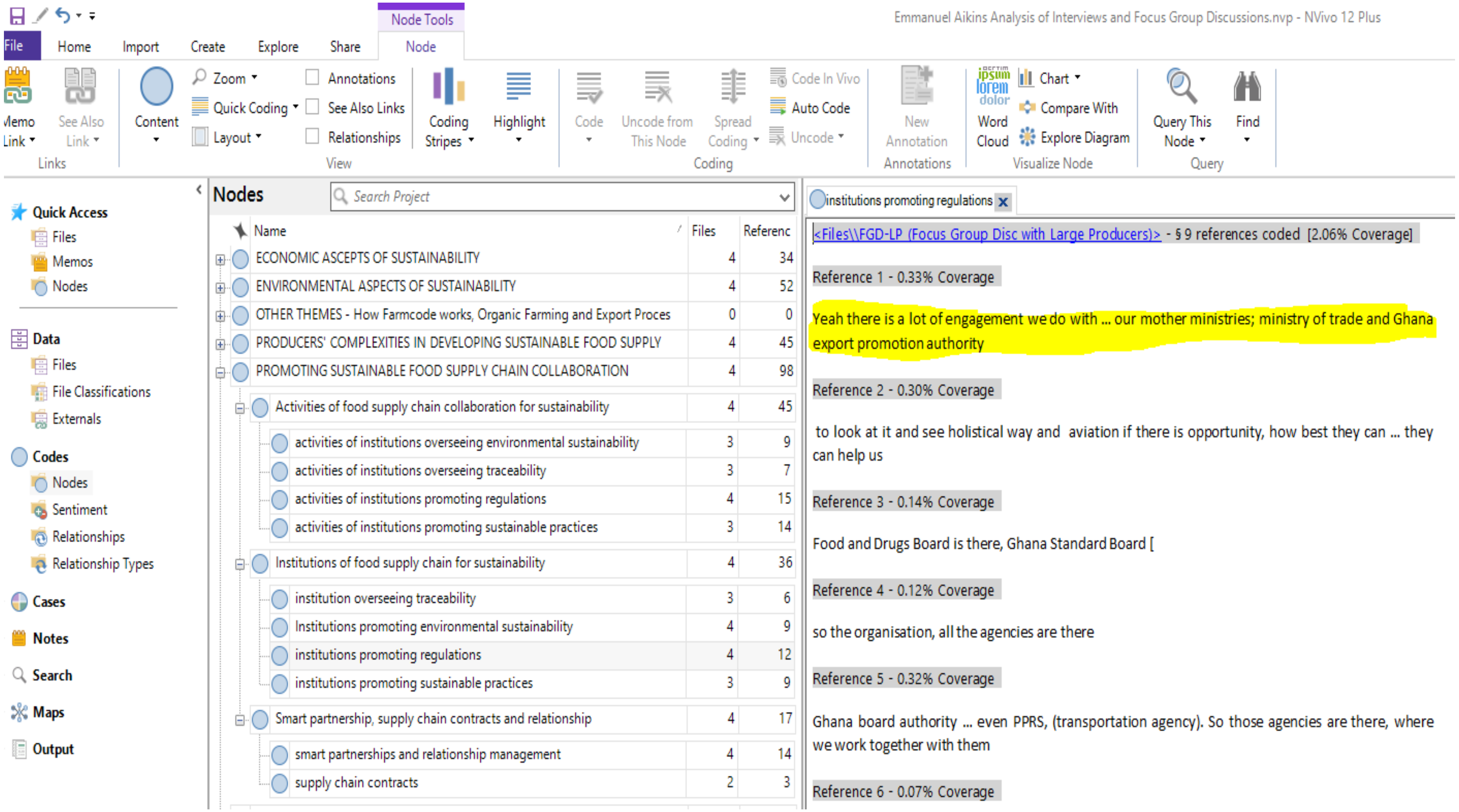
Appendix 14: Code for Sub-theme I: Promoting transparency and traceability under Social Aspects of Sustainability (from I-LSP)



