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Title	Developing indicators of the social sustainability of farming using the Teagasc National Farm Survey
Authors	Brennan, Mary
Publication date	2022
Original Citation	Brennan, M. 2022. Developing indicators of the social sustainability of farming using the Teagasc National Farm Survey. PhD Thesis, University College Cork.
Type of publication	Doctoral thesis
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Download date	2026-08-23 14:42:15
Item downloaded from	https://hdl.handle.net/10468/14104

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Developing indicators of the social sustainability of farming using the Teagasc National Farm Survey

Thesis presented by

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for the degree of

Doctor of Philosophy

University College Cork

Department of Food Business and Development

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2022

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Author Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism and intellectual property.

Mary Brennan Date April 1st 2022

Acknowledgments

I wish to extend my sincere gratitude to my supervisors, Prof. Thia Hennessy, University College Cork (UCC) and Dr Emma Dillon of Teagasc, Ireland's Agriculture and Food Development Authority, for their wonderful support, expert guidance and mentoring throughout my PhD studies. I also wish to thank Dr David Meredith, Teagasc, for his insight and guidance, and for fulfilling supervisory duties for a period. I am extremely grateful to have benefitted from their friendly and supportive approach to developing both my research and career.

I also wish to acknowledge the advice and support I received from colleagues within UCC and Teagasc's Rural Economy Development programme, Athenry, for which I am extremely grateful. I thank Teagasc for funding my research under the Teagasc Walsh Scholarship programme and for providing me with training opportunities throughout my studies. I am grateful to the Teagasc National Farm Survey team, and I particularly wish to thank Brian Moran for the provision of data and expert advice. I also wish to thank all of the stakeholders who provided their expertise for this work.

Finally, I wish to thank my friends and family who have supported and motivated me throughout my PhD journey, and in particular to my partner Michael, for his patience and encouragement. I have found completing a PhD to be an incredibly rewarding, insightful and at times, challenging experience, and I am extremely grateful to all those who have helped me along the way.

Abstract

The emergence of agricultural and food sustainability as a major societal objective has resulted in a considerable shift in the focus and design of EU policy relating to agriculture, food, and rural development. As such, the dimensions of sustainability (economic, environmental and social) are reflected in the Farm to Fork Strategy and the Common Agricultural Policy (CAP) 2023-2027. The monitoring and evaluation of policy is a key element of the new CAP and consequently, there exists a need for harmonised multidimensional indicators to gauge progress towards specific sustainability targets. Moreover, the transition of the Farm Accountancy Data Network (FADN) to the Farm Sustainability Data Network (FSDN) reflects the commitment of the European Commission to enhancing sustainable farming practices, and this necessitates an expansion of existing farm level indicators to improve policy monitoring and evaluation, particularly with regard to social and environmental metrics.

In response to this policy need, this thesis aims to contribute to the ongoing development of sustainability metrics at the farm level, cognisant of evolving policy themes and drivers impacting Irish and European agriculture, and focuses on social indicators of sustainability. Indicators to assess the economic, and more recently, environmental sustainability of agricultural systems have dominated much of the sustainability discourse to date, with little on the assessment of social sustainability. The broad nature of social sustainability does not lend itself readily to measurement by conventional, quantitative means. An extensive review of the literature suggests that agricultural social sustainability can be considered as either 'internal' (relating to farmer wellbeing) and 'external' (at societal level)', encompassing animal welfare and community wellbeing.

Expanding on this 'internal' and 'external' classification, and following consultation with stakeholders, this thesis categorises social sustainability into dimensions reflecting farmer, animal and community wellbeing, and identifies relevant indicators for each dimension. Farmer wellbeing incorporates elements relating to quality of life (i.e. working hours, stress etc.), animal wellbeing consolidates herd level welfare data, while community wellbeing examines indicators measuring multifunctionality, service accessibility and heritage and culture (including generational renewal). Statistical analysis of data collected through a special survey, in addition to supporting socio-demographic data from the Teagasc National Farm Survey (NFS) relayed key information on the social sustainability of Irish farms.

From a farmer wellbeing perspective, this research finds that dairy farmers are more likely to experience farm related stress relative to operators of cattle, sheep or tillage systems. In addition to a stress assessment, this thesis assessed farmer wellbeing levels through the development of a composite index, the Farmer Sustainability Index (FSI), comprising indicators which reflect farm continuity, community and social connections, and farmer comfort. The FSI indicates that farmers working in the cattle sector, of older age profile, and residing in more peripheral regions experience relatively lower levels of wellbeing. Indicators assessing community wellbeing reveal regional variation, with communities in the Border and West performing less well in terms of wellbeing compared to other regions. In terms of farm continuity, a higher proportion of dairy farmers have identified a successor. Moreover, in terms of animal wellbeing, representative data from the NFS finds that welfare on dairy farms has remained relatively stable during an expansionary phase following EU milk quota abolition in 2015.

These findings indicate that farm level social sustainability varies considerably by farm system and subsequently region. Variations in the FSI scores and those of its components reveal the extent to which farm heterogeneity influences wellbeing levels. Additionally, the underlying farm economic and socio-demographic attributes are influential. This serves to highlight difficulties in applying a common policy approach in the pursuit of improved social sustainability across farm systems with differing wellbeing needs.

As the FADN expands its remit to better encapsulate sustainability through the FSDN, it is imperative that additional social sustainability indicators are developed. This thesis finds that, with modifications, the FADN framework retains the ability to effectively assess and collect social sustainability metrics for European farms. Indeed the Teagasc National Farm Survey has been at the forefront in this regard, devising a bank of social sustainability indicators and providing a roadmap for data collection and analysis. This research contributes to the discourse on agricultural social sustainability measurement, through the development of a range of indicators reflective of farmer, animal and community wellbeing dimensions. Recommendations for future data collection and research are also provided.

Dissemination and Awards

Journal Publications

Brennan, M., Hennessy, T. & Dillon, E. 2020. Towards a better measurement of the social sustainability of Irish agriculture. *International Journal of Sustainable Development*, 23, 263-287. DOI: 10.1504/IJSD.2020.115229

Brennan, M., Hennessy, T. & Dillon, E. 2021a. Embedding animal welfare in sustainability assessment: an indicator approach. *Irish Journal of Agricultural and Food Research*, 60 129-141. DOI: 10.15212/ijafr-2020-0133

Brennan, M., Hennessy, T., Meredith, D. & Dillon, E. 2021b. Weather, Workload and Money: Determining and Evaluating Sources of Stress for Farmers in Ireland. *Journal of Agromedicine*, 1-11. DOI: 10.1080/1059924X.2021.1988020

Working Papers

Brennan, M., Hennessy, T., Dillon, E., & Meredith, D. 2022. Beyond farm income: Assessing multiple dimensions of social sustainability amongst a nationally representative sample of farmers in Ireland.

This paper is currently under revision for resubmission to *Sociologia Ruralis*.

Popular Publications

Brennan, M., Hennessy, T., Meredith, D. & Dillon, E. 2021. 'Weather, Workload and Money' *T Research*, 17(1), Teagasc

Oral Presentations

EAAE Seminar on Sustainability in the Agri-food Sector 2018, NUIG.

Agricultural Economics Society (AES) Annual Conference 2019, University of Warwick, UK.

Cork University Business School Postgraduate Symposium 2017-2021, UCC.

Poster Presentations

Teagasc-SRUC Rural Futures Conference, 2018. Edinburgh, Scotland.

Agricultural Economics Society (AES) Annual Conference 2018, University of Warwick, UK.

Awards

Best Poster- Agricultural Economics Society (AES) Annual Conference 2018, University of Warwick, UK.

Dean's Best Paper Award- Cork University Business School Postgraduate Symposium 2020, UCC.

Chapter 1. Introduction

The concept of sustainable development has become an omnipresent paradigm for conscientious development over the past number of decades. The term ‘sustainability’ possesses multiple interpretations, owing to its inherent broad terminology, indeed there are now more than seventy definitions for sustainability existing, emphasising the different values, goals and priorities of the individual user (Kraft, 2017). The seminal 1987 Brundtland Report brought the concept of sustainable development into common parlance, surmising that global environmental issues were the consequence of enormous poverty in developing countries and overconsumption of resources in more highly developed and industrialised nations (Brundtland et al., 1987). The report is credited with devising guiding principles for sustainable development and mooted the importance of uniting strategic development with environmental considerations to achieve optimum development. Emerging from the report were three distinct but inherently linked attributes deemed necessary for effective sustainable development; namely protecting the environment, promoting economic growth, and ensuring social equity. The Brundtland report outlined the dimensions of economic, environmental and social sustainability, a triad which has resonated throughout sustainable development policies since, from the 1992 Agenda 21 reform, a programme of action to achieve sustainable development with recommendations for the preservation of natural resources, the improvement of living standards, and the development a more sustainable economy (United Nations, 1992) to the more recent 2030 Agenda for Sustainable Development, and it’s 17 Sustainable Development Goals (SDG’s).

Public interest in the sustainability of agriculture and food production has gained prominence over the past number of decades, particularly as concerns grow regarding environmental degradation, biodiversity loss, pesticide use, and greenhouse gas (GHG) emissions (Heyl et al., 2021, Willett et al., 2019, Pretty, 2008). Indeed, sustainable agricultural production, including its economic, environmental and social dimensions, is now expressly recognised as a key objective for the EU's Common Agricultural Policy (CAP) (Matthews, 2020). This is reflected in the development of a range of initiatives that seek to foster a sustainable and competitive agricultural sector that supports European farmers to respond proactively to current and future challenges, and promotes prosperity across rural regions. One such initiative is the transformation of the Common Monitoring and Evaluation Framework (CMEF), which monitors the implementation of CAP policies, to the Performance Monitoring and Evaluation Framework (PMEF), a more performance-based delivery model. This represents a significant change in emphasis of the CAP from a current focus on compliance towards the achievement of specific objectives (Matthews et al., 2020b). Reflecting the changing focus of the CAP and shift towards performance monitoring the Farm Accountancy Data Network (FADN) will take account of sustainability metrics in the form of a Farm Sustainability Data Network (FSDN). The FADN collates data on an annual basis from each member state through nationally representative surveys of farm enterprises for the determination of incomes and business analysis for agricultural holdings (Buckley et al., 2015). A key strength of the FADN is the provision of a harmonised platform for the collection of directly comparable farm statistics by each member state, one supported by a rigorous data management and validation infrastructure, thus making the FADN the primary monitoring instrument used to evaluate agricultural policies in the EU (Vrolijk and Poppe, 2021). The evolution of the FADN to the FSDN represents a fundamental shift in its focus and purpose, one which is currently oriented towards understanding the economics of food production, to one more cognisant and supportive to sustainable farming practices. This evolution in the agricultural monitoring framework may also assist the CAP to better align its objectives with those of the Sustainable Development Goals (SDG's). The agricultural sector plays a particularly important role in regards to achieving the SDG's owing to the benefits it provides which must be balanced against potential social and environmental harm caused by its operations. However, some issues prevail regarding the ability of the CAP to fully contribute towards the objectives of the SDG's, such as a lack of adequate indicators for evaluating the contribution to overall objectives (Scown and Nicholas, 2020). In order to support the transition of the FADN to a more sustainably focused monitoring framework, and by extension, the ability of the CAP to better determine standards of sustainability, the scope of data collection for the FSDN needs to be adapted to derive appropriate, meaningful and relevant agricultural sustainability indicators.

At this juncture, however, the assessment of the dimensions of agricultural sustainability has been somewhat unbalanced, with economic, and more recently, environmental matters, dominating much of the sustainability discourse; indeed the original priority of the CAP was to increase production in order to stabilise agricultural markets and farmers' incomes (Emmerson et al., 2016). The vast majority of sustainability objectives within legislative reforms over the past thirty years, such as the Agenda 2000 reform for the CAP, and the more recent EU Green Deal and Biodiversity Strategy have focused predominately on remediating and mitigating environmental concerns, and given the drastic impacts of climate change and ecological destruction on the health of the planet, this is wholly justified. Consequently, this centralised frame of reference resulted in a somewhat distorted interpretation of sustainable development and agriculture, one in which economic and environmental attributes dominated and the social or 'human' component had been relatively under-developed (Wojewódzka-Wiewiórska et al., 2020, Janker and Mann, 2020, Kelly et al., 2018, Latruffe et al., 2016b), perhaps hindered somewhat by its subjective nature and broad remit. Indeed, social sustainability does not lend itself readily to measurement by conventional, quantitative means, such as those used for the assessment of economic and environmental sustainability. Rather, agricultural social sustainability may be more effectively determined from an evaluation of farmers wellbeing and quality of life, (Lebacq et al., 2013, Van Calker et al., 2007, Van Cauwenbergh et al., 2007). In addition, the social dimension of agricultural sustainability include the impacts of agriculture beyond the farm gate, such as its contribution to rural viability and maintenance of rural socio-economic infrastructure (Šūmane et al., 2018, Dillon et al., 2016) and the protection of farm animal welfare (Kelly et al., 2018).

Exton and Shinwell (2018) postulate that the measurement of social sustainability is moving beyond indicators which infer "good" societal wellbeing as synonymous with financial or economic status; indeed the concept of eudemonic wellbeing has now emerged as a principal attribute within the paradigm of holistic sustainability assessment (Scott, 2012). Wellbeing builds on and develops livelihoods concepts, which view people's economic activity as a complex mix of priorities, tactics, influences, activities, and alliances that draw on a variety of material and social resources (White, 2009). As such, wellbeing can be better understood as a multifaceted phenomenon that can be assessed by measuring a wide array of subjective and objective constructs (Forgeard et al., 2011). Indeed, there is a growing recognition for the need to examine overall wellbeing and quality of life within agricultural sustainability assessments, for a more holistic and representative determination of farm level social sustainability (Ryan et al., 2016) and to measure the effectiveness of evolving sustainability policy objectives (Scown and Nicholas, 2020, Kelly et al., 2018).

Measuring the wellbeing of farmers is necessary to better interpret the social sustainability of agricultural systems, as issues such a poor work-life balance and social isolation can adversely impact wellbeing (Ryan, 2016). This highlights the inadequacy of inferring farmer's wellbeing from pecuniary matters alone, and the need to incorporate more subjective quality of life indicators within measurement frameworks, such as the Teagasc National Farm Survey (NFS) and the FADN, to better determine the sustainability status of agricultural systems. Moreover, the societal impact of agriculture incorporates factors which extend beyond the farm gate

(Kelly et al., 2018), such the contribution of farms to their local economy, and their maintenance of the land and rural landscape (Cooper et al., 2009). In addition, the impact of agricultural production on animal wellbeing is another component fitting to the wider social sustainability paradigm; indeed the protection of animal welfare is a social theme that impacts society as a whole (Kelly et al., 2018). In consideration of these different, albeit interconnected components of societal wellbeing, this thesis proposes that agricultural social sustainability may be more effectively described as *'The support of systems and relationships that enhance current and future wellbeing of farmer and farm families, farm animal welfare, and the viability of the local, rural community'*.

Within the Teagasc NFS, the wealth of economic data collected has made the design of economic sustainability indicators relatively straightforward, while its recent expansion of environmental metrics which focus on GHG emissions, ammonia emissions, nitrogen and phosphorus use have greatly enhanced the ability of the NFS to determine and compare the environmental sustainability of different farm systems. To date however, the collection of social sustainability indicators within the NFS is limited by the range of suitable farm level data available within the FADN dataset. Social themes are difficult to assess without collecting additional data on the farm and social information on the farm and farmers may be deemed overtly sensitive (Kelly et al., 2018). Moreover, the invoice-based methodology utilised within the FADN and the Teagasc NFS is not conducive to the collation of more subjective type data, which is required to provide a holistic assessment of wellbeing.

Considering the perceived difficulty in gathering subjective and sensitive data, and a sense of apathy on the part of policy regarding the social dimension of agricultural sustainability in comparison to economic and environmental concerns, there exists a dearth of social sustainability indicators available in national and EU databases for the measurement of agricultural social sustainability. Given the increasing reporting requirements for policy evaluation and impact assessment, monitoring and data collection systems for European agriculture must evolve to take account of new policy topics, and require robust and representative sustainability indicators for successful and effective measurement.

1.1. Research objective

Optimum sustainable development cannot be achieved in isolation or through detached initiatives, rather, the integration of economic, environmental and social aspects is paramount in this regard (Mensah and Casadevall, 2019). An integrated approach towards sustainability ensures that the potential of each dimensional pillar is recognised and utilised, while any trade-offs or synergies existing between the various dimensions can be addressed. It is essential therefore that each pillar is recognised as an equitable component of the sustainable development concept, and that no one pillar should be overlooked in favour of a more cogent analysis of another. Over the past few decades, the ‘profit’ and ‘planet’ components of sustainable development and agricultural sustainability appear to have taken precedence over the social or ‘people’ aspect (Janker and Mann, 2020, Ketschau, 2017, Latruffe et al., 2016b). This historic lack of information and analysis across the social dimensions of sustainability has resulted in an unbalanced and skewed interpretation of sustainable development, and one in which the social aspect holds a minor role.

As international and local governments, scientists, policymakers and society seek to embrace a more sustainable way of living and working, it is counter-intuitive to remain impassive towards advancing the social dimension of sustainable development. To this end, this thesis aims to address this shortfall and expand the knowledge base of social sustainability assessment for the agricultural sector through the development of relevant, robust and insightful farm-level social indicators for Irish agriculture, in conjunction with the Teagasc NFS. These indicators will derive data from the different ‘wellbeing’ aspects of agricultural social sustainability, namely farmer, animal and community wellbeing, and will merge with and expand upon the existing range of farm level social sustainability indicators developed by the NFS, which currently gauge farmers quality of life through quantifying social life dimensions not determined by economic activity (Dillon et al., 2016, Hennessy et al., 2013). This expanded social indicator set will complement the suite of existing economic, environmental and innovation sustainability indicators currently utilised by the NFS. Farm level sustainability measures that capture the concepts of productivity, profitability and viability comprise the economic indicator dataset, while the environmental indicators devised by the NFS focus on greenhouse gas emissions, ammonia emissions, nitrogen and phosphorus use efficiency (Buckley et al., 2019b). Finally, the use of more innovative technologies and management practices can result in increased agricultural sustainability, and the innovation indicators assessed by the NFS examines the adoption of such practices by farmers, in addition to discussion group membership. A more detailed description of the full suite of sustainability indicators developed and analysed by the Teagasc NFS is provided in Chapter 2.

1.2 General aim and outline of the thesis

The objective of this thesis is to contribute to the measurement of social sustainability at the farm level and to expand the current suite of sustainability indicators with those more cognisant of evolving policy themes and drivers impacting Irish and European agriculture. Policy reform within the CAP and evolving societal expectations regarding the sustainability of agricultural practices has resulted in a need for improved information on the effectiveness of policy to achieve objectives for more sustainable farming operations in the EU. Consequently, modifications are required to improve the data monitoring programmes by which CAP targets are assessed, and to expand the scope of data collection to indicators more cognisant to social sustainability. At this juncture, there exists a lack of appropriate farm level social sustainability data for the assessment of agricultural sustainability within national and European scale databases.

The overall structure of this thesis takes the form of eight chapters, including this introductory chapter. Chapters 3, 4 and 5 have been peer-reviewed and published, and following the Viva Voce examination, a few minor additions have been made.

Chapter 2 provides a contextual background for the concept of social sustainability, one which considers the 'human' attributes of sustainable development, measured through subjective indicators which assess wellbeing and quality of life. This chapter discusses the position of social sustainability within the wider sustainable development movement, and outlines the evolution of agricultural sustainability and policy development and the effectiveness of its' monitoring frameworks. Furthermore, this chapter provides an overview of the farm level sustainability indicators devised and utilised by the Teagasc NFS to determine farm sustainability in Ireland, and identifies gaps and opportunities for the development of additional social indicators to better ascertain the sustainability status of farms.

Chapter 3 begins by laying out the theoretical dimensions of the research and encompasses a comprehensive literature review to evaluate the range and variance of social sustainability indicators implemented across numerous EU countries and beyond. This review informed a framework, which segregated the social attributes of sustainability into farmer, animal and community wellbeing. A stakeholder consultation process followed, which informed and validated the prioritisation of thematic areas of social sustainability, and the final identification of potential farm level indicators. The social sustainability framework of farmer, animal and community wellbeing follows through in the next four chapters, which examines each of these wellbeing attributes in further detail.

Chapter 4 focuses upon farm animal wellbeing, namely dairy cow welfare, in the context of the expansion of the dairy sector in Ireland in recent years. Numerous technical performance and management indicators are extracted from the Teagasc NFS over the period 2014-2017, and utilized to develop a composite welfare indicator, the Dairy Cow Wellbeing Indicator (DCWI) to infer welfare status on surveyed dairy farms.

The wellbeing of the farm holder is assessed through a stress identification survey in Chapter 5, where the prevalence of stress and the identification of specific farm-level stressors are determined. Statistical modelling techniques are used to identify and quantify the factors that impact farmer's experience of stress.

Chapter 6 expands upon the farmer wellbeing aspect of social sustainability, and develops a Farmer Sustainability Index (FSI), a composite index which assesses indicators representative of different dimensions of farmer wellbeing; namely farm continuity, community and social connections, and farmer comfort. Farm level socio-demographic data was extracted from both core and supplementary 2018 NFS, and statistical analysis was undertaken to compare the distribution of FSI and the individual dimension scores for farms across farm system, farmer age cohort and region.

Chapter 7 focuses on the wellbeing and relationship between the farm holder and the local community in which they reside, from the perspective of the farm holder. This chapter assesses community wellbeing with numerous farm level indicators, which measure (i) multifunctionality, (ii) heritage and culture, and (iii) access to services.

Chapter 8 provides a holistic interpretation of the wider sustainability concept for Irish farms, and analyses the trade-offs and synergies existing between the economic, environmental and additional social sustainability metrics utilised in this study.

Finally, Chapter 9 draws upon the entire thesis and provides discussion on findings with recommendations for agricultural policy, and future work.

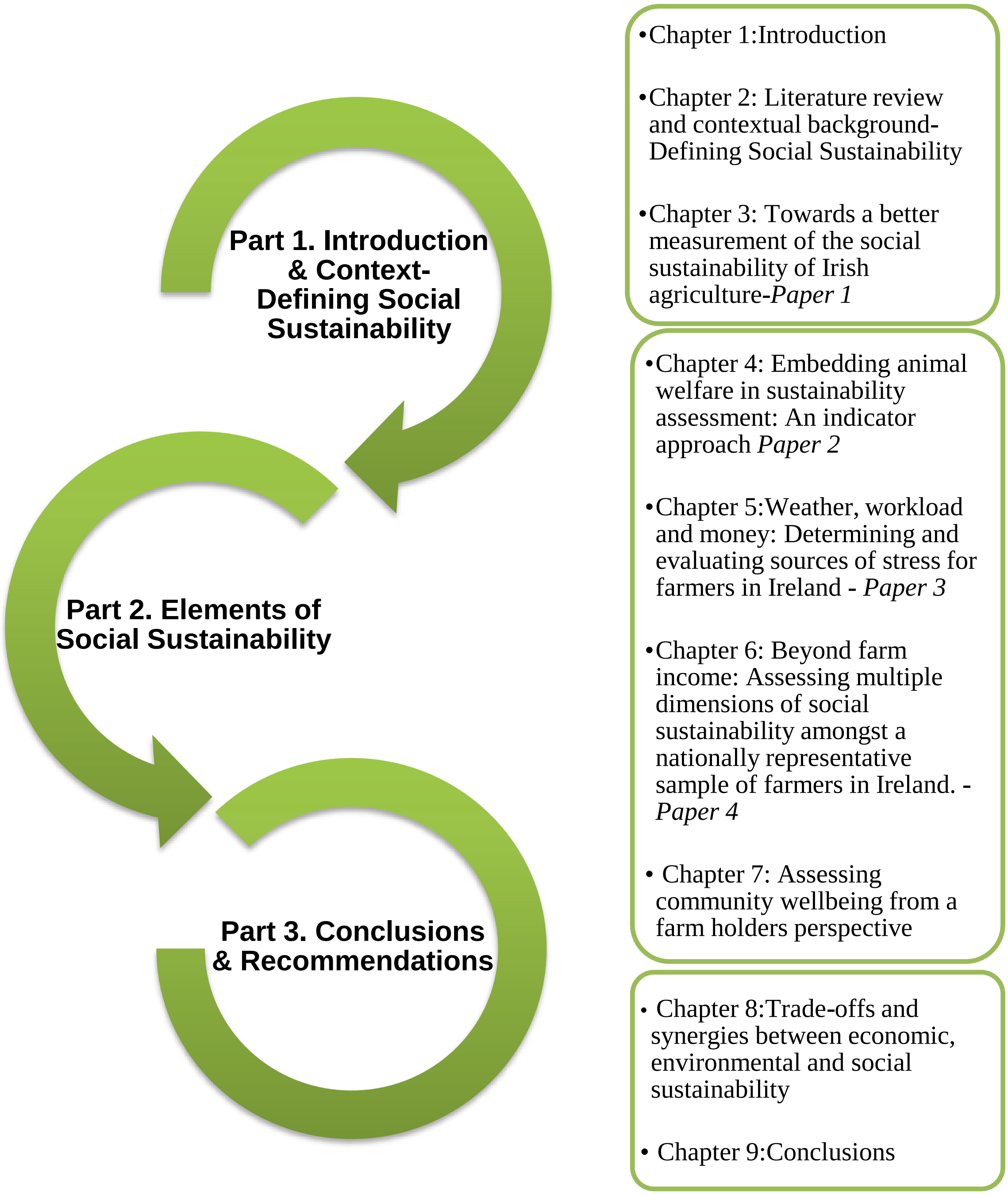

Figure 1.1. The theoretical framework for this thesis

Chapter 2. Contextual background

In this chapter, we first discuss the concept of social sustainability, and its position within the wider sustainability discourse. A review of the progression of sustainable development and sustainability policies follows, tracing its evolution from the seminal 1987 Brundtland Commission Report, through to the incorporation of sustainability within agricultural policy. We review the monitoring and evaluation framework in place to assess the progression of agricultural policy towards different sustainability objectives, and review the use of the FADN data collection programme for the assemblage of sustainability indicators. Finally, we examine the range of current FADN indicators utilised by the Teagasc National Farm Survey (NFS) to measure social sustainability, and identify a need to expand the scope of farm level indicators to ascertain a more comprehensive determination of social sustainability, one which is cognisant to farmer, animal and community wellbeing dimensions, and one which meets the need of evolving agricultural policy.

2.1. The social pillar of sustainable development

Although the concept of sustainable development is characterised in a familiar typology comprising three pillars, environmental, economic and social, there has been a somewhat unbalanced approach towards research and policy development into these three pillars, most noticeably neglecting the social aspect of sustainable development. Since the publication of the Brundtland Report in 1987, the concept of sustainable development has established a method of guidance for the promotion of environmental considerations, assisting both public and private entities in highlighting areas requiring reform. While the Brundtland Report has assisted in the promotion of issues surrounding environmental considerations for sustainable development, the social dimension of sustainability garnered less attention throughout the 1990's, owing somewhat to its perceived fluidity and subjective character (Mills et al., 2021, Janker and Mann, 2020, Lebacq et al., 2013, Boström, 2012). Indeed, a report drafted by the OECD in 2001 discussed the issue that social sustainability was not effectively being researched and developed as an independent and prominent pillar in its own right, rather it was being dealt with as a '*connection to the social implication of environmental politics, rather than as an equally constitutive component of sustainable development.*' (Colantonio, 2007).

The recognition of social sustainability as a fundamental pillar within the wider sustainable development discourse has gradually emerged since the early 2000's, bringing with it a somewhat speculative and broad definition of its terminology. Indeed, many authors have attempted to address this issue of ambiguity in the definition of the term 'social sustainability' (Vallance et al., 2011, Cuthill, 2010, Bebbington and Dillard, 2009). A better understanding of the social concept is imperative to reconcile the often competing elements of the societal, environmental and economic tripartite comprising sustainable development (Vallance et al., 2011). The ambiguity surrounding the definition of the term 'social' has led to a multitude of 'fuzzy' interpretations of what the concept of 'social' sustainability means, with much research focusing on specific and separate elements.

Vallance et al. (2011) elude to three different points of view that can assist in deciphering the term 'social sustainability', dividing it between 'development', 'bridge' and 'maintenance' social sustainability. Later Åhman (2013) narrowed the focus to development and maintenance sustainability, arguing that whilst bridge sustainability reflects attempts to harness the human potential to build links or bridges between people and the bio-physical environment, these processes are mediated by the capacity to engage in sustainable practices, i.e. development sustainability, and the willingness to be sustainable, i.e. maintenance sustainability. In describing the ‘development’ typology of social sustainability, the author discusses the widely interpreted Brundtland Report definition of sustainable development, and highlights the appealing nature of the definition, as it seeks to incorporate the three pillars of sustainable development, satisfying anthropological needs with the bio-physical environment through economic management. Maintenance sustainability focuses on desires and actions by various, and sometimes conflicting, sections in society to maintain traditions, practices, preferences and places. The processes of resolving local, regional, national and international tensions concerned with the valuing of certain groups, practices or places over others, i.e. what is to be maintained or sustained, is readily discernible within multiple policy discourses. These reflect different perspectives on the part of different groups or sectors within society of *‘the ways in which social and cultural preferences and characteristics, and the environment, are maintained over time.’* (Vallance et al., 2011 p.345)

Cuthill (2010) outlined a framework for the assessment of social sustainability, encompassing social capital, social infrastructure, social justice, and equity and engaged governance, based upon research conducted with government bodies and stakeholders concerned with social policy and community development. Social capital is defined as networks together with shared norms, values and understandings that facilitate cooperation within or amongst groups (OECD, 2001). While human capital is held by individuals and can help generate wellbeing, income and cooperation, social capital is held by communities and societies (NESC, 2003). Social capital can be categorised between three types; bonding social capital, which describes the connections amongst individuals who are emotionally close, such as family or friends, bridging social capital which refers to individuals loosely connected by social groupings, such as class or race, and linking social capital, which connects regular citizens to those in power(Aldrich and Meyer, 2015). The concept of community development is closely related to the term social capital; indeed, social capital is a set of resources inherent within communities, whereas community development describes a process and outcome arising from a wide range of community-led resources (NESC, 2003). Social capital can therefore act as a lever in linking to public agencies, bridging across to other disadvantaged groups, and bonding in terms of developing critical community level supports and mutual care at the local level.

Cuthill (2010) hypothesised that social capital provides a theoretical starting point for social sustainability, and in line with research conducted by the OECD in 2000, demonstrated that high levels of social capital and civic engagement in communities provide positive outcomes for economic, democratic and social development, and contributes towards overall community wellbeing. Indeed, from a public policy perspective, it is important to be cognisant to the range of broad principles and civic values that have an immediate and practical bearing on the formulation of policy strategies. Heavy top-down policy formation tends to operate in isolation from communities and citizens and can result in a "one-size-fits-all" approach to public service in the rural development and agricultural sector, amongst others (NESC, 2003). Alternatively, higher levels of accountancy and transparency from policymakers to citizens and communities can enhance trust and the potential of local communities, although it is important to recognise that an over reliance on 'bottom up' approaches may overlook areas of disadvantage. Therefore, a proper balance must be struck between self-help and externally provided support.

Moreover, sustainable wellbeing requires investment in key resources, namely natural, human, institutional and social, and so changes in these various forms of capital, particularly from a planning perspective, can adversely affect long-term sustainability if insufficient consideration is paid to the quality of investment and renewal in key areas. In the context of regional planning, the 2002-2020 National Spatial Strategy identified a number of aspects deemed essential for sustainable and balanced regional development, including the potential role of small towns and villages, and the need to protect key rural assets and to promote the potential of rural areas (NESC, 2003). As such, when addressing social capital through public policy, consideration must be made for additional factors that can impact community wellbeing, such as the availability and quality of social and community infrastructure in the locale. This remit may include the provision of health and education services, transportation initiatives, social amenities and rural development. Indeed, assessing the localized social infrastructure can provide an 'operational perspective' of the ambition held by governments to address regional social sustainability issues. Moreover, the interaction between human capital and social capital is imperative in the transfer of unique skills and knowledge in specific communities, and can help build a sense of community identity and responsibility. From an agricultural perspective, the expansive nature of social sustainability facilitates the encapsulation of societal concerns and interest in farming issues such as food quality and security or acceptable agricultural practices that occur at the farm level but whose externalities, positive or negative, have an impact beyond the farm gate (Gadanakis, 2015).

The concept of social equity pertains to more ethical considerations within society, intending to ensure '*fair, just and equitable management of all institutions serving the public directly or by contract, and the fair and equitable distribution of public services, and implementation of public policy, and the commitment to promote fairness, justice, and equity in the formation of public policy*." (Wooldridge and Bilharz, 2017). This concept strives to ensure that public services are attainable for all within society, and on a regional level, translates to the provision of affordable health services, housing, food and education. Furthermore, services need to retain equitable access for those with limited mobility and provide resources to enable people to upskill and develop their ability to participate within social and civil networks. Lastly, the concept of a more engaged form of governance, whereby the more traditional 'top-down' approach to governance is eschewed in favour of a more community-led method, is encouraged, as it facilities a more diverse viewpoint of stakeholders. Cuthill (2010) stipulates that the concept of engaged governance provides a methodological foundation for social sustainability.

Bebbington and Dillard (2009) discuss the issues surrounding the measurement of social sustainability, and the historical lack of research conducted into social sustainability, with researchers favouring the investigation into environmental and economic perspectives of sustainability. Indeed, the authors highlight the recurring theme of ambiguity and subjectivity regarding social sustainability;

'Social sustainability appears to present different and more severe challenges in specification, understanding and communication than environmental sustainability because there is no widely accepted scientific basis for analysis, unlike the ability to debate population ecology, acceptable levels of toxicity, or acceptable concentrations of greenhouse gases in the atmosphere. Nor is there a common unit of measure such as monetary units with the economic dimension of sustainability.'

The research conducted into social sustainability by the authors cited above assists in highlighting the challenges which exist towards the measurement of social sustainability, indeed, the subjective and broad nