The University Of Sheffield.

Sustainable Procurement in British Dairy Supply Chain

By:

William Rongxuan Zhao

A thesis submitted in partial fulfilment of the requirements for the degree of

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Abstract

Purpose – Dairy industry has several negative environmental impacts while continuous decline of number of British farmers in the supply chain questions the overall sustainability of the UK dairy supply chain. The research aims to explore the promotion of sustainable development in the British dairy sector and its supply chain through specific objectives, which are: to identify the current penetration level of different sustainability practices on dairy farming and milk purchasing; to investigate drivers, barriers and benefits of implementing sustainability practices in dairy sector; to identify different supply chain types existing in dairy sector and their implications to sustainability performance.

Design / methodology / approach – questionnaire survey was used to collect data from dairy producers and dairy processors. 43 and 53 valid questionnaires returned from dairy producers and dairy processors, respectively, were used in the analysis.

Findings – Social sustainability requirements received highest penetration level in sustainable procurement practices, while GHG emission requirements received lowest level of penetration. The most important driver for processor implementing sustainable procurement practices is company's reputation and brand image, barrier is economic reasons, benefit is the creation of competitive advantage. The research also identified two major types of SC structure operating in the British dairy sector, Type A (farmer – processor - customer) and Type D (farmer and processor –- customer). Type D SC is advantageous to implement sustainability practices and achieved high sustainability performance.

Practical implications –Improving sustainability performance throughout dairy supply chain needs continuous financial inputs. It would be very helpful to establish dairy sustainability accreditation and labelling scheme.

Originality / value – This work is the first research so far which examined the penetration level of 15 environmental and social sustainability practices in dairy farming and milk sourcing, also identified drivers, barriers and benefits of implementing these practices. Financial incentive, information transparency and lead firm pressure can affect the coupling / decoupling of primary and secondary agency role in dairy supply chain.

Key words - Sustainable procurement, Supply chain management, British dairy sector, Environmental sustainability, Social sustainability, double agency theory

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List of Abbreviation

AD - Anaerobic Digestion

ADPP – Approved Dairy Processing Plant

AMP – Approved Milk Purchaser

CF – Carbon Footprint

CH_4 - Methane

CO_2 – Carbon Dioxide

CO_2e – Carbon Dioxide Equivalent

CS – Countryside Stewardship

CSR – Corporate Social Responsibility

DEFRA – Department for Environment, Food and Rural Affairs of UK

GDP – Gross Domestic Product

GHG – Greenhouse Gas

IPCC - Intergovernmental Panel on Climate Change of UN

TBL – Triple Bottom Lines

NI – Northern Ireland

N_2O – Nitrous Oxide

NRBV – Nature Resource Based View

PV - Photovoltaic

SC – Supply Chain

SCM – Supply Chain Management

SME – Small Medium Enterprise

SP – Sustainable Procurement

SSCM – Sustainable Supply Chain Management

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1. Introduction

1.1. The Emergence of Sustainability as a Business Issue

In the 1990s, the British author John Elkington (1997) popularised the idea of the triple bottom line (TBL), in his book *'Cannibals with Forks: The Triple Bottom Line of 21st Century Business'*. Figure 1.1 illustrates the specific elements that constitute TBL. The notion behind TBL is that corporate health and success are not only by its economic merit, but also by its social responsibility and environmental performance (Norman and MacDonald, 2004).

Figure 1.1 The triple bottom line: planet, people and profit (Christopher, 2012)

On the other hand, Hart (1995) proposed the natural resource based view (NRBV) to emphasise that, *'natural environment could create a serious constraint on firms' attempts to create sustainable advantage'.* He also highlighted the necessary capabilities of firms pursuing sustained competitive advantage: pollution prevention, product stewardship and sustainable development.

Prevention of waste and pollution are increasingly given attention by business management of large company. In 2006, over half of the FTSE 100 companies (Financial Times Stock Exchange 100 Index) named waste management and pollution prevention as key business strategies (Environment Agency, 2006). In addition to environmental benefits, waste reduction has positive effects on firms' financial performance, as most of the waste comes from inefficient utilisation of physical resources (Hart and Ahuja, 1996). In addition, pollution reduction helps firm to avoid compliance and liability costs (Rooney, 1993).

Secondly, product stewardship implies that a company should have a supply chain based view to implement its strategies and take responsibility. In other words, it is not limited to its own boundary, but instead extends to the wider supply chain, from upstream to downstream suppliers. Environmental and ethical risks may arise at every part of supply chain, from raw material extraction to end-of-use disposal (Klöpffer, 1997). The Gulf oil spill, for example, was caused by Transocean, BP's subcontractor; and the horse meat scandal was caused by meat producers beyond first tier direct suppliers. However, these environmental and ethical disasters had tremendously negative impacts on the focal companies.

Mihelcic et al. (2003) offered a new understanding of business, using the sustainable development lens. It was argued that eco-efficiency and business ethics are two important ways of leading organisations to sustainable development. Eco-efficiency combines economic and environmental bottom lines, and the pursuit of high eco-efficiency means 'saving the earth and making money too' (Tierney, 2002). Business ethics, which integrates social and economic bottom lines, leads organisations to eradicate unethical exploitation and urge them to improve their corporate social responsibility (Hutchins and Sutherland, 2008). In conclusion, sustainability is an emerging issue for business success.

This thesis will focus on environmental and social sustainability issues in the dairy industry, and the next section will discuss how the dairy supply chain affects environmental and social sustainable development.

1.2. Sustainability Issues in the Agri-food Supply Chain

The agri-food industry and its supply chains may have significant negative environmental and social impacts, including in terms of natural resource exploitation, greenhouse gas emission, and pollutant discharging. Worldwide, the agriculture sector consumes 70% of water resources (UN-Water and FAO, 2007). Crop production is a process of converting carbon and water into biomass, which makes intensive use of water resources. The agri-food sector was responsible for 18% of the UK's total GHG emissions, and 31% of those of EU countries (Garnett, 2008).

On the other hand, arable land is one of earth's limited resources, and intensification of agricultural farming inevitably leads to deforestation, which releases around 17% of the world's greenhouse gases (IPCC, 2007). Along with improvements on an economic level, humans' dietary structure is transitioning from cereal-originated protein to animal-originated protein (i.e. meat and dairy products) (Popkin, 2006). Moreover, more than a third of world grain outputs are used as feed for husbandry rearing (WRI, 2004), which has led to a surge in the use of land and water resources, and consequent damage to biodiversity and the equilibrium of the ecosystem (Gregory et al., 2005). Therefore, the husbandry segment carries a heavier environmental burden than does horticulture, as meat and dairy production are two of the most salient environmental stressors, accounting for more than half of the GHG emissions in the European agri-food sector (European Commission, 2006).

The research priority of this thesis is the British dairy sector and its supply chain, the largest subsector of UK agriculture, accounting for 17.8% of the total agricultural output in the UK in 2014 and worth £4.6bn in market prices (Baker and Bate, 2016). Although, in terms of economic output, the UK dairy sector only contributed 0.2% of UK GDP, it was responsible for 2% of the UK's total GHG emissions (DairyCo, 2012) and 1% of the country's surface and ground water extraction (Hess et al., 2012). The significant asymmetry between economic output and environmental impact will be probed in order to develop ideas on ways of reducing negative environmental impacts and promoting sustainable development in the British dairy supply chain.

1.2.1. The Introduction to British Dairy Industry

Dairy products are essential food for everyday life in the UK. Milk and milk products have played an important role in the life of the British since the Neolithic period (1900–1400 B.C.) (Jenkins, 1970). The DEFRA family food survey (2012b) gave the annual

consumption of dairy products per person as follows: liquid milk, 78.33 litres; yogurt, 10.12 litres; cream, 1.29 litres; butter, 2.15 kg; cheese, 5.93 kg; and dairy desserts, 2.13 kg. These figures demonstrate that milk and dairy products are an extremely important part of the British dietary structure.

The UK dairy industry is highly developed. As noted in Table 1.1, from 1962 to 2012, despite the UK's dairy cow head size being halved, the quantity of milk yield per cow was doubled. This was due to breed reformation and improvements in production efficiency. The demand for milk and dairy products in the UK domestic market is steady and self-sufficient (FAO, 2006b). In 2012, the total milk produced in UK was 13,345 million litres, and milk imports were minor (129 million tonnes).

Table 1. 1 Cow number, annual milk production and milk yield per cow of UK (FAOstat, 2012a)

	Number of Dairy Cows (Million)			**Annual Milk Production (Million tonnes)**			**Milk Yield per Cow (Tonnes)**		
Year	**1962**	**2012**	**Change**	**1962**	**2012**	**Change**	**1962**	**2012**	**Change**
UK	**3.33**	**1.81**	**-54.35%**	**12.30**	**13.88**	**+12.85%**	**3.69**	**7.68**	**+108.1%**

The distribution of UK dairy processors follows the '80-20 rule'. In terms of the volume of milk sourcing, the top 2% of UK dairy processors bought almost 70% of the country's annual UK milk production (DairyCo, 2014). Figure 1.2 ranks the key milk buyers in UK, in terms of the total milk purchased, as Arla food (UK), Dairy Crest, Müller Wiseman Dairies, First Milk, Meadow Food, Caledonian Cheese and Glanbia Cheese (DairyUK, 2014b). Additionally, Figure 1.2 indicates that all of the top dairy processors have a direct contract with at least 70% of their milk suppliers, which not only secures their milk pool but also guarantees the milk's technical, hygiene and sustainability standards.

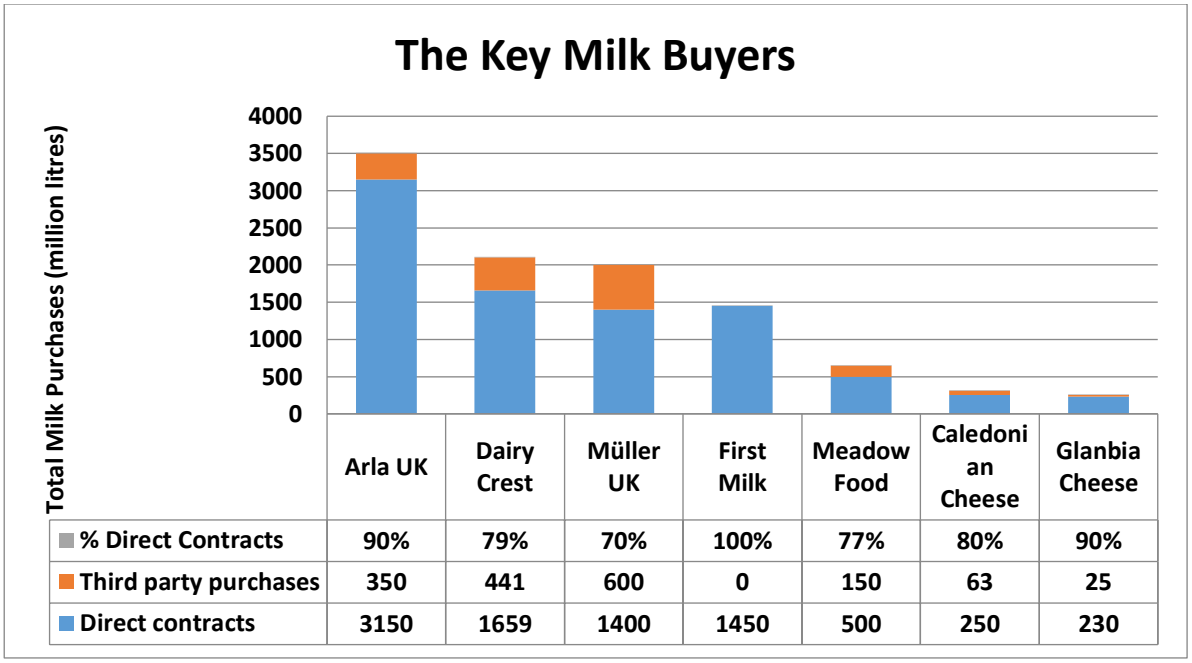


Figure 1.2 The key milk buyers in the UK

In terms of milk utilisation, Figure 1.3 shows that raw milk is processed into liquid milk (50.8%), cheese (27.4%), condensed milk and powders (8.8%), butter (2.2%), yogurt (2.0%) and cream (1.9%) (DairyCo, 2013b). Thus, it is evident that milk and cheese are the two most important dairy products, using more than three quarters of the UK's total raw milk. Numerous niche markets exist in the cheese-making business, with around 750 flavours of cheese produced in the UK, thus most cheese processors are SMEs (small-medium enterprises) (Harbutt, 2014).

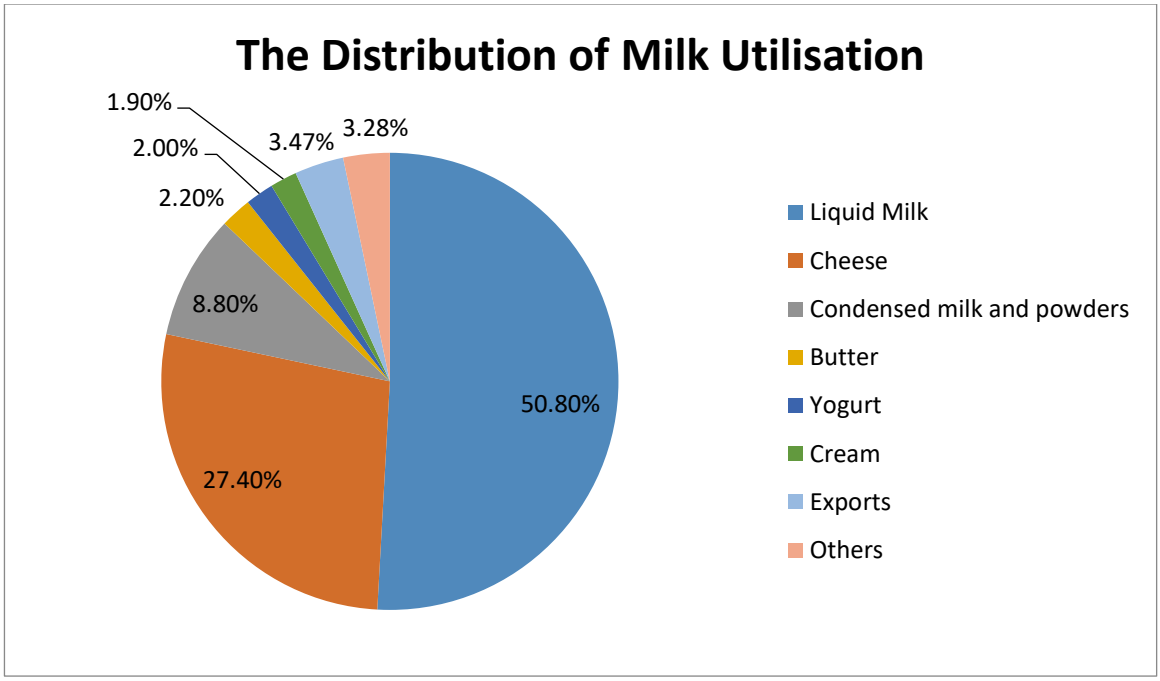
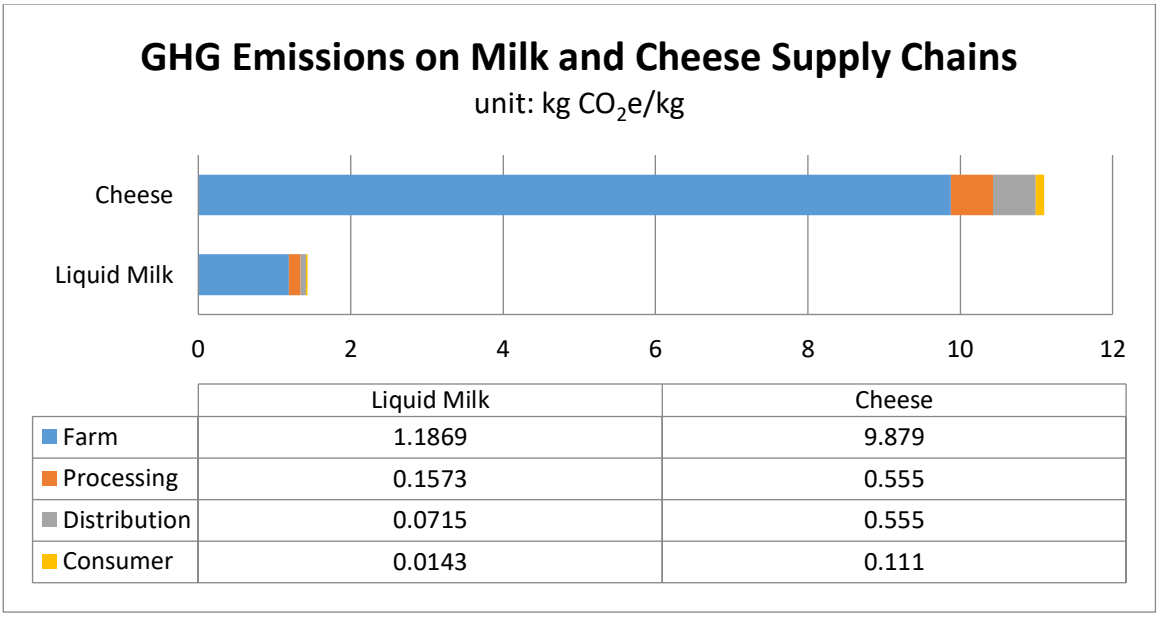


Figure 1.3 The distribution of milk utilisation

1.2.2. Sustainability Issues in Dairy Supply Chains

Dairy supply chains have significant negative impacts on GHG emissions, water pollution and land degradation, and most of these impacts are caused by dairy farming.

Dairy supply chains are highly GHG emission intensive. For instance, producing one litre of ready-to-sell milk emits 1,309 g CO_2e (carbon dioxide equivalent) along its supply chain (DairyCo, 2012), and for cheese the total is much higher, which mainly because making 1 kg of hard cheese is taking around 10 litres of milk (British Cheese Board, 2017). Figure 1.4 indicates 'hot spots' of GHG emissions in the milk and cheese supply chains, highlighting that more than 80% of GHG emissions are related to dairy farming (Sheane et al., 2011).



	Liquid Milk	Cheese
Farm	1.1869	9.879
Processing	0.1573	0.555
Distribution	0.0715	0.555
Consumer	0.0143	0.111

Figure 1.4 GHG emissions on milk and cheese supply chains

In addition, dairy farming is the largest contributor of methane (CH_4) and nitrous oxide (N_2O) in Europe (Weiske et al., 2006), with 52% and 27% of GHG emitted along the dairy supply chains being CH_4 and N_2O, respectively (FAO, 2010). Those biogenically-related emissions only generated on dairy farms, as detailed in Table 1.2, may come from feed production, rumen digestion and biomass waste disposal (Flysjö, 2012).

Table 1. 2 GHG emissions in dairy farming

Life cycle stage	**Emission type**
Animal feed production; Silage production	N_2O from fertiliser application
Cow's rumen digestion	CH_4 from enteric fermentation
Biogenic waste	CH_4 and N_2O from manure and urine disposal

Dairy supply chains are water-use intensive, with the production of one litre milk consuming 1,000 litre water, and cheese even more so (Gruener, 2010). Most of the water resources are used for dairy farming related purposes, such as livestock drinking, plate cooling, milking parlour washing, plant washing, general using, sprayer using, slurry flush systems, irrigation and domestic use (DairyCo, 2009).

Dairy supply chains have a strong impact on land use (Geist and Lambin, 2002). Dillon and Hoff (2013) demonstrate that only 40% of crop calories can be converted to animal calories through dairy farming systems, and the expansion of cropland can cause deforestation and damage biodiversity (Foley et al., 2011). The farmland bird index is a proxy for biodiversity, and it revealed that performance in 2011 was half of the 1970 level (GOV.UK, 2014).

As we can see, dairy farming is a significant factor in the pursuit of sustainable development in dairy supply chains.

1.2.3. Research Aims

In order to promote sustainable development, the government enacted both legally binding legislation and industry level policies to protect the environment and reduce waste energy. The Climate Change Act 2008 demands a reduction in the UK's GHG emission levels by 2050 of at least 80% of the 1990 baseline (Climate Change Act, 2008). The Department for Environment, Food and Rural Affairs (DEFRA) launched its 'Food 2030' strategy as a guideline for food supply chain stakeholders, to help them transform to long-term sustainable growth (DEFRA, 2010). The role of the food producer is to, *'reduce the impact they have on environment, manage natural resources and biodiversity even better, and adapt to a changing climate'*.

Specific to the dairy sector, DairyUK (2014a) is the UK's dairy industry-wide association, comprised of dairies and producer co-ops, and it published *'Leading the way – Sustainable growth plan'*. Most of the detailed terms in the plan focus on upstream supply chains, e.g. sustainable use of natural resources, minimising environmental footprint, enhancing biodiversity, and improving standards of animal health and welfare.

From national level legislation to industry level plans, sustainability has entered the sightline of the decision-maker, and subsequently become a real business issue, particularly in terms of the dairy supply chains.

The aim of this research is thus:

> To explore the promotion of sustainable development in the dairy sector through efficient supply chain management.

This guiding research aim and focus will now be explored through the literature to derive more specific research questions.

2. Literature Review

2.1. Introduction

In this chapter, a literature review is presented, which follows the logic of Table 2.1. All three sustainability strategies have implications for the dairy sector, as most of the environmental and social hot spots are around dairy farming, and therefore implementation of sustainable practices on farms is essential to improving sustainability levels for the dairy sector. Moreover, dairy processors and retailers also have an impact on sustainable farming, and can convey their own sustainability requirements and ambitions through use of sustainable procurement and supply chain management.

Finally, the literature review will be followed, at the end of this chapter, by a discussion of the research gaps and research questions.

Table 2. 1 Level of sustainable development studies

Sustainability strategy	**Sustainability implication**
Sustainable farming	Within farm's boundary
Sustainable procurement	Dyadic level, both farmer and processor
Sustainable supply chain management	Supply chain level, all supply chain stakeholders

2.2. Sustainable Farming

There are several ways for dairy farmers to implement sustainable farming. The IPCC (Intergovernmental Panel on Climate Change) details five principles for promoting sustainable dairy farming (Metz et al., 2007):

1) Enhancing carbon removals: measures to restore degraded lands, afforestation, no or minimum tillage, the incorporation of organic matter;

2) Optimising nutrient use: precise dosage and timing when applying organic and inorganic fertilisers; incorporating nitrogen-fixing legumes into rotations;

3) Improving productivity: approaches that increase the yield of edible output per unit of emissions generated including: crop and animal breeding; feed optimisation and dietary additives; pest and disease management;

4) Managing and benefiting from the outputs: including manure and plant biomass: composting, and the use of anaerobic digestion;

5) Reducing the carbon intensity of fuel inputs through energy efficiency improvements and the use of alternative fuels such as biomass, biogas, wind and solar power.

These five approaches are summarised as GHG emission reduction, farmland conservation, resource utilisation, and waste disposal (sections 2.2.1 – 2.2.4). In addition to environmental sustainability, social sustainability is a critical part of sustainable development and this will be discussed in section 2.2.5.

2.2.1. GHG Emission Reduction

Dairy farming is Europe's largest contributor of methane (CH_4) and nitrous oxide (NO_2) (Weiske et al., 2006), and thus there are many opportunities to reduce greenhouse gas emissions on a farm level. Quantification of carbon footprint is the cornerstone of the carbon controlling process. However, the history of carbon quantifying practices in milk production systems in Britain is relatively short. In 2010, then DairyCo launched a three-year project to measure the national average for greenhouse gas emissions in the UK milk production system, using actual farm data (DairyCo, 2012). The national benchmark project was initiated by Defra and supported by large and medium-sized dairy processors, with 415 farms participating in the research. The results indicated the GHG emissions ranged from 832 to 2,808 g CO_2e/litre, and 1,309 g CO_2e/litre on average (DairyCo, 2012). The variation in GHG emission figures showed the great potential for reduction.

At the agricultural stage, both technological and managerial approaches can be used to reduce GHG emissions. Beukes et al. (2010) examined three technical approaches to GHG reduction: introducing high genetic merit cows, use of fewer imported supplements to reduce embedded emissions, and reduction in herd replacement rate. Friel et al. (2009) proposed three managerial approaches: improving farming efficiency,

better land use and manure management, use of more renewable energies in place of fossil fuels.

2.2.2. Farmland Conservation

Farmland conservation is mainly achieved through sustainable management of soil practices, which can solidify nitrogen in soil, improve soil fertility, and restrain nitrogen related GHG release (e.g. nitrous oxide) (Schader et al., 2014).

Organic farming accreditation can improve farming practices, creating an incentive to achieve greater sustainability. The Soil Association is the largest approved organic control body in the UK. Regulated organic farming can lead to significant improvements in soil quality, and minimisation of chemical fertilizer and pesticide application (Jonathan, 2014).

In addition, the UK government funds Countryside Stewardship (CS) to encourage land managers to care for the environment. Dairy farmers join CS by participating in a series of environmental protection activities that could have significant effects on farmland conservation, and protect and improve natural habitats on dairy farms (Defra, 2015). A significant body of literature has emerged over the past twenty years or so in relation to such schemes and their effectiveness, but investigation of this literature is beyond the scope of this study, simply for reasons of brevity.

2.2.3. Resource Utilisation

On-farm energy use is an important source of GHG emissions in upstream dairy supply chains, e.g. diesel used for operation of machinery, and the electricity used for milking, cooling, and lighting (Flysjö, 2012). Use of more clean energy sources in place of fossil fuels would be one method of reducing GHG emissions. An anaerobic digestion (AD) system could collect and convert farm waste (e.g. manure, biomass waste) to biogas, then later converting this to electricity and thermal energy, and reducing the methane (CH_4) and nitrous oxide (NO_2) generated by inappropriate slurry management (Kay Camarillo et al., 2012). One study suggests that an AD facility can reduce on-farm GHG emissions by as much as 7.1% (Weiske et al., 2006). On the other hand,

installing PV (photovoltaic) panel on farms not only sustainably generates clean energy, but is also a financially attractive project, with farmers receiving subsidies called ‘feed-in-tariffs’ (FiT) and selling their generated electricity (Dairy Development Centre, 2012).

The Food and Agriculture Organisation of UN and International Dairy Federation (FAO and IDF, 2011) suggests that utilising farm inputs such as water and feed efficiently and sustainably can benefit both the environment and product quality. Sustainable feed production is that which manages fertiliser and pesticides application appropriately, and is neither harmful to the natural environment nor food safety (FAO and IDF, 2011). Therefore, efficient use of water and sustainable feed are critical approaches to promoting sustainable dairy farming.

2.2.4. Waste Disposal

Jonathan (2014) and Jurgilevich et al. (2016) indicate that increasing resource efficiency and reducing resource waste are important ways of helping farm to improve their sustainability. Any biogenetic waste (e.g. manure, urine, slurry) should be treated properly, otherwise the nitrogen and phosphorus contained within the waste can pollute underground water and cause greenhouse effects (FAO, 2006a). The AD system is not only an installation which turns waste into clean energy, but also a slurry disposal solution (Dairy Development Centre, 2012). In addition, the dairy farms on NVZs (Nitrate Vulnerable Zones) should obey stricter restrictions to prevent slurries percolating in the underground water (Defra, 2009a).

2.2.5. Social Sustainability

Social sustainability in the context of dairy farming is mainly concerned with the protection and improvement of animal health and welfare. There are three levels of animal health and welfare requirements: statutory, common, and additional requirements.

Statutory requirements are the minimal levels that every farm must meet. The statutory status is safeguarded by legislation, such as the Animal Welfare Act 2006, the Code of

Recommendations for the Welfare of Livestock, Keeping Farm Animals and Horses in Extreme Weather, Live Transport: Welfare Regulations. Genovese et al. (2013b) conclude that these compulsory hygiene, environmental and social conditions are pre-qualification requirements for milk selling, as milk producers who do not meet these conditions are considered to be in breach of the law.

The common level is a set of animal health and welfare requirements embedded in The Red Tractor Assurance scheme. 94% of milk and creams produced in the UK are assured by Red Tractor (Case, 2012), which asserts animal welfare protections beyond the statutory level in the following areas: animal health and welfare, proactive trace and management, artificially reared young stock calves, and livestock transportation process.

In addition to the statutory and common requirements, there are some higher ethical standards. The Welfare Quality Assessment Protocol for Cattle measurement takes into account the welfare status of the animals, including body condition, health, injuries, behaviours, and fearfulness (Welfare Quality Network, 2009). The RSPCA standard focuses on mobility and free range animals (RSPCA, 2011).

2.2.6. A summary of sustainable farming approaches

In conclusion, there are a variety of methods that can be used to improve environmental and social sustainability in dairy farming.

1) GHG emission reduction: quantifying GHG emissions, implementing technical and managerial processes to reduce GHG emissions
2) Farmland conservation: joining countryside stewardship schemes, protecting natural habitats, sustainable management of soil, joining the Soil Association
3) Resource utilisation: use of renewable energy sources and sustainable feed, efficient use of water
4) Waste disposal: anaerobic digestion installation, reducing waste generated at farm, excellent slurry management
5) Social sustainability improvement: complying with animal welfare requirements of Red Tractor, RSPCA's freedom foods welfare assessment protocol, Welfare Quality® assessment protocol

2.3. Sustainable Procurement

Sustainable procurement means buying sustainable alternatives, *'A company is no more sustainable than the suppliers from which it sources'* (Krause et al., 2009), which gives sustainable procurement an imperative role in achieving sustainable development (Joe et al., 2012). In this section, the core issues of sustainable procurement (SP) are discussed, e.g. drivers, barriers and performances.

2.3.1. History of Sustainable Procurement

2.3.1.1. Procurement Management

Until the late 1980s, procurement was regarded as a clerical and administrative task like record-keeping, rather than a strategic function, and thus little academic research considered procurement management at that time (Johnsen et al., 2014). Procurement became an academic issue when mass manufacturing works began moving to emerging countries (particularly countries with budget labour), and increasing numbers of Western enterprises began outsourcing their non-core business to third-parties in low cost countries, which in turn attracted intense attention to the issue of procurement management (Teece, 1986).

An investigation into 738 UK listed firms revealed that outsourcing levels have reached 78% in terms of revenue (Strassmann, 2004), and this prevailing of outsourcing activities has put procurement management in a central role to achieve competitiveness.

In traditional respects, procurement should stress price reduction and quality assurance, as summarised in the well-known '5R' definition: *'The management of an organization's interface with suppliers, ensuring that the right quantity is bought at the right time, at the right price, to the right quality specification, and from the right sources'* (Law, 2009). Through a strategic procurement lens, a firm's long-term competitiveness comes from how they source materials and services (Ryals and Rogers, 2006). Strategic procurement management engages in streamlining the supply base, negotiating with suppliers, and developing long-term relationships with reliable suppliers, all of which contribute to a firm's performance (Swinder and Srivatsa, 2001).

Kraljic (1983) proposes that, *'purchasing must become supply management',* because of *'purchasing should focus more on high value and high supply risk items and that these called for 'supply management' rather than 'purchasing management'*, which

raises procurement management to a more strategic level. In order to encapsulate the meaning of both purchasing and supply, many academic publications, such as the Journal of Purchasing and Supply Management, use both terms. Following more in-depth research into supply chain management, a trend of adding the word 'chain' to 'purchasing' and 'supply management' has arisen, thereby denoting system boundaries which go beyond supplier relationships to wider supply chain elements, such as higher tier suppliers, distributors and customers (Johnsen et al., 2014). Joe et al. (2012) detail three levels of analysis in purchasing and supply: dyadic, supply chain, and network. Almost half of the existing sustainable purchasing and supply research focuses on the dyadic level, although some of dyadic research claims to focus on supply chain or network level. Hence, sustainable purchasing and supply management research on the dyadic level (supplier relationship) is fundamental, and must be a cornerstone of further research in this area.

2.3.1.2. Sustainable Procurement Management

The history of sustainable buying behaviour can be traced back to the late 1970s. In 1977, the German Institute for Quality Control and Labelling launched the first environmental label in the world, ‘Blue Angel’, to be licenced for products and services with an environmentally-friendly aspect (THE BLUE ANGEL, 2015). Hemmelskamp and Brockmann (1997) elaborated on how Blue Angel labelled products could guide customers to select eco-friendly products, and to help sellers increase their market penetration. Between 1986 and 1994, the market shares of a new type of paint with little or no solvent, ‘emulsion lacquer’, increased 117% after it was accredited by ‘Blue Angel’ as a low-pollution paint, whilst traditional paints containing more solvent lost 10% of their market share. It should be noted, however, that most of customers purchasing Blue Angel labelled paints instead of traditional paints did so due to personal health concerns and concerns about toxic emissions, and the decision was less to do with environmental concerns.

It is widely believed that the first published sustainable procurement work was authored by Drumwright (1994). The paper argued that some American businesses had added social responsibility (represented by environmental performance) as a new type of criterion on sourcing in the early 1990s. This was underpinned by a survey investigation into 35 purchasing processes, which found business organisations adopting non-economic criteria mainly driven by the following four drivers:

1) The presence of skilful policy entrepreneurs, which play imperative roles. Those entrepreneurs are not government officials, but conduct new ideas in public practices;
2) Pressure from regulation;
3) Support from top management. Nonetheless, the all-out support of top management is not a necessary requirement for the successful implementation of social responsibility buying practices;
4) Perception of extrinsic rewards.

However, this initial research did not examine the barriers to, and benefits of sustainable procurement, nor did it give examples of buyers setting environmental criteria for supplier selection. Green et al. (1996), however, assessed six companies in the UK and revealed more information about this. Three of the six organisations had set environmental criteria in their procurement processes, particularly in the case of the company with the BS 7750 environmental management system (EMS). One of the companies was driven by their key customer, British Telecom (BT), a public corporation with advanced EMS and therefore stricter environmental requirements for their suppliers. The other three of the case companies had not engaged with sustainable procurement practices, but like the other three companies, had built partnerships with their suppliers for long-term continuous improvement and focus on other environmental practices, for example waste recycling, disposal and management, development of eco-friendly products.

The pertinent academic research in sustainable procurement emerged no earlier than 1997 (Handfield et al., 1997), a decade after the famous sustainable development manifesto arrived, describing the process as that which *'meets the needs of present without compromising the ability of future generations to meet their own needs'* (Brundtland, 1987). The emergence of sustainable procurement inspires procurement and supply chain practitioners to gauging the success of business not only by its traditional metric (e.g. price, quality, reputation) but also by its environmental and social performance.

Large et al. (2013) demonstrate that many German companies engage with sustainable procurement in logistics services sourcing on environmental and social aspects, e.g. reduction of emissions and land use, improvement in working condition. Zhu and Geng (2013) note that Chinese manufacturers have integrated environmental pollution and energy consumption criteria into their procurement decisions. Zailani et al. (2012) find that the Malaysian manufacturing industry seeks to mitigate its

environmental impact by promoting environmental purchasing and sustainable packaging.

The UK's '*Sustainable Procurement National Action Plan'* suggests that waste treatment issues should be considered an important criterion in the procurement process (Defra, 2006). Many UK based agri-food companies require their suppliers to conserve farmland, minimise waste generation and protect animal welfare by joining third-party assurance schemes, e.g. Sodexo (2011), which sources food from environmentally responsible farms who are members of LEAF (Linking Environment and Farming). Thus, as we can see, in addition to traditional procurement attributes, the firms seeking to practise sustainable procurement may scrutinise further on environmental and social criteria, e.g. greenhouse gas (GHG) emission, farmland conservation, waste reduction, resource utilisation, and ethical improvements. For the dairy sector, '*Leading the way - The British Dairy Industry's Sustainable Growth Plan'* (DairyUK, 2014a) offers more detailed environmental and social sustainability indicators that allow dairy producers and processors to work together to create a more sustainable future for the British dairy sector.

In conclusion, Joe et al. (2012) define sustainable procurement as, '*The consideration of environmental, social, ethical and economic issues in the management of organization's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the organization's primary and support activities provide value not only to the organization but also to society and the economy'.* In addition, they highlight that almost 70% of the research into sustainable purchasing focuses on environmental issues. This research thesis will therefore initially discuss environmental sustainability practice in the procurement process. Berry (2011) highlights radical differences in the orientation and principles of procurement in the public sector and private sector. In this research, we focus on ordinary business organisation, hence we pay attention to sustainability adoption in the private sector, rather than the public sector.

2.3.2. Drivers of Sustainable Procurement

Previous research suggests that there are multiple drivers and enablers of businesses' adoption of sustainable procurement. 'Institutional theory' was proposed by DiMaggio and Powell in 1983, and this postulates that there are three mechanisms which can induce organisations to adopt environmental management practice: coercive pressure,

mimetic pressure, and normative pressure. Based on institutional theory, Zhu and Geng (2013) work defines three types of pressures (drivers) acting on organisations to extend sustainability cooperation beyond the firm's boundaries, namely to upstream suppliers and downstream customers:

1) Coercive drivers, which are derived from influences exerted by legal power, such as *The Environmental Regulation, Climate Change Act, Pollution Prevention Law*

2) Mimetic drivers, which motivate companies to pay attention to external stakeholders with interests in the organisation. Typically, customers' preferences and requirements are core mimetic drivers

3) Normative drivers, which stimulate companies to learn from competitors in same business area

ElTayeb et al. (2010) classified five types of drivers: regulation, customer pressure, social responsibility, expected business benefits, and firm ownership. Moreover, Walker et al. (2008) conducted a systematic literature review of sustainable procurement drivers, and categorised them into two groups and six sub-group: internal (organisation-related) and external (regulatory, customers, competition, society, and suppliers).

This thesis largely utilises the categorisation method of Walker et al. (2008). However, whether suppliers are regarded as a driver is still up for debate. Although some suppliers may support core supply chain players to create environmental benefits, these efforts were normally counted as supply chain collaborations in the integration paradigm, rather than in the procurement domain. Indeed, empirical evidence suggests that proactive collaboration with first tier suppliers results in better environmental monitoring (Walker et al., 2008). In conclusion, this thesis does not consider suppliers as a driver of sustainable procurement.

2.3.2.1. Organisation

The internal drivers consist of multiple operational variables, such as the size of the firm, corporate culture, and preference for senior management and ownership. In some multinational corporations (MNCs), Western parent companies have a strong influence on their foreign subsidiaries in developing countries, compelling them to adopt environmentally and socially ethical purchasing practices because most European

Union and North American companies take environmental and social issues seriously (ElTayeb et al., 2010). Zhu and Geng (2013) also found that foreign manufacturers in China operated with high environmental standards, as such foreign corporations often had environmentally proactive cultures. On the other hand, in developed countries, large size companies and well-known brands tended to pay more attention to their environmental image than did SMEs, proactively sourcing from suppliers with high environmental and social standards. This was because those enterprises faced stricter scrutiny from outside stakeholders, and consequently attempting to avoid public embarrassment and reputation risk (Walker et al., 2008).

From another point of view, Blome et al. (2014) highlighted that firms' market performance and top management's commitment were antecedents to sustainable procurement and green supplier development, though the firms' financial performance was not a compelling influence on decisions. In addition, corporate functional strategies should align with general corporate strategies, therefore corporate strategies were a significant driver (Leppelt et al., 2013). Giunipero et al. (2012) found that top management support clearly drove companies sustainable sourcing behaviour; and similarly, Chan et al. (2012) established that a pro-environmental corporate culture was a driver of environmentally-oriented procurement.

2.3.2.2. Regulatory

Much research indicates that government regulation is the most important driver of a company's sustainability strategy (Giunipero et al., 2012, Hsu et al., 2013). For some transitional countries, despite a lack of compulsory regulation on sustainable procurement, the authorities legislate against toxic substance use and unmanaged pollutant emissions. In addition, the government strongly promotes '3R': the reducing, reusing and recycling of raw materials (ElTayeb et al., 2010). For instance, China's law on 'Prevention and Control of Atmospheric Pollution' strictly restricts sulphur dioxide emissions, with the result that thermal powerplants in China source low-sulphur coal in place of the high-sulphur variety (despite the latter being cheaper) in order to meet the pollution prevention requirement (Zhu and Sarkis, 2006).

However, in developed countries, like UK, although regulation undoubtedly plays an important role in motivating environmental practices, it is not decisive in private sector purchasing decisions (Walker et al., 2008), though some indirect regulations may refer to sustainable procurement, thus influencing companies' purchasing behaviour.

Genovese et al. (2013b) conducted a survey of 36 of the top 100 manufacturing factories in South Yorkshire, UK, and found those companies' procurement managers chose 'availability of a waste management system' as their first priority in terms of environmental criteria, as all organisations in the UK must comply with waste legislation and regulations on waste disposal.

2.3.2.3. Customers

Zhu and Geng (2013) indicated that companies often seek to cater to customers' requirements on green and ethical product preference, thus eco-labelling is increasingly promoted in order to allow customers to easily distinguish between eco- and non-eco-products. Hsu et al. (2013) named customer pressure as a principle motivator for sustainability supply chain practices, particularly green purchasing and reverse logistics.

2.3.2.4. Competition

In the private sector, an enhanced corporate social responsibility (CSR) profile can help to strengthen a company's commercial profit and market position in fierce competition (Walker et al., 2008). China, as an emerging country with rapid economic development and deep integration in the global market, is seeing many of its industries, such as the automobile industry, suddenly confronting heavy competition from their foreign counterparts. Since China joined the WTO, import tariffs for car have decreased and import quotas have been abolished, meaning that price is no longer a competitive advantage for the national auto industry. However, the 'greening' of production processes could generate a continuous competitive advantage for the country (Zhu and Sarkis, 2006).

2.3.2.5. Society

ElTayeb et al. (2010) surveyed 132 manufacturing businesses in Malaysia, looking at motivators for sustainable purchasing actions, and the results suggested that social responsibility was not a significant enabler, despite most claiming to be highly socially

conscious. However, in the UK, as non-governmental organisations (NGOs) exert increasing pressure on famous brands, more and more high profile companies have embarked on supplier assessment processes (Walker et al., 2008). In addition, whether or not a company is listed in sustainability indices (for example, the FTSE4Good Index and Dow Jones Sustainability Indices) also strongly influences the company's sustainable supplier relationship management (SSRM) (Leppelt et al., 2013). This is thought to be because listed companies are typically the leading companies in their industries, and are therefore under greater obligation to present an image to stakeholders of valuing sustainability, which they achieve by making public information on how they select their suppliers.

The FTSE4Good Index, which is "designed to measure the performance of companies demonstrating strong Environmental, Social and Governance (ESG) practices" (FTSE 2016).

Dow Jones Sustainability Indices track the stock performance of the world's leading companies in terms of economic, environmental and social criteria (DJSI 2016).

Most importantly, scrutinising suppliers in terms of sustainability can prevent the type of reputation damage that can be caused by upper supply chain players' environmental and social misconduct (Leppelt et al., 2013). For example, the collapse of a sweatshop in Bangladesh negatively affected the reputation of a British high street clothes brand.

2.3.2.6. A summary of drivers of sustainable procurement

In conclusion, Table 2.2 gives a summary of the drivers of sustainable procurement initiatives.

Table 2. 2 The summary of drivers of sustainable procurement

Author	Country	Industry	Method	Drivers
Internal – Organisational				
ElTayeb et al. (2010)	Malaysia	Manufacturing	Case	Company's ownership
Zhu and Geng (2013)	China	Manufacturing	Survey	Proactive environmental culture
Walker et al. (2008)	UK	Mixed	Case	Corporate's environmental and social image
Blome et al. (2014)	W Europe	Services and Manufacturing	Survey	Top management commitment
Leppelt et al. (2013)	Europe	Chemical	Case	Corporate's internal strategy
Giunipero et al. (2012)	USA	Mixed	Survey	Top management support
Chan et al. (2012)	China	Mixed	Survey	Pro-environmental corporate culture
External - Regulatory				
ElTayeb et al. (2010)	Malaysia	Manufacturing	Case	Government's regulation on reducing, reusing and recycling
Zhu and Sarkis (2006)	China	Manufacturing	Survey	Government's legislation on emission reduction
Green et al. (1996)	UK	Healthcare	Case	Governments' policies for achieving improved environmental performance
Handfield et al. (1997)	USA	Furniture	Case	Government regulation – environmentally-oriented laws
External - Customers				
Zhu and Geng (2013)	China	Manufacturing	Survey	Customers' requirement on environmentally friendly product
Hsu et al. (2013)	Malaysia	Manufacturing	Survey	Customers' pressure

Björklund (2011)	Sweden	Food and Forestry	Survey	Customers' environmental demand
Walker et al. (2008)	UK	Mixed	Case	Customers' environmental expectation
External – Competition				
Zhu and Sarkis (2006)	China	Manufacturing	Survey	Pursuing continuous competitive advantage
Rao and Holt (2005)	South East Asia	Mixed	Survey	Creating competitiveness by efficiency, quality and productivity improvement, also cost saving.
Melnyk et al. (2003)	North America	Mixed	Survey	Improve firm performance – reduced cost, waste and lead time; improved quality
Walker et al. (2008)	UK	Mixed	Case	Gaining competitive advantage
External – Society				
Leppelt et al. (2013)	Europe	Chemical	Case	Company's listing on sustainability indices / pressure by public
Hall (2006)	UK	Supermarket	Case	Pressure by environmental advocacy groups
Delmas (2001)	USA	Mixed	Survey	Non-economic external stakeholder (Community members)
Sharma and Vredenburg (1998)	Canada	Oil and Gas	Case & Survey	External stakeholder (local communities and environmental group) / Environmental award / preventing environmental crisis

2.3.3. Barriers of Sustainable Procurement

Walker et al. (2008) detailed five types of barriers to sustainable procurement: costs (internal), lack of legitimacy (internal), regulation (external), poor supplier commitment (external) and industry-specific barriers (external). This thesis relies largely on this categorisation, albeit with some reservations. Zhu and Sarkis (2006) identified that businesses in different industries faced different motivators and adopted different practices; and similarly, they encounter different barriers. Walker et al. (2008) categorised industry-specific barriers as an independent group, stressing the discrepancy between the public sector and private sector. This research only considers the private sector, hence industry-specific barriers will not be treated as a type of barrier listing below.

In addition, research suggests that a lack of resources (including tangible and intangible resources) is a barrier to the implementation of sustainable procurement (Zhu and Geng, 2013), and this research treats it as such accordingly.

2.3.3.1. Costs

ElTayeb et al. (2010) point out that businesses only adopt expensive green technologies and activities when there is expected profitability. On most occasions, expected profitability is not tangible, though the extra costs associated with conducting environmental best practice are obvious. In other words, *'There are conflicts between environmental variables and traditional supplier selection measures'* (Genovese et al., 2013b). Research from Leppelt et al. (2013) also supports this argument, pointing out that the development of sustainable supplier relationships costs money and time, for example in training staff and establishing codes of practice, whilst the benefits are intangible. Giunipero et al. (2012) also reported that preliminary financial and time inputs prevent companies from adopting sustainable purchasing practices.

2.3.3.2. Lack of Legitimacy

'Lack of legitimacy' refers to the lack of unified opinion amongst the top management of a company on investment in sustainable procurement practices (Walker et al., 2008). Appolloni et al. (2014) point out that the discrepancy between a company's short-term

and long-term goals, as well as a lack of support from the CEO level of the company, are hindrances to setting up sustainable procurement systems.

2.3.3.3. Regulation

Regulation is one of the most important drivers of sustainable procurement, but it can also act as a barrier. In the United States, CEOs from top companies in the chemicals industry (e.g. Dow and Texaco) complained about environmental legislation and regulations which merely force companies to comply, and fail to stimulate a spirit of innovation and responsibility (Popoff, 1995). Conversely, in most developing countries, such as China, environmental practices for energy saving and emission reduction (ESER) do not extend to upstream suppliers and/or downstream customers if the government only sets flexible or voluntary regulations (Zhu and Geng, 2013).

2.3.3.4. Poor Supplier Commitment

Genovese et al. (2013b) named a lack of transparency as a major barrier, with some suppliers reluctant to share their environmental and ethical performance records with the focal companies. Sometimes, though those records were obtained, buyers still struggled to make judgements on their reliability. Adapting sustainability beyond a company's boundary requires collaboration across the supply chain (Genovese et al., 2013b), with specific practices such as sharing environmental goals and environmental records, creating transparency and traceability, and working together (Vachon and Klassen, 2008).

Ageron et al. (2012) indicated that when one party, on the supplier side or buyer side, regarded sustainability as a new concept, a higher degree of dependency and trust was required between two parties. Therefore, it was difficult to accept the cost of investment in green upgrading, and the distribution of the profit and share venture, leaving suppliers reluctant to cooperate with the buying company.

2.3.3.5. Lack of Resource

In emerging countries, such as China, the difficulties in promoting sustainability in the extended supply chain come from a shortage of both tangible (financial and technology input) and intangible (management experience and intellectual property) resources (Zhu and Geng, 2013, Zhu and Sarkis, 2006). Such problems are also present in developed countries. Genovese et al. (2013b) claimed that one big obstacle was procurement professionals struggling to compare different sources as most environmental variables could not be quantified and were not intuitive. However, Blome et al. (2014) argued that financial resources had no positive correlation with a willingness and ability to employ environmentally-oriented procurement strategies for buying companies, whilst the market performance of the focal companies positively influenced procurement strategy.

2.3.3.6. A summary of barriers to sustainable procurement

In conclusion, Table 2.3 gives a summary of the barriers to sustainable procurement initiatives.

Table 2. 3 The summary of barriers to sustainable procurement

Author	Country	Industry	Method	Barriers
Internal - Costs				
Giunipero et al. (2012)	USA	Mixed	Survey	Financial and time inputs
Leppelt et al. (2013)	Europe	Chemical	Case	Cost expensive and effort input
ElTayeb et al. (2010)	Malaysia	Manufacturing	Case	week return
Internal – Lack of legitimacy				
Appolloni et al. (2014)	Multi	Mixed	Literature Review	Misalignment between company's short term goal and long term goal.

Greer and Bruno (1996)	Global	Chemical, energy, logging, and fishing	Case	Corporate create greenwashing, advertising green strategy while at the same time damaging environment
Min and Galle (2001)	USA	Mixed	Survey	Top management's lack of environmental commitment
External - Regulation				
Popoff (1995)	USA	Chemical	Case	Inhibits innovation
Zhu and Geng (2013)	China	Manufacturing	Survey	Poor execution of regulation and policy
External – Poor supplier commitment				
Ageron et al. (2012)	France	Manufacturing, Power generation, Pharmaceutical, Retail and Logistics.	Survey	Trust level between buyer and supplier
Genovese et al. (2013b)	UK	Manufacturing	Survey	Lack of transparency
Wycherley (1999)	UK	Beauty and Cosmetics	Case	Supplier unwilling to exchange information
External – Lack of resource				
Genovese et al. (2013b)	UK	Manufacturing	Survey	Have no ability to quantify supplier's environmental performance
Zhu and Geng (2013)	China	Manufacturing	Survey	Lack of appropriate management and expert resource

2.3.4. Benefits of Sustainable Procurement

2.3.4.1. Environmental Benefits

Pagell et al. (2010) highlighted that environmentally aware sourcing can lead to superior performance in multiple dimensions of the triple bottom line, of course including environmental performance. Zhu and Sarkis (2004) surveyed more than 100 firms in different Chinese industries, including automobile, power plant, electrical and electronic, chemical, steel, petroleum and pharmaceuticals, and found a clear and positive relationship between green supply chain management practices (GSCM) (including green purchasing) and environmental performance, e.g. emission and waste reduction, energy saving, and reductions in number of accidents. Ruparathna and Hewage (2015) reveal that reducing harmful emissions and waste generation have been noted amongst the benefits of implementing sustainable procurement practices in the Canadian construction industry. Moreover, Gimenez and Sierra (2013) highlight that waste reduction and improvements in recycling levels are two of the environmental benefits of operating sustainable procurement. Similarly, Blome et al. (2014) identify waste and packaging minimising as the most important environmental benefits.

2.3.4.2. Financial Benefits

Some previous literature suggests that sustainable procurement practices can boost a focal company's economic performance. Blome et al. (2014) concluded that green supplier development is a mutual process, which normally involves close collaboration, frequent communication, and trust-building. When a focal company invests effort in helping suppliers to reinforce their environmental ability, particularly in terms of transferring knowledge to their suppliers, then better economic performance by the buying company is expected. Conversely, if the buying company merely sources green products from suitable suppliers, this process itself does not result in increased profits or enlargement of market share. Chan et al. (2012) demonstrated a clear positive link between sustainable procurement and corporate performance in terms of financial and market position.

Financial benefits can be achieved through cost saving. Long-term cost saving by sustainable procurement practices has been observed in the Canadian construction industry (Ruparathna and Hewage, 2015). Carter et al. (2000) found that sustainable

procurement strategies can benefit focal firms by improving their net income and reducing costs. For example, Li et al. (2006) reported that sustainable procurement practices had created competitive advantages for organisations in the US construction material and equipment industry.

2.3.4.3. Operational Benefits

Appolloni et al. (2014) concluded that sustainable procurement practices could have a positive impact on a firm's operational performance in several aspects, including more efficient delivery of products and services to customers, and greater fulfilment of customers' requirements. Lee et al. (2012) investigated the causal relationship between GSCM practices and business performance in the Korean electrical and electronic industry, and found no direct link. However, GSCM variables all have positive, clear and definite links to operational efficiency, relational efficiency, and employee job satisfaction, with another test showing that all these factors, except employee satisfaction, were closely linked to business performance. Craig (2005) points out that sustainable procurement practices have a positive impact on product quality, lead time, and supply security in the US consumer product supply chain.

2.3.4.4. Social Benefits

Sustainable supplier co-ordination can support the implementation of social and green behaviours. Although social practices have no clear impact on cost reduction, nor do they lead to cost increases, and they can enhance corporate reputation by creating an image of social responsibility (Hollos et al., 2012). Wilhelm et al. (2016) highlights that employing sustainable procurement practices to source 'Fairtrade' accredited tea products can significantly improve farmers' livelihoods and prevent unethical working conditions in developing countries (i.e., use of child labour and harassment).

2.3.4.5. A summary of benefits of sustainable procurement

In conclusion, Table 2.4 gives a summary of benefits of sustainable procurement initiatives.

Table 2. 4 The summary of benefits of sustainable procurement

Author	Country	Industry	Method	Benefits
Environmental Benefits				
Ruparathna and Hewage (2015)	Canada	Construction	Survey	Reducing harmful emissions and waste generation
Gimenez and Sierra (2013)	Spain & Germany	Mixed	Survey	Waste reduction, increasing level of recycling
Blome et al. (2014)	Europe	Mixed	Survey	Waste and packaging reduction
Financial Benefits				
Ruparathna and Hewage (2015)	Canada	Construction	Survey	Long-term cost saving
Carter et al. (2000)	USA	Mixed	Survey	Improving net income, reducing cost
Li et al. (2006)	USA	Machinery, Equipment, Construction materials	Survey	Creating competitive advantage
Operational Benefits				
Craig (2005)	USA	consumer products	Survey	Improving product quality, reducing lead time and strengthening supply security
Lee et al. (2012)	S Korea	Electrical and Electronic	Survey	Developed stronger relationship with supplier
Social Benefits				

Hollos et al. (2012)	W Europe	Mixed	Survey	Enhanced reputation – positive effect on firm's performance due to selling environmental and social friendly products
Brammer and Pavelin (2006)	UK	Mixed	Survey	Better working condition, employee satisfaction
Wilhelm et al. (2016)	Africa, China	Food, Cloth	Case	Avoid unethical employment risk, improve farmer's income

2.4. Theories of Sustainable Supply Chain Management (SSCM)

Sections 2.2 and 2.3 argued that both sustainable procurement and sustainable farming have significant impacts on sustainable development. However, farming practices can only have sustainability implications within a dairy farm's own boundaries, whilst sustainable procurement practices involve dyadic buyer-supplier relationships and therefore may also affect suppliers. Beyond a dyadic relationship, procurement research can also be conducted on the supply chain level, incorporating suppliers, focal companies, and customers (Johnsen et al., 2014, Joe et al., 2012). In this section, two theories are presented to explain how sustainability requirements can be transmitted along multi-tier supply chains and how supply chain configuration can have an impact on sustainability performance.

There are different types of supply chain configurations in the British dairy sector. Genovese et al. (2013a) explain that supply chain configurations are differentiated by their inherent 'power fulcrum', or the key decision-makers within the supply chains. Glover et al. (2014) identify supermarkets (retailers) as the key power fulcrum in the British dairy supply chain, with supermarkets holding much more power than other

stakeholders in the supply chain and exerting pressure on other organisations. On the other hand, there are also many small and localised dairy company operations in the UK (Harbutt, 2014), most of which are both dairy producer (farmer) and dairy processor. These operations do not source milk from other farms, and they serve their products to local residents and businesses. Therefore, two distinct supply chain configurations exist and are explored in this research. With a similar supply chain configuration to that of Energy Efficiency Retrofitting Services (EERS), the long, national supply chain configurations are defined as 'powerhouse', with low degrees of localisation and SME involvement. This ensures the optimisation of economic scale and highly standardised raw materials sourced, whereas the later short and localised configurations are defined as 'duet', with high degrees of localisation and SME involvement. For this reason, economic scale and standardisation of raw material is maintained at a low level (Genovese et al., 2013a).

Firstly, agency theory is reviewed here, as a very important theory for understanding how sustainability requirements are conveyed from the principle (retailer) to the second-tier agent (dairy producer, farmer), via an intermediate first-tier agent (dairy processor). The theory emphasises that first-tier agents can affect the transmission of sustainability requirements (Wilhelm et al., 2016). In a multi-tier dairy supply chain context, the first-tier agent is the dairy processor, and agency theory can be used to understand the functions of the dairy processor in terms of improving supply chain wide sustainability performance.

Secondly, it is very meaningful to compare the sustainability performance of long national supply chain and short localised supply chain, the significant differences between these two supply chain configurations are in connectedness to nature (CTN). The former has the weak connection to nature since the milk is sourced from numerous dairy farmers in the nation, while the latter has the strong connection to nature because the dairy producer owns the land and animals. Gosling and Williams (2010) suggest the pro-environmental behaviors increase with connectedness to nature (CTN), the CTN theory will be reviewed and applied in this research to help to understand the factors may have implications for sustainability performance in different supply chain paradigm.

2.4.1. Agency Theory

Agency theory was developed to resolve the problems arising out of unaligned goals or different aversions to risk levels in agency relationships composed of two parties: principal and agent. It is assumed that agents' behaviours are driven by self-interest and opportunism; therefore, in a business context, when the principal organisation delegates work to an agent, it is difficult for the principal itself to monitor the agent's activity for two reasons: firstly, information asymmetry puts the principal in a disadvantageous position, and second, there is conflict between principal's and agent's goals (Eisenhardt, 1989).

In multi-tier supply chains (MSCs), first tier suppliers play a critical and complex role in achieving sustainability compliance along the supply chain. On one hand, first tier suppliers must satisfy the sustainability requirements of the lead firm (primary agency role); whilst on the other, as the majority of environmental violations and social scandals are caused by sub-suppliers rather than direct suppliers (Plambeck, 2012), first tier suppliers must also enable second-tier suppliers to comply with those requirements in their operation (the secondary agency role). For this reason, first tier suppliers are said to have a sort of 'double-agency' role when it comes to sustainability practices in supply chains (Wilhelm et al., 2016).

Figure 2.1 illustrates the structure of principle and agency relationships in three-tier supply chains. First tier suppliers have to strike a balance between operating their businesses profitably and legitimately. The former can come from improving operational efficiency, and the latter can be achieved by complying with institutional and regulatory requirements. When facing a lead firm's requirements, first tier suppliers may display different attitudes, from completely fulfilling the sustainability requirements, to 'paying lip service' to compliance, to rejecting them entirely (Christmann and Taylor, 2006). Whether sustainability requirements can be disseminated and implemented across the upstream supply chain is dependent on the coupling or decoupling of the first tier supplier's secondary agency role.

Wiese and Toporowski (2013) also emphasise that, based on the complex food supply chain structure, with hundreds or thousands of small farmers on second tier and a few cooperatives and firms on first tier, the lead firm must rely heavily on first tier suppliers to monitor farms' production in terms of production efficiency, safety and sustainability. In addition to information asymmetry and incentive alignment, the two paramount factors influencing principle-agent relationship, Wilhelm et al. (2016) highlights several contingency factors that affect the exercising of the secondary agency role of a first tier supplier: the lead firm's focus on three-pillar sustainability construct, the first tier

supplier's internal resource availability, the coordination of lead firm's internal sustainability strategy and purchasing function, and the lead firm's use of power.

Figure 2. 1 Principle and agency relationship in three-tier supply chain structure

2.4.2. Connectedness to Nature Theory

Connectedness to nature (CTN) theory suggests that "a relationship with the natural world directly affects people's physical, mental and overall being due to benefits gained by increased exposure to nature and positive experiences in the natural world" (Tauber, 2012). Figure 2.2 presents a relationship between connectedness to nature (CTN) and pro-environmental behaviour, several papers have verified the CTN can positively affect the pro-environmental behaviour, for example Gosling and Williams (2010) identify Australian farmer's vegetation protection behaviours increased with CTN; Mayer and Frantz (2004) conclude the CTN is an important antecedent of ecological behavior such as sustainable consumption; Fox and Xu (2017) investigate tourist's recycling behavior in national park and find individual's feelings and attitudes toward nature are influenced by their social-cultural constructions, particular their current living space. Nevertheless, it is very important to understand the reasons why connectedness to nature results in pro-environmental behavior in a positive way. The basic notion to understand this relationship is from a psychological perspective.

Sustainability can be understood from different points of view in terms of the position and opinion of the user: ecocentrism and anthropocentrism (Calker et al., 2005). Ecocentric perspectives posit that humans are not inherently superior to other living beings, and therefore value nature for its own sake. The anthropocentric perspective, however, focuses on the sustainable welfare of humans, thus valuing nature because of the material or physical benefits it provides for humans (Barrett and Grizzle, 1997, Gagnon and Barton, 1994). Schultz et al. (2004) demonstrate a positive relationship between ecocentric concerns and CTN, and negative relationship between CTN and anthropocentric concerns; Nilsson et al. (2016) find individual's strong ecocentric and anthropocentric values were associated with positive and negative evaluation of

environmental policy proposal; Quinn and Burbach (2008) focus on how farmer's personal characteristics influence their adoption of best management practices for improving water quality: positive correlation of pro-environmental behavior with ecocentric moral reasoning about environmental issues, and negative correlation between pro-environmental behavior with anthropocentric moral reasoning. Therefore, it is clear that ecocentric/anthropocentric value-orientation toward environmental issues act as a crucial role to mediate the relationship between CNT and pro-environmental behavior.

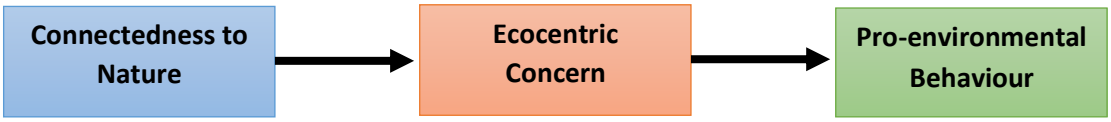


Figure 2. 2 relationship between connectedness to nature (CTN) and pro-environmental behavior

2.4.2.1. Environmental Ethics

Understanding the motivation and composition of environmental concern is crucial to the study of society's engagement with environmental problems (Rhead et al., 2015). This section will follow environmental ethics approach to review current literature on what are the distinctions between different environmental value orientation and how to measure environmental attitude.

2.4.2.1.1. Distinctions between different environmental value orientations

Although individuals express similar environmental concerns and interest in preserving natural resources, their motives are distinct (Gagnon and Barton, 1994). Seligman (1989) analysed environmental ethics and concluded two motivations for environmental protection. First, a human-centred utilitarian approach considers the environment necessary to satisfy a variety of human demands (recreational, aesthetic, convenience, and survival), and therefore considers environmental pollution a threatens to the satisfaction of human needs. However, the utilitarian position is not sufficient to provide an ethical ground for natural protection. Thus, an alternative approach gives moral consideration to non-human elements (animals and plants) in the planet.

Gagnon and Barton (1994) offer two value orientations for the preservation of environment: the ecocentric perspective, which posits that humans are not inherently superior to other living beings; and the anthropocentric perspective, which focuses on the sustainable welfare of humans, valuing the environment for its role in serving

human interests. The table below illustrates the differentiation of ecocentrism and anthropocentrism in terms of motivation for environmental attitudes and environmental behaviour.

Table 2. 5 The comparison between ecocentrism and anthropocentrism in terms of attitudes toward the environment (Gagnon and Barton, 1994)

	Ecocentrism	Anthropocentrism
Motives underlying environmental attitudes	Valuing nature for its own sake	Valuing nature because of material or physical benefits it can provide for humans
Motives for preserving natural resources	Nature deserves protection because of its intrinsic value, regardless of the economic or lifestyle implications of protection	Human comfort, quality of life, and health can be dependent on the preservation of natural resources and a healthy ecosystem

Epistemologist discrepancies exist in the human motivations for the preservation of the environment, which leads to discrepancies in how people understand 'sustainable development'. Two widely used definitions of sustainable development are offered by *Our Common Future* (Brundtland, 1987) and *Caring for the Earth* (Munro and Holdgate, 1991). They are respectively:

- 'development that meets the needs of present without compromising the ability of future generations to meet their own needs'

and

- 'development that improves the quality of human life while living within the carrying capacity of supporting ecosystems'.

It is obvious that sustainability can be understood from different points of view, therefore, it is important to understand how to evaluate ecocentric and anthropocentric values and attitudes.

2.4.2.1.2. Evaluation of ecocentric and anthropocentric values and attitudes

There are several ways of measuring ecocentric and anthropocentric values and attitudes. The most widely applied is the evaluation method proposed by Gagnon and Barton (1994), which has been used for many researches, such as Ruiz-Ruano and Puga (2016), to evaluate ecocentric and anthropocentric values of potential entrepreneurs. Amérigo et al. (2007) evaluated the cognitive components of the environmental attitudes of citizens of Madrid. Kopnina (2013) proposed the method of 'Ecocentric and Anthropocentric Attitudes towards Sustainable Development' (EAATSD), used to measure the distinction between the anthropocentric and ecocentric view of the environment. New Environmental Paradigm (NEP) can be used to measure environmental value orientation, and this strongly suggests that high NEP scores are correlated with pro-environmental attitudes. Gangaas et al. (2015) employed NEP to test the attitudes of human tolerance for carnivores in Norway and Sweden. The drawback of this method is that it can only provide ecocentric indicators and cannot be applied to anthropocentric attitude measurement.

Notwithstanding, the items used for ecocentric / anthropocentric attitude measuring can be further developed in order to be more country-focused or industry-focused. For example, Siegrist (1996) developed a Garman version measuring scale to be used in Germany which is extended from Gagnon and Barton (1994). The core measuring theory of Gagnon and Barton (1994) is that appraising ecocentrism by behaviours expressed appreciating nature for its own sake, positive affect associated with being out in nature and seeing a connectedness between humans and animals; and it appraise anthropocentrism by behaviours reflected a concern with environmental issues primarily because of their effects on human quality of life and survival. Larrère and Larrère (2007) further explained anthropocentrism can be gauged by behaviours reflected a focus on instrumental value of the resource they draw from their environment.

In conclusion, Agency theory can be used in this research to understand how sustainability requirements are conveyed from retailer to farmer in long and national supply chain. CTN theory can be employed in this research to understand the variation of sustainability performance caused by different supply chain configurations and what environmental value-orientation frames the sustainability commitment in different supply chain types.

2.5. Research gaps and research questions

Several research gaps have been identified from the literature review:

1) On the dairy farm level, several surveys have investigated the penetration rate of single sustainable farming practice. For example, DairyCo (2012) investigated the penetration of GHG emission reduction practice, and NNFCC (2016) reported the penetration of installations of on-farm AD system. Nonetheless, to the author's knowledge, no research provides the results of a comprehensive survey on diffusion of all key environmental and social sustainability practice. Some top UK dairy companies claim that they offer financial bonuses to their farmers for meeting suppliers' sustainability requirements (Arla, 2015a, Dairy Crest, 2012), however this has not been validated on the dairy farmer side. In addition, it is unclear whether farmers supplying milk to small-medium dairy company receive financial support.

2) In studies of the dyadic relationship, some papers have identified supplier selection criteria in agri-food industry. Dimitrios et al. (2005) found error-free delivery, on-time delivery, delivery of product without defects, efficient handling of returned products, reporting shortages in the order, offers of technical information, and rapid responses to customer requests were the key attributes buyers sought in the Greek sausage supply chain. Melina et al. (2006) identified procurement price as the paramount factor in supplier-retailer relationships in the Australian fresh produce supply chain. Lin and Wu (2010) named the most important factors when sourcing fresh products for Taiwan supermarkets as being price, quality, and product consistency. Ray and Andrew (2003) noted five factors that UK supermarkets emphasised when building sustained buyer-supplier relationships as velocity, flexibility, quality, cost, and service.
   Notwithstanding, all of these researches focused on traditional procurement criteria rather than sustainable procurement criteria. Sustainable procurement in the food supply chain aims *'to ensure the best of the food supply chain's ability, products or goods purchased have no, or a limited, negative impact on the communities and ecosystems from which they are sourced'* (IGD, 2008). After 2008, some papers touched on integrating triple bottom lines (TBL) on procurement practice. Sustainability criteria, including environmental issues, waste management and local food preference, became compulsory requirements

for food procurement of Finland school meals (INNOCAT, 2015). Nutritional value and packaging reduction are the top priorities of procurement managers when sourcing food in British and Irish zoos (Jonathan and Diane, 2014). However, schools and zoos are non-profit driven public organisations. They fulfil an educational function for children and teenagers, as well as promoting environmental awareness to public (Ulla, 2012). There is no existing research on sustainable procurement in the private agri-food sector, e.g. dairy sector, hence the diffusion of sustainability requirements between dairy processors is unavailable, and the drivers, barriers and benefits of implementing sustainable procurement practices are as yet unknown.

3) On a supply chain level, research on the British dairy supply chain employing double agency theory is unknown. This theory could be used to understand how sustainability requirements are conveyed from focal company to dairy farmer, and this understanding could then guide supply chain stakeholders to further improve their sustainability practice. Since different industries have different traits, the conclusions of previous studies may not apply to the dairy industry, e.g. Wilhelm et al. (2016) considers the tea supply chain, however tea farmers are located in low cost countries where institutional pressure to ensure ethical production is relatively weak. In addition, milk consumers are seeking a fresh taste (Helene and Fidelma, 2002), and therefore small-medium companies tend to operate on a short local supply chain. Styles et al. (2012) found businesses operating on short supply chains were more proactive in taking up environmentally-oriented procurement practices than were their counterparts on longer supply chains, but whether this is applicable to the dairy supply chain is as yet unknown.

Corresponding to these research gaps, several research questions have been identified:

RQ1: For dairy producers, what sustainability practices are required of their milk buyers?

RQ2: To what extent do dairy processors engage in sustainable procurement practices?

RQ3: What are the drivers, barriers, and benefits of implementing sustainability practices for dairy processors?

RQ4: Are there different supply chain structures in the dairy sector? If yes, will this have any impact on sustainability practice implementation?

RQ5: How can sustainability diffusion be improved throughout the dairy supply chain?

3. Research Methodology

3.1. Introduction

The research questions have been listed in chapter 2, in order to find the best ways to answer those research questions, this chapter is aiming to explore research methodology and data collection method according to “research onion” paradigm (Saunders et al., 2009). Figure 3.1 illustrates the approaches to narrow down a research methodology, then the following sections are organised by sorting them in research philosophy, research method, data method and finally questionnaire design.

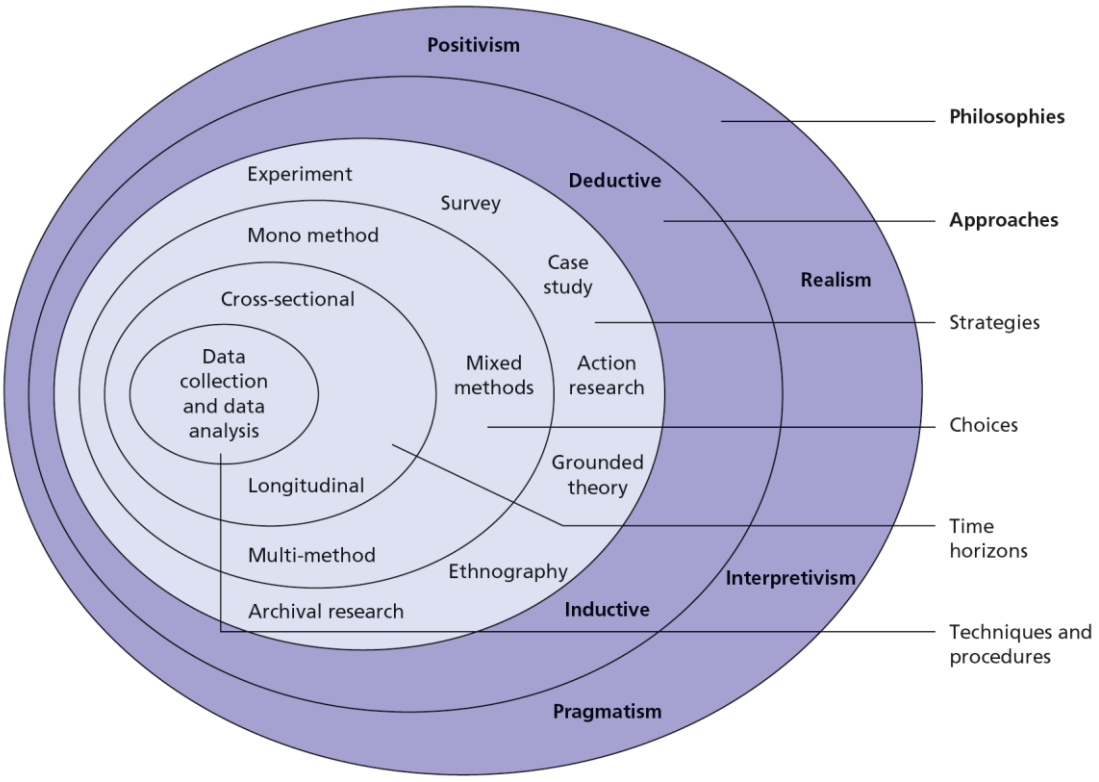


Figure 3. 1 Research Onion

3.2. Research philosophy and approach

The main purpose of this research philosophy section is to clarify what philosophical stance will be used in this study, which requires to critically think over philosophical choices and justify why not to adopt the alternatives (Johnson and Clark, 2006). In this research, the belief about the approach to discover knowledge about the world is critical realism. Table 3.1 detailed how to understand critical realism philosophy through three philosophical assumptions – ontology, epistemology and axiology (Saunders et al., 2009).

Table 3. 1 The understanding of critical realism philosophy

	Critical Realism
Ontology	- Layered (the empirical, the actual and the real) - External, independent, intransient - Objective structures - Causal mechanisms
Epistemology	- Epistemological relativism - Knowledge historically situated and transient - Facts are social constructions - Historical causal explanation as contribution
Axiology	- Value-laden research - Researcher acknowledges bias by world views, cultural experiences and upbringing - Researcher tries to minimise bias and errors - Researcher is as objective as possible

Ontology: This study sees reality as external and independent, also it is layered. Fleetwood (2005) highlights reality can be understood from three layers: empirical, actual and the real . What the people experience is empirical, which means sensations - the image of the things in the real world rather than the actual things. Then, the observed empirical experiences are only a small fraction of the “actual”, furthermore, “actual” is generated by “real” – the causal structures and mechanisms (Bhaskar, 1978). This study believes the empirical is the events that dairy supply chain stakeholders are actually observed and experienced, e.g. the sustainability practices

they participated, which all are representations of the actual – the full image of their sustainable attitude. Then, the real is the underlying causes of the situation (the actual) – the causal mechanism, e.g. relevant theories.

Epistemology: Epistemology refers to “a general set of assumptions about the best way of enquiring into the nature of reality” (Easterby-Smith et al., 2012). Social facts are socially constructed rather than socially isolated, its dependence on contingent aspects of our social selves (Bhaskar, 1989). Thus, different needs, values and interests can constitute to different social constructions, which affect the social facts built on it (Boghossian, 2001). Furthermore, the world is constantly changing with an enduring property, therefore, this research stands on the viewpoint of epistemological relativism, which believe knowledge is historically situated as well as geographically situated. In relation to this study, the sustainability attitudes of dairy supply chain stakeholders can be different in different time and different country. Thus, epistemological relativist notions of causality are impossible to be reduced to statistical correlations, then several research methods are acceptable (Reed, 2005).

Axiology: Followed by critical realist believes that human’s knowledge of reality is influenced by social conditioning then have to be understood in consideration of social facts (Dobson, 2002), on the other hand, researcher’s world view, cultural experiences and upbringing may display bias on the process of understanding knowledge (Saunders et al., 2009), then an appropriate research method should be choose to reduce these bias to minimise level and try to be as objective as possible.

Since the philosophical stance in this research has been cleared, which enable researcher to choose the most suitable methods for the nature of research (Easterby-Smith et al., 2008). Before entering next section to discuss the method to be used for this research, it is very crucial to decide which approach is opted for theory development. By efficiently integrating deductive and inductive approach, abductive approach *“begins with the observation of a ‘surprising fact’; it then works out a plausible theory of how this could have occurred”* (Suddaby, 2006). The abductive approach is adopted for this research for two reasons: firstly, remarkable facts observed from initial analysis can be explained by using appropriate theories; secondly, following by applying these theories, more notable facts can be uncovered (Maanen et al., 2007).

3.3. Research Method

The selection of research method should always depend on the nature of research and research questions. For this research, survey method is the most appropriate for five reasons:

1) Firstly, it allows the research focusing on contemporary events (Yin, 2009);
2) Secondly, its suitable for the exploratory nature of this research, especially it compatible with the initial approach of surveying sustainability attitudes of dairy farmers and dairy processors (Saunders and Lewis, 2012);
3) Thirdly, survey research enables analysts move beyond the initial observation to examine the role played by several intervening variables (Babbie, 1990);
4) Fourthly, it provides superior level of data standardisation and reduce researcher's bias to minimise level (Robson, 2011);
5) Fifthly, it permits to collect information from a large set of people or company, with anonymous option (Robson, 2011).

Since the research method is identified, the following parts are going to explore the most suitable sample selection techniques followed by questionnaire design.

3.3.1. Sample selection

The research questions involve two major stakeholders in dairy supply chain – dairy producer (dairy farmer) and dairy processor (dairy company), hence, sample selection should cover both dairy producer and dairy company.

3.3.1.1. Dairy producer

The author attended *Total Dairy Seminar* in Bristol on 1st and 2nd June 2016 then collected data by delivering and collecting questionnaire. There are two reasons for selecting samples by this way: Firstly, there were around 10,000 dairy producers in the UK (DairyCo, 2015b), unfortunately, it is very unlikely to retrieve all dairy producers information by yellow page or other public available channel; Secondly, *Total Dairy*

Seminar is an occasion for sharing latest dairy technology and management knowledge, it is a national conference which attracts around 100 dairy farmer from different regions of the UK every year to attend (TotalDairy, 2016). Then *Total Dairy Seminar* is a great opportunity to captive audience therefore more likely to achieve a high response rate by distribution and collection of questionnaire than any other data collection approach. Nonetheless, it is acknowledged that there are also some negatives of this approach due to failure to use a probability sampling technique, i.e. chance of only local farmers turning up, biased sample due to only 'progressive' farmers attending.

3.3.1.2. Dairy processor

Unlike dairy producer, the population size of dairy processor is manageable and all information of dairy processor is publicly available. Therefore, it is theoretically possible to collect data from the entire population. There are two types of dairy processor: Approved Milk Purchaser (AMP) and Approved Dairy Processing Plant (ADPP). AMP is buyer who purchased milk in wholesale way from milk producers to treat, process or resell to another firm to treat or process; ADPP is regulated food business handling milk and dairy products. There are some differences between two types of dairy processor.

1) Only AMP were allowed to buy milk directly from dairy producer before the lifting of EU Milk Quota System on 31st March 2015, this because of two reasons: Firstly, AMP should report technical specifications (e.g. volume of milk delivered and weighted butterfat content) for national statistical purpose; Secondly, it was required for milk quota management. Therefore, all AMP can source milk directly from dairy farmers, then AMP can either process milk or resell milk to another firm, the reselling model is called agent purchasing - buying milk in bulk way and selling milk in wholesale way (Rural Payments Agency, 2014). Whereas ADPP may buy milk from wholesaler (agent) or they may be on-farm dairy (both milk producer and processor).

2) Traditionally, AMP is composed by large and medium size dairy companies whereas ADPP is composed by small and micro size companies. In 2016, there

were 102 AMP and 1,023 ADPP (Rural Payments Agency, 2015, Food Standards Agency, 2016), the number of ADPP was ten times to AMP, it is obvious that the large majority of dairy processors are small and micro business.

Notwithstanding, this research conducted a population refining process to minimise unqualified survey targets, followed by sampling, in order to get better representative of entire population, also implemented a pilot study to help choosing more appropriate data collection technique.

1) Population refining: there were a total of 1,125 dairy processors in UK in 2015 (102 AMP and 1,023 respectively), however the AMP list and ADPP list includes many duplicated information and out-of-date information. In addition, all non-dairy-processing focused businesses in ADPP list are excluded (e.g. cold storage, distribution). The processes for excluding these unqualified survey targets have been mentioned in Appendix 1. Thus, the entire population reduced to 898, where AMP reduced to 93 and ADPP reduced to 805.

2) Sampling: Based on the business registration details documented in ADPP, businesses are categorised into 11 groups according to the nature of business (listed on table 3.2, the methods of categorisation are detailed in Appendix 1). This research is prioritising on dairy processors, therefore all AMP and ADPP group 1 – 5 (i.e. dairy company, cheesemaker, ice cream maker, milk powder maker, butter maker and yoghurt maker) has been identified as the sample. Thus, the sample number is 500.

Table 3. 2 Categorisation of approved dairy businesses

Dairy Processor Type	Business number
AMP - Total	93
ADPP - Total	805
1. Dairy Company	173
2. Cheesemaker	147
3. Ice Cream	78
4. Milk Powder	4
5. Butter	2
6. Yoghurt	3
7. Dessert & Bakery	13
8. Food & Beverage Manufacturing	136
9. Food Service & Hospitality	69
10. Dairy Farming	165
11. Intermediate Product	15
AMP + ADPP	898

3) Pilot study: This research did a pilot study prior to the formal distribution of questionnaire. In pilot study, the questionnaire was administrated by online survey software *Qualtrics*, the questionnaire was distributed by email to the milk purchasing manager of dairy processors in AMP list. Unfortunately, from 93 questionnaires distributed, only 1 was completed. Since dairy processor is organisation rather than individual, Baruch and Holtom (2008) examine that conducting questionnaire survey to organisation has much more challenge than individual and the response rate of organisation is at least a third lower than those of individual. This is mainly because that many organisations may have strict and explicit policies against sharing information to external parties (Fenton-O'Creevy, 1996), this also may have implications on refusing to complete the questionnaires from large and nationwide dairy companies. Nevertheless, Jobber and O'Reilly (1998) suggested that guarantee of anonymity and using more formal documentation type (i.e. postal questionnaire with returned envelop) can improve response rate. Moreover, Baruch and Holtom (2008) reported making the intension of research more relevant to organisation's interest can reduce refusing rate. Thus, the data collection technique of dairy processor research was altered to postal questionnaire with stamped returning envelope provided. In addition, the cover letter of the

questionnaire was given more stress on the facts that data anonymity is guaranteed and research design is approved by ethical committee; also, participant can get access to the wider results of this research which can benefits their further sustainability improvement. Research employed postal questionnaire approach in the UK can be expected to get around 10% respond rate, e.g. Holt and Ghobadian (2009) got 13% and George and Thomas (1998) got 12.5%. The expected low response rate could decrease the sample size to less than 100, as it large and national dairy processes are expected to be reluctant to participate in this research. The majority of the respondents are therefore likely to be small and localised processors, which may affect the representativeness of the samples.

3.3.2. Questionnaire Design

The questionnaires for dairy producer and dairy processor are attached in Appendix 2 and 3, respectively. Table 3.3 presented the logic of questionnaire design is in corresponding to relevant literature review and in order to answer research questions. In addition, business background information is asked. Caniëls et al. (2013) examined that companies of different size can have different drivers and barriers for adopting sustainability practices. Company size can be distinguished by number of employee (Genovese et al., 2013b), or it can be classified by cow number and volume of milk produced per annum either (AHDB Dairy, 2012). On the other hand, business's sustainability orientation can be highly influenced by their downstream supply chain structure. For those operating business in business to customer (B2C) markets may face stronger incentives than business operating in business to business (B2B) markets (Hoejmose et al., 2012). Also Chan et al. (2012) outline that business's sensitivity to environmental demand of external stakeholder is a crucial driver for firm being more sustainable in highly competitive market. Therefore, business size, milk and dairy product destination should be included in questionnaires of both dairy producer and processor. Except that, since on-farm dairy (dairy producer with processing function) do not source milk, for those interviewee, it is allowed that answering "drivers, barriers and benefits" of sustainable procurement for "drivers, barriers and benefits" of sustainable farming instead; also question "sustainability requirements of your supplier" can be answered to "sustainable farming practices they

have adopted" instead. Finally, both questionnaires should be ended by an open comment question.

Table 3. 3 The structure of questionnaire design

	Dairy producer (Appendix 2)	Dairy processor (Appendix 3)
Business background information	Q1 – Q4	Q1 – Q3
Product type	Q6	Q5
Processor type		Q4
Milk and dairy product destination, downstream SC structure	Q5, Q8	Q6
Sustainable farming requirement	Q7, Q9 Sustainability requirements of your buyer	Q7 Sustainability requirements of your supplier
Financial reward	Q10 (financial reward from buyer)	Q8 (financial reward to supplier)
Drivers of sustainable procurement		Q9
Barrier of sustainable procurement		Q10
Benefits of sustainable procurement		Q11

4. Results

4.1. Sustainable Procurement Attitude from Dairy Producers Perspective

4.1.1. Introduction

In this section, an initial descriptive analysis of the questionnaires collected from dairy farmers who attended the *"Total Dairy Seminar"* (held on 1-2 June 2016) is conducted. The sampling method used was effectively a convenience sampling approach. This ensured a good response rate to the 50 questionnaires sent out, with 46 returned, giving a response rate of 92%. However, three of the questionnaires were deemed invalid; the first because that business was only involved with dairy product retailing, and neither producing milk nor processing milk products; the second because the related business was located in Limerick, Republic of Ireland, which is not part of the United Kingdom; and in the third case, two questionnaires were identical, having come from two respondents at the same farm, thus only one was deemed valid. Therefore, 43 questionnaires were accepted and used in the following analysis (Figure 4.1). Descriptive analysis will be employed to analyse the data for two reasons. First, the nature of this research is the exploration a new area, of which there is limited previous knowledge, therefore an exploratory qualitative research method is used, rather than testing a quantitative hypothesis and making inferences. Secondly, the sample size is small, which makes it unsuitable for operating advanced statistical methods. Nevertheless, the author acknowledges that a descriptive analysis approach can limit the generalisability of the results.

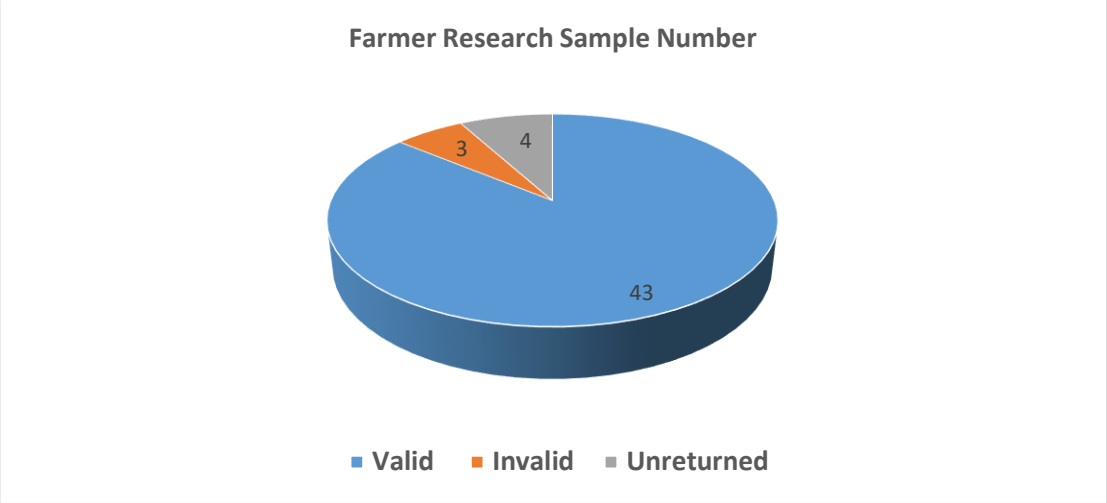


Figure 4. 1 Farmer Research Sample Number

4.1.2. Standard Categorisation of Farms

Several classification methods can be utilised in order to group different farms according to various attributes. The three most common categorisation methods used for dairy farms are those of AHDB Dairy (DairyCo, 2013a), which categorise by farm size, farm production type and geographic location. These categories are used in this study. In addition, this research also classifies dairy farms on the basis of their milk buyer, i.e. national milk processor or local/regional milk processor. However, this is not an attribute of the dairy farm itself, therefore this categorisation method will be mainly utilised in the following descriptive analysis. The following parts (4.1.2.1 through to 4.1.2.3) first introduce and explain how farms are normally categorised for analysis; then a descriptive analysis of the sample data in each of these categories follows in subsection 4.1.3.

4.1.2.1. By Farm Size

There are several classification standards used to categorise farms by size, including the Standard Gross Margins method (SGM) and the Standard Labour Requirement method (SLR), and the appropriate classification method depends upon the intention of the research. The SGM method categorises farms from an economic perspective and is derived from the European Farm Size system. It measures the economic value of output of a single farm, therefore supporting data such as costs of production, outputs, subsidises and investments are required (Farm Business Survey, 2014). The SLR method, however, is more straightforward, calculating the total annual standard labour

requirements, with this interim result converted to Full-Time Equivalent (FTE) units. A farm's size group can therefore be determined by the value of FTE. The SLR method is used in the Farm Business Survey (2014) and has been tested by previous studies, for example the June Survey of Agriculture and Horticulture (Defra, 2012).

$$Full-Time\ Equivalent\ (FTE) = \frac{\text{Standard Labour Requirements (SLRs)}}{\text{Standard Annual Working Hour Per Fulltime Worker}}$$

In a dairy scenario, the farming livestock is dairy cow, thus:

$$SLRs = Cow\ Number \times SLR\ Coefficients$$

In line with the Farm Business Survey (2014), the SLR coefficients for dairy cows is 42, which means a 42-hour workload is required for one cow per year. The Standard Annual Working Hour per Full-time Worker is 1900 hours. The Farm Business Survey (2014) uses the SLR method, and classifies farms by size, according to FTE values (Table 4.1).

Table 4. 1 Farm size definition

Farm size	Definition
Very small	$FTE < 1$
Small	$1 \leq FTE < 2$
Medium	$2 \leq FTE < 3$
Large	$3 \leq FTE < 5$
Very large	$FTE \geq 5$

The standard to classify farms by herd size can be converted to:

Table 4. 2 Classification of dairy farms by number of dairy cows

Size	Value of FTE	Number of Dairy Cows
Very Small	$FTE < 1$	$Cow \leq 45$
Small	$1 \leq FTE < 2$	$46 \leq Cow \leq 90$
Medium	$2 \leq FTE < 3$	$91 \leq Cow \leq 135$
Large	$3 \leq FTE < 5$	$136 \leq Cow \leq 226$
Very Large	$FTE \geq 5$	$Cow \geq 227$

AHDB Dairy (2015a) reports the average size of a UK dairy farm is 142 herds per farm. In addition, AHDB Dairy (2016) also assessed the distribution of dairy cows by herd size, and this is used here to compare the distribution of sample farms in Table 4.7.

4.1.2.2. By Farm Production Type

The standard classification for dairy production systems notes two types of dairy system: organic and conventional. There are several differences between organic dairy farming and conventional dairy farming. Organic farming has stricter requirements to keep production processes separate from artificial fertilisers, instead using crop rotation methods to maintain soil fertility. Organic farming uses only approved substances to treat weeds, pests and diseases. Moreover, organic farming systems enable dairy cows to graze on green grassland, thus giving the animals more space and better ensuring their welfare (DEFRA, 2016). Organic milk is thought to have a higher nutritional value than conventional milk. Recent research published in the British Journal of Nutrition and authored by Średnicka-Tober et al. (2016) provided evidence that organic milk is healthier than conventional milk, offering more Omega-3 fatty acids as well as a range of crucial health nutrients (e.g. iron and Vitamin E).

In order to qualify as an organic farming producer, the farm must register with an organic control body and then perform a regime of soil improving work. The whole accreditation process normally takes two years. Given that organic milk constitutes a healthier diet choice, whilst at the same time realising higher production costs due to stricter farming conditions and a longer production period, the price of organic milk tends to be higher than conventional milk due to both demand price premiums and supply cost inflation.

In the retail liquid milk market, organic milk accounts for 2.4% of total sales in terms of volume (AHDB Dairy, 2015b). Organic Milk Suppliers Cooperatives (2015a) note that around 3% of total UK milk output, in terms of volume, is organic.

4.1.2.3. By Geographic Location

Table 4.3 and Table 4.4 present two geographical classification methods. The AHDB Dairy (2015b) method classifies the UK into seven statistical regions: Scotland, North, Midland, South East, South West, Wales and Northern Ireland. Meanwhile, the Farm Business Survey (2015) method follows the typical social-geographic demographic approach used by the Census, and classifies England into seven sub-regions: North East, Yorkshire and The Humber, East Midlands, East of England, London and South East, South West, West Midlands and North West. In this research, the AHDB dairy method is used as the relatively small sample size makes it inappropriate for classification into numerous groups.

Table 4. 3 Categorisation of UK dairy farms by geographic location – AHDB Dairy method

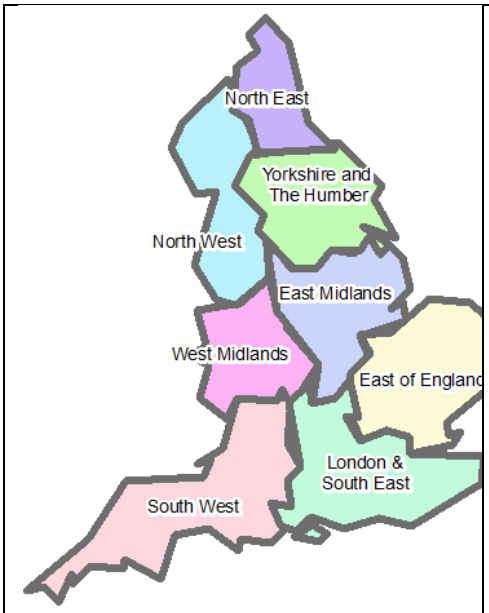
Map illustration of geographic classification	Number of dairy producer in each geographic area

Area	Number of Producers (June 2014)	Percentage
Scotland	886	8%
North	2018	18%
Midlands	2702	24%
South West	3178	28%
South East	596	5%
Wales	1853	16%
Total	11233	100%

Source: AHDB Dairy (2015b), page 12.

Northern Ireland had 2655 dairy producers in June 2014 (AHDB Dairy, 2015b). Therefore, from an entire country perspective, milk producers in GB account for 81% of the total, NI for 19%.

Table 4. 4 Categorisation of UK dairy farms by geographic location – Farm Business Survey method



Region	Sample Number	Percentage
North East	10	3%
North West	62	22%
Yorkshire and The Humber	25	9%
East Midlands	24	8%
West Midlands	41	14%
East of England	14	5%
London and South East	17	6%
South West	93	33%
Total	286	

Source: Farm Business Survey (2015)

4.1.3. Descriptive Analysis

In the following parts, a descriptive analysis of the data collected through the questionnaire is presented. Firstly, a comparison of collected data and national-level figures in terms of farm population is conducted according to three farm categories: farm size, farm production type and geographic location. Secondly, core questions about membership of agri-environmental schemes, milk destination, sustainability requirements as well as financial rewards are analysed. Variations between different farm groups in terms of size, milk production type and geographic location are also identified, followed by a detailed analysis.

4.1.3.1. The Comparison of Sample and Population

Table 4.5 illustrates the comparison of the sample (the collected data from 43 farms) and the population (national average level). Table 4.5 and Figure 4.2 illustrate the sample farm locations. As can be seen, the figures for farmers in Scotland, the North, the Midlands and Northern Ireland were lower than those of the national level; whilst, those from the South West, the South East and Wales were higher. The most significant reason for this is that the 'Total Dairy Seminar' was held in South Gloucestershire; therefore, unlike farmers from Scotland and Northern Ireland, farmers in South West, South East and Wales did not require long-distance travel. A second reason is that owners of larger farms tended to be more keen to study and learn about the latest dairy technical and management knowledge than smaller farmers, and the larger farms are mainly located in the South West, as this is the main milk producing region of the UK (i.e. Chippenham, Dorset, Devon, Cornwall, Somerset). For this reason, farmers from the South West accounted more than 40% of total dairy farmers responding to this questionnaire. However, the overall representation of the sample in terms of national distribution by farm size is relatively good, with proportionate representation following a fairly stable pattern.

Table 4. 5 Comparison between the sample and wider population in terms of geographic location

	Sample Number	Sample Result	Population (AHDB Dairy) result
Percentage distribution of GB dairy producer			
Scotland	1	2.4%	8%
North	5	12.2%	18%
Midlands	2	4.9%	24%
South West	17	41.5%	28%
South East	6	14.6%	5%
Wales	10	24.4%	16%
Percentage distribution of UK dairy producer (GB+NI)			
Northern Ireland	2	4.7%	19%

Figure 4. 2 The map of geographic locations in the sample (Source: Google Map)

Table 4.6 shows the proportion of organic versus conventional dairy farm production types in the sample and the wider population.

Table 4. 6 The comparison between the sample and the population in terms of milk production type

The comparison between the sample and the population in terms of milk production type			
	Quantity	Sample Result	National Result
Conventional Milk	40	93.0%	97%
Organic Milk	3	7.0%	3%

The farms using organic production methods accounted for 3% of the total dairy farms in the UK, and 7% of the dairy farms participating in this research. Again, this is due to the majority of the dairy farmers attending the seminar being from the South West, the main milk producing region of the UK, which is home to a large proportion of the country's organic farms. The figures show again, however, that in general the sample is a fairly good reflection of national distribution. Table 4.7 refers to the distribution of sample farm sizes.

Table 4. 7 The comparison between the sample and the population in terms of farm size

The comparison between the sample and the population in terms of farm size			
	Quantity	Sample Result	National Result
Medium	9	20.9%	14.42%
Large	11	25.6%	13.68%
Very Large	23	53.5%	7.79%
Average Cow Number		329	142

Medium, large and very large farms account for 20.9%, 25.6% and 53.5%, respectively, of the dairy farms in the sample, with the average herd size 329 cows per farm. On the population side, medium, large and very large farms constitute 14.42%, 13.68% and 7.79% of total dairy farms in the UK (AHDB Dairy, 2016). Moreover, AHDB Dairy

(2015c) records the UK dairy farm's average herd size is 142. Therefore, the samples are dominated by large and very large farms, with an average herd size twice that of the population. This could be due to large farm owners being more willing and able to explore up-to-date technical, breeding, hygiene and environmental knowledge, and their consequently taking a more active role in the dairy farming community. It is acknowledged that very large farms make up to 53.5 per cent of the respondents, but only account for 7.8 per cent of UK dairy farms. This may affect the representativeness of the sample to the wider population.

Table 4.8 presents a comparison of the sample and the wider population in terms of the destination of the milk. Around 70% of sample farms sell their produced milk to a national milk processor, with the others selling to local and regional milk processors. At a national level, 80% of GB produced milk is sold to the seven biggest milk processors (DairyCo, 2013b), with the remaining 20% sold to regional and local buyers. The results of the sample are fairly similar to those in the general population, and it is therefore a good representation.

Table 4. 8 The comparison between the sample and the population in terms of milk destination

The comparison between the sample and the population in terms of milk's destination			
	Quantity	Sample Result	National Result
National Milk Processor	30	69.77%	80%
Local & Regional Milk Processor	13	30.23%	20%

4.1.3.2. Farmer Joining Agri-Environmental Stewardship Scheme

Given the focus of this research is sustainable dairy procurement, it is important to look at the different sustainability commitments of the sample farmers. The following parts look at different agri-environmental or sustainability schemes and cross analyse the uptake of such schemes by the different farm categories described above.

Table 4.9 details the number of farms joining different agri-environmental stewardship schemes.

Table 4. 9 Farmers Joining Agri-Environmental and Stewardship Schemes

Agri-environmental Stewardship Scheme Name	Number of Participants	Percentage
Red Tractor	26	60.5%
Countryside Stewardship	22	51.2%
Soil Association	5	11.6%
On-Farm Anaerobic Digestion	2	4.7%
RSPCA welfare	2	4.7%
Others	4	9.3%

More than half of the farms joined Red Tractor assurance (60.5%) and Countryside Stewardship (51.2%). In contrast, only a small proportion of the farms joined Soil Association (11.6%), On-Farm AD (4.7%) and RSPCA welfare schemes (4.7%). In addition, four farms participated in other environmental schemes. The attributes of the farms joining these different environmental schemes are analysed below, along with national average compliance or participation rates.

4.1.3.2.1. Red Tractor Assurance Schemes

Although the questionnaire shows that only around 60% of dairy farms are members of the Red Tractor scheme, answers to the later question on 'Social Sustainability Requirements' indicate that 72% of dairy farms are required by their milk buyers to follow Red Tractor welfare standards.

Figure 4.3 illustrates how the sample farms who have joined the Red Tractor scheme are distributed, according to the destination of milk sales (the first two columns) and farm size (second two columns). The figures show that the farms selling milk to national dairy processors join at a 10% higher rate than sellers to local and regional dairy processors. This may be a result of joining a food assurance scheme (i.e. Red Tractor) having become a market qualifier for livestock producers supplying to most UK supermarkets (Duffy and Fearne, 2009). At the same time, large and very large dairy farms join Red Tractor at higher rates than medium size farms, and this could because for two reasons: firstly, participating in the Red Tractor assurance scheme means

financial input (administration fees) and effort (preparing for annual reviews and more detailed daily recording); and secondly, Duffy and Fearne (2009) indicate that although Red Tractor accreditation has become a market qualifier when selling to top nationwide supermarket chains, justifying a price premium needs an unique selling point, and Red Tractor is not regarded as a unique selling point for processors and retailers. Thus, small and medium dairy farms face greater barriers to joining Red Tractor than larger farms do, due to relatively limited internal resources.

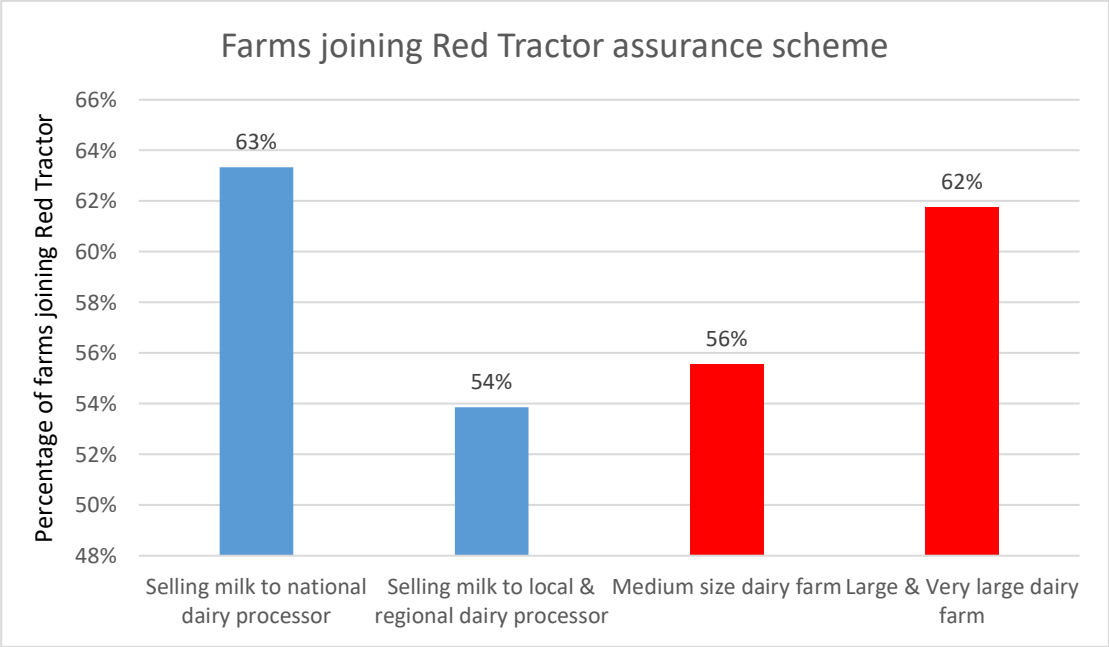


Figure 4. 3 Farm joining Red Tractor Assurance scheme

4.1.3.2.2. Countryside Stewardship

The questionnaire results indicate that 51.2% of farms are members of the CS scheme. Figure 4.4 highlights the variation in farms participating in CS scheme, again categorised by different farm sizes and milk destination groups. There are no obvious discrepancies between national milk buyer groups and local and regional milk buyer groups. However, the participation rate for large and very large dairy farms is twice that of medium farms. Morris et al. (2000) concludes that the arable field margins option was the most attractive pathway to engaging in the CS scheme, as it is technically convenient and brings a decent level of economic rewards to the farmer. The superior sizes of large and very large farms mean more preferences and financial incentives to entering the CS scheme.

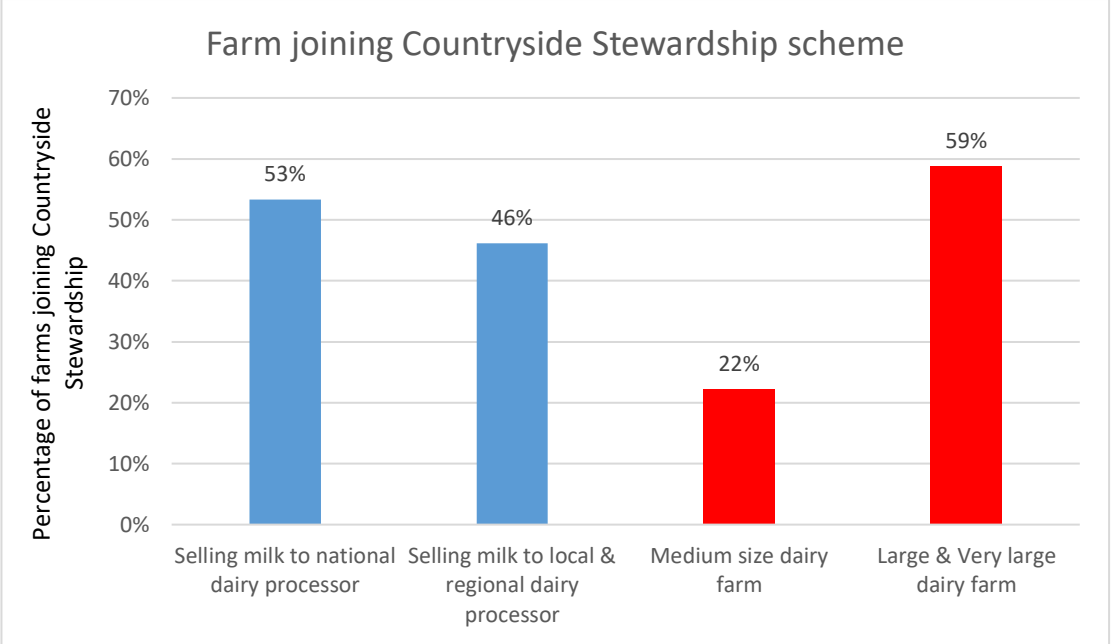


Figure 4. 4 Farms joining the Countryside Stewardship scheme

4.1.3.2.3. Soil Association

Figure 4.5 indicates that all of the organic farms in this survey are participants in the Soil Association scheme, which is unsurprising as the Soil Association certifies organic producers. Organic milk farms must register with an organic control body, and their milk production processes must follow organic standards. The Soil Association is a UK-based organic control body which has established an organic system standard and provides certification. However, unlike the Red Tractor and Countryside Stewardship scheme, the Soil Association sees lower joining rates for large farms than for medium size farms. This reflects the fact that organic farms typically have smaller herd sizes than conventional farms. Olesen et al. (2006) argue that the basic differences between organic and conventional farms were reflected in their respective livestock density, with cows grazing on pastureland in organic systems and therefore achieving 100% self-sufficiency from natural feed, whilst in conventional farming systems cows are reared in barns or feedlots and have limited access to grassland. In this scenario, animal nutrition intakes rely heavily on imported fodder concentrates. Hence, conventional farming was deemed to have 75% greater farming density than organic systems. Where farms are of similar size, conventional farms have larger herd sizes than organic farms.

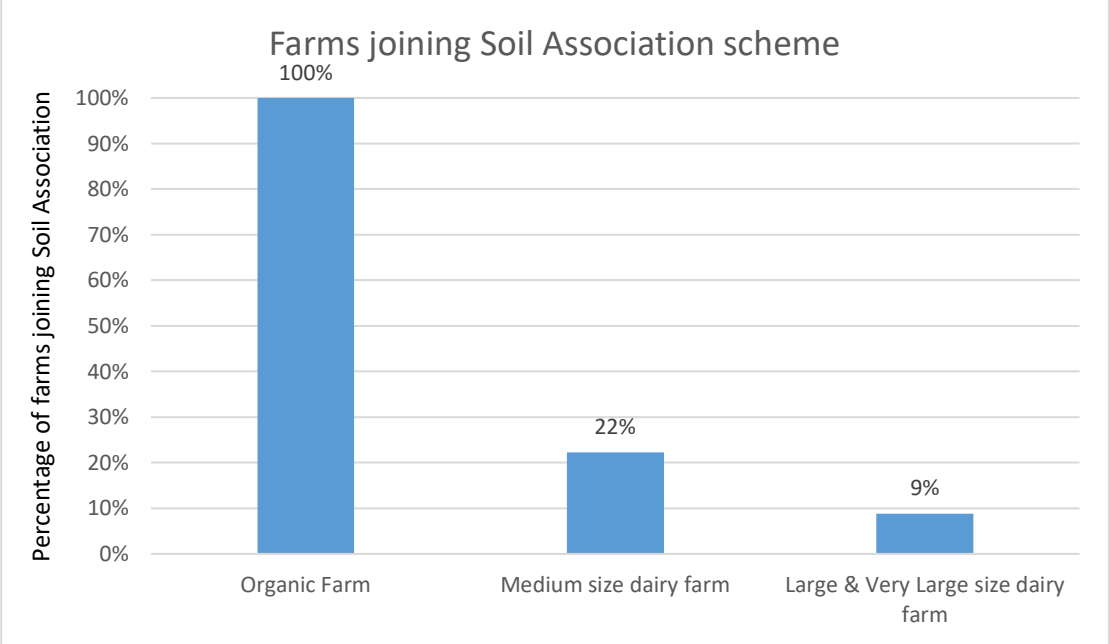


Figure 4. 5 Farms joining Soil Association scheme

4.1.3.2.4. Other Agri-Environmental Schemes

On-Farm Anaerobic Digestion and RSPCA welfare schemes will be discussed in more detail in the parts related to 'Environmental Sustainability Requirements' and 'Social Sustainability Requirements'. In addition, four farms mentioned they were participating in Arla Garden, Retailer-Based Animal Welfare Code, White Gold (Davidstow Processor Assurance) and Entry Level Stewardship (ELS, now replaced by Countryside Stewardship). Arla and Davidstow are nationwide UK dairy processing companies and they have large numbers of contracted dairy farmer to secure their milk pool, therefore giving them a strong bargaining position with which to require their milk suppliers join their environmental scheme. This is discussed further in the following parts on buyers' sustainability requirements.

4.1.3.3. Sustainability Requirements of Buyers

Figure 4.6 compares the dairy farms with and without sustainability requirements from their milk buyers, under different scenarios. In general, more than 80% of dairy farms are given sustainability requirements by their milk buyers, with 57.14% of these being strict requirements.

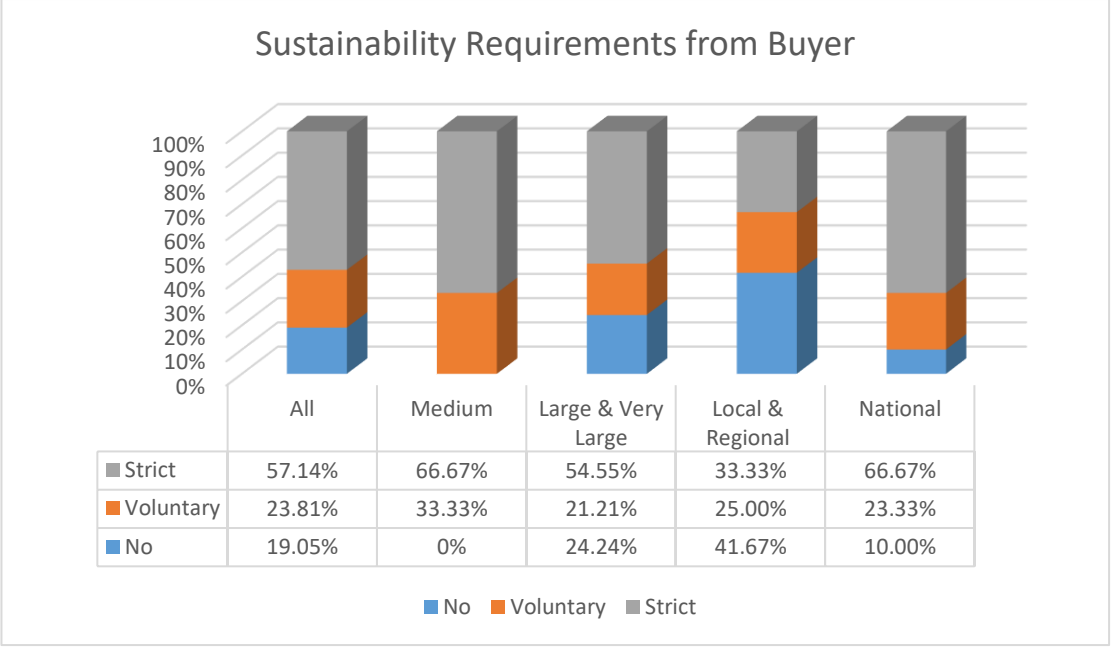


Figure 4. 6 Sustainability requirements from buyer

Comparing medium and large farm groups, all of the medium size farms have sustainability requirements, whilst a quarter of large and very large farms are not obliged to satisfy the requirements. Therefore, medium size farms face stricter environmental and social conditions. On the other hand, the farms selling milk to nationwide dairy producers must meet higher environmental and social level standards than those selling only through local and regional channels. Two-thirds of dairy farms supplying to national companies have strict sustainability provisions, whilst only a third of those selling to local and regional dairy companies do. At the same time, dairy farms with environmental and social requirements beyond the statutory level constitute only a quarter of the total in the local and regional supply chains.

This distinct variance between medium and large farms in terms of sustainability requirements appears highly significant, and more in-depth investigations were conducted to explore the reasons for this phenomenon. Eight sample farms in the large and very large size categories selected the “no sustainability requirements from buyer” option. Five of these (62.50%) supply to local and regional SC, whilst the other three (37.50%) supply to national SC. Thus, from a SC structure perspective, those farms were dominated by local and regional SC, which typically means loose sustainability requirements. However, most of the farms engaged with at least one sustainability practice, e.g. Red Tractor Assurance (five farms), Countryside Stewardship (five farms), the Soil Association (one farm), On-Farm Anaerobic Digestion (one farm) and

the RSPCA (one farm). Only one farm had not engaged with any sustainability practice, and it gave cost as the reason for this. As we can see, those farms have internal initiatives to promote environmental and social sustainability, and may have a narrow understanding of sustainability, perceiving it to cover environmental issues only, as four of the farms (50%) admitted that they were obliged to obey the Red Tractor welfare requirement in later responses.

4.1.3.4. Environmental Sustainability Requirements

In this part of questionnaire, 11 questions were asked of the dairy farm owners and managers about the environmental control conditions that they must satisfy. Some of the conditions are interconnected, and therefore the environmental variables are analysed according to four categories: greenhouse gas emissions, farmland conservation, resource utilisation and waste disposal.

4.1.3.4.1. Greenhouse Gas Emissions

The research results suggest that penetration rates of environmental sustainability requirements relating to carbon footprint are decreasing, with farm commitment levels increasing. Figure 4.7 illustrates three levels of greenhouse gas emission controlling commitments: the basic level is represented by benchmarking current greenhouse gas emission performance; the next most advanced level includes the implementation of practices aimed at cutting down emissions; and the top level is reached when targets for emission reduction are set.

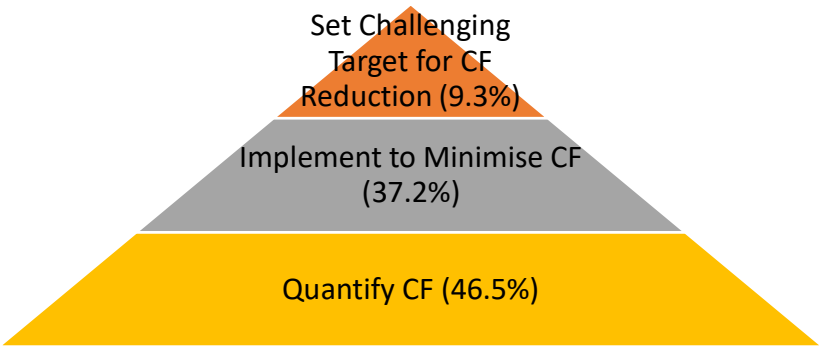


Figure 4. 7 The pyramid of commitment to greenhouse gas emission control and the penetration rate of each level commitment, from the research

Carbon footprint quantification practice in the industry was not initiated before 2010. Between 2010 and 2016, the sustainability requirements on quantifying carbon footprint

has increased from 0 to 46.5%, with dairy processors having hugely increased their environmental awareness of carbon emissions and global warming issues (DairyCo, 2012).

Implementing to minimise carbon footprint is higher level requirement than quantifying carbon footprint, this is for two reasons: Firstly, if a farm's carbon footprint assessment is completed and 'hot spots' are identified, measures can be implemented to minimise emissions. Secondly, 40% of on-farm greenhouse gas emissions come from rumen fermentation (enteric emissions), and 26% are caused by concentrate feed inputs, and these are difficult to compress (DairyCo, 2012). However, the remaining 34% of emissions are either energy- or excrement-related. Energy-related emissions may come from diesel input into farming machinery (direct emissions) or electricity use (indirect emissions). Excrement emissions may come from inappropriate excrement management. To minimise these types of emissions, equipment improvement and financial investment are required; for example, the instalment of photovoltaic solar panels to generate clean energy or he establishment of excrement treatment facilities. This trend is more distinct where there is higher level commitment. At the top of the pyramid, only 9.3% of farmers are asked to set challenging targets for carbon footprint reduction, which is just one fourth of the medium tier and one fifth of the base tier.

Figure 4.8 shows that farms who sell to national processors face more rigorous GHG emission standards. This is likely to be driven by the fact that well-known brands pay more attention to their reputation and corporate social responsibility (CSR), and are able to invest in sustainability to help their dairy suppliers to achieve better environmental performance (Dauvergne and Lister, 2013).

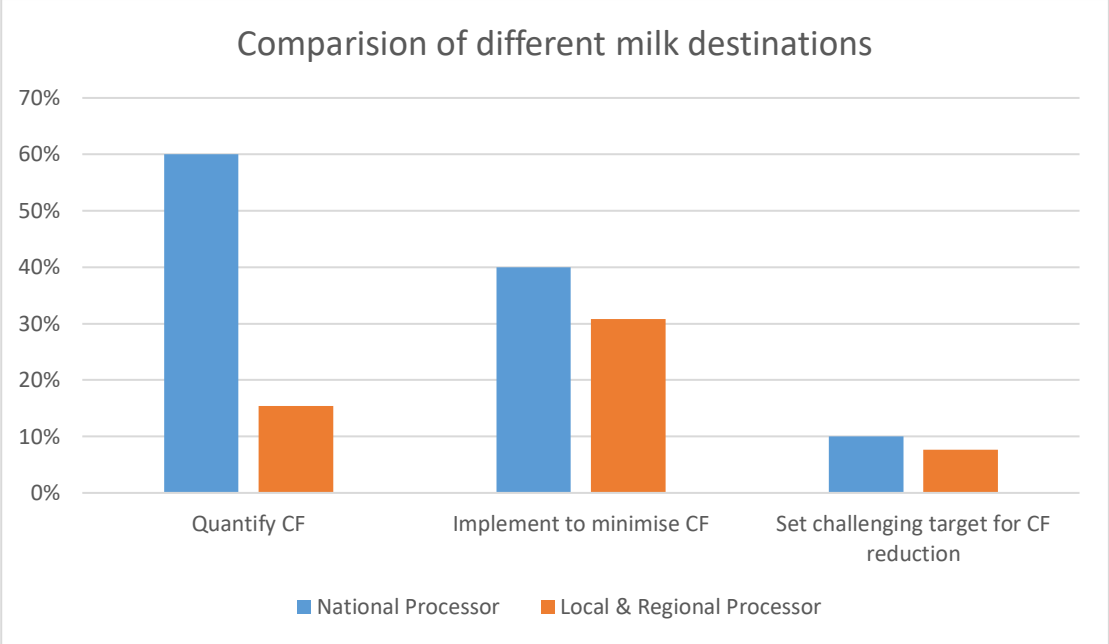


Figure 4. 8 Comparison of different milk destinations in relation to GHG emission requirements

4.1.3.4.2. Farmland Conservation

In order to provide an image of farmland conservation, this part considers the variable of joining Soil Association, which was discussed briefly above in the 'Voluntary Agri-Environmental Stewardship Scheme' part.

Figure 4.9 highlights that 37.2% of dairy farms are required to manage soil using sustainable methods. Meanwhile, about 14% of dairy farms were accredited by the Soil Association. In this comparison, we focus on soil matters and its vegetative cover (grassland) to explore the importance of sustainable management of soil and the requirements of the base pyramid level (sustainable management of soils) and top pyramid level (accredited by the Soil Association).

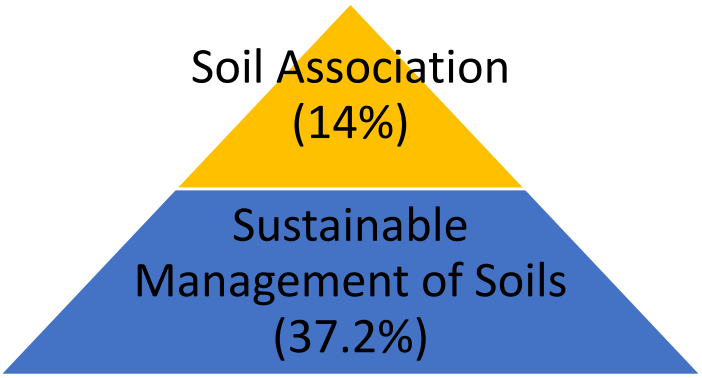


Figure 4. 9 The pyramid of commitment to farmland conservation

The concept of “encouraging sustainable management of soils” was initially proposed in DairyUK's 'Leading the way – sustainable growth plan' (DairyUK, 2014a), which was the first British dairy sector level sustainable growth plan for environmental, economic and social sustainability. The plan details activities in each pillar and gives first priority to “striving for the sustainable use of natural resources” in the environmental pillar. In the natural resource sustainable use pathway, there are three orientations. (See table below.)

As Table 4.10 indicates, sustainable management of soil is given first priority within the “natural resource sustainability” category. This is for two reasons: firstly, soil is one of earth's most important natural resources, not only for agriculture but also for animal habitats (Paustian et al., 1997); and secondly, agricultural soil acts as a sink to mitigate carbon dioxide emission, with the sequestrated carbon emissions released back into atmosphere when soil erosion is encountered (Paustian et al., 1997). The mechanism of good soil management practice for environmental sustainability is filed in the Appendix 4.

Table 4. 10 Sustainable use of natural resources pathway (DairyUK, 2014a)

Orientation	Key Resources
1. Encourage the sustainable management of soils	Soil
2. Invest in the use of renewable energy sources	Energy
3. Optimise water use efficiency	Water

In order to reach the target of sustainable management of soil, soil should be assessed using sampling and testing in every fixed term. To maintain a certain level of fertility, farmers can improve mineral matter status by adding manufactured fertilisers, and improve organic matter status by adding organic materials such as livestock manures, bio-solids and composts. However, if a farm wants to be accredited by the Soil Association, there are much greater requirements. The Soil Association (2016) uses the EU's organic regulations as its baseline, with three principles for organic dairy farming:

1) To achieve good quality
2) To maintain the long-term fertility and biological activity of soils
3) To treat livestock ethically, meeting their physiological and behavioural needs

As we can see, the Soil Association's organic product regulation principles are far more than simply the sustainable management of soils, and also cover grassland and forage, animal welfare, general livestock management and cattle management. Getting a product accepted as organic is a systematic project and a period of transition time is required for land conversion. Here, the methods of achieving sustainable soils differ. In an organic scenario, this would be approached in a natural way, with blended fertiliser and artificial pesticide not normally accepted. The Soil Association (2016) prescribes the use of pastures (clover and herb-rich leys) to build soil fertility on dairy farms, and asserts the need to control intestinal worms by rotational and clean grazing systems. In addition, organic milk should only be produced from cows with a diet of organic grass/clover, therefore the cow should have access to grassland for the majority of its time. Completely intensive rearing methods are not permitted. Compared to non-organic dairy farming systems, the cows in the organic system enjoy better welfare since they have more moving space and more freedom. In addition, from an economic perspective, the selling price of organic milk is around 30% higher than that of conventional milk (OMSCo, 2015a). Table 4.11 makes a comparison between two levels of soil management from four perspectives.

Table 4. 11 Comparison between two levels of soil management

	Sustainable management of soil	Soil Association
Legitimate	Voluntary Scheme	Voluntary Scheme
Accreditation	Not required, no unified standards, but should better than normal soil condition	Should by accredited by Soil Association
Target	Better soil fertility	Accredited to organic farming standards, high level soil fertility
Impact	No clear impact on final dairy product, but good for soil resource and environment	Firstly, since the final products are qualified as organic products, selling price is higher than for conventional dairy products. Secondly, clearly good for soil resource and environment because there are definite standards to improve soil standard

In addition to soil management, protection of natural habitats and enhancement of biodiversity are other crucial activities for balancing the ecosystem and promoting sustainable development. 'Leading the way – The British Dairy Industry's Sustainable Growth Plan' (DairyUK, 2014a) suggests, "using land sharing and land sparing techniques to protect and improve habitat on dairy farms". Land sharing strategies in particular not only facilitate dairy farming, but also benefit wildlife on the same land. Robinson et al. (2001) indicates that pastoral farmland with 'arable pockets' have higher densities of seed-eating birds. The density of bird populations on farmland is an important proxy for biodiversity (Defra, 2009b). For the above reasons, one of the top UK supermarket chains, Waitrose, has launched its 'WildCare' initiative to ensure their milk producers retain at least 10% of their farm for wildlife habitats (Waitrose, 2017).

Figure 4.10 outlines the penetration rate of farms facing the requirement of protecting natural habitats. Around a third of farms are required to contribute to natural habitat protection, though a decreasing trend can be observed with farm size upscaling. Bigger farms have greater preferences for intensive farming systems, and therefore milk production areas are limited and less space is dedicated to habitat protection. Despite

this, the owner of one very large farm, with 550 cows and in a retailer-aligned contract, commented that milk buyer have clear requirements for habitat protection, with a 'minimum 10% land under cultivation and environmental conservation and enhancement plan in place'.

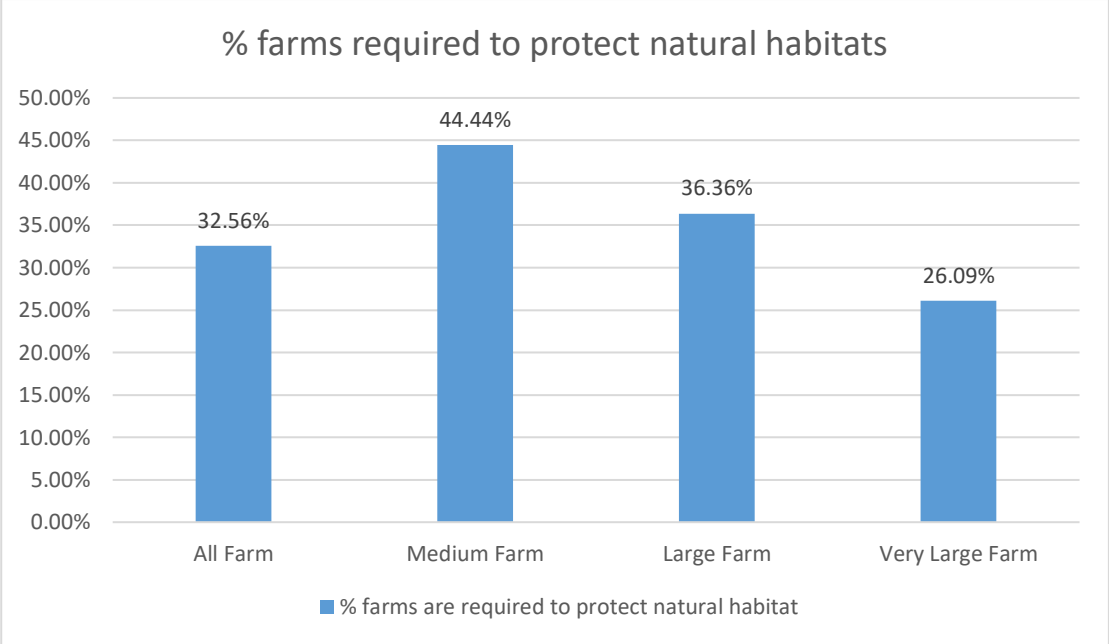


Figure 4. 10 Farms facing requirements to protect natural habitats

4.1.3.4.3. Resource Utilisation

This part considers the input of milk production, namely energy, water and feed. Ensuring the input of dairy farms is a crucial part of promoting sustainability in milk production.

Figure 4.11 reports the popularity of sustainability activities implemented by dairy farms. 'Renewable energy' is the electricity generated from clean resources other than fossil fuels. The most popular type of renewable energy invested in by UK dairy farms is solar photovoltaic (PV). Installing PV on farms not only sustainably generates clean energy, but it is also a financially attractive project, with farmer receiving subsidies called ‘feed-in-tariffs’ (FiT) and selling their generated electricity. Notwithstanding, only 13.95% of dairy farms participate in renewable energy programmes, with high in-front installation costs and poor return cited as the most common reasons for this lack of take-up. The Dairy Development Centre (2012) claims the payback period of investment is 8.3 years on average. As a result, no medium-sized farms are currently engaging in renewable energy programmes. For the larger size farms, due to their

relatively greater economic power, 17.65% are able to afford PV investment. The farms in the national dairy companies supply chain have greater involvement than their local and regional counterparts, mainly due to the farms selling to nationwide companies being larger than local and regional companies (366 and 242 cows per farm respectively), and thus the bigger farms having greater financial incentives.

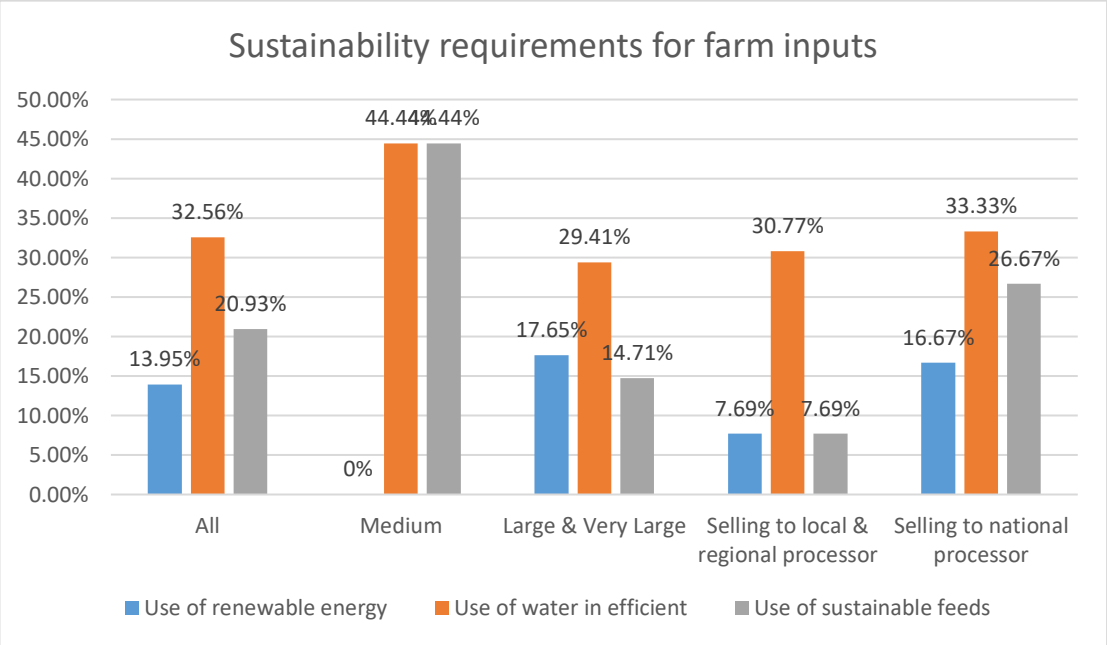


Figure 4. 11 Sustainability requirements for farm inputs

'Good Dairy Farming Practice', published by the Food and Agriculture Organisation of UN and International Dairy Federation (FAO and IDF, 2011), suggests that utilising farm inputs such as water and feed efficiently and sustainably can benefit both the environment and product quality. From an economic perspective, using water in an efficient way also helps farms to save on cost. For this reason, around one-third of farms make efforts to reduce water consumption (Figure 4.11). In this area, there is no obvious discrepancy between nationwide company sellers and local and regional company sellers. However, surprisingly, medium-sized farms have higher adoption rates of water saving than do large farms (44.44% and 29.41), which could be due to medium farms having more precise management than larger farms.

In the dairy farming system, feed refers to pastures plus forage crops. Many dairy farms in the UK combine feed planting and milk production, thus home-grown feeds are becoming a crucial animal nutrition source. 'Good Dairy Farming Practice' defines sustainable feed production as that which manages fertiliser and pesticides application

appropriately, and is neither harmful to the natural environment nor food safety (FAO and IDF, 2011). In an intensive farming system, cows are reared in barns and feedlots, and animal feeding relies heavily on blended fodder. In these cases, farmer should ensure the traceability of feed and keep records of this. The empirical data reveals that more than a fifth of farms engage in sustainable feed practice, with farms in the national dairy supply chain almost three times more likely to do so than farms in the regional supply chain. This reflects nationwide dairy companies' greater requirements for sustainable feed production. Moreover, medium-sized farms are three times more likely than large farm to participate in sustainable feed use activities, with large farms more likely to conduct milk production in intensive systems with home grown feed, and almost all blended feed products in the market complying with sustainable feed production requirements, hence large farms did actually satisfied with the principle of using of sustainable feed, however they ignored this selection in the questionnaire.

4.1.3.4.4. Waste Disposal

There are three levels of waste disposal commitment: slurry management, waste reduction and anaerobic digestion. Figure 4.12 illustrates this three-level commitment with a pyramid, Slurry management is a fundamental level requirement and is mainly about dairy housing management, namely storing and spreading slurries (including manure, dirty water and slurry). In practice, the requirements for slurry management are twofold, with the statutory requirement detailed in the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulation (1991), which mandates the hygiene of the milk production area and the prevention of water pollution. In addition, the dairy farms on NVZs (Nitrate Vulnerable Zones) should obey stricter restriction to prevent slurries percolating in the underground water (Defra, 2009a). In addition to the statutory requirements, voluntary requirements are higher level conditions that dairy farms have to satisfy in order to comply with milk buyers' policies on better management of slurries and consequent reduction of environmental impact. There are no obvious variations in slurry management practice in terms of location, production type, size and milk destination groups.

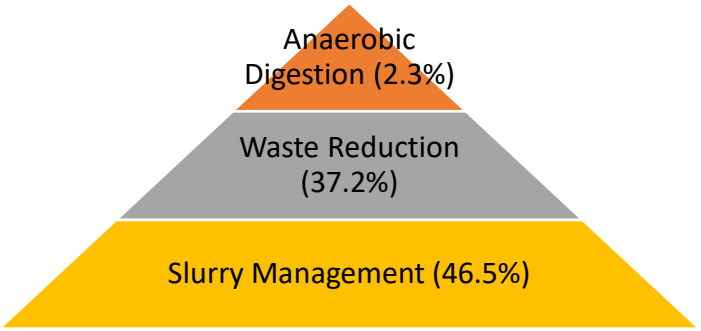


Figure 4. 12 Pyramid structure of waste disposal commitment

On the middle level of the hierarchy, waste reduction activity sees a lower participation rate (37.2%) than slurry management. Although waste reduction is not forced by any authority, minimising the amount of waste generated by farms saves time and money in disposing of waste, as well as lowering the potential impact on the ecosystem. At the same time, waste reduction also means a more efficient use of raw materials. Waste reduction can be achieved by reducing, reusing and recycling, and it offers both economic and environmental benefit. The farms on the national dairy supply chain have higher rates of engagement than local and regional chains (40% and 30.77%, respectively), as large dairy companies have stricter codes and clearer standards on waste disposal.

At the top of the hierarchy, only 2.3% of farms engage with Anaerobic Digestion (AD) equipment investment. The principle of AD is to decompose organic materials using bacteria in a closed vessel. In this way, manures and slurries produced by farms can be converted to biogas and organic fertiliser, instead of being stored and spread on the farms, thus uncontrolled GHG emission and slurries are captured. Moreover, generated biogas can be used to displace fossil fuels, with chemical fertiliser replaced by nutrient-rich fertiliser (Jones and Salter, 2013). Nevertheless, by 2016, only 208 AD plants were in operation on UK farms (NNFCC, 2016). Tranter et al. (2011) conclude that there are three constrains on the development of AD: low returns, establishment costs which are too high, and difficulty obtaining permission for construction. Bywater (2011) also indicates that capital investment and a lack of capital support from banks and governments are significant barriers to AD's application. In addition, it is normally perceived that only large-scale AD plants are economically feasible, hence small and medium size farms cannot meet the economic scale required to operate AD units with potential financial reward. The field study also revealed that no medium and large dairy farms have invested in AD units, with only 4.35% of very large farms (those with 477 cows on average) big enough to operate AD facilities.

4.1.3.5. Social Sustainability Requirements

Figure 4.13 shows that 72.1% of dairy farms comply with Red Tractor Assurance, which gives it the highest penetration rate among all sustainability requirements, either environmental or social. The dairy farms in national dairy SC have a higher percentage than local and regional SC (80.00% and 53.85%, respectively). On the other hand, six farms selling milk to big brands and supermarkets must follow the companies' own environmental and ethical codes. For example, three follow the Tesco Sustainable Dairy Group (TSDG) Code, one follows the Arla Graden code, one is required to graze milking cows a minimum of 100 days per annum (to ensure the cows live in a free-range environment), and two have to obey further animal welfare requirements prescribed by the Soil Association as part of their organic accreditation.

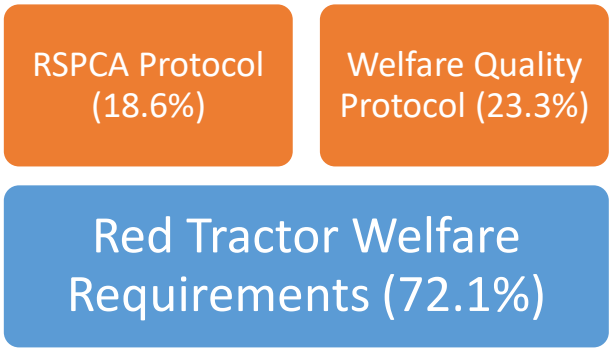


Figure 4. 13 Social sustainability requirements for farms

Table 4.12 provides a brief comparison of three animal welfare standards. Welfare Quality Assessment Protocol for Cattle is a scientifically based and animal actual body condition based tool to measure animal welfare. The measurement takes into account the actual welfare status of the animal, such as body condition, health, injuries, behaviours and fearfulness. The protocol has a very detailed scoring criteria, and is the strictest of the animal welfare standards. The RSPCA standard falls in the middle between Red Tractor and Welfare Quality, focusing mainly on mobility and free range animals. Due to the scientifically-based nature of Welfare Quality protocol, it is more difficult to obtain this accreditation. However, 23.26% of farms are participating in the Welfare Quality protocol, 5% higher than the RSPCA scheme (18.6%), as Welfare Quality has more authority than any other assurance.

Table 4. 12 A brief comparison of Red Tractor, RSPCA and Welfare Quality

	Red Tractor	RSPCA Farm Animal Welfare Standards	Welfare Quality Assessment Protocol
Assessment Method	Management-based, Resource-based	Resource-based, management-based	Animal-based, scientifically-based
Detailed Quantitative Scoring Criteria	Weak	Medium	Strong

4.1.3.6. Financial Rewards from Buyers

An analysis of revenue proportions is conducted in this part, followed by further analysis to establish the connection between milk producers' sustainability commitments and their bonuses. Figure 4.14 illustrates the penetration rate of financial rewards and shows the proportion of farms who receive financial rewards for their sustainability commitments by farm size (green), milk destination (red) and percentage of total revenue that this financial reward reflects (yellow).

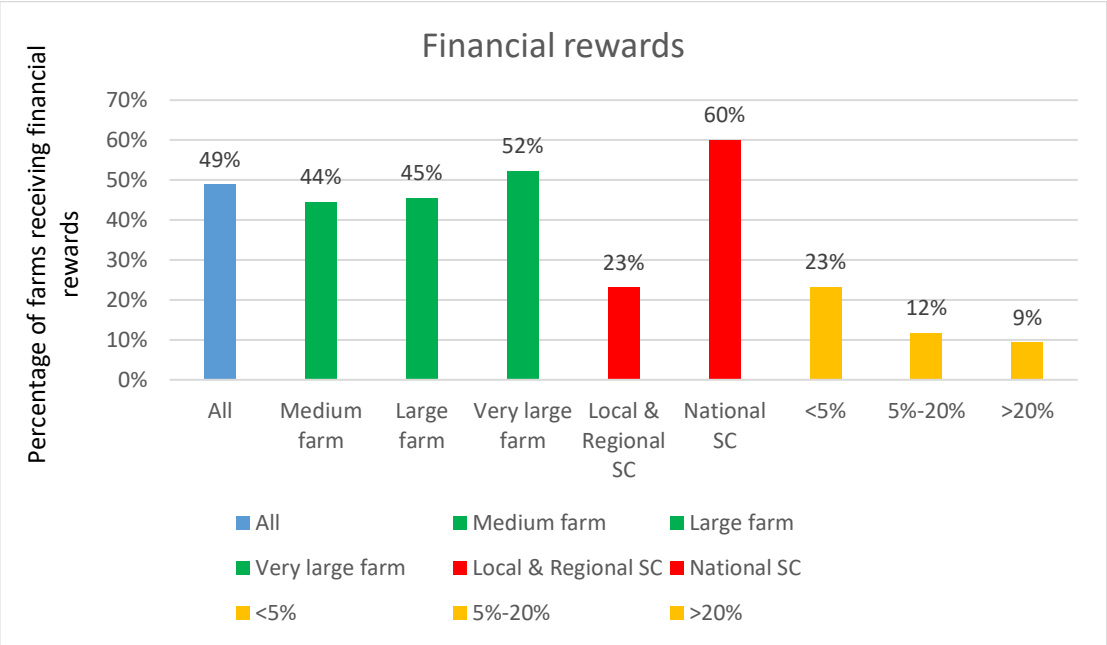


Figure 4. 14 The penetration of financial rewards

Of all 43 participating farms, 21 (48.84%) receive financial rewards, with three receiving funding from the government (e.g., Countryside Stewardship, or other subsidies), and others paid by their milk buyers. Large farms are more likely to receive premiums than small farms, although the gap is not vast (52%, 45% and 44% for very large, large and medium, respectively). Farms in the national SC have a significant advantage over local and regional SC, being twice as likely to receive a bonus. This indicates that national dairy companies have more capability and willingness to fund sustainability practices than do small companies. Around a quarter (23.26%) of farmers receive financial rewards on <5% segment (proportion of revenue does the financial reward received account for). The opportunities for receiving higher percentage premiums are more scarce, and dairy farmers receiving rewards in 5%-20% and >20% segments are rare (11.63% and 9.3%). Finally, only farms in the national SC can obtain a high percentage of rewards, with no farms on the local and regional SC receiving rewards above 5%.

The key driver of successful sustainability practices is financial support; and the following analyses focus on sustainability commitment and financial reward levels.

Figure 4.15 contrasts GHG emission reduction commitment and financial reward levels. The benchmark reflects an average of 48.84% farmers receiving financial rewards. 70% of farmers received premiums in the 'Quantify CF' group, and 81.25% in the 'Implement to Minimise CF' group. All of the farmers in the 'Set Challenging Target for CF Reduction' group received a bonus. Therefore, in the GHG emission reduction series, financial reward levels were higher than the benchmark, and the opportunities for farmers' environmental rewards increased along with their commitment levels.

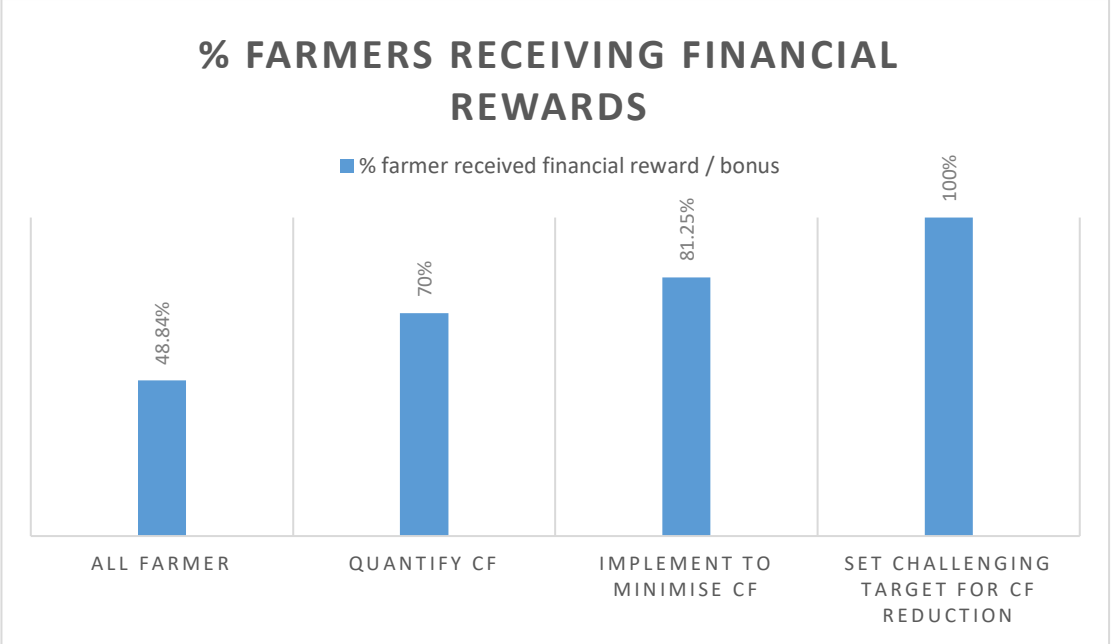


Figure 4. 15 Financial reward and GHG emission reduction commitment

Figure 4.16 shows that 68.75% of the farmers who implement sustainable practices in soil management received rewards, and for the higher commitment level, that of joining the Soil Association, 80% received premiums. These figures were all above the all farmer average level.

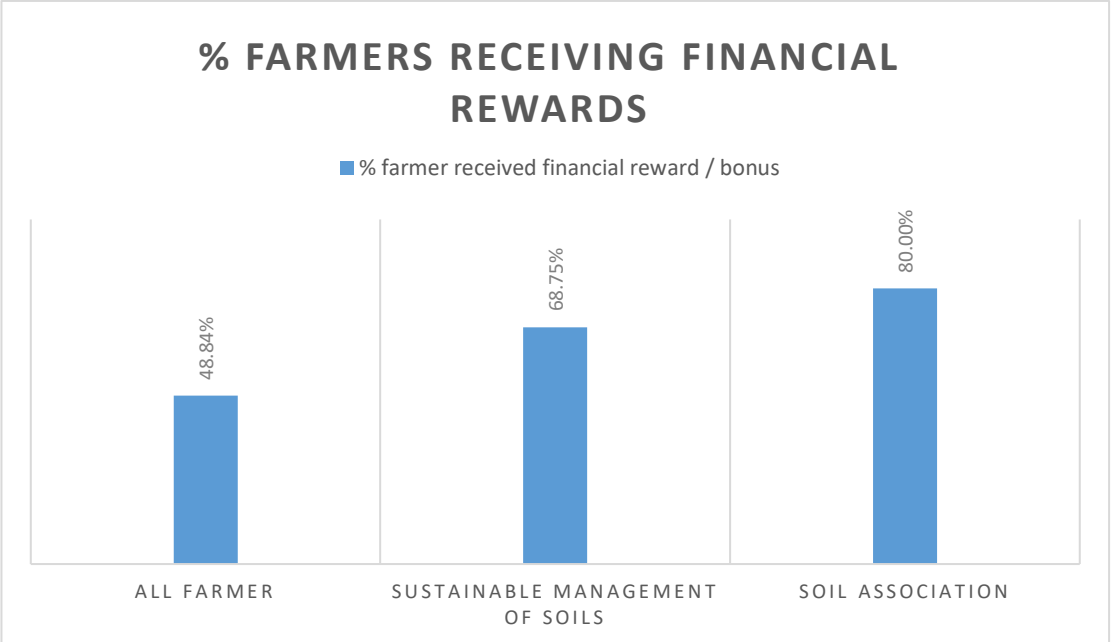


Figure 4. 16 Financial reward and farmland conservation commitment

Figure 4.17 shows that 55% of farmers who acted on slurry management, and 75% of those who complied with waste reduction measures, were rewarded with financial bonus. Waste reduction is a higher level environmental commitment, thus there is a 20% greater opportunity for participants to be economically encouraged.

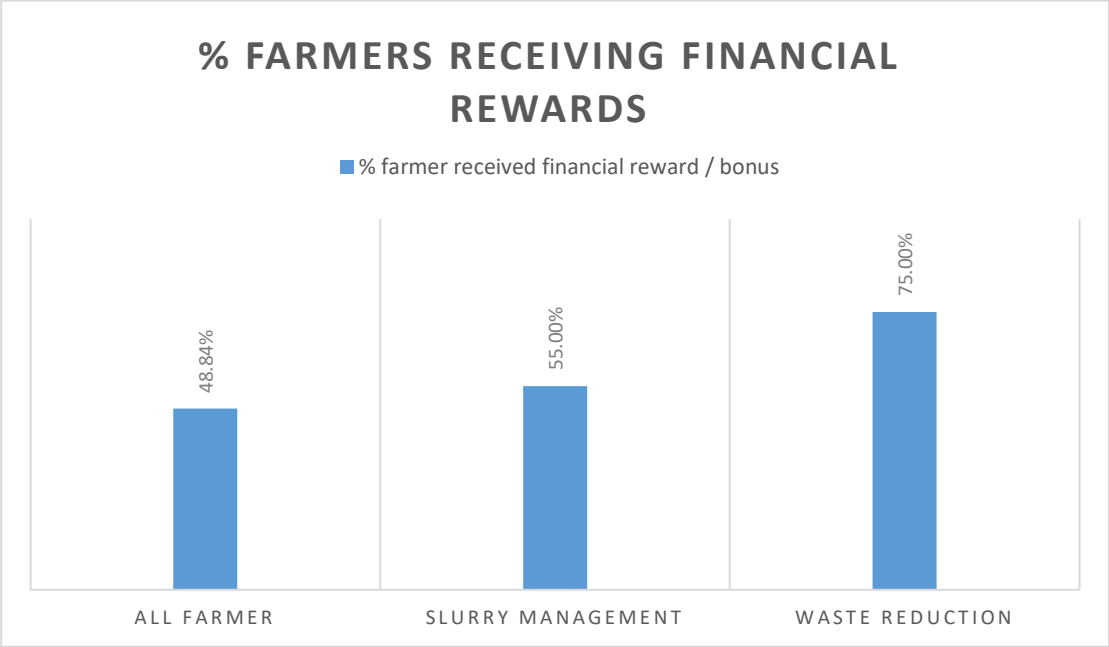


Figure 4. 17 Financial reward and waste disposal commitment

Figure 4.18 outlines the situation of financial bonuses as rewards for the social sustainability scheme. 51.61% of farmers who complied with the animal welfare and hygiene requirements of the Red Tractor Assurance scheme received premiums. However, this bonus penetration level was almost the same as the benchmark level, as Red Tractor Assurance is an essential requirement for milk producers. Farmers complying with RSPCA Farm Animal Welfare Standards have a higher probability of receiving a bonus (62.50%). Finally, due to the scientifically-based nature of the Welfare Quality protocol, it is technically the most difficult to meet this standard, and thus 70% of protocol operators were financially rewarded for doing so.

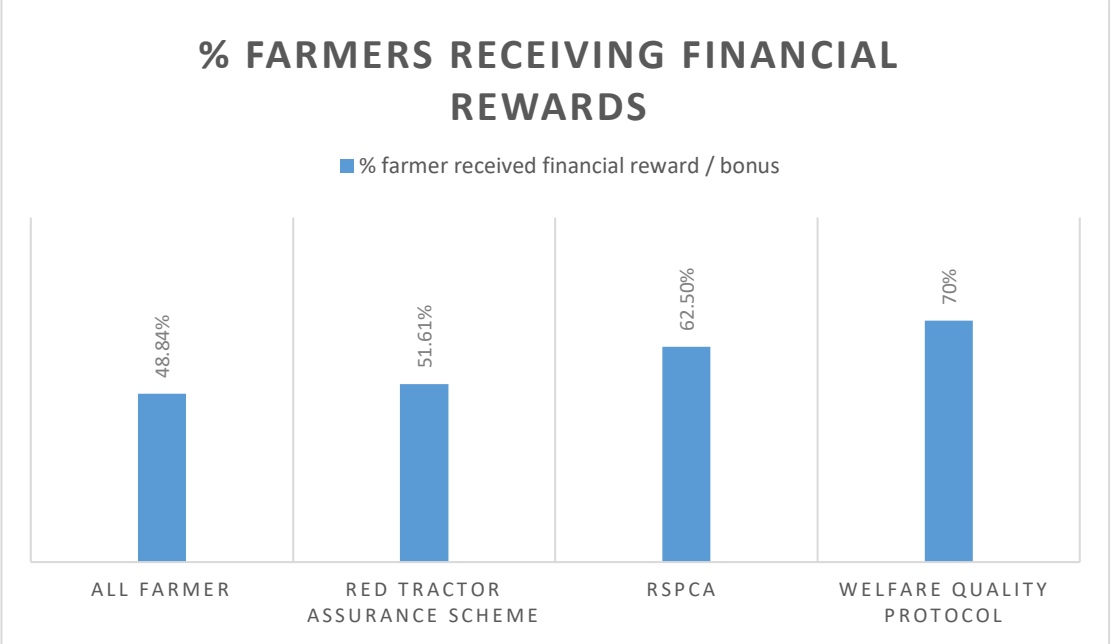


Figure 4. 18 Financial reward and social sustainability commitment

Figure 4.19 outlines the reward levels and environmentally friendly schemes related to resource utilisation. As mentioned above, these schemes have no hierarchy relations, and therefore a connection between environmentally friendly commitment and economic bonuses is not expected. Nevertheless, the figure suggests that the reward level for these schemes are better than the benchmark. Among them, the reward level for renewable energy schemes is the lowest, with 66.67% of participants receiving financial support from their buyers. One of the reasons for this is that farms investing in the PV solar panel project typically receive financial support from the government, rather than from their milk buyer.

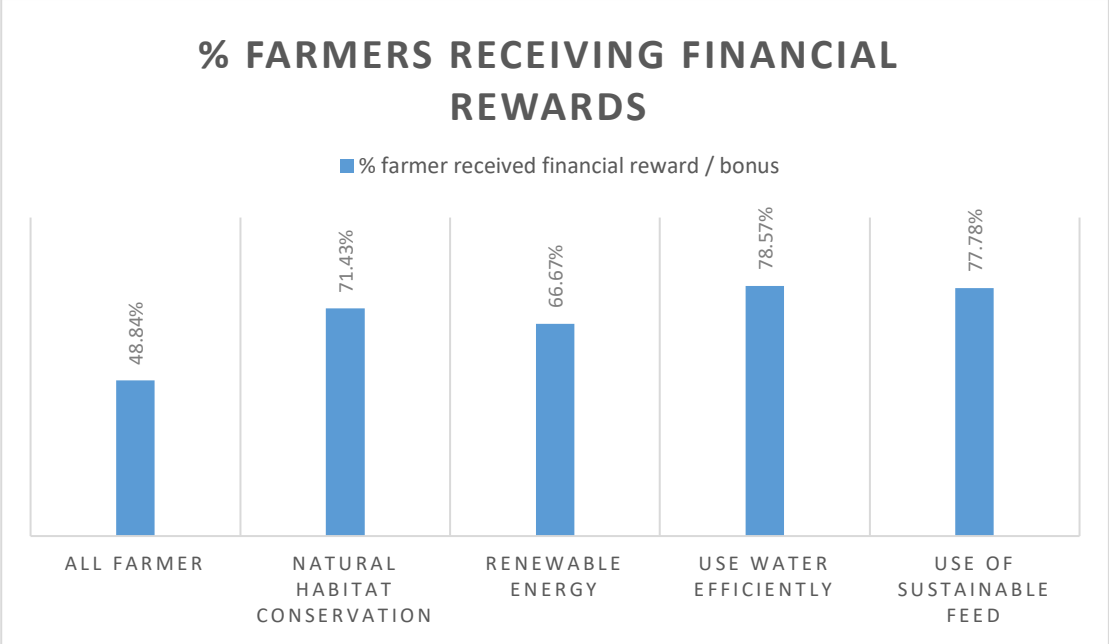


Figure 4. 19 Financial reward and resource utilisation

Finally, the farmer questionnaire proposed 14 environmental and social sustainability requirements, and asked milk producers to mark those they are expected to meet. The farmers selected 0 to 9 of these sustainability variables. On average, each farm marked 4.3 sustainability requirements, and most farmers selected five. Thus, the following discussion proposes three levels of sustainability commitment: low (meets 0-2 requirements), medium (3-5) and high (6-9).

Figure 4.20 suggests that most farms achieve a medium sustainability level. Furthermore, the higher the sustainability level they reach, the better their chance of receiving premiums: the high commitment group has twice and nine times more likely than medium and low commitment groups, respectively. On the other hand, in the high sustainability performance group, 84.62% of farmers said their business is economically sustainable and can make money; in contrast, only 66.67% of those in the medium sustainability performance group agreed.

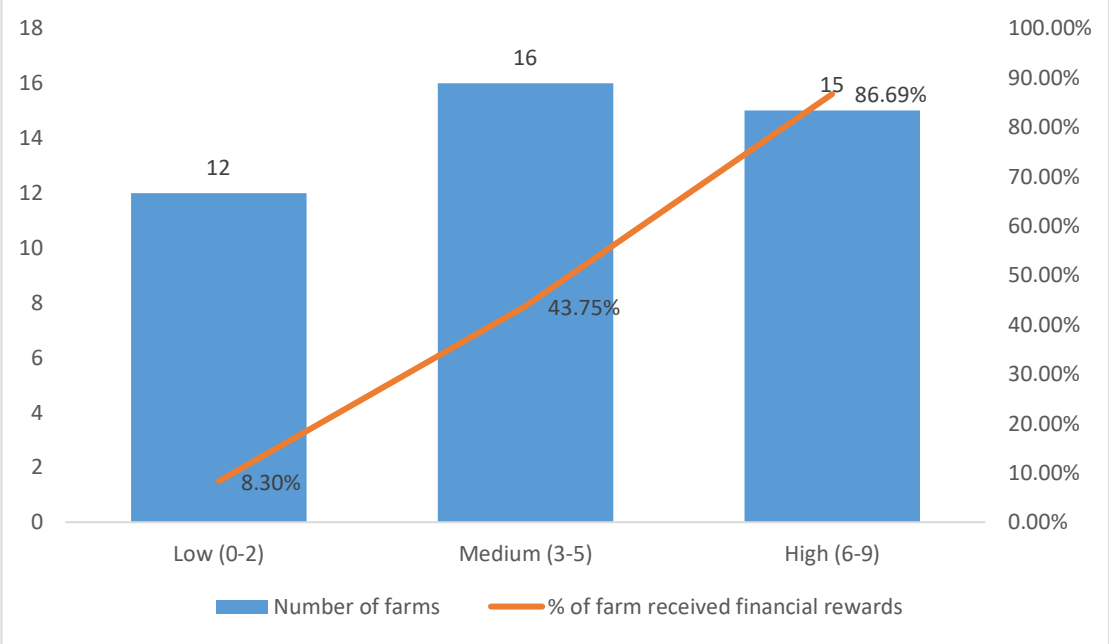


Figure 4. 20 Financial reward and sustainability performance

4.1.4. A summary of key findings related to sustainable farming

In conclusion to this section, the key findings are in terms of who provides farm funding to achieve higher sustainability levels, which factors influence farms in terms of implementing sustainability practices, and how financial incentives interact with sustainability performance.

Who provides farm funding to achieve higher sustainability levels?

Firstly, our findings indicate that three sources of funding support dairy farms to improve sustainability levels both environmentally and socially. These are government subsidies, buyer incentive and market premium. The sustainability practices related to government subsidies include Countryside Stewardship (CS), use of renewable energy and On-Farm Anaerobic Digestion (AD), and farms who join those scheme may receive financial support from government subsidies rather than their milk buyers.

On the other hand, the sustainability practices related to buyer incentives include social sustainability, Red Tractor Assurance, GHG emission restriction, use of sustainable feed, waste reduction and buyer/retailer based environmental and social codes. The farms which achieve buyer-specified environmental and/or social requirements may receive financial bonuses, or in some scenarios, obtain buyers' sustainability standards

as a pre-requisite to a contract. (Part 4.1.3.2.4 lists several retailer-based sustainability codes which the farms in the sample must obey.)

Finally, market premium related sustainability practice is the Soil Association's organic scheme. Soil Association labelled organic milk can have a market price 30% higher than that of conventional milk, thus market premiums drive farms to work on soil and animal welfare improvements in order to obtain Soil Association accreditation.

What factors influence farms' implementation of sustainability practices?

In terms of sustainability practices driven by government subsidies, farm size is the most important influence on a farm's willingness to participate in the scheme. For Countryside Stewardship, the penetration rate of large and very large farms is almost three times that of medium-sized farms. In terms of the use of renewable energy, no medium size farm engages in the PV scheme, whilst 17.65% of large and very large farms do. Similarly, no medium or large size farms had constructed on-farm AD projects, whilst 4.35% of very large farms (with 477 cows on average) are big enough to be operating AD facilities.

For sustainability practices driven by buyer incentives, SC structure greatly influenced the implementation of these practices. Farms on the national SC can always achieve higher sustainability performances than local and regional SC. The participation rate in the Red Tractor scheme for farms on the national SC is more than 25% higher than that of those on the local and regional SC, use of sustainable feed is around 20% higher, waste reduction is 10% higher, and there is more rigorous GHG emission restriction (Figure 4.8). On the other hand, regarding receipt of financial bonuses from buyers, Figure 4.14 illustrates a huge gap between farms on the national SC (60.00%) and those on the local and regional SC (23.08), but no marked differences within the groups. Therefore, farm size was not a key influence on sustainability practices driven by buyer incentives.

For sustainability practices driven by market premiums, unique selling point (USP) is decisive, as justifications for price premiums require a USP (Duffy and Fearne, 2009).

How does financial incentive interact with sustainability performance?

As illustrated by Figure 4.20, this is a very useful result, and it will be discussed in more detail later in this thesis. However, it basically confirms that financial reward can improve dairy producers' environmental commitment. If one were to take a linear progression result from this, for example, one could suggest that there were

approximately a 10% movement in financial reward (from zero to the maximum attainable) for each additional environmental commitment made.

In the next section, an analysis of dairy processors' sustainable procurement attitudes will be conducted.

4.2. Sustainable Procurement Attitudes from Dairy Processors' Perspective

In this section, the sustainable procurement attitudes of dairy processors (dairy companies) will be discussed, including the current penetration rate of sustainable procurement practices, financial rewards for dairy producers, and the drivers, barriers and benefits of sustainable practices. In so doing, the study will compare such practices and attitudes with those of producers (as described in Section 4.1) to evaluate the similarities and differences between the sustainability attitudes of buyers and suppliers of milk in the procurement process.

Questionnaires were posted to 500 UK-based dairy companies registered with the FSA (Food Standards Agency, 2014) and/or the RPA (Rural Payments Agency, 2015), as approved milk/dairy establishments. 68 questionnaires were returned, reflecting a response rate of 13.6%, which is average in the UK context for sustainable procurement research. For example, Holt and Ghobadian (2009) surveyed the UK manufacturing industry and saw a 13% response rate, and George and Thomas (1998) investigated UK mixed industries, with a 12.5% response rate. Notwithstanding, it is acknowledged that the low response rate may affect the representativeness of the sample to the wider population. Of those questionnaires returned, 53 were valid, and 15 were deemed invalid due to missing data (Figure 4.21).

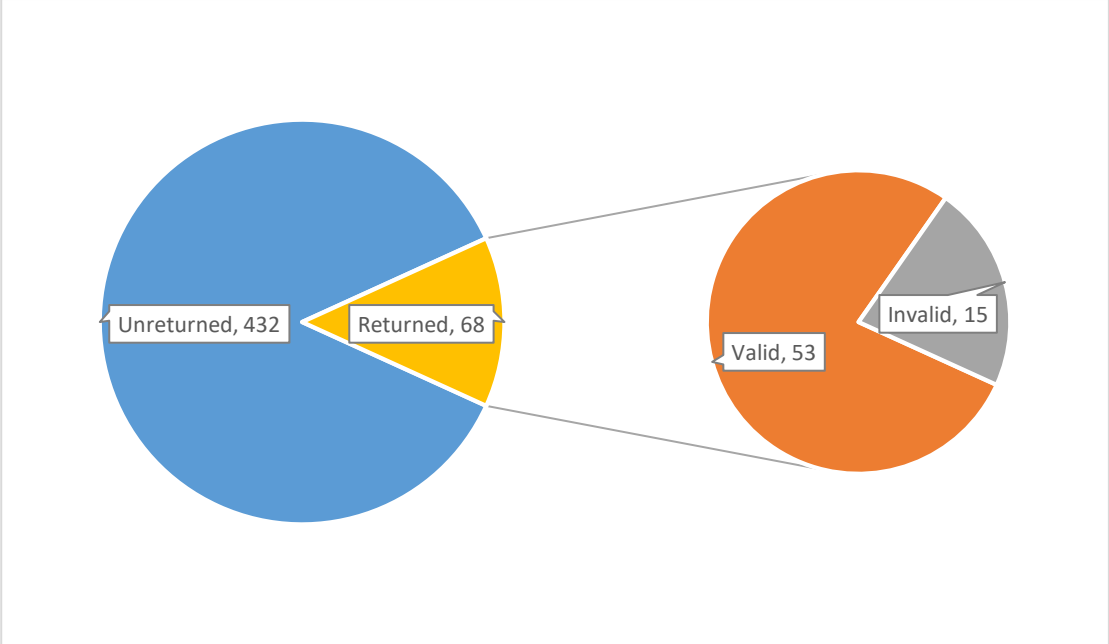


Figure 4. 21 Dairy processor survey return statistics

Those returning the invalid questionnaires gave their reasons for non-completion as being: a belief the question(s) was/were not applicable to their business, their dairy business was no longer in operation, they were busy, or they were reluctant to disclose sensitive information (Figure 4.22).

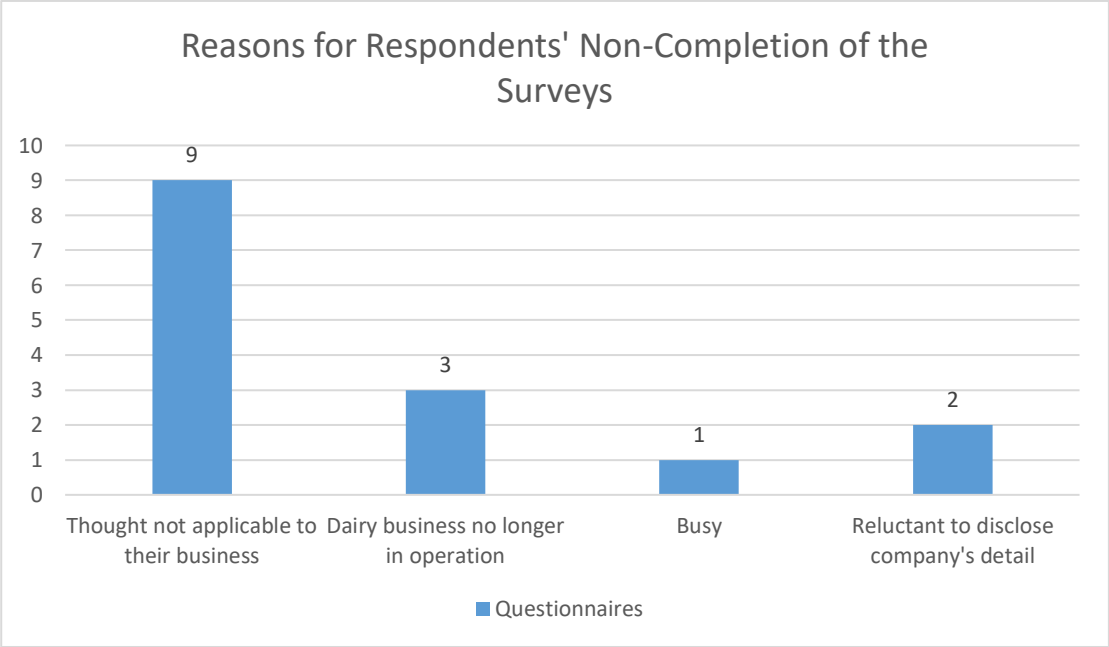


Figure 4. 22 The reasons for respondents' non-completion of the survey

As the essential character of the dairy companies participating in this survey is dairy processing, some respondents said they had not fully completed the questionnaire as they were solely traders/packagers. These respondents were also placed into the 'thought not applicable to their business' category.

4.2.1. Companies' Background Analyses

The collected data indicates that there are four types of supply chain operating in the British dairy sector (figure 4.23):

- Type A: Farmer – Processor – Customer
- Type B & C: Farmer – Agent Purchaser (B) – Processor (C) – Customer. If focused on the buying and selling activities of the Agent purchaser, it is identified as Type B. If focused on the buying and selling activities of the Processor, it is identified as Type C.
- Type D: Farmer & Processor – Customer

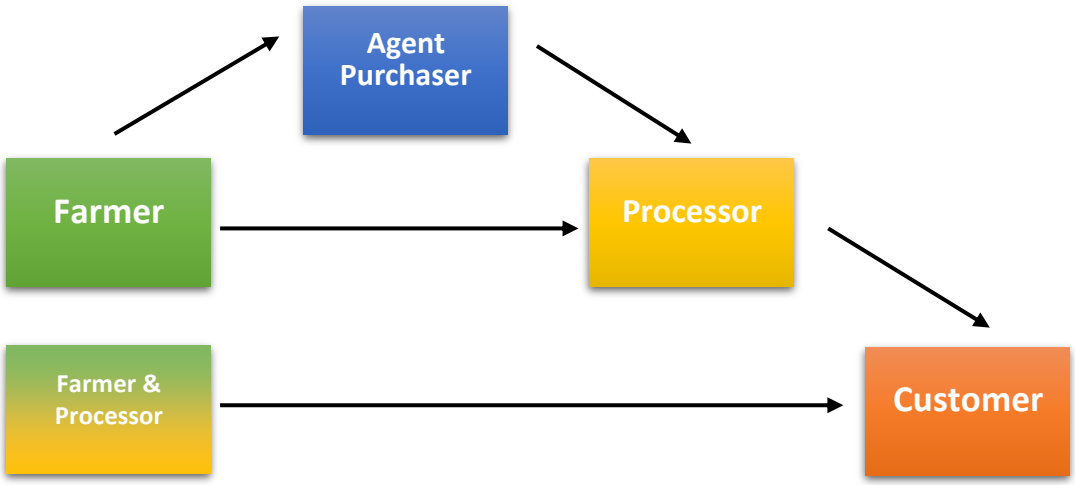


Figure 4. 23 Four types of supply chain operating in the British dairy sector

Section 4.2 focuses on the penetration of sustainable procurement practices and drivers, barriers and benefits of conducting sustainable procurement practices on Type A, B and C supply chains. In a Type D supply chain, the farmer and processor are an

integrated entity. The dairy companies (processors) do not buy milk, and therefore a separate section (Section 4.3) will analyse Type D supply chains' use of sustainable production practices.

Figure 4.24 highlights that of the four types of SC identified in the collected data, 34 and 16 of them are straightforward Type A and Type D SCs. One company is a farm-owned milk sales company and an Agent Purchaser (Type B). The main distinction between Type A and Type C is whether dairy products processing is the main business, or whether milk or other dairy products are only ingredients for manufacturing other food/beverages/snacks. In these cases, the businesses source milk and dairy products from wholesalers rather than farmers, and this kind of SC is a Type C. There are two Type C food manufacturers.

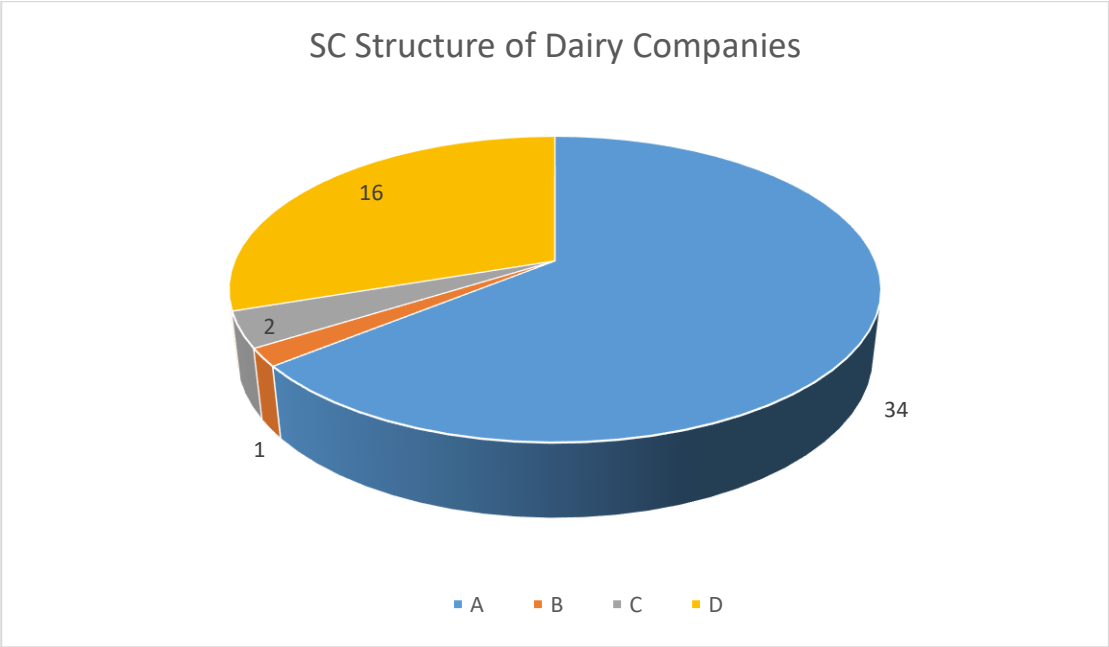


Figure 4. 24 SC structure of dairy companies participating in this survey

Eurostat (2016) identified four sizes of enterprise groups: micro enterprises (fewer than ten employees), small enterprises (10-49 employees), medium enterprises (50-249 employee), and large enterprises (250 or more employees).

Figure 4.25 illustrates that 20 respondents were micro enterprises, 11 small-medium enterprises (SMEs) and five enterprises. (One further respondent did not state the number of employees in their organisation.) Therefore, the company size distribution is roughly 6:3:1 (micro, small-medium and large). It is acknowledged that the bulk of the

processors who responded are very small companies, which may affect the representativeness of the sample to the wider population.

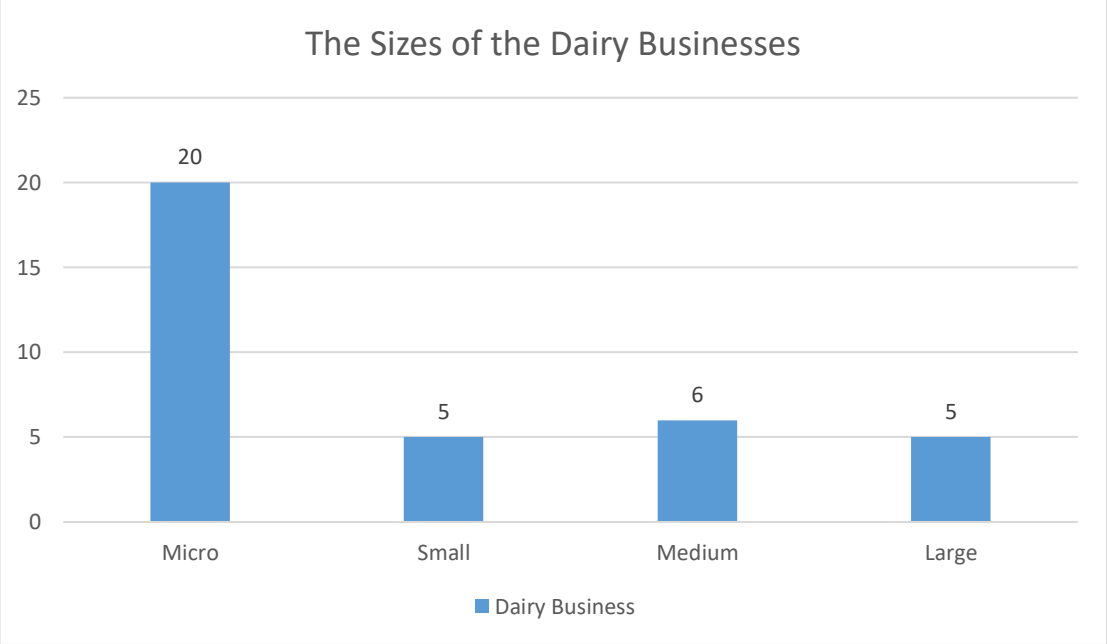


Figure 4. 25 The sizes of Type A, B and C dairy processors

Figure 4.26 identifies the dairy businesses' products. Cheese, milk and ice cream are core businesses of Type A, B and C dairy companies, all achieving more than ten responses, with some also specifying 'other products' (four mentioned creams, one UHT milk, and one cream liqueur).

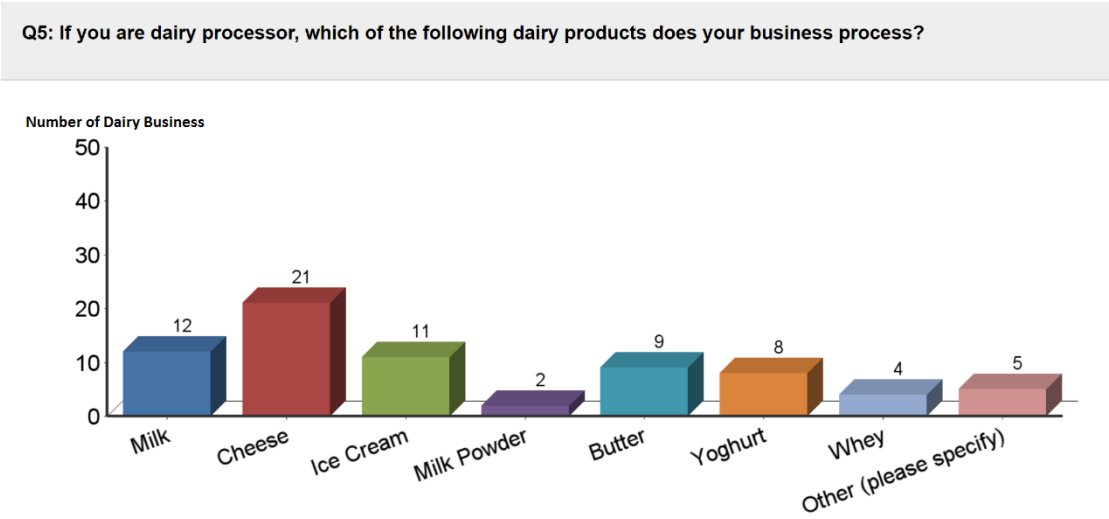


Figure 4. 26 The products processed by dairy businesses

It should be noted that the cheese market is quite different to that of liquid milk, with cheeses having much greater value-added than milk, and more diverse flavours. Currently, there are roughly 250 cheesemakers in UK, producing 750 unique British cheeses (Harbutt, 2014). Therefore, many niche markets exist for special flavours of cheese. 11 of the 34 Type A dairy businesses are solely cheesemakers of varying sizes. Nine have employee counts ranging from 1.5 (one full-time and one part-time) to seven. They are all micro enterprises or family businesses, focusing on niche markets, e.g., local food, special breeds. One business owner mentioned that they use ewe's milk to produce cheese, whilst another one said their cheese was made from native breed ayrshire cow's milk. The other two cheesemakers, with employees of 340 (large size) and 120 (medium size), are the leading European mozzarella cheese manufacturer and the UK's leading pasta filata (stretched curd) cheese producer serving the UK and overseas market. Thus, the respondent cheesemakers were all either the best in a niche market or a strong player in large-scale cheese-making for the food industry (e.g. as an ingredient in frozen pizza).

4.2.2. Customer Analysis

Figure 4.27 illustrates the dairy products' destinations. In terms of arithmetical mean (rather than weighted mean), 25% of the dairy products go to the food service and hospitality industry, 19% are sold directly to consumers, and 17% are sold through other channels, including wholesalers, exporters, healthy food distributors and organic doorstep box schemes. On the other hand, cheese, milk and ice cream were the top

three dairy products processed by the respondent dairy businesses, with differing supply chain structures for each of these products.

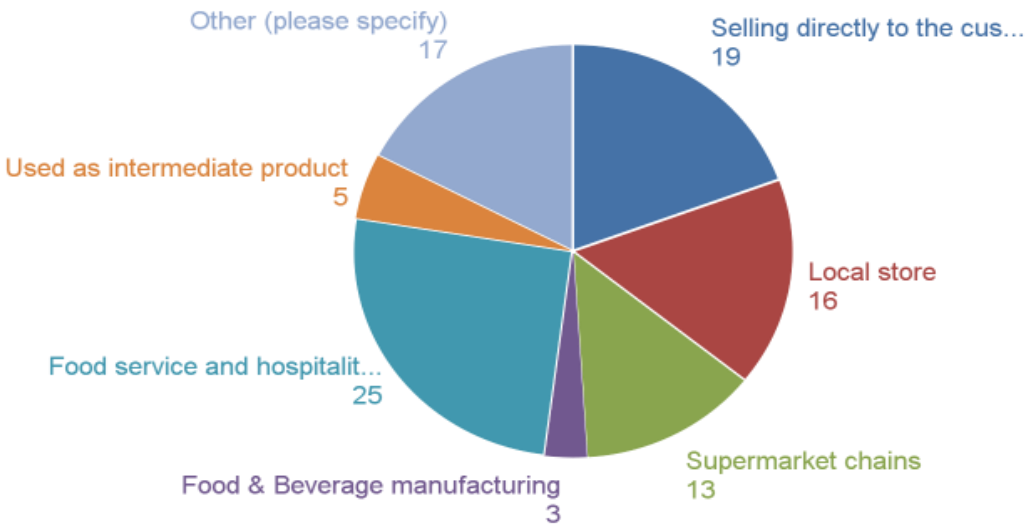


Figure 4. 27 Dairy product destinations (unit: %)

As illustrated by Figure 4.28, the cheese products downstream supply chain is dominated by the food service and hospitality industry (26%), followed by other wholesalers (22%). Selling directly to the consumer (via farm shops) and local stores comprise 16%. Interestingly, sales to supermarket chains and food and beverage manufacturing are not significant, as most of the returned questionnaires came from micro cheesemakers. The core activities of these companies were focused on local and niche markets, rather than large and medium dairy companies manufacturing cheese and entering supermarket chains or the food industry for further processing.

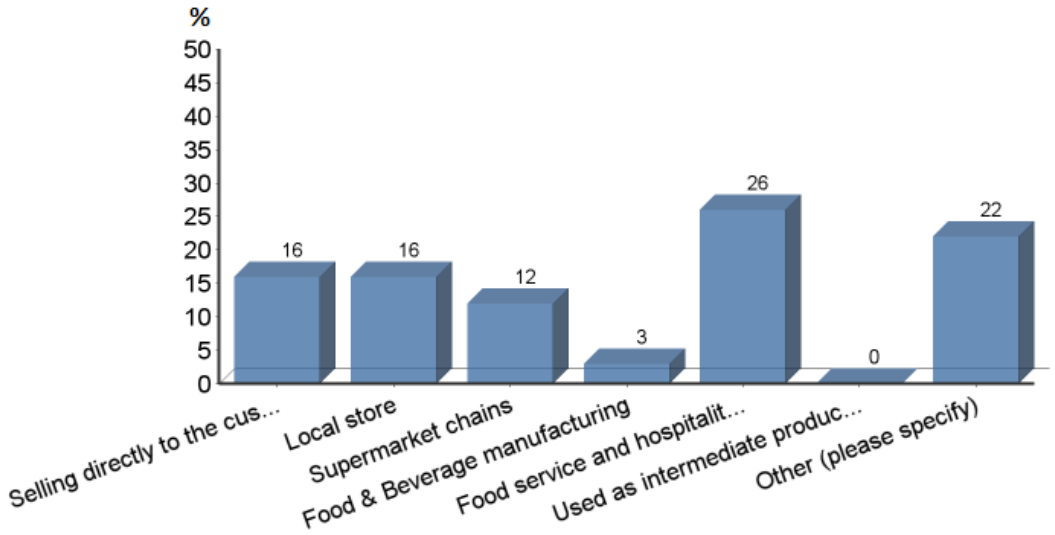


Figure 4. 28 Cheese destination (unit: %)

Figure 4.29 illustrates the milk downstream SC structure, with 26% selling directly to consumers, 25% to supermarket chains, and 24% to the food service and hospitality industry. Since milk products are not substantially differentiated, and have fewer processing techniques than cheese products, many small milk companies concentrate on delivering fresh milk to local consumers. Some of the micro or small companies commented that their priority was quality. Doorstep delivery and selling directly to households are two special modes in the milk downstream market.

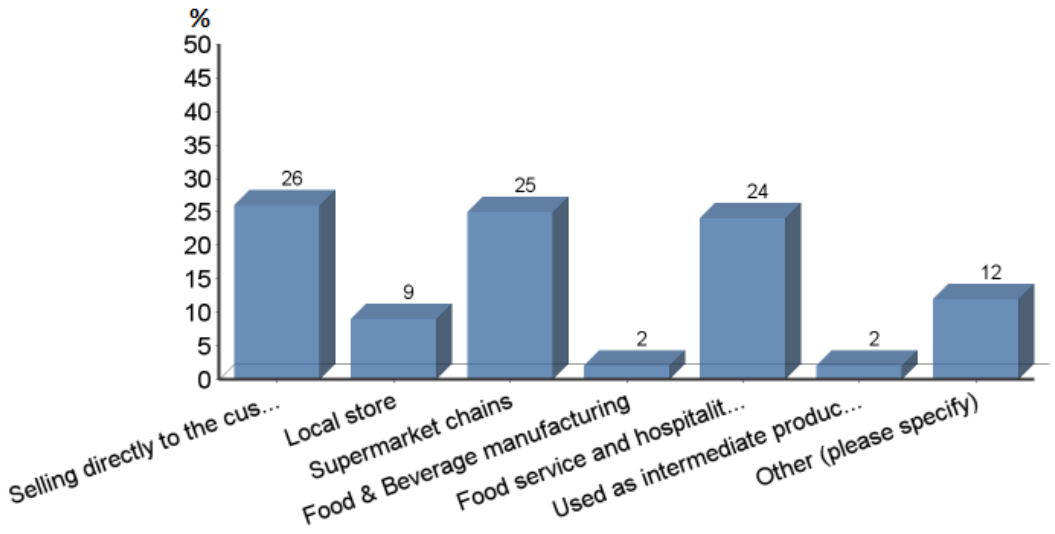


Figure 4. 29 Milk destination (unit: %)

The ice cream business has more concentrated selling channels (Figure 4.30), selling directly to consumers, the food service and hospitality industry, and local stores in more than 80% of cases. Some ice cream business owners sold their product in their own shops and tea rooms, and others traded at market stalls and from ice cream vending vans. These channels appear to be easier for small businesses to utilise than supermarket chains.

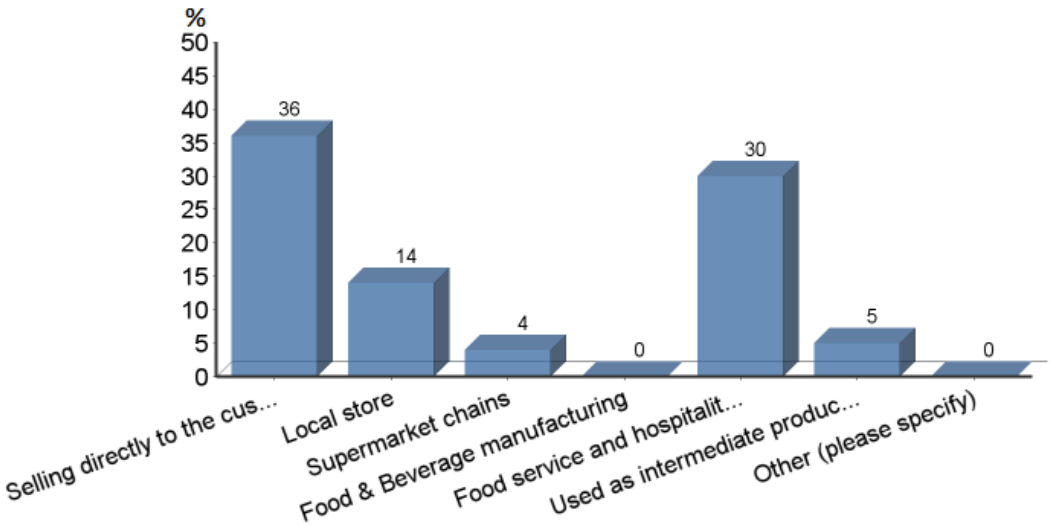


Figure 4. 30 Ice cream destination (unit: %)

4.2.3. Sustainability Requirements of Suppliers

Figure 4.31 highlights the penetration index of 15 different environmental and ethical variables in milk sourcing. Respondents were asked to rate their sustainable procurement practice penetration levels using the following values:

no requirement = 0

voluntary requirement = 1

compulsory requirement = 2

Sustainability Penetration Index =

*no requirement *0 + voluntary requirement *1 + compulsory requirement *2*

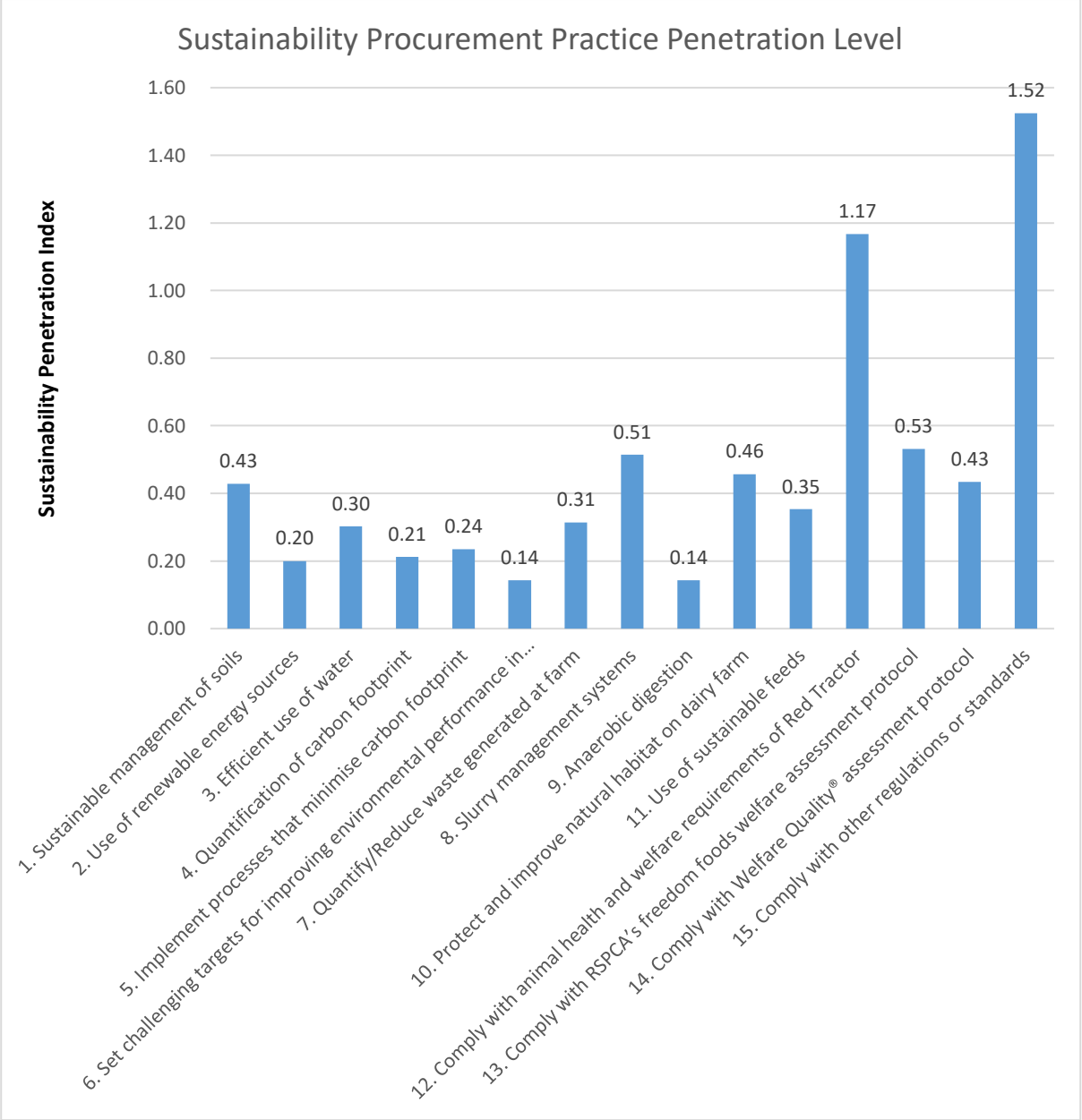


Figure 4. 31 The penetration levels of different sustainable practices in milk sourcing

Excluding 'comply with other regulations or standards', which will be discussed in the last segment of subsection 4.2.3, the 15 environmental and ethical requirements are analysed below, categorised into five themes: GHG emissions, farmland conservation, resource utilisation, waste disposal, and social sustainability.

GHG Emissions

Variables – GHG	Value
Set challenging target for CF reduction	0.14
Implement to minimise CF	0.24
Quantity CF	0.21

GHG emission variables on milk sourcing processes remain low impact, which means that GHG emission reduction does not play an important role in environmental policy at a company level. Taking environmental commitment as a spectrum, starting from quantification of CF and moving to strict requirements on setting targets for CF reduction, the penetration rate appeared to increase slightly and then decline sharply as commitment level increased. Such findings suggest that CF quantification is not a prerequisite of CF reduction. A management route (e.g. better management of slurry) also may lead to mitigation of CF. In fact, most micro and SMEs have neither teams nor techniques and funds to quantify CF emission.

Farmland Conservation

Variables – Farmland Conservation	Value
Sustainable management of soil	0.43
Protect natural habitat	0.46

Farm conservation variables have a medium impact on procurement decisions. Three dairy processors named the Soil Association as the source of their regulations not otherwise specified. The companies which process organic dairy products (including one farmer-owned organic sales company, i.e. an Agent Purchaser) must source raw milk produced under Soil Association accreditation.

Resource Utilisation

Variables – Resource Utilisation	Value
Use of renewable energy	0.20
Use of water in efficient way	0.30
Use of sustainable feed	0.35

Resource utilisation variables have a low impact on milk sourcing decisions. As the installation of renewable energy facilities, such as PV panels and biomass boilers, may receive financial support from government subsidies rather than milk buyers, milk buyers do not set compulsory requirements for this practice. Similar to CF reduction, water footprint reduction is difficult in that it is hard for micro and SMEs to ensure the transparency of their upstream supply chain. One dairy processor mentioned a compulsory requirement of no genetically modified (GM) feed.

Waste Disposal

Variables – Waste Disposal	Value
Anaerobic Digestion	0.14
Waste Reduction	0.31
Slurry Management	0.51

Waste disposal variables have an impact on milk sourcing that ranges from low to medium. Again, Anaerobic Digestion facilities can be funded by government subsidies rather than dairy companies, hence only a few buyers have compulsory requirements. Slurry management plays a more important role, since inappropriate slurry disposal may contaminate milk or have a negative impact on animal living conditions and the farm environment.

Social Sustainability

Variables – Social Sustainability	Value
Welfare Protocol	0.43
RSPCA	0.53
Red Tractor	1.17

Social sustainability is the key focus of dairy processors in terms of supplier selection and supervision. The Red Tractor Assurance Scheme has become a common milk production standard, the returned result indicate that Red Tractor received high penetration rate and it is a compulsory requirement that most supplier should comply with. Two dairy processors commented that their sustainability requirements all included Red Tractor. Another processor added that *'farming well and with respect for [their] animals'* was a compulsory criterion.

In addition to aforementioned criteria, several processors indicated that they *'comply with other regulations or standards'*, and detailed the specific requirements. Four businesses mentioned the minimum legal requirements (hygiene and animal welfare) of the Food Standard Agency (FSA). As these are fundamental requirements for all milk production entities, this questionnaire did not incorporate this selection. Two dairy businesses gave the technical specifications of their milk suppliers, with one noting, *'min 3.5% fat and 3.4% protein in the milk'*. Two dairy companies put their focus on farming methods, *'least intensively farmed, traditionally managed, native breed cows'*, and stated that, *'Good quality, all-year-round milk is the most important criterion'*. One processor set additional requirements on animal health by ensuring suppliers participated in the Kite Herd Health Monitoring Scheme. Three processors showed concern about local and low food miles, for example requiring milk suppliers to be situated within a one-mile radius, *'which is cost effective and logistically and environmentally sustainable'*, *'sourc[ing] our milk from the only local dairy herd'*, and *'comply[ing] with SALSA (Safe and Local Supplier Approval)'*.

Large dairy companies or dairy companies in certain regions may also have their own regulations and standards. Two dairy processors located in Northern Ireland also

sourced milk from the Republic of Ireland, hence they require their suppliers to comply with the Origin Green Ireland sustainability scheme. A company located in the Isle of Man commented that the island is not a part of UK, and therefore they obey only local standards. A large food manufacturing company with 4,000 employees has its own welfare policy for suppliers. A small dairy company with 30 employees processing milk and cheese indicated that they must comply with Arla's environmental and social requirements as they are producing food under the Arla brand. A famous cheesemaker with around 150 employees also set its own standards and regulations on milk sourcing.

4.2.4. Financial Awards

Figure 4.32 outlines the distribution of financial awards or bonuses to suppliers for meeting sustainability requirements, covering all of the respondent companies in all three scenarios: micro, small-medium and large companies. At all company levels, around a quarter of companies (26%) provide financial bonuses to their suppliers, this is similar to the SME scenarios (27%). For micro companies, 18% pay for sustainability achievements, whilst 40% of large size dairy processors pay their suppliers for meeting their sustainability regulations.

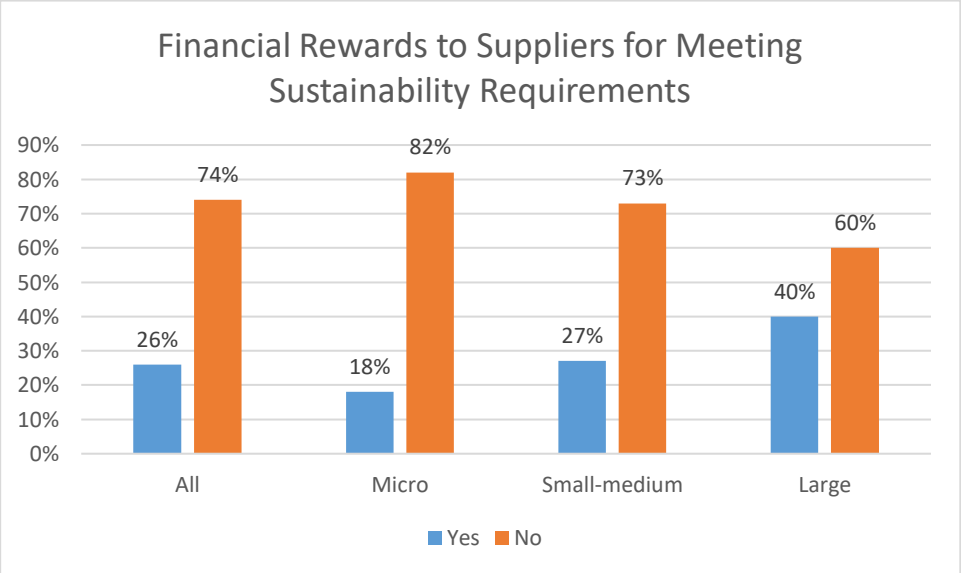


Figure 4. 32 Financial rewards to suppliers for meeting sustainability requirements

Figure 4.33 illustrates the proportion of the prices which the financial rewards account for. From the perspective of all the companies, 44% of processors paid financial rewards which accounted for less than 5% of the price; 33% paid between 5% and 20% of the price; and 22% paid more than 20% of price. However, all of the large dairy processors offered rewards of less than 5% of the price, whilst micro and SMEs provided more generous proportions, rewarding more than 5% of price in 66% and 67% of cases, respectively.

In addition to sustainability bonuses, supporting their famers' economic sustainability drove some processors to provide premiums to their supplier. A medium size dairy company commented that they paid a 0.8 ppl (pence per litre) premium above a defined basket of six other milk buyers in the South West. A cheesemaker with four part-time workers offered a price bonus to help their three suppliers (small local farmers) to confront financial hardship in the current fatigued market. All organic dairy processors offered a premium of at least 10% of the price, with one even offering a 100% bonus, as the cost of milk production in the organic model is higher than in that of conventional milk.

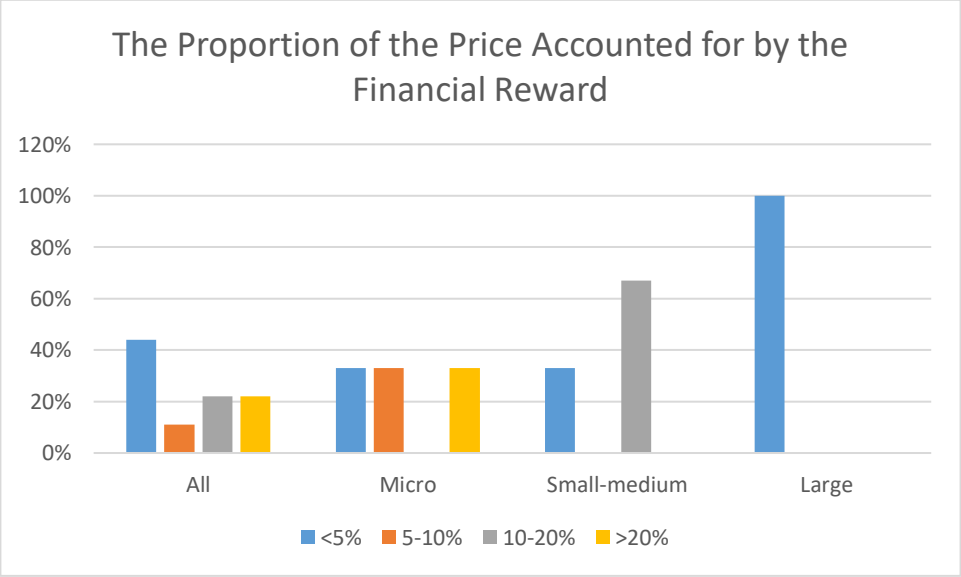


Figure 4. 33 The proportion of the price accounted for by the financial reward

4.2.5. Drivers

In this subsection, the drivers of sustainable milk sourcing practices are analysed. Figure 4.34 uses a driver index to conduct a numerical comparison of ten potential drivers. The driver index is calculated using the following formula:

Driver Index =

*Strongly disagree *-2 + somewhat disagree *-1 + neither agree nor disagree *0 + somewhat agree *1 + strongly agree *2*

The company's reputation and brand image with the public ranked as the most important driver of sustainable milk sourcing (1.38), followed by a desire to improve product quality (1.32), sustainability demands from customers (1.30), pro-environmental corporate culture (1.29), and support from suppliers (1.05). All of these five factors' parameters are larger than one, which indicates the respondents' confident agreement with these drivers.

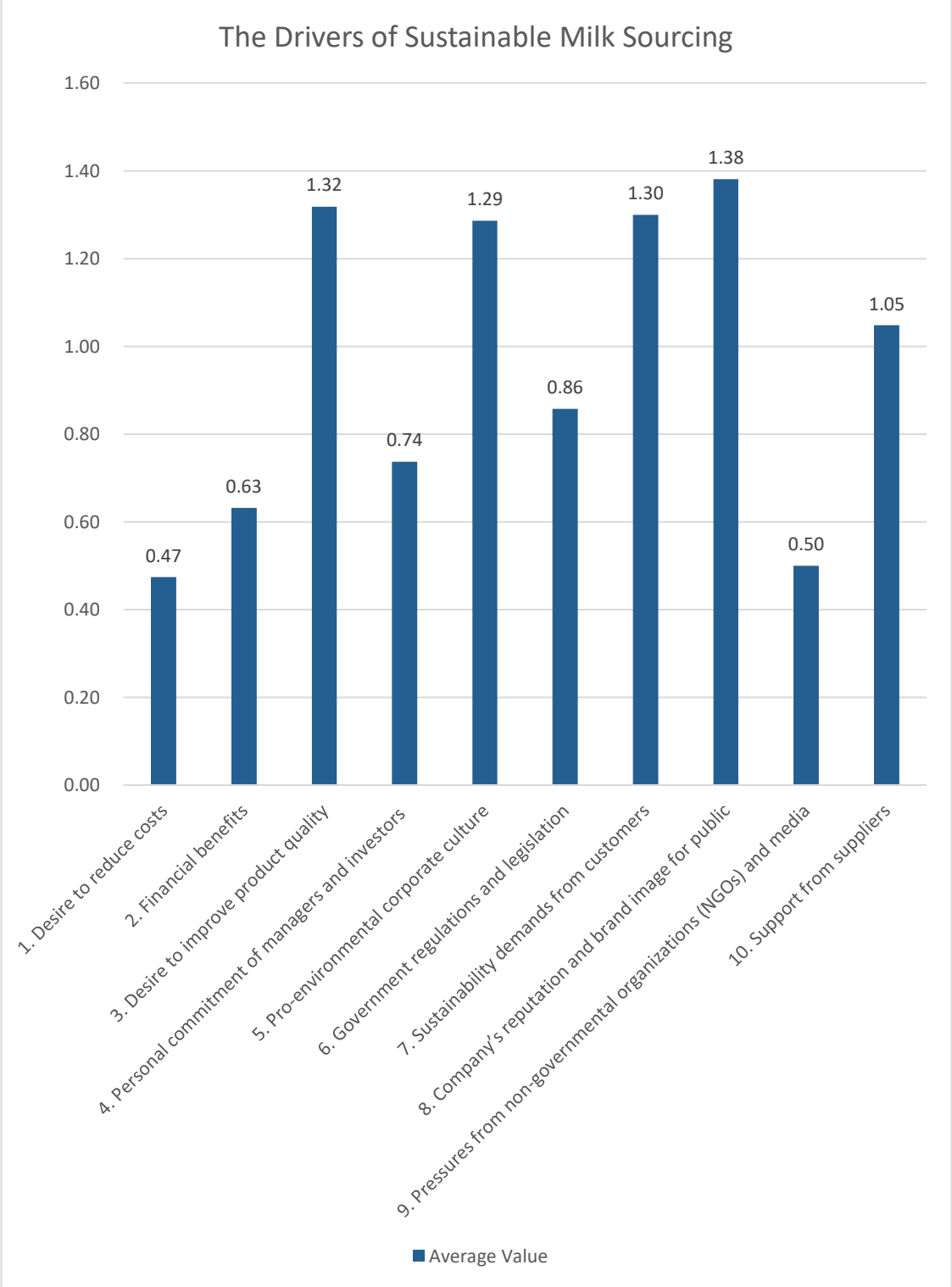


Figure 4. 34 The drivers of sustainable milk sourcing

One dairy food manufacturer commented: *'Retailers put enormous pressure on dairy companies to source milk from farms that comply with recognised standards. The retailer's worst nightmare is to see their name linked to bad press (animal welfare, food*

safety, environmental issues)'. Unsurprisingly, the company's reputation and brand image ranked the top driver of sustainable procurement. A company's brand image is always represented by its core products (Haake and Seuring, 2009), and the results of this research support those of previous research – that a firm's image and reputation are the key drivers of sustainable procurement (Björklund, 2011).

The desire to improve product quality has been found to be the second most important driver of sustainable milk sourcing. One medium size milk and cheese processor mentioned the main driver of their sustainable milk production was their intention to improve their milk's quality and flavour. A micro cheesemaker (with just one full-time and one part-time worker) said better cow welfare (social sustainability) and soil welfare (environmental sustainability) produced better cheese-making milk, hence improving product quality was the most important driver for them.

Some previous research also identified consumers' demands as a main driver of sustainable practices. Björklund (2011) identified that consumers' environmental demands had a critical impact on company purchasing decisions. A micro butter maker (with just one member of staff) said that, *'What the customer pays seems the most important'*, therefore customer's demands play a key role in purchasing decisions.

Environmentally-friendly corporate culture is another significant driver. This was empirically tested by (Chan et al., 2012), who identified a positive relationship between internal environmental orientation and sustainable procurement practices. This survey further reveals the dichotomy between companies' internal environmental attitudes and their sustainability requirements for milk producers. One micro cheesemaker said, *'Any sustainability requirement on our suppliers would be laughed off… nor do we have much litany choice of supplier'*. Conversely, another cheesemaker said, *'We drew milk from three small farms, despite their financial hardships. The farms all put the welfare protect of their cattle and implemented as many environmental measures as they could afford. As procurers, we offered a price bonus on the milk we took"*. Clearly, corporate internal environmental orientation has a strong impact on purchasing preference.

It is particularly typical that 'getting support from their suppliers' as a driver for organic dairy processor, with one organic company saying that all their suppliers produce milk in an environmentally-friendly way, within strict certified codes of practice and standards (e.g. Soil Association). In conclusion, the five aforementioned drivers are most significant in terms of sustainable milk sourcing.

4.2.6. Barriers

In this subsection, the barriers to sustainable milk sourcing practices are analysed. Figure 4.35 uses a barrier index to conduct a numerical comparison among nine potential barriers. The barrier index is calculated using the following formula:

Barrier Index =

*Strongly disagree *-2 + somewhat disagree *-1 + neither agree nor disagree *0 + somewhat agree *1 + strongly agree *2*

Figure 4.35 highlight the five main barriers to dairy processing businesses exercising sustainable milk purchasing. Neither of the barrier indices were calculated to be equal to or larger than one, which suggests most respondent would not confidently agree with either of them. The identified barriers were economic reasons (0.73), weak returns on investment in sustainability (0.41), a lack of environmental policies and regulation (0.27), a lack of transparency from suppliers on environmental and social issues (0.09), and poor supplier commitment (0.08). Interestingly, another four variables received either neutral (=0) or negative results (<0), indicating that respondents did not agree those variables were barriers at all. These non-barriers included a lack of awareness among top management (0), low commitment of employees (0), suppliers with low competencies (-0.10), and non-proactive compliance with government regulations (-0.10).

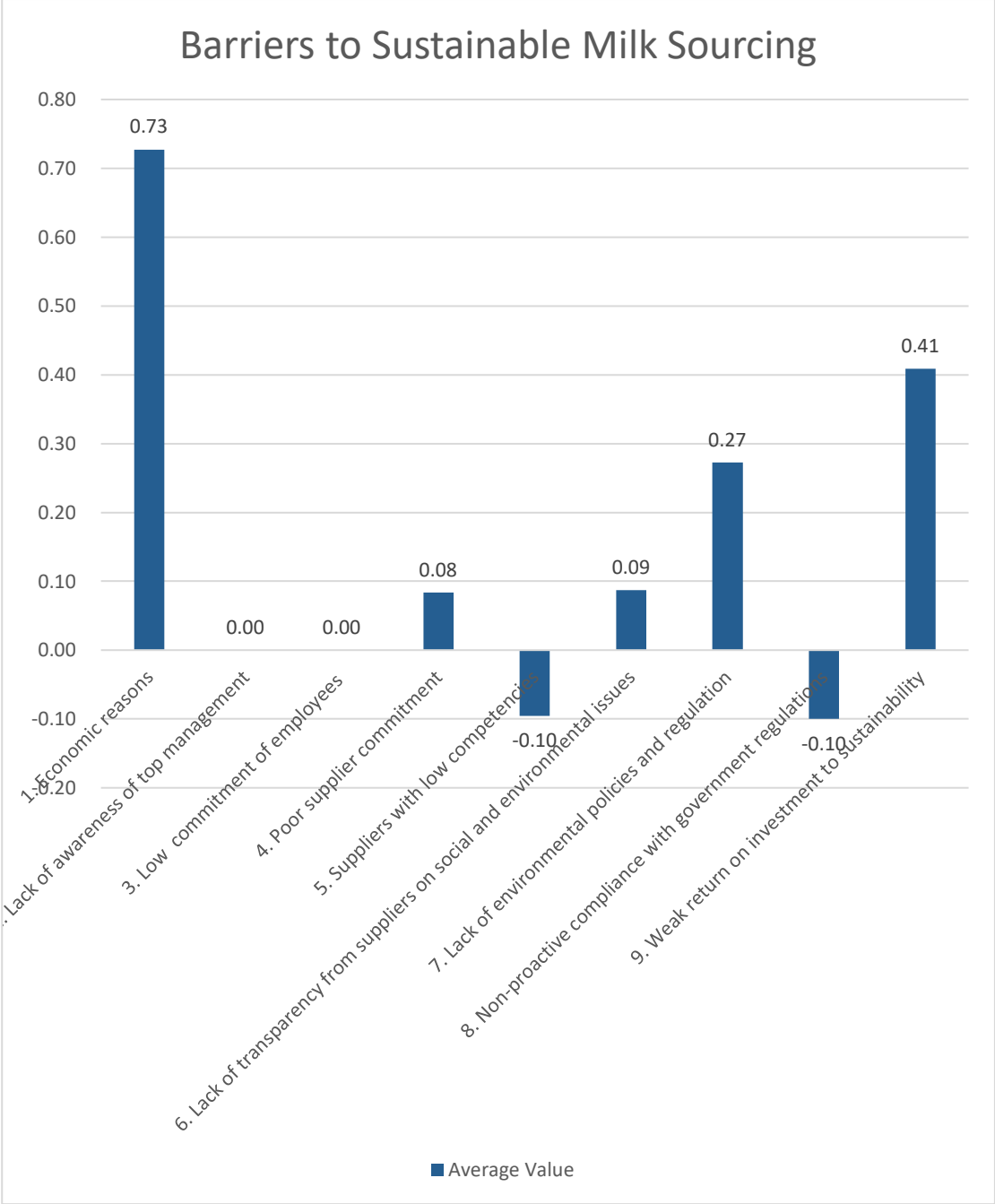


Figure 4. 35 Barriers to sustainable milk sourcing

Economic reasons were named as the most important barrier, and this finding is compatible with those of 14 other sustainable procurement research papers published between 1996 and 2013, all of which found economic preoccupations constituted the principal barrier (Appolloni et al., 2014). In this research project, a micro size cheesemaker commented, *'We are told that unless the benefits of make funds or create efficiency, then do not suggest altruistic policies!' (sic).* Another micro size cheesemaker mentioned, *'You cannot expect family farms to embrace environmental*

improvement when financially most are struggling with rising fuel, feed, fertiliser, labour and marketing costs, even when the will is these to implement green policies'.

The second most important barrier agreed upon by dairy processors – weak return on investments in sustainability – was also related to an ambiguous relationship between input and output. The empirical results suggest that SMEs will implement green procurement practices only if they can see the potential for financial competitiveness creation.

Respondents did not agree that suppliers with low competency might constitute a barrier. The previous section on sustainable procurement from farmers' perspectives highlighted that the financial rewards/bonuses can make positive impacts on farmers' commitment to sustainability. Therefore, farmers' willingness to improve social and environmental sustainability performance beyond the fundamental legal requirements is largely impacted by milk buyers' willingness to fund sustainability action, rather than farmers' internal competency.

In addition, dairy processors also disagreed that non-proactive compliance with government regulation was a barrier. The government currently only set a minimal legal requirement for food hygiene and animal welfare, and some initiatives on environmental and social sustainability are entirely voluntary. Most milk processors require their milk producers to comply with Red Tractor or other standards (e.g. RSPCA, Welfare Quality, SALSA, Original Green Ireland, buyers' environmental codes), as these standards and schemes provide detailed requirements and technical specifications which are measurable. A dairy food manufacturer commented, *'We see a similar issue with all factories needing to comply with BRC standards, but retailers and other large food companies, insisting on their own standards set at a higher level. Rather than just accepting the cost of an audit, the higher standards require further independent audits'*. Therefore, non-proactive compliance with voluntary environmental and social codes could be a barrier.

4.2.7. Benefits

In this subsection, the benefits of sustainable milk sourcing practices are analysed. Figure 4.36 uses a benefit index to conduct a numerical comparison among five potential benefits. The benefit index is calculated by the following formula:

Benefit Index =

*Strongly disagree *-2 + somewhat disagree *-1 + neither agree nor disagree *0 + somewhat agree *1 + strongly agree *2*

Figures 4.36 presents the results of the benefits ranking. The three most important benefits are revealed to be as follows: created a competitive advantage (0.91), a positive effect on firm's performance due to the unique selling point (0.82), and development of stronger relationships with suppliers (0.77). However, environmental benefits (reduction of emissions, waste and energy) and financial benefits were cited only by a small proportion of respondents (0.32 and 0.27, respectively), which means most selected 'neither agree nor disagree'. In response to the financial benefit option, more than one fifth of dairy processors stated they disagreed or strongly disagreed this was a factor.

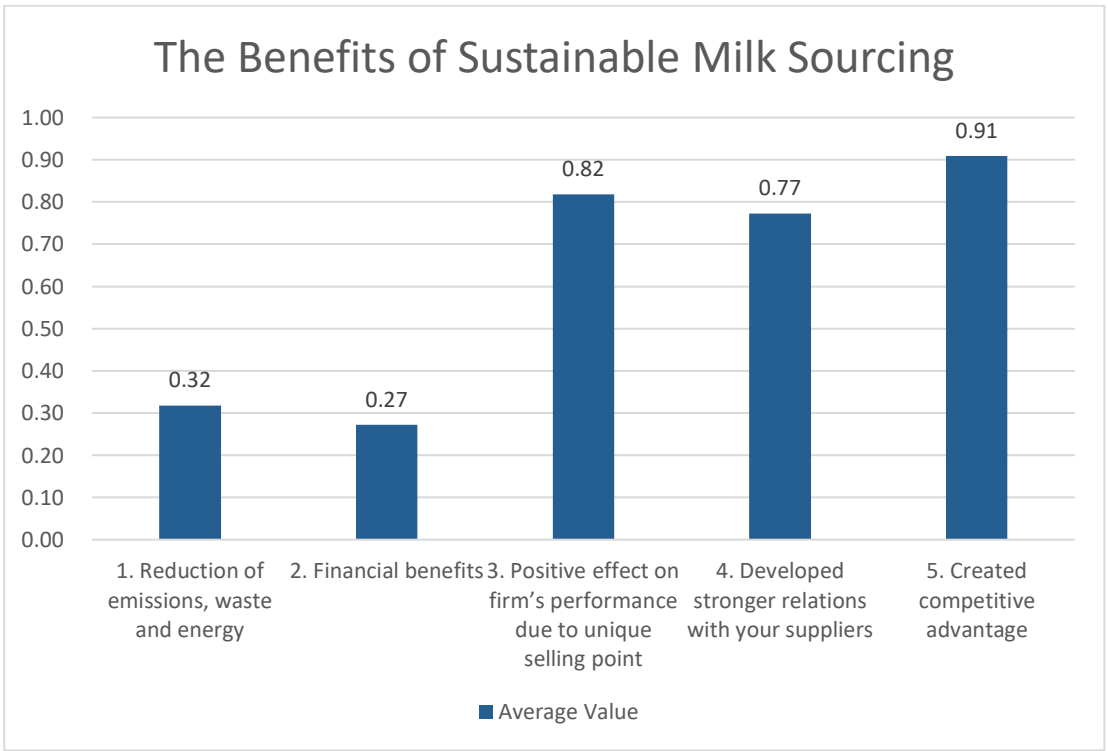


Figure 4. 36 The benefits of sustainable milk sourcing

A medium size milk, butter, yoghurt and cream processor mentioned, *'We focus mainly on milk hygiene, quality and herd welfare and happiness. We work with excellent farmers who are confident [and] good stewards of the land, but we have not formalised*

this'. This processor also offers a price premium to their farmers, and holds a strong and close relationship with their milk producer. One organic milk company said, *'Our unique selling point is being able to procure milk in an environmentally friendly way within strict certified code of practice and standards'*. Competitive advantages can be derived from unique selling points (niche market) and stronger buyer-supplier relationships, and the empirical results gathered here conform to those of previous research performed by Walker et al. (2008) that green procurement has a positive impact on companies' operational performance.

4.2.8. A summary of key findings related to sustainable procurement

In conclusion, there are six key findings generated from this section.

1) The dairy processor survey identified four types of SC structures existing in the British dairy sector. The three-tier structure (Type A: farmer – processor - customer) and two-tier structure (Type D: farmer and processor –- customer) are the most typical. The next section will analyse Type D structure SC.
2) The penetration rates of sustainability requirements from buyers are sequenced as social responsibility > farmland conservation > waste disposal > resource utilisation > GHG emission. The fact that GHG emission control received the lowest penetration rate shows the dichotomy between policy proposal and realistic application.
3) Large size dairy processors show greater willingness and ability to pay financial bonuses to their milk suppliers for higher sustainability performance. 40% of large companies paid sustainability bonuses, whilst small-medium companies and micro companies had less capacity to fund their suppliers (27% and 18%, respectively).
4) A company's reputation and brand image was the most important driver for dairy processors to implement sustainable procurement practices, followed by a desire to improve product quality, sustainable demands from customers and pro-environmental corporate culture.
5) The most significant barrier to dairy processors' sustainable procurement practice was economic. Processors disagreed that suppliers with low competencies and non-proactive compliance with government regulation were barriers.
6) Dairy processors were in agreement that three of the benefits to sustainable procurement practices were the creation of competitive advantage, a unique

selling point (USP) and stronger relations with suppliers.

In the next section, there will be an analysis of the penetration of sustainable production practices in Type D dairy companies, and consideration of the drivers, barriers and benefits of sustainability practices. The similarities and differences between Type A and Type D SCs in terms of sustainability drivers and performance will be compared.

section 4.1 and 4.2 have described and analysed different aspects of dairy sustainability from the perspectives of both a supplier (producer) and a buyer (processor). The next section draws these analyses together to compare the perspectives and suggest where the main similarities and differences lie. This will provide an indication as to the likely success of sustainable procurement relationships and suggest the extent to which sustainable procurement faces barriers or opportunities for the future.

4.3. Sustainable Production Attitudes from On-Farm Dairy Processors

This section aims to analyse the sustainable production attitudes of on-farm dairy processors (Type D dairy processors). These dairy businesses have the dual roles of dairy production and dairy processing, hence questions about sustainable milk procurement do not apply to these businesses. There are 16 respondents falling into the type D SC category. The following analysis begins with the penetration rate of sustainable production practices, then considers drivers, barriers and benefits of implementing these practices, finishing with a consideration of the similarities and differences between types A and D.

4.3.1. The Penetration Level of Sustainable Production Practices

The average number of staff at a Type D dairy company is 11.4, the lowest is 0 (a family business operated by a husband and wife). Two-thirds (66.6%) are micro companies with fewer than ten staff, and the other third fall into the SME category (33.3%). Hence, dairy companies with both farming and processing functions are almost all micro and SME, and their supply chain structures are straightforward.

Figure 4.37 illustrates the selling channels of dairy companies on the Type D SC. The main destinations are: directly to the final consumer (37.19%), local stores (17.81%), and the food service & hospitality industry (11.75%), which presumably includes options such as local or nearby restaurants and bars. Selling to 'other' parties accounts for nearly 15% of the total, and this option mainly comprises brokers (cheese mongers, local milkmen), wholesalers and exporters. The fact that the bulk of the producers/processors who responded are very small, localised companies may affect the representativeness of the sample to the wider population.

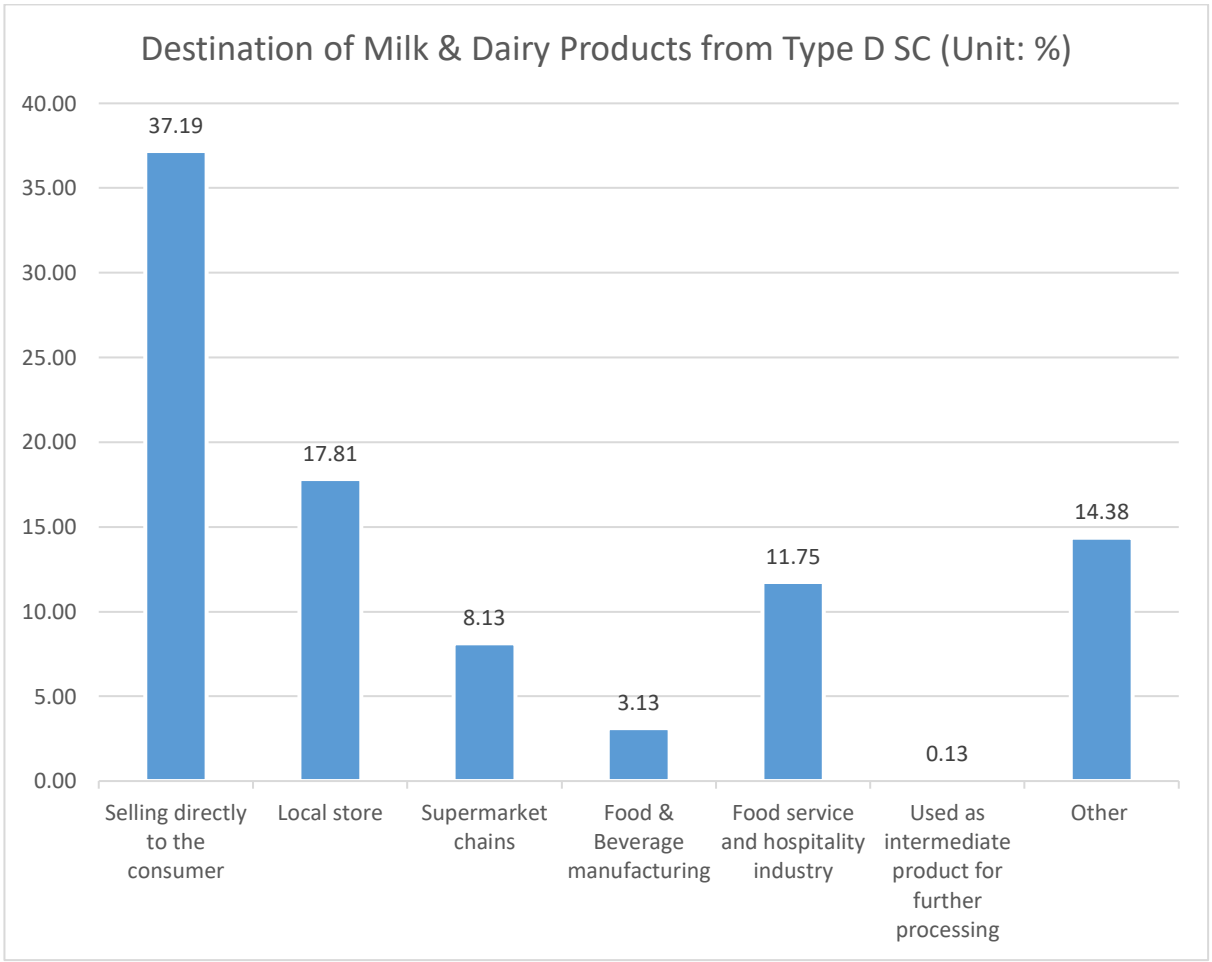


Figure 4. 37 Destinations of milk and dairy products from Type D supply chain

Figure 4.38 highlights the popularity of different dairy products produced by on-farm processors. Liquid milk and cheese are the mainstream dairy products, with 80% and 46.67% of on-farm dairy processors making liquid milk products and cheese products, respectively. Also, around a quarter of companies produce ice cream, butter and other products (cream). Due to the nature of these small companies (endowed with limited resources in terms of cows, financial capital and labour), no respondent dairy company processed milk powder and whey, as these need more sophisticated facilities.

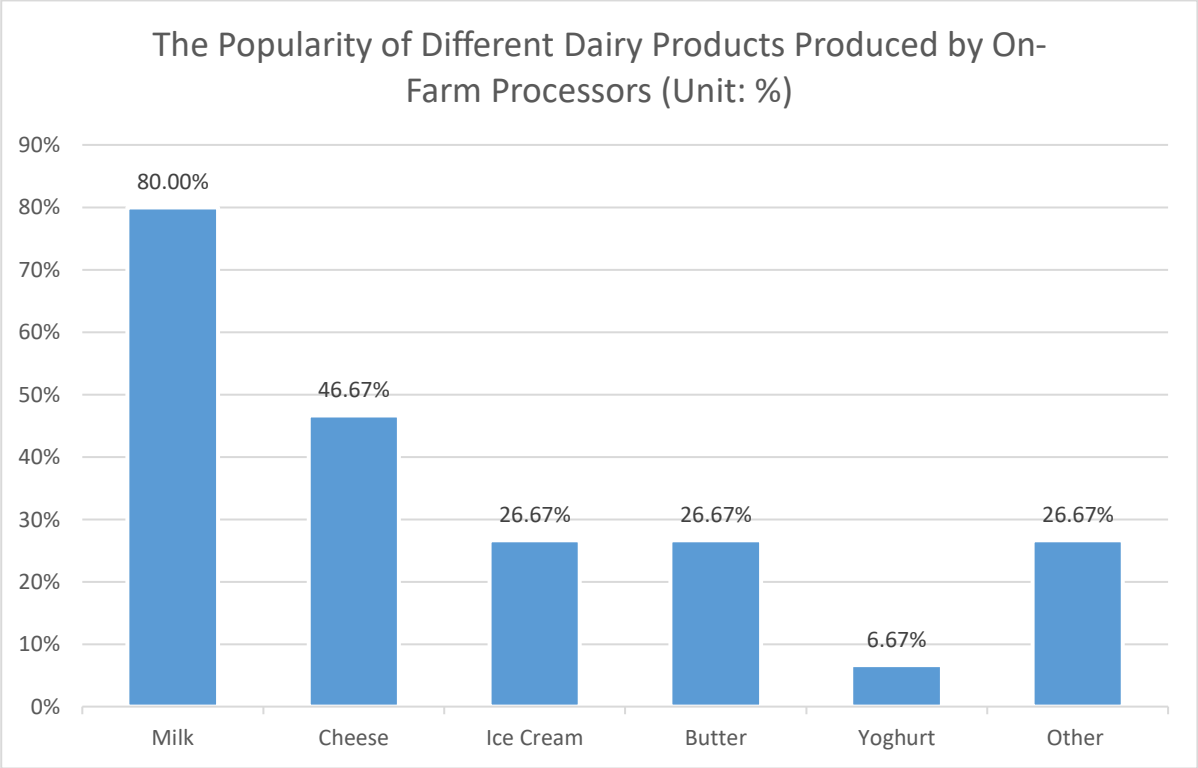


Figure 4. 38 The popularity of different dairy products produced by on-farm processors

Figure 4.39 indicates the sustainability penetration index of 15 sustainable production practices adopted by Type D dairy processors (the definition and calculation method of sustainability penetration index refer to Subsection 4.2.3). High sustainability diffusion is defined as sustainability penetration index >1.5, which implies that most dairy companies regard those sustainability practices as compulsory requirements. The following sustainability practices have high diffusion: slurry management systems, protecting and improving natural habitats on dairy farms, and complying with “other regulations and standards”. In terms of the latter, two businesses specified the SALSA

(Safe and Local Supplier Approval) standard, which they utilised to create a unique selling point (USP) for their local and fresh products, and another noted that adhere to organic farming standards. One small family dairy farmer and processor said, *'Since not using fertilisers, etc., birds have increased'*. Slurry management and the protection and improvement of natural habitats on farm are more intuitive and feasible and less technically difficult for small size dairy companies.

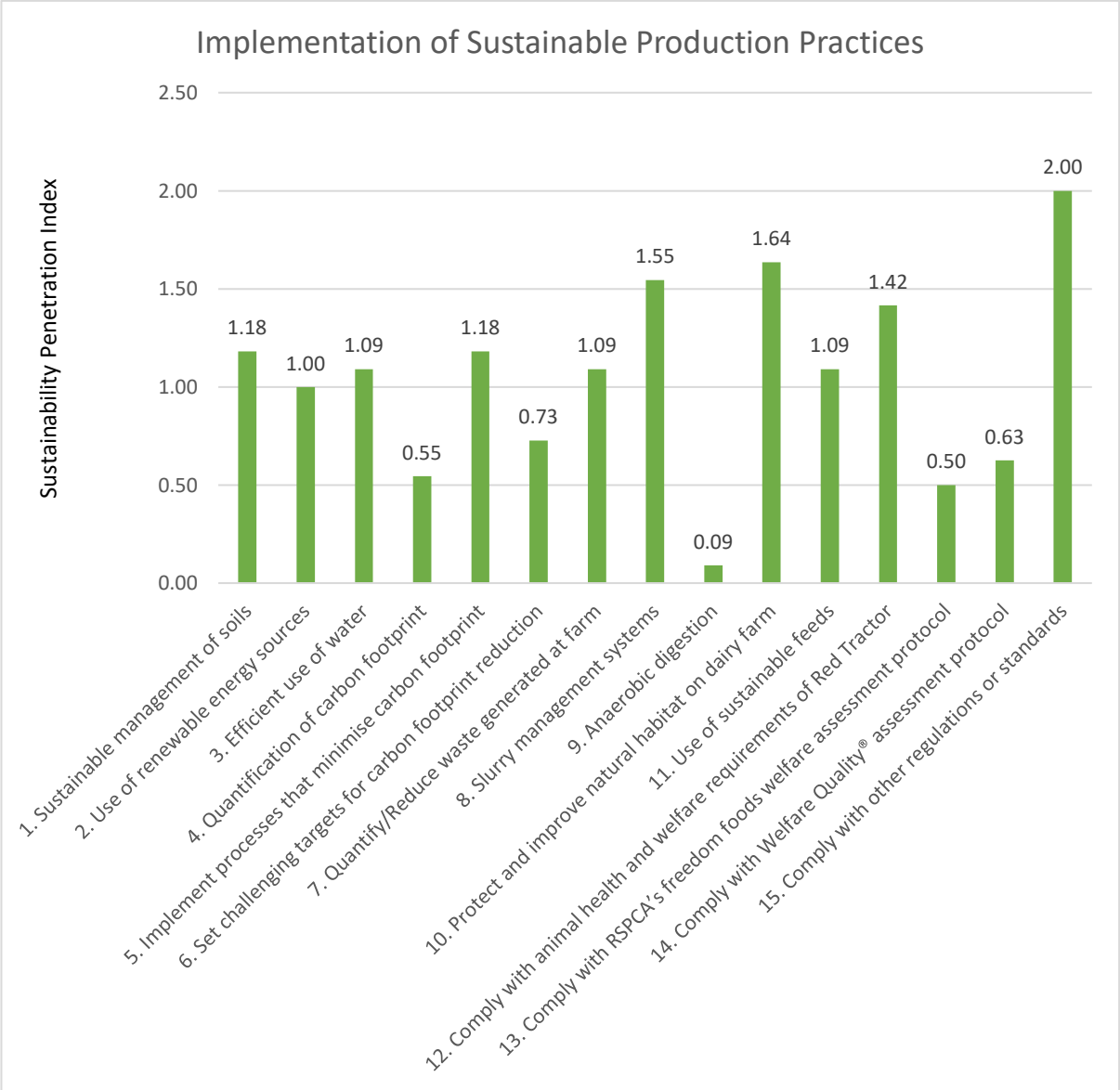


Figure 4. 39 The implementation of sustainable production practices

Some of other sustainable production practices achieved a medium level of diffusion (sustainability penetration index > 1.0), which means dairy companies set those requirements at, at least, a voluntary level.

Sustainable management of soil and use of sustainable feed are popular amongst small dairy producers and processors, with the majority also planting animal feed by themselves. A medium size traditional cheesemaker, with 34 employees, remarked, *'We use sustainable farming methods as part of how we operate'*. Ultra-High Stock Density (UHSD), commonly known as 'mob grazing', can create fertility in grassland by strengthening soil-building and carbon/nutrient cycling (Archuleta and Peterson, 2010). One family-run milk, cheese and ice cream producer employed rob grazing to upgrade their soil fertility: *'We grow our own grass, silage, haylage and hay; sustainable management of soils is our top priority; this year we plan to mob grazing the milk in a bale in the field spring to autumn'*. These two cases are examples of dairy businesses taking steps to improve their soil quality by various means. Caring for land and the benefits of preserving and harnessing soil are not only about environmental sustainability, but also better product quality.

Resource saving and waste reduction (e.g. use of renewable energy, efficient water use, reducing waste) also have attracted much attention. 19% of dairies have installed innovative facilities, such as photovoltaic panels. One small size producer mentioned that, *'Whey and waste bread are used to feed pigs (through one of our milk customer)'*. Another small size liquid milk producer and processor said, *'We use heat recovery for hot water and solar panels (220) on roofs of cattle sheds'.* Similarly, a small size goat dairy product producer noted, *'We use solar panels and have our own water source'.*

Very few companies conducted quantification of CF emissions or set challenging targets to reduce emissions, and the significant barriers here were technical and resource-related. One small-scale company commented, *'We would love to be able to able to quantify this (carbon footprint) but sadly are unable to'.* This shows that even though some small companies have ambitions to go further with carbon reduction, they are hindered by either limited internal resources or lack of help from their buyers in terms of funding, technology and knowledge. On the other hand, reduction of carbon emissions is the only practice adopted by more than half of interviewees. Without KPIs (key performance indicators) of CF reduction, the small dairies tended to make contributions to CF reduction in straightforward, convenient and affordable ways.

A small size farmer and processor believed they achieved carbon emission reductions by minimising food miles, saying, *'Whole business are very low carbon footprint since*

all (feed planting, milk production and further manufacturing) processed on farm" (sic). Another small size goat cheesemaker remarked, *'Hay and straw comes from our own farm and we try to ensure we have a low carbon footprint with choosing our raw material suppliers from the local area'.*

Carbon reduction is also achieved through resource saving and use of clean energy. One small size cheesemaker and milk producer said that, *'Emission reduction is mostly achieved by installing P-V panels and biomass boilers, as well as applying very low levels of chemical fertiliser'.* In addition, low carbon operations may be reached using environmentally friendly logistics. One small-scale local milk company which sold 85% of its bottled milk through doorstep delivery cut down CF using low carbon logistics, with six electric milk floats purchased to travel a 20-mile radius of the farm for milk delivery. Thus, small dairies could achieve CF reduction by lowering food miles, choosing local suppliers, adopting clean energy and configuring low carbon logistics.

Most on-farm processors sought to comply with the animal health and welfare requirements of Red Tractor. One milk and cream producer with two full-time and three part-time workers stated there was *'no requirement (on sustainability), however [we] want to be welfare sustainable and affordable'.* This comment illustrated a greater enthusiasm for social sustainability than environmental sustainability. Some dairy producers and processors also follow welfare standards which have bias in favour of free-range. One small size milk, butter and flavoured milk produce disclosed, *'We are RSPCA freedom food producers, which means high welfare'.* In addition, when pursuing animal welfare standards beyond prescribed standards, business operators may focus on their desired field; for example, a milk and cheese producer with four employees commented, *'We try to farm ethically and to very high husbandry standards. We do not use hormones or artificial lighting to extend the breeding season'.*

4.3.2. Drivers, Barriers and Benefits of Implementing Sustainable Production Practices

Figure 4.40 shows the degree of penetration of each potential sustainable production driver. The definition and calculation method of driver index refer to Figure 4.34. A desire to improve product quality and the company's reputation and image with the public remain the two most important drivers. These drivers are well connected with a company's economic profits; but in addition to pure economic reason, small local dairy

business also driven by their local markets' preferences and the business owners' sentiments around environmental and social benefits.

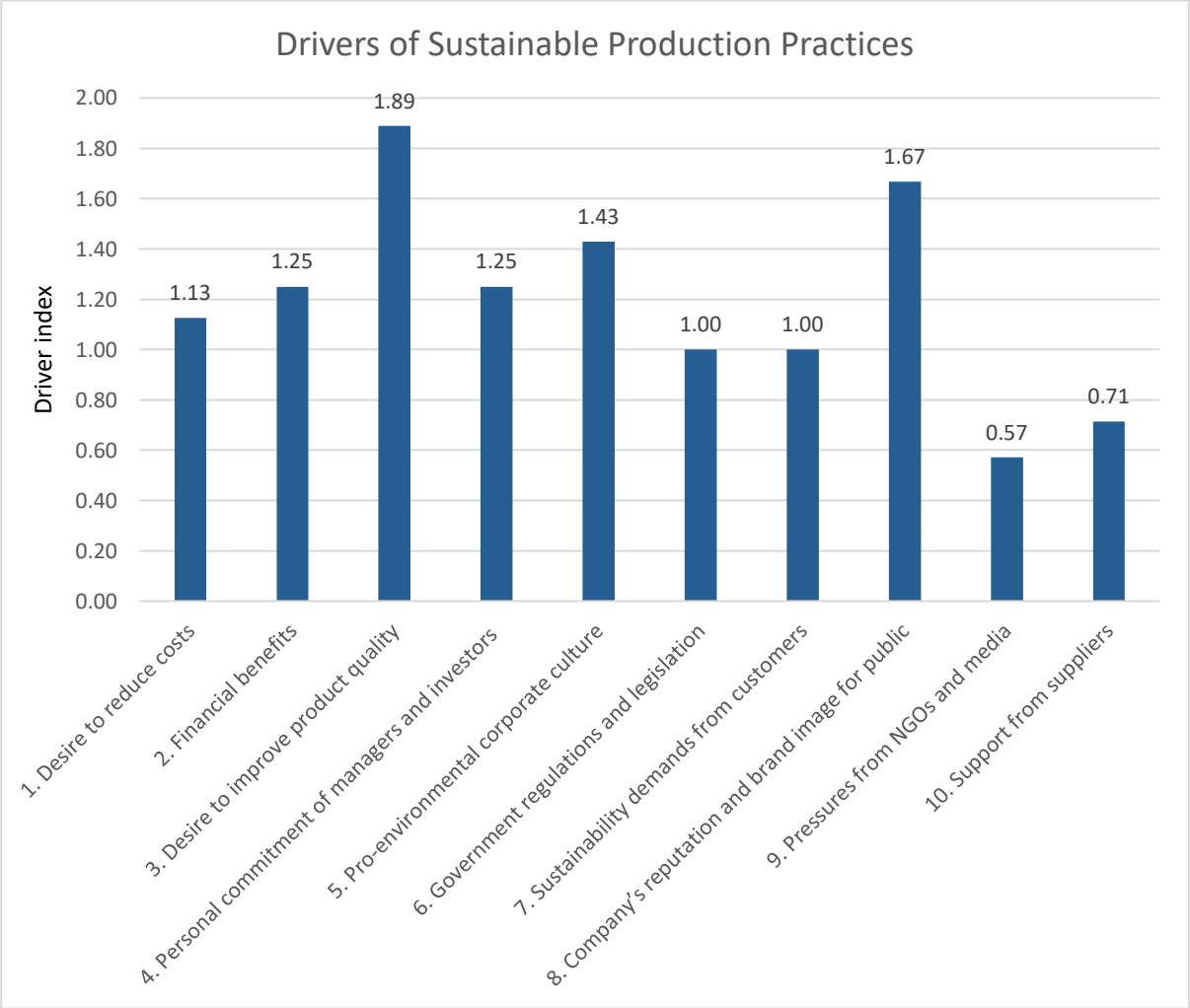


Figure 4. 40 Drivers of sustainable production practices

Sustainability demands that customers perform a crucial role. One small size dairy company with an output of 1.5 million litres of milk, and 60% of its output selling directly to final consumers, agreed that sustainable demands from customers were a significant driver, adding that, *'Especially lately, people are much more aware and interested in buying local, animal welfare and our treatment of the environment'.*

Pro-environmental culture and the personal commitment of managers have a substantial impact on small on-farm dairies' environmental and social orientation, especially for family businesses. One small milk and cheese producer, selling the majority of its produce directly to consumers via market stalls, stated, *'Large*

industrialised farms do not suffer from this winter 'drop' in production. [It is] easy to push the food in and get the milk out and with hormones', and strongly agreed that a pro-environmental culture and managers' personal commitment are drivers for implementing sustainable farming practices, especially high animal welfare standards.

One micro dairy producer and processor agreed that its motivation for sustainable production was its desire to show that an alternative form of dairying was possible for a small-medium family farm. This reflected the owner's personal commitment to protecting natural ecosystems and promoting animal welfare. Similarly, one micro goat cheesemaker believed that they were very environmentally-minded, carefully looking after their holding and plant animal's feed by keeping the hay and stew as natural as possible.

Finally, pressure from NGOs was the lowest ranked driver, as micro and small size businesses do not tend to fall into the supervision jurisdiction of NGOs.

Figure 4.41 demonstrates the main barriers to integrated dairy businesses conducting sustainable production. The definition and calculation method of barrier index refer to Figure 4.35. Surprisingly, all variables were selected as either negative or neutral, except economic reason. Economic reason is believed to be the paramount barrier.

One small dairy business noted that ethical production is very expensive: *'We try not to push cows to produce more milk by artificial lighting and hormone, therefore in the winter, our milk supply drops dramatically. [It is] much more difficult and expensive to produce an ethical product'.* One family dairy business owned by a social movement supporter criticised this view, stating that, *'People are just stuck in a vat ([and] have been doing it that way all their lives) and [they] don't think there is a viable alternative. We know this [is] rubbish'.*

More detailed insight was afforded by one cheese company, manufacturing cheese with 700,000 litres of raw milk, also produced by themselves, for local stores, bars, restaurants and delis. Evidently angered by the comments, the producer complained that, *'No one is prepared to pay for sustainability. They won't even pay for the milk! I was paid 21.5 pence per litre (ppl) for my supplied milk in October'* (which implies less than production cost).

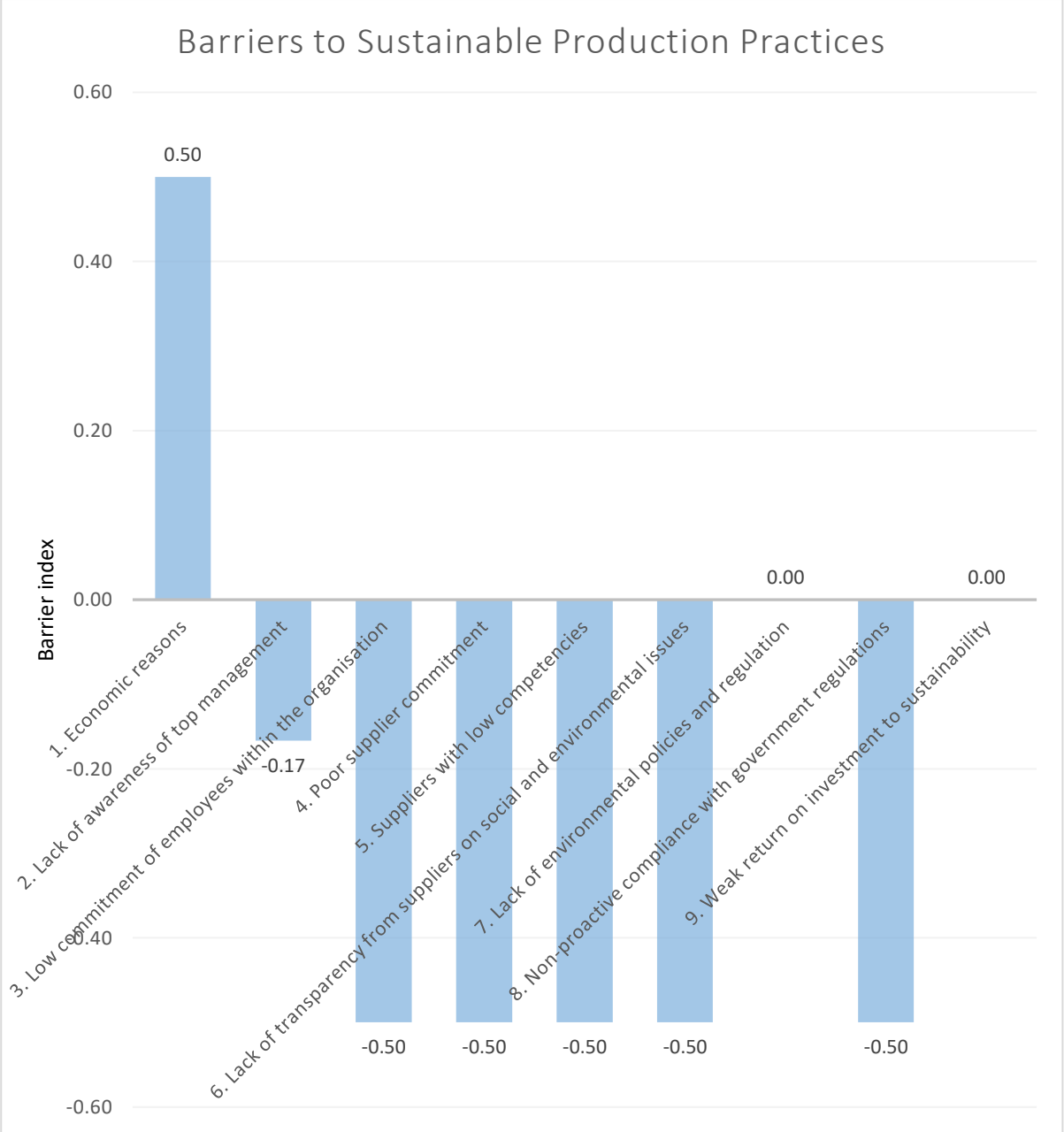


Figure 4. 41 Barriers to sustainable production practices

Some businesses may have very limited or no means of operationalising sustainable alternatives, due to adverse geographic or climate conditions. One dairy producer located in the Shetland islands (the most northern part of the UK) underlined that, "The Shetland Islands are an island community, and everything with packaging, feed, concentrates, fertiliser have to be imported onto the islands', thus leaving few alternatives.

Figure 4.42 identifies the benefits of adopting sustainable production practices. The definition and calculation method of benefit index refer to Figure 4.36. Most dairy business agreed that they benefited from the positive effects on their firms' performances due to the unique selling point, which also led to a competitive advantage. One local processor which sold 80% of its product direct to consumers agreed that their environmentally- and socially-friendly products benefited from their unique selling point, and that this reflected well on the business. Two of the respondent businesses are accredited by SALSA (Safe and Local Supplier Approval), which improved their businesses' credentials.

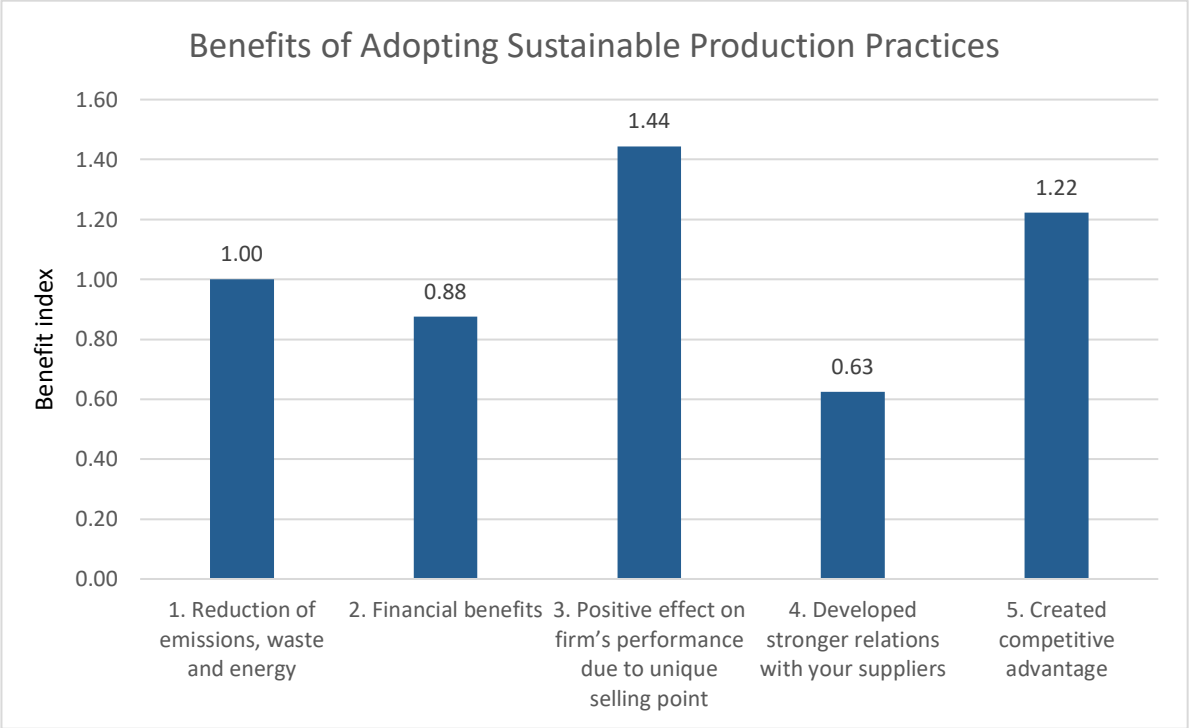


Figure 4. 42 Benefits of adopting sustainable production practices

High achievements in sustainability were closely linked with social and environmental benefits, e.g. reduction of emissions, waste and energy. The sustainable development model also led to financial benefits in both direct and indirect ways. The direct link is obvious, including the fresh-tasting local products sold to local consumers, and the short supply chains with lower administrative, transportation and other interim costs. The indirect economic benefits detailed by one organic on-farm dairy included the farm's high level of environmental protection and great natural beauty, which allowed for the running of a B&B (Bed & Breakfast) business to raise additional income, and its

high animal welfare standards, which gave careful production from dairy crossbreeding and created a new business for dairy male calf retailing.

The lowest ranked variable was 'developed stronger relations with your suppliers'. This is due to the animal feed being grown on the producers' own farms to minimise the application of chemical fertilisers and pesticides, thus demands for raw materials continuously declining, which in turn discouraged stronger relationships with the production material suppliers.

4.3.3. Comparison between Dairy Processors on Type A and Type D Supply Chains

This part draws on the comparisons between Type A and Type D SC in three aspects:

1) Main customers
2) The penetration level of sustainability practices
3) Drivers, barriers and benefits of conducting sustainability practices

Two dairy supply chain structures have been retrieved: Type A (a standard three-tier SC) and Type D (two-tier structure, dairy farmer and dairy processor are integrated). Although two types of SC co-exist in the British dairy sector, they all sell their processed dairy products to customers. The 53 Type A and Type D SCs can be further categorised into five groups, according to their main customer:

1) Local buyer – processors selling 50% or more of their dairy products to local stores and/or directly to consumer
2) Supermarket – processors selling 50% or more of their dairy products to supermarket chains, and/or supermarket chains are the largest single buyer
3) Food service & hospitality - processors selling 50% or more of their dairy products to food service & hospitality industry
4) Wholesaler – processors selling 50% or more of their dairy products to wholesalers
5) Manufacturer – processors selling 50% or more of their dairy products to food & beverage manufacturer and/or used as intermediate product for further processing

Figure 4.43 compares Type A and Type D SCs in terms of their main customers. It is clear that local buyers dominated Type D SCs, with 81% of customers were local buyers. Meanwhile, 36% of Type A SC customers were local buyers. In addition, for the

customers of Type A SCs, the food service and hospitality industry shared 22%, followed by wholesalers and supermarket (19% and 17%, respectively). This highlights that Type D SCs are simpler and shorter than those of Type A. The most important buyers for Type D dairy processors are local stores, and selling directly to local consumers. These dairies therefore have more frequent interaction with their final consumers, and thus gain a better understanding of their consumers' demands, obtain direct feedback on their products, and are able to quickly implement necessary improvements.

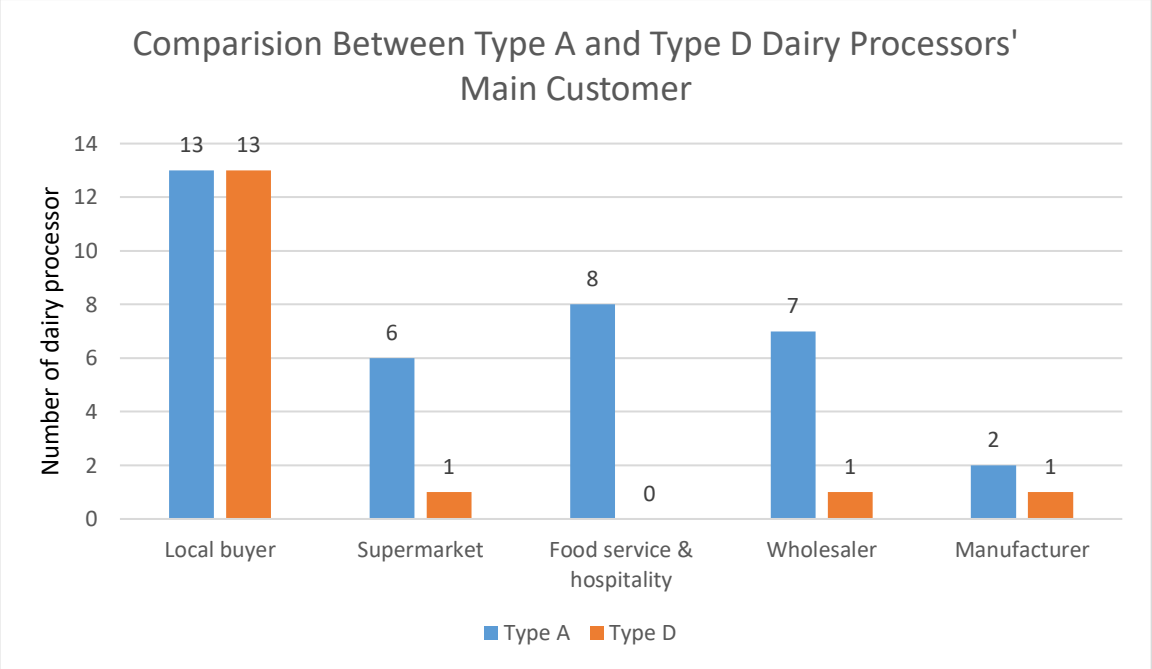


Figure 4. 43 Comparison between Type A and Type D SCs' main customers

Figure 4.44 compares the sustainability practices adopted by Type A and Type D supply chains (Sustainability penetration indexes refer to Figure 4.31 and Figure 4.39). It is clear that dairies on Type D SCs achieved higher environmental and social performance than their Type A counterparts, except in the fields of 'anaerobic digestion' and 'complying with the RSPCA's freedom foods welfare assessment protocol', albeit the sustainability penetration level for these were similar. Therefore, this suggests that short and local SC structures are more favourable for dairy processors seeking to adopt environmental and social sustainability practices.

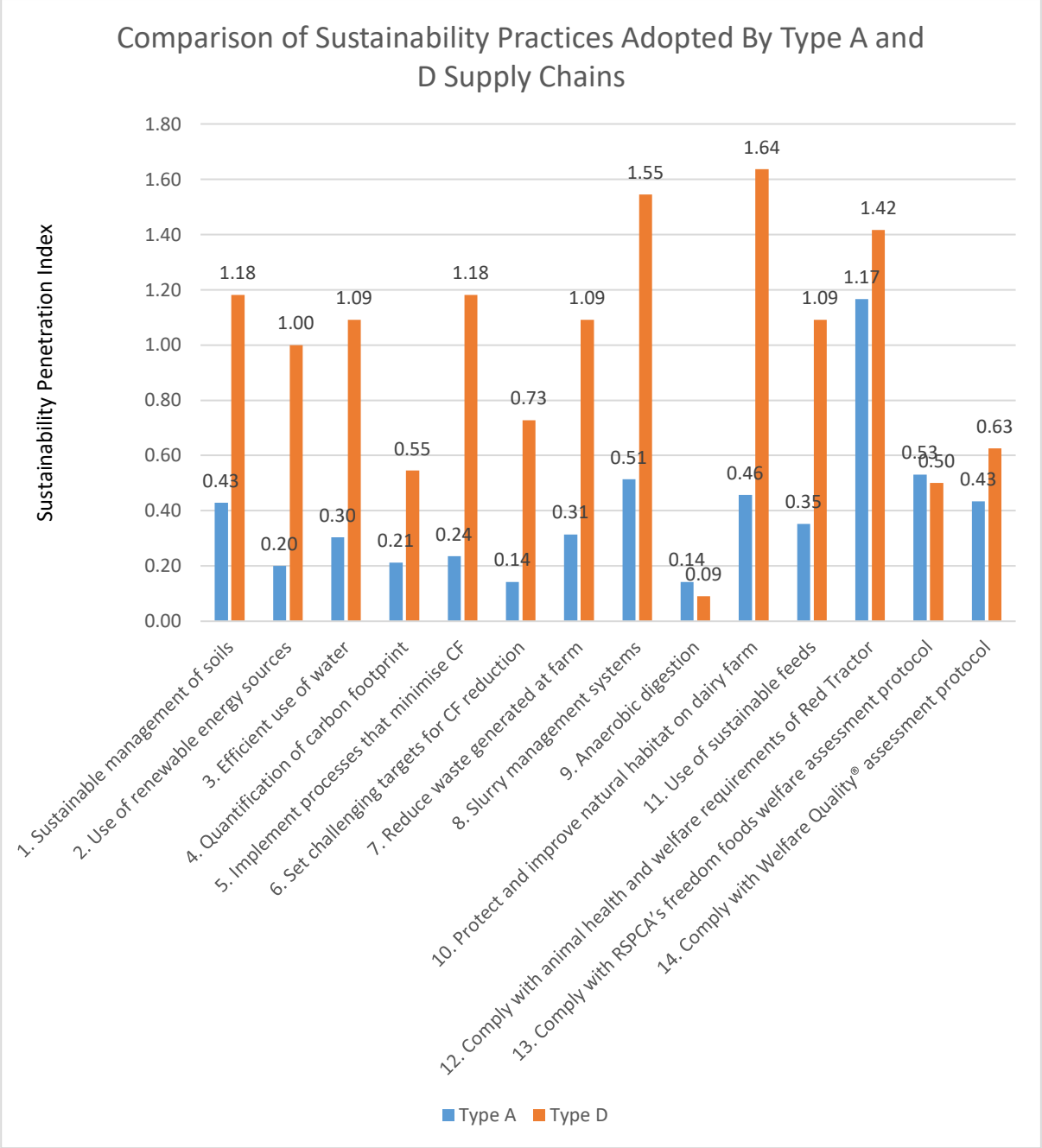


Figure 4. 44 Comparison of Type A and D SCs' adoption of sustainability practices

In order to understand whether internal drivers or external drivers played more important roles in sustainable supply chain management (SSCM), and further, whether there were any differences in this area between Type A and Type D SCs, we chose several key drivers to be used as proxies for further analysis. The criterion for selection is that two most selected internal drivers two most selected external drivers, in addition, the drivers of their sustainability practice have to satisfied that impact factor equal to or

greater than 1.0 on both Type A and Type D scenarios. Therefore, four drivers were selected and categorised as either internal drivers or external drivers.

Key Internal Drivers:

1. Desire to improve product quality (I1)
2. Pro-environmental corporate culture (I2)

Key External Drivers:

1. Sustainability demands from customers (E1)
2. Company's reputation and brand image with the public (E2)

The calculation of the driver index follows the formula presented on subsection 4.2.5. Table 4.13 and Table 4.14 reflect that Type A SCs are driven by external SSCM drivers, whilst Type D SCs are driven by internal SSCM drivers.

Table 4. 13 SSCM driver analysis on Type A

	I_a1	I_a2	E_a1	E_a2
Local buyer	1.30	1.00	1.33	1.60
Supermarket	1.50	1.50	1.00	0.50
Food service & Hospitality	1.20	1.60	1.40	1.60
Wholesaler	1.33	1.33	1.00	1.00
Manufacturer	1.50	1.50	1.50	1.00
All	1.32	1.29	1.30	1.38

Table 4. 14 SSCM driver analysis on Type D

	I_d1	I_d2	E_d1	E_d2
Local buyer	1.83	1.40	1.00	1.71
All	1.89	1.43	1.00	1.67

On the other hand, in terms of barrier comparison, both dairy processors on Type A and Type D SCs claimed that economic reasons were their primary barriers to implementing sustainability practices. Regarding benefit analyses, dairy processors on Type D SCs recognised greater benefits of sustainability practices, since the benefit impact factor (IF) for Type D (1.03) was much higher than for Type A (0.62). On the

other hand, both Type A and Type D dairy processors saw positive effects on their firms' performance due to their unique selling point (USP), and identified this, with competitive advantage, as the two most significant outcomes of their adoption of sustainability practices.

The next chapter will contextualise the empirical findings generated in Chapters 4 into double agency theory, then explain the phenomena observed in the dairy supply chains.

5. Discussion

In this discussion chapter, the empirical evidences will be interpreted through the lenses of the theoretical framework: agency theory (Wilhelm et al., 2016).

5.1. Agency Theory in the Dairy Supply Chain

Three-tiers dairy supply chains (farmer – processor - retailer) are the most common type of supply chain in British dairy industry, subsection 4.2.1 classified that 37 of 53 responded dairy processors are belonging to this type supply chain, those dairy processors source milk from farmers, and sell processed dairy products to customers. The following parts will discuss about whether double-agency framework (Wilhelm et al., 2016) works on dairy supply chain context.

Figure 5. 1 Principle and agency relationship in three-tiers dairy supply chain

5.1.1. Primary Agency Role

In the context of sustainable practices in dairy supply chains, the primary agency role is represented by the responsibility of the agent (processor) to fulfil the lead firm's sustainability requirements. Wilhelm et al. (2016) highlights four contingency factors that affect the coupling or decoupling of primacy agency role. Each factor is going to be discussed in connection with the empirical evidences found in this research.

1) Regulation pressure

In the UK context, every business involved with milk and dairy products related handling (i.e. processing, packaging, transportation and storing) is subject to strict food

safety and hygiene regulation. Dairy farming activities are regulated by Food Standard Agency (FSA) to meet the legal standards. The driver of sustainable procurement analysis (figure 4.34) also indicates that most processors agree that government regulation and legislation is a driver for them to invest in sustainability practices.

2) Lead firm pressure

The driver of sustainable procurement analysis (figure 4.34) proves that most processors strongly agree that sustainability demands from customer is a driver for them to conduct sustainable procurement practices. Both regulation pressure and lead firm pressure are belonging to institutional factors, which exert positive effects on dissemination of sustainability practices to upstream supply chain. Even though, the institutional factors act weaker roles than agency factors on promoting sustainability level on upstream supply chain particularly in UK, since the country has sound regulations and legislations system to protect the basic environmental and social sustainability, e.g. *Environmental Protection Act 1990, Animal Welfare Act 2006.* Therefore, agency factors, i.e. incentives and information transparency, can have stronger impact on sustainability practices dissemination to upstream suppliers.

3) Incentives

Incentives structures are a key variable related to core agency theory. Sustainability requirements of supplier (subsection 4.2.3) research identifies that 13 of 15 sustainability practices received penetration index less than 1, which implies sustainability is still a voluntary option for dairy processors. Since most dairy processors only voluntarily adopted sustainability practices, the functioning of primary agency role should support by incentives, e.g. financial sponsoring and wider business opportunity. The empirical evidence also supports this point. Subsection 4.2.7 identifies that most dairy processors agree with their businesses achieved positive effect on firm's performance due to unique selling point (0.82) and created competitive advantage (0.91) after they implemented sustainable procurement practices.

4) Information Transparency

The most dairy processers get involve with third party accreditation body to transmit a clear signal to their buyer that they are complying with sustainability and / or social commitment. Subsection 4.2.3 shows the most accepted third party regulation scheme is Red Tractor food assurance scheme (1.17). Except that, many processors require farmer to follow RSPCA (0.53) and Welfare Quality assessment protocol (0.43). Introducing third party auditing can effectively mediate the conflict of sustainability

interests among lead firm, first-tier supplier and second-tier supplier, and labelling an accreditation from a well reputable third-party can create more business opportunities. Park and Brorson (2005) highlight increased transparency throughout supply chain can facilitate company to disclose credible environmental and / or social performance information as well as build up corporate reputation. Raynolds et al. (2007) point out application of labelling and certification not only has positive effect on increasing sustainability level but also enable company to achieve better opportunity on positive publicity, market access and higher prices.

5.1.2. Secondary agency role

1) Lead firm pressure

This research also supports that lead firm's pressure is a catalyst for coupling of double agency role. There are several second-tier suppliers (dairy farmer) confirmed that they are required to follow lead firm established sustainability code, e.g. Arla Garden, White Gold (Davidstow Processor Assurance), Tesco Sustainable Dairy Group (TSDG), those are either biggest dairy firm or top retailer in the UK. In order to enter those biggest companies' milk pool, following high standard sustainability requirement has become a necessary condition. Both primary agency and second agency have to fulfil the identical environmental and social code of practice, which significantly works for coupling of double agency role. On the other hand, Wilhelm et al. (2016) also discuss that lead firm use of power could have influence to the coupling/decoupling of double agency role. However, if the lead firm coerces the supplier to follow its sustainability requirement only through power, then the use of power can become a decoupling factor of double agency role (Jiang, 2009). In a dairy supply chain scenario, despite the fact that aforementioned nationwide dairy companies and supermarkets possess absolute purchasing power, farmers who supply milk to those milk pool can benefit from stable selling channels, better technical support and sustainability bonus. In this way, power is mediated; this contributes to the coupling of the double agency role.

2) Incentives

Obviously, the 86.69 % of dairy farmer in high sustainability commitment group received financial rewards, twice and nine times more likely than medium (43.75%) and

low (8.30%) sustainability commitment groups (figure 4.20), which concludes that financial reward can make a positive impact on farmers' sustainability commitment level. Financial incentive is very efficient for coupling of double agency role in dairy supply chain scenario.

3) Information transparency

Information transparency plays a greater role at the secondary agency level than at a primary agency level, since a lack of direct interaction between the lead firm and second-tier suppliers is very common. Thus, increased transparency level is required to guarantee the achievement of lead firm's expected sustainability level for second-tier suppliers (dairy farmers). Hence, at a secondary agency level, third party and retailer-based sustainability auditing activities play significant role to ensure information transparency. It must be noted that auditing bodies and retailer may increase interaction with second-tier suppliers through several methods: requiring a complete environmental / social record, vet visiting and farmer meeting. For example, Dairy farmers joined Tesco Sustainable Dairy Group (TSDG) are supervised by fortnightly veterinary visits (Tesco, 2014); Red Tractor (2014) assurance scheme ensures information transparency by both record keeping (e.g. body condition scoring, mobility scoring, dairy vet health & condition review, manure management plan) and on-farm audit by qualified assessor.

4) Lead firm's focus on triple bottom line dimension

Wilhelm et al. (2016) concludes that the lead firm's focusing on different sustainability pillars (environmental, social or economic) may have different outcomes on the coupling of double agency. Ashby et al. (2012) identify that environmental sustainability practices are wider acceptable by firm than social sustainability practices, since environmental measures are process based and most of the environmental indicators are measurable. For example, use of unauthorised chemicals, pesticide, hormone, antibiotics, also pollution in animal living environment, that can affect milk quality and those the residuals are detectable by processor and downstream customers. On the other hand, environmental sustainability application can have positive effects onto quality improvements and create competitive advantage (Appolloni et al., 2014). This also can be reflected by the findings from this work (subsection 4.2.5 and 4.2.7), dairy processors strongly agree (driver index=1.32) that desire to improve product quality is

their driver to implement sustainable procurement, moreover, competitive advantage is created after taking sustainability practices (benefit index=0.91). Hence, lead firms focusing on environmental performance is believed to be incentivising the coupling of double agency role. On the contrary, previous research affirms that social sustainability can be a driver of the decoupling of the double agency role of the first tier supplier, particularly as concerns the second agency role due to information asymmetry. Wilhelm et al. (2016) give an example of consumer electronics supply chain that second tier supplier is located in low-cost country, which the genuine ethical condition at production site is invisible and cannot be reflected from the final product. However, the findings from this research tell a completely different story, in dairy supply chain case, there were certain amount of first-tier suppliers (dairy processor) have social sustainability assessment for second-tier suppliers (dairy farmer). For example, welfare quality assessment protocol (penetration index=0.43), which is a scientific-based measurement focusing on actual welfare status of animal, such as body condition, health aspects, injuries, behaviours and fearfulness (Welfare Quality Network, 2009); red tractor assurance scheme (penetration index=1.17) conduct body condition and mobility scoring for cow and check by on-farm assessor (Red Tractor, 2014). Thus, the actual social sustainability condition at second-tier supplier level becomes visible and measurable, information transparency on animal welfare performance have significantly improved, which support to the coupling of primary and second agency role.

5) Processor's internal resource availability

Limited internal resource of first-tier supplier (processor) can be a prominent factor causing the decoupling of the double agency role, i.e. preventing diffusion of sustainability practices to the upstream part of the supply chain (including, for instance, dairy farmers). The overarching barrier of hindering processor to set sustainability requirements on milk sourcing is economic reason (barrier index=0.73). Since most dairy processors in the UK are micro and small size enterprises, they are lack of essential knowledge and technique as well as no necessary funding to invest sustainability.

6) Internal functional alignment at the lead firm organisation

A very large food manufacturer with several thousand employees claimed that they have high sustainability and welfare policy, but their milk sourcing requirements are still focusing on traditional purchasing metrics. This validates that poor alignment between company's internal sustainability orientation with external procurement function. Also, this case suggests the existing of "greenwashing", which means advertising operating in consideration of environment, however, lack of actual environmental practices (Greer and Bruno, 1996). Even though, there are some good examples validate that corporate strategy aligned with procurement practice. Two Northern Ireland large size dairy companies both have sustainable development strategy, they also set up environmental and social sustainability requirements to their suppliers and provide financial bonus to those farmers meet the condition.

5.2. Connectedness to Nature

Table 5.1 gives a comparison of average sustainability penetration index in between Type A and Type D Supply Chain, obviously, Type D SC achieved higher sustainability performance, achieved an average 1.05 sustainability penetration index, one-and-a-half times higher than sustainability performance achieved by Type A (0.41). On the other hand, dairy processors on type A SC source milk from dairy farmers, thus they have no or a weak connection with nature; whereas processors on type D SC own the land and animals, thus they have a strong connection with nature. These findings are basically consistent with CTN theory (Gosling and Williams, 2010) – weak connection to nature correlated with low pro-environmental behaviours, and strong connection to nature correlated with high pro-environmental behaviours. Furthermore, how do ecocentric / anthropocentric attitude act for a mediation role in the relationship between CTN and pro-environmental behaviours is going to be explored, then the core sustainability practices and the central drivers of Type A and Type D SC are going to be considered.

Table 5. 1 Comparison of average sustainability penetration index in between Type A and Type D Supply Chain

Average Sustainability Penetration Index of all 15 sustainability practices (calculation refer to figure 4.44)	Type A	Type D
	0.41	1.05

Table 5.2 ranks all 15 sustainability practices by five function groups, the method of grouping was described in subsection 2.2.6. Regarding type D supply chain, farmland conservation practices ranked highest, achieved an average 1.41 sustainability penetration index. For type A supply chain, social sustainability practices ranked highest, achieved an average 0.71 sustainability penetration index. Table 5.3 identified the central driver of implementing sustainability practices in Type A and Type D SC, the method of calculating driver index refers to subsection 4.2.5, the categorisation of internal/external drivers refer to table 2.2. It is clear that Type A processors ranked "company's reputation and brand image with the public" as their central driver, which is extrinsic motivation. Type D processors ranked "desire to improve product quality" as their core driver, which is intrinsic motivation.

Table 5. 2 Ranking sustainability practices by different function group

	Type A	Type D
1st	**social sustainability** (average sustainability penetration index = 0.71)	**farmland conservation** (average sustainability penetration index = 1.41)
2nd	farmland conservation (0.45)	resource utilisation (1.06)
3rd	waste disposal (0.32)	waste disposal (0.91)
4th	resource utilisation (0.28)	social sustainability (0.85)
5th	GHG emission (0.20)	GHG emission (0.82)

Table 5. 3 Central driver of Type A and Type D SC

	Type A	Type D
Core driver	Company's reputation and brand image with the public (driver index= 1.38) – External driver, extrinsic motivation	Desire to improve product quality (driver index= 1.89) – Internal driver, intrinsic motivation

Referring back to the measuring method for ecocentric/anthropocentric attitude discussed on subsection 2.4.2.1.2, farmland conservation behaviours (sustainable management of soil and protection of natural habitat) reflect processor's ecocentric

attitude, since these behaviours fit in with ecocentric attitude measuring standard (Gagnon and Barton, 1994): the behaviours expressed appreciating nature for its own sake, positive affect associated with being out in nature and seeing a connectedness between humans and animals. Therefore, the commitment of sustainability of Type A SC is constructed by ecocentric concerns.

Social sustainability behaviours (joining Red Tractor, RSPCA and Welfare Quality protocol) reflect processor's anthropocentric attitude. In consideration with the central driver for implementing sustainability practices ranked by Type A processor - "company's reputation and brand image with public", getting certificate from relevant accreditation body can enhance company's public image, these behaviours fit in with the anthropocentric attitude measuring standard (Gagnon and Barton, 1994, Larrère and Larrère, 2007): the behaviours reflected a focus on instrumental value of the resource they draw from their ecosystem. Therefore, the commitment of sustainability of Type D SC is constructed by anthropocentric concerns.

Table 5.4 gives a conclusion. Processors on Type A SC source milk from farmers, the processors have a weak connection to nature; Type A SC achieved low sustainability performance, their sustainability commitment is framed by anthropocentric concerns. Processors on Type D SC own the land and animals, they have a strong connection to nature; Type D SC achieved high sustainability performance, their sustainability commitment is framed by ecocentric concerns. These findings are consistent with the CTN theory (Gosling and Williams, 2010). In addition, it has been observed that Type A SCs are primarily motivated by extrinsic drivers and achieved low sustainability performance, Type D SCs are primarily motivated by intrinsic drivers and achieved high sustainability performance, these findings are consistent with the Ryan et al. (2003) that "farmers with strong intrinsic motivations were more likely to adopt conservation practice than extrinsically motivated".

Table 5. 4 The interaction between sustainability performance and CTN

	Connectedness to Nature	Ecocentric / Anthropocentric concern	Sustainability Performance	Central driver
Type A	Weak	Anthropocentric	Low	Extrinsic
Type D	Strong	Ecocentric	High	Intrinsic

6. Conclusion

In the final chapter, the conclusion of this research is going to be given from three aspects: summary of findings, practical implications and suggestions for future research.

6.1 Summary of findings

In order to summarise the key findings of this research, the research questions set up in Chapter 2 are recalled, then the key findings will be discussed around these research questions.

RQ1: For dairy producers, what sustainability practices are required of their milk buyers?

All 15 pre-identified sustainability requirements in GHG emission control, farmland conservation, resource utilisation, waste disposal and social sustainability have been validated from dairy producer side survey research. In addition, buyer/retailer based environmental and social codes also have been identified, e.g. Arla garden, White Gold (Davidstow Processor Assurance) and Tesco Sustainable Dairy Group (TSDG) Code (part 4.1.3.4 and 4.1.3.5). Even though, the penetration of different sustainability practices varies in sustainability commitment level, funding source and SC structure.

Along with the upscaling of sustainability commitment, the penetration level was decreasing. For example, quantify carbon footprint (46.5%), implement to minimise carbon footprint (37.2%), set challenging target for carbon footprint reduction (9.3%). Similarly for social sustainability requirements, the penetration level was in the order: Red tractor (72.1%) > Welfare quality (23.3%) > RSPCA (18.6%).

On the other hand, some sustainability practices are sponsored by government subsidise rather than milk buyer, buyer's requirements on those sustainability practices were remained on low level, i.e. use of renewable energy (14.0%) and installing on-farm anaerobic digestion facility (2.3%). Similarly, organic milk is focusing on unique market orientation, since the company's business strategy should align with their

procurement strategy, the dairy company producing conventional milk would not have "soil association" requirement of their supplier, therefore the penetration rate of "soil association" was low (14.0%).

The findings suggest that SC structure is an issue can affect the penetration level of sustainability practices. 90% of dairy producers on national SC faced sustainability requirements, in comparison, only 58% of producers on local & regional SC were required to meet sustainability requirements.

RQ2: To what extent do dairy processors engage in sustainable procurement practices?

RQ4: Are there different supply chain structures in the dairy sector? If yes, will this have any impact on sustainability practice implementation?

There are two major SC structures had been identified in British dairy sector. In this research, they are called Type A (farmer – processor - customer) and Type D (farmer & processor - customer).

For type A SC (farmer – processor - customer), penetration rates of sustainability requirements from buyers are sequenced as social sustainability (average sustainability penetration index = 0.71) > farmland conservation (0.45) > waste disposal (0.32) > resource utilisation (0.28) > GHG emission (0.20).

Meanwhile, for type D SC (farmer & processor – customer), penetration rates are sequenced as farmland conservation (average sustainability penetration index = 1.41) > resource utilisation (1.06) > waste disposal (0.91) > social sustainability (0.85) > GHG emission (0.82).

Obviously, Type D SC have higher degree of sustainability practice application than Type A SC. In addition, two types of SC have different priorities on sustainability practices implementation. Type A SC give their priority on social sustainability practices, while Type D SC underlines the importance of farmland conservation. But, both Type A SC and Type D SC give GHG emission restriction practices the least consideration, which suggests the dichotomy between the theory and realistic application.

RQ3: What are the drivers, barriers, and benefits of implementing sustainability practices for dairy processors?

For Type A processor, company's reputation and brand image was the most important driver for dairy processors to implement sustainable procurement practices, followed by a desire to improve product quality. Type D processor, desire to improve product quality and the company's reputation and image with the public remain the two most important drivers.

Both Type A and Type D processor considered economic reason is the paramount barrier to prevent them from adopting sustainable procurement practice.

Type A processor were in agreement that two of the most important benefits to sustainable procurement practices were the creation of competitive advantage and a unique selling point (USP). Type D processor agreed that they benefited from the positive effects on their firms' performances due to the unique selling point, which also led to a competitive advantage.

6.2 Practical implications

The practical implications of this research is to propose suggestions to improve sustainability diffusion throughout the supply chain in British dairy sector (RQ 5).

Firstly, short supply chain structure is advantageous to implement sustainability practices than long supply chain structure. Hence, it should be given more promotion of local milk and dairy products, not only because local dairy products are more fresh tasty, but also because local dairy products are more environmental and social friendly.

Secondly, financial incentives act a very efficiently role on coupling of primary and secondary roles in dairy supply chain. As discussed on section 4.2, on dairy producer level, financial reward can make a positive impact on producer's sustainability commitment; on dairy processor level, both Type A and Type D processors believed economic reason is the most important barriers to hinder their sustainability practices implementation. Therefore, improving sustainability performance throughout dairy supply chain needs continuous financial inputs.

Thirdly, it would be very helpful to establish dairy sustainability accreditation and labelling scheme. Styles et al. (2012) pointed out that lead supermarket in Europe

employing third party sustainability labelling scheme can optimise environmental performance across supply chain. From economic perspective, the scheme can create sustainability premium for labelled dairy products, which enable dairy producer and dairy processor to receive sustainable source of funding to continue and improve their environmental and social sustainability practices. On the other hand, information transparency is a key factor to couple primary and second agency role in SC, the scheme can extremely facilitate the transparency of environmental and / or social condition from farm to final products. In addition, the scheme is useful to build up lead company's reputation and brand image, the credible environmental and social sustainability selling point can also help dairy company to create more business opportunity.

6.3. Limitations of the research

This research has limitations in terms of its sampling techniques. At the first research stage, on dairy producers' sustainability attitudes, the author collected data by delivering questionnaires at the Total Dairy Seminar, and thus large farms made up 53 per cent of respondents, whilst only accounting for 7-8 per cent of UK dairy farms. At the second research stage, on dairy processor sustainability attitudes, the author used a postal survey method to distribute questionnaires, and the bulk of the respondents were very small, localised companies. These limitations may weaken confidence in making broader generalisations of the results. In addition, this resulted in the data analysis processes of both first stage and second stage being based upon a relatively small sample size. These limitations are difficult to overcome, however, due to a lack of publically accessible information and large companies' information protection policies.

At the first stage, there were around 10,000 dairy producers in the UK (DairyCo, 2015b). Unfortunately, it is unlikely to be possible to retrieve all dairy producers' information from the Yellow Pages or other publicly available channel. At the second stage, although it is theoretically possible to collect data from the entire population, and the author did send questionnaires to all qualified dairy processors, many organisations have strict policies against sharing information with external parties (Fenton-O'Creevy, 1996), thus most large size and nationwide companies did not send responses.

In addition to data sampling techniques, the data analysis techniques had limitations. As descriptive analysis was used, rather than statistical testing, no correlations between the two sets of variable can be proven, which limits the generalisability of the

results. This complies, however, with the exploratory and inductive nature of this work. On the other hand, the qualitative/Likert scale responses from dairy producers and dairy processors made it more difficult to conduct quantitative analysis using statistical inference. Moreover, as the sample size was very small, more complicated data analysis techniques were not suitable.

Furthermore, the survey of sustainable farming and sustainable procurement in this research were conducted in two separate steps, with the average dairy farmer sample and dairy processor sample used to analyse the British dairy sector as a whole. In future research, case study research could be employed to explore the sustainability attitudes of several lead firms and their suppliers, measuring the potential alignment of sustainability attitudes of dairy producers and dairy processors on same SC.

6.4. Suggestions for future research

This work also has significant findings related to Agency theory and Connectedness to Nature Theory.

1) Through Agency theory lens, this work has identified that the transmitting of sustainability requirements throughout the supply chain depend on the coupling / decoupling of dairy processor's primary agency role (fulfill the lead firm's sustainability requirement) and second agency role (enable second-tier supplier to comply with those requirements).

   Also, this work validated four factors have impact on the coupling / decoupling of dairy processor's primary agency role:
   - regulation pressure
   - lead firm pressure
   - incentives
   - information transparency

   On the other hand, five factors have impact on the coupling / decoupling of dairy processor's second agency role:

   - lead firm pressure
   - incentives
   - information transparency
   - processor's internal resource availability

- internal functional alignment at the lead firm organisations.

These findings have important impacts on improving the efficiency of conveying sustainability requirements throughout the multi-tier dairy supply chain, then enhancing the sustainability performance on long and national dairy supply chain. The future research can focus on two directions:

- Use more structured data sampling / collection methods and more advanced statistical techniques to rank the importance of the factors which have impact on coupling / decoupling of primary and second agency roles.
- In this research, examination of processor's primary agency role used Phase 2 data (dairy processor study), and examination of processor's second agency role used Phase 1 data (dairy producer study), however this will have potential limitation because the surveyed dairy processors and surveyed dairy producers do not necessarily locate on the same supply chain. In order to overcome this limitation, the future research can use case study method to focus on several dairy processors and research their upstream and downstream supply chain, then give a further testing for this tentative proposal.

2) Through CTN theory lens, this work identified two distinct supply chain configurations, also the characteristics (CTN, value-orientation formulated sustainability commitment, sustainability performance, central driver) associated with each supply chain configuration (Table 6.1). These findings have implications on improving the sustainability performance of whole British dairy sector by bettering supply chain design, also providing suggestions for sustainable development policy maker to make evidence-based decision. The findings enable the author to tentatively propose a typology of dairy supply chain:

- Type A SCs (long and national supply chain structure): processors source milk from dairy farmers, processors have weak connection to nature, processors' adopting sustainability practices is driven by extrinsic drivers and the sustainability commitment is framed by anthropocentric concerns. This type of supply chain achieves low sustainability performance.

- Type D SCs (short and local / regional supply chain structure): processors own the land and animals, processors have strong connection to nature,

processors' adopting sustainability practices is driven by intrinsic drivers and the sustainability commitment is framed by ecocentric concerns. This type of supply chain achieves high sustainability performance.

Table 6. 1 Proposition of Supply Chain Typology

	Connectedness to Nature	Ecocentric / Anthropocentric concern	Sustainability Performance	Central driver
Type A	Weak	Anthropocentric	Low	Extrinsic
Type D	Strong	Ecocentric	High	Intrinsic

Future research can focus on collecting more structured data and using more advanced statistical techniques to test the causality and correlations between those variables in British dairy supply chain.

Appendix

Appendix 1. Sample selection method of dairy processor

Population Refining

There are 102 AMPs in the UK (Rural Payments Agency, 2015). This research removed 9 of them for the reasons listed on table A.1. Then 93 AMPs remained.

Table A. 1 The AMPs removed from sample

Sequence Number in AMP list (Rural Payments Agency, 2015)	Trading Name (and business name if different to trading name)	The reasons for removing from this research
3 & 5	Remove Arla Milk Cooperative (3) and Arla Milk Link (5), keep Arla Food Ltd (4).	Milk Link was merged into Arla Foods. Arla has three AMP licenses, Arla Milk Link sources milk from 1,400 farmers, Arla Food sources milk from 200 farmers, Arla Milk Link sources milk from 1,600 farmers, but those licences were managed by same person in same address. Therefore, Arla is deemed to be one group and milk sourcing policy is managed by one team.
6	Armaghdown Creameries Ltd	Armaghdown Creameries is recorded closed. (http://www.bbc.co.uk/news/uk-northern-ireland-37121221)
8	Remove Ballyrashane Creamery Ltd (8), keep LacPatrict (93).	The company was merged into LacPatrick (93). LacPatrict is a company in AMP list.

27	Remove County Milk Products Ltd (27), keep Capital Milk Ltd (15).	County Milk and Capital Milk are actually the same company.
45 & 47	Remove Glanbia Agribusiness (45) and Glanbia Cheese Ltd (47), keep Glanbia Cheese Limited (46).	Glanbia Cheese Limited has three licenses.
81	Rew Valley Dairies (Retail) Ltd	Recorded closed. (http://www.iwcp.co.uk/news/news/dairy-ends-milk-processing-after-30-years-57290.aspx)
96	Remove United Dairy Farmers (96), keep Dale Farm (32).	United Dairy Farmers is managed under Dale farm (32)

There are 1,023 ADPPs in the UK (Food Standards Agency, 2016). This research removed 218 of them for two reasons: duplicated information and non-dairy-processing focused business.

130 ADPPs were excluded because these businesses are just processing sites of AMP, which neither make decision on business strategies nor set up milk sourcing criteria. For example, Arla is the largest dairy company in the UK, Arla has around 3,200 milk suppliers (Arla, 2015c), in order to process such huge amount of milk, Arla has 12 processing plants (based on counting from ADPP list). Similar to Arla, Dairy Crest has 6 processing plants, Dale Farm (Northern Ireland) has 5 processing plants, First Milk has 3 processing plants, Muller Wiseman (formerly Robert Wiseman and Muller Milk, merged in 2012) has 10 processing plants. In addition, there were 15 ADPPs deemed invalid for the reason of one trading name registered under two licenses.

The second scenario excluded from this research is non-dairy-processing focused business. In ADPP list, each dairy processing business registered with background information, for example trading name, address, business activities. The business's irrelevant to dairy processing business are excluded, since these businesses neither involved with sustainable farming nor established sustainable procurement strategy for

milk sourcing. Therefore, 73 ADPPs whose core business are relevant to the processes and / or products listed below, were removed.

1. Spray drying, freeze dry
2. Cold storage, cold store
3. Food trading, Trading, wholesale
4. Distribution, transport
5. Packer (s), Packaging
6. Edible Oils
7. Butcher(s), Bacon, Pig(s)
8. Egg
9. Smoked Salmon, Fish
10. Mustard, Sauce
11. Beef
12. Meat

Sampling

In this research, ADPPs are categorised into 11 groups according to their core business activities.

1. Ordinary dairy company, trading name including
   Dairy (Dairies), Dairy Product(s), Creamery, Goat(s), Cow, Organic(s), Sheep, Milk
2. Cheesemaker
   Cheesemaker(s), Cheese(s), Gouda, Cheddar, Mozzarella, Smokehouse(s), Smoke, Pickle, Smokery
3. Ice Cream maker
   Ice Cream (Icecream), Milk Ices, Ice(s), Gelato
4. Milk Powder maker
   Powder(s), Nutricare
5. Butter maker
   Butter
6. Yoghurt maker
   Yoghurt(s)
7. Dessert and Bakery
   Dessert(s), Bakery (Bakeries), Bakers, Sweet, Cake

8. Food and Beverage Manufacturing

   Food(s), Food Product(s), Product(s), Production, Manufacturing, Processing, Drink(s), Provision(s), Supply(Supplies), Fine food, Cold food, Soup, Ready meal(s), Cuisine, Chilled foods, Prepared meals

9. Food service and Hospitality industry

   Foodservice(s), Food Service(s), Service(s), Catering, Restaurant(s), Feast, Skychefs, Kitchen(s), Food Centre, Parlour, Deli(Delicatessen), Store, Event(s), Market, Cottage, Inn, Lodge, Farmhouse

10. Dairy farming and processing

    Farm, Farming, Estate, Farmer(s), “& Son(s)”

11. Intermediate product

    Ingredient(s)

Appendix 2. Questionnaire for dairy producer

Sheffield University Management School

Research on the environmental and social sustainability requirements of milk production and procurement

by

William Zhao

Dear Participant

Thank you for your participation for this research. I am a postgraduate research student at Sheffield University Management School and the intention of this questionnaire is to explore first-hand information about the environmental and social sustainability requirements of milk production and procurement. This survey will help me to create in-depth understanding about the diffusion of sustainable milk production and sustainable procurement, and this survey will be a part of my research project – Sustainable Procurement in British Dairy Industry. The aim of this research project is to promote dairy supply chain sustainability in environmental, economic and social pillars, in order to protect the environment, promote benefit to farmers and understand other benefits such as animal welfare.

This research has been approved by Sheffield University Management School Research Ethics Committee. It is entirely voluntary to complete this questionnaire. All data collected from this questionnaire will be kept confidentially and would not be shared with any other parties. The result generated from the questionnaire will only be used for academic purposes, for example degree thesis and paper. All results will be reported anonymously. If you have any problem, please do not hesitate to contact my supervisor, Professor David Oglethorpe, Dean of Sheffield University Management School and Professor of Environmental Sustainability at d.oglethorpe@sheffield.ac.uk. If you do not understand any questions in this questionnaire or if you think any questions are not appropriate, please leave your comment on the right hand side of the question.

Thank you once again for your help and participation.

1. Where is your farm? (please provide the first four digits of your postcode_____)

2. How many lactating cows do you currently have?

3. How many paid full-time (f-t) or part time (p-t) employees to you have?
   Average____(f-t)_____(p-t) High season____(f-t)_____(p-t)

4. How much milk did you produce in your last reporting year?
   _____Thousand litres

5. Which of the following enterprises does your business involve? (multiple choice)
   - ☐ Milk producing
   - □ Dairy products processing
   - ☐ Dairy products retailing
   - ☐ Others _____

6. What kind of milk do you produce and/or process? (multiple choice)
   - ☐ Conventional milk
   - ☐ Organic milk
   - ☐ Unique milk to niche market
     - □ Goat milk
     - □ Special breed ( )
   - □ Others_____

7. Are you a member of a voluntary agri-environmental or stewardship scheme?
   - ☐ No
   - ☐ Countryside Stewardship (formerly, Environmental Stewardship)
   - ☐ Red tractor
   - ☐ Soil association
   - ☐ On-farm anaerobic digestion
   - ☐ RSPCA welfare standards for Dairy Cattle
   - ☐ Others, please indicate _____

8. Milk and dairy product destinations

We recognise that some dairy farmers produce milk and also process part or all of their own milk and may also sell some or all of their processed products. These may represent different enterprises in the business. Please can you indicate which of the following may apply to you (you can tick as many boxes as you like):

For the part of your business for which you are producer only, do you sell that milk to:

- ☐ Local dairy processors
- ☐ Regional dairy processors
- ☐ National dairy processors

☐ Others, please indicate
_____

For the part of your business for which you are producer and processor, do you sell that milk to:

☐ Local retailer
☐ Regional retailer
☐ National retailer
☐ Others, please indicate
_____

For the part of your business for which you are producer, processor and retailer, do you sell that milk within a:

☐ Local market
☐ Regional market
☐ National market
☐ Export market
☐ Others, please indicate
_____

9. We are interested to know if there are any sustainability requirements embedded in your contract with any of your buyers.

9.1. If you are producer, do you have any sustainability requirement embedded with your buyer?

☐ I don't have a contract
☐ No sustainability requirements
☐ Yes, there are some voluntary requirements
☐ Yes, there are some strict requirements

9.2. If you are producer and processor, do you have any sustainability requirement embedded with your buyer?

☐ I don't have a contract
☐ No sustainability requirements
☐ Yes, there are some voluntary requirements
☐ Yes, there are some strict requirements

9.3. If you answered yes to either of the above, please could you indicate what specific characteristics the buyer is looking for?

A. Environmental Requirements

Sustainable use of natural resources

□ Sustainable management of soils
□ Use of renewable energy sources
□ Use of water in efficient way

Minimise the carbon footprint (carbon dioxide, methane and nitrous oxide)

□ Quantify the carbon footprint

□ Implement processes that minimise carbon footprint

□ Set challenging targets for improving environmental performance in terms of carbon footprint reduction

Waste Management

□ Quantify/reduce waste generated at farm

□ Slurry Management systems

□ Anaerobic digestion

Protect and enhance biodiversity

□ Protect and improve natural habitat on dairy farm (e.g. certain proportion of land not used of grazing or just have natural trees for protecting and encouraging wildlife and farmland bird on farm)

□ Use of sustainable feeds (e.g. Round Table Responsible Soy)

Any other requirements?

□ Yes, please indicate:

_____

B. Social Requirement

Animal health and welfare

□ Comply with animal health and welfare requirements of Red Tractor

□ Comply with RSPCA's freedom foods welfare assessment protocol

□ Comply with Welfare Quality® welfare assessment protocol

□ Comply with other regulations or standards Please indicate:

_____

Any other requirement?

□ Yes, please indicate:

_____

10. Do you get any financial reward or bonus for achieving these environmental and/or social sustainability requirements?

□ No

□ Yes

10.1. If you selected yes, who provides this bonus?

□ buyer / customer

□ EU / Government subsidy

10.2. What proportion of your revenue does the financial reward you received account for?

□ <5%

□ 5%-10%

□ 10%-20%

□ >20%

10.3. If you receive financial reward for meeting sustainability requirements, does this make a difference about whether you can cover your cost of production?

□ No
□ Yes

11. What do you think the future challenges are for sustainable development for British dairy industry?

Thank you once again for completing this survey. Please enclose in the envelope provided.

Appendix 3. Questionnaire for dairy processor

Dear Milk Purchasing Manager

Sustainable Dairy Supply Chain Management Project

at Sheffield University Management School

My name is William Zhao, I am a research degree student at Sheffield University Management School. I am conducting a research project entitled “sustainable dairy supply chain management” to explore the sustainability issues in milk procurement processes and supplier selection. We recognise there are different aspects of sustainability, in relation to economic, social and environmental goals but in this project, for which we would like to gather some data, we are primarily concerned about environmental sustainability.

Of particular interest to us in the project are the environmental attributes that milk processors consider important when procuring milk and the sort of compliance requirements they may have on their suppliers.

In order to carry out my research, I would like to gather more in-depth information to understand your company’s supplier selection criteria and environmental requirements for your milk suppliers. I have constructed a very short survey to do this and I would be extremely grateful if you could take a very short moment of you time to complete the survey. Your participation in this survey is voluntary and if you do not feel comfortable answering this questionnaire then you can leave the process. I estimate it will take only about 5 minutes. I can assure you that all the data will be treated with strictest confidentiality.

Engaging in this research project will not only benefit my academic research and enable a better understanding of environmental supplier selection criteria, but I would hope also help you by having access to my wider results and developing a relationship with Sheffield University Management School, one of the few triple-accredited Management Schools in the world.

Many thanks for your time and contribution.

Yours sincerely

William Zhao (Email: rzhao9@sheffield.ac.uk)

Supervisors: Professor David Oglethorpe (Dean of Sheffield University Management School, Professor in Environmental Sustainability); Dr. Sonal Choudhary (Lecture in Sustainable Management); Dr. Andrea Genovese (Lecture in Logistics and Supply Chain Management). *This research has been approved by the Ethics Committee of Sheffield University*

Management School (SUMS) on ethical grounds. Completion of this questionnaire is entirely voluntary. All data collected from this questionnaire will be treated as confidential and will not be shared with any other parties. The results generated from the questionnaires will only be used for academic purposes (e.g. reports, papers and thesis) and all results will be kept anonymous.

1. What is your business's name?

2. How many tonnes of milk did you purchase in your last reporting year?

3. How many employees do you have?

4. Are you a dairy processor or an agent purchaser?
   □ Dairy processor □ Agent purchaser
   □ Other (please specify)

5. If you are dairy processor, which of the following dairy products does your business process?
   □ milk
   □ cheese
   □ ice cream
   □ milk powder
   □ butter
   □ yoghurt
   □ whey

   □ Other (please specify)

6. To the nearest 10%, for the following the destinations, what percentage of your output do you sell your products to?
   □ Selling directly to the customer _____%
   □ Local store _____%
   □ Supermarket chains _____%
   □ Food & Beverage manufacturing_____%
   □ Food service and hospitality industry _____%
   □ Used as intermediate product for further processing _____%
   □ Other (please specify) _____ _____%

7. Do you have any sustainability requirements of your suppliers?

	I Don't Know	No Requirement	Voluntary Requirement	Compulsory Requirement
Environmental Requirements				
Sustainable management of soils				
Use of renewable energy sources				
Efficient use of water				
Quantification of carbon footprint				
Implement processes that minimise carbon footprint				

Set challenging targets for improving environmental performance in terms of carbon footprint reduction				
Quantify/Reduce waste generated at farm				
Slurry management systems				
Anaerobic digestion				
Protect and improve natural habitat on dairy farm				
Use of sustainable feeds				
Social Requirements				
Comply with animal health and welfare requirements of Red Tractor				
Comply with RSPCA's freedom foods welfare assessment protocol				
Comply with Welfare Quality® assessment protocol				
Comply with other regulations or standards, please indicate:				

8. Do you give any financial reward or bonus to your suppliers for achieving these environmental and/or social sustainability requirements?
   □ No □ Yes

   8.1. If yes, what proportion of your price does the financial reward account for?

   □ <5% □ 5%-10% □ 10%-20% □ >20%

9. If you do have sustainability requirements for your milk suppliers, what would you say are the main drivers for this?

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Corporate Internal Drivers					
Desire to reduce costs					
Financial benefits					
Desire to improve product quality					
Personal commitment of managers and investors (top management involvement)					
Pro-environmental corporate culture					
External Drivers					
Government regulations and legislation					
Sustainability demands from customers					
Company's reputation and brand image for public					
Pressures from non-governmental organizations (NGOs) and media					
Support from suppliers					

10. If you don't have sustainability requirements for your milk suppliers, what wold you say are the barriers which prevent you from implementing sustainable procurement practices?

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Economic reasons					
Lack of awareness and involvement of top management					
Low competencies and commitment of employees within the organisation					
Poor supplier commitment					
Suppliers with low competencies					
Lack of transparency from suppliers on social and environmental issues					
Lack of environmental policies and regulation					
Non-proactive compliance with government regulations					
Weak return on investment to sustainability					

11. If you have been adopting green procurement practices on your milk sourcing, on what performance dimensions are you benefiting from it?

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Reduction of emissions, waste and energy					
Financial benefits					
Positive effect on firm's performance due to unique selling point on environmental-friendly and socially responsible products					
Developed stronger relations with your suppliers					
Created competitive advantage					

12. Any other comments?

Appendix 4. The good soil management practice

Soil is composed of a mixture of organic and mineral matter, also including air and water, with rock particles (figure A.1). Sustainable management of soils is aiming to "function effectively today and will continue to be productive long into the future" (LEAF, 2016), otherwise, over-exploitation will cause soil erosion and degradation. Good and fertilised soil can supply the nutrients that the crop and grassland rely on to grow, however poor soil will not. Therefore, soil structure should be managed in sustainable and efficient way for both environmental and economic reasons.

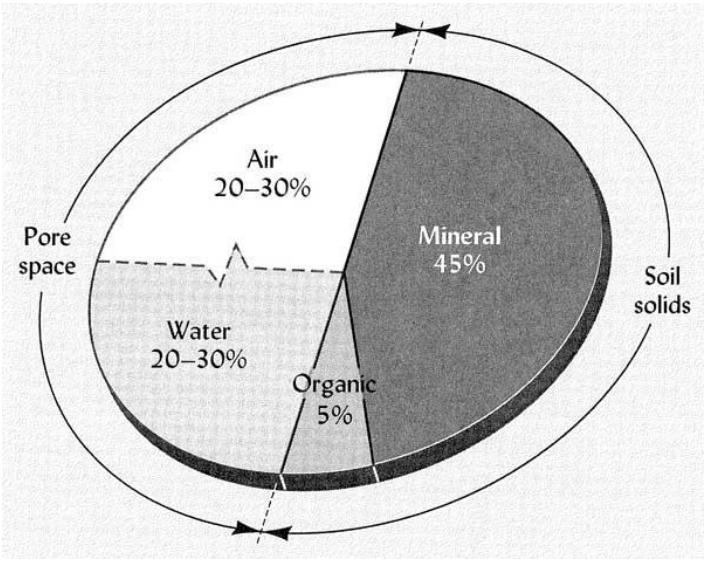


Figure A. 1 The good soil management practice (Brady and Weil, 2003)

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