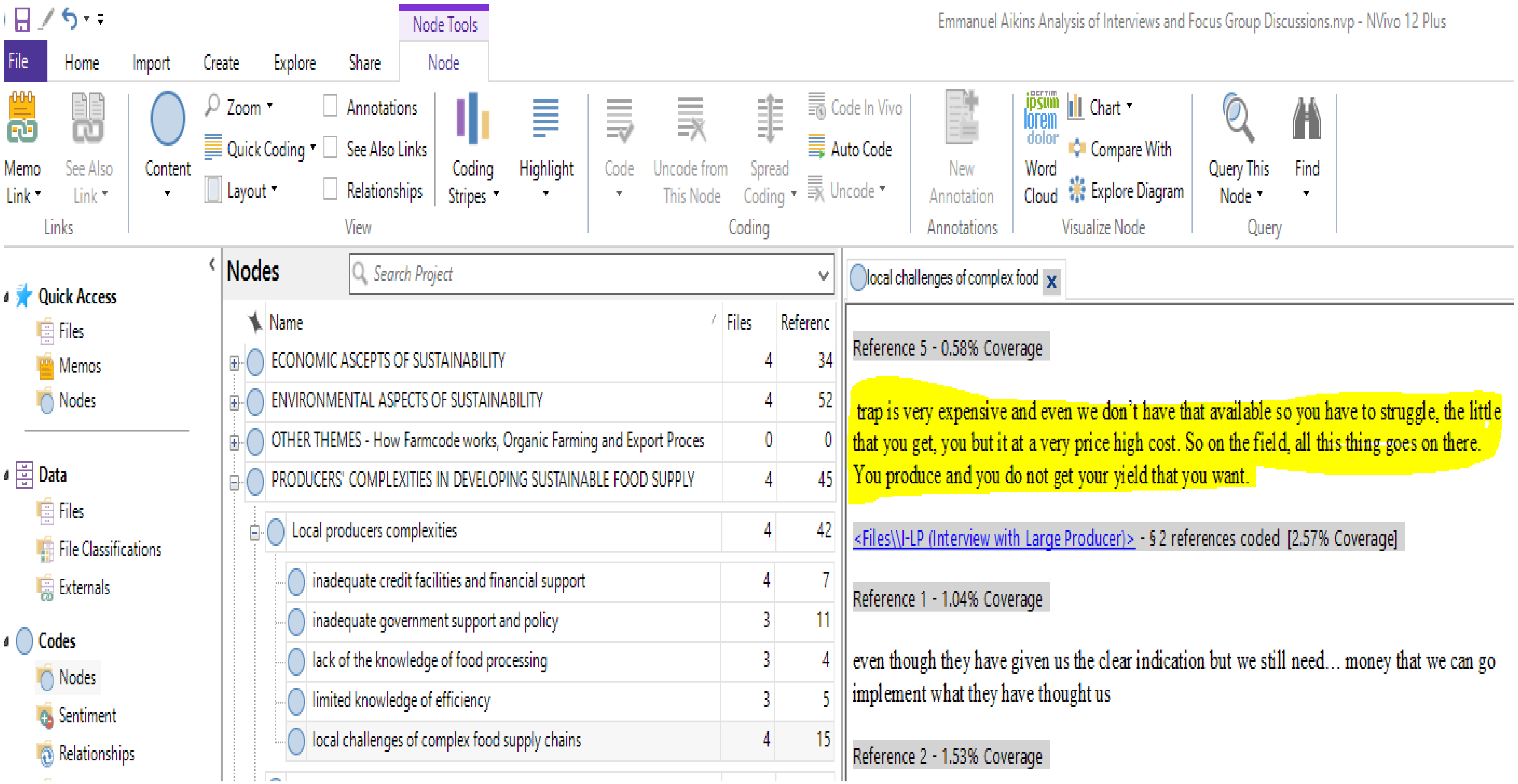
Appendix 15: Code for Sub-theme I: External regulatory oversight under Regulatory (from THR of FGD-LSP).



Appendix 16: Code for Sub-theme II: Institutions of food supply chain for sustainability under Collaboration (from FR of FGD-LSP)



Appendix 17: Code for Sub-theme II: Local producers' complexities under Complexities (from SR of FGD-LSP)



Appendix 18: Evidence of Matrix coding from NVivo 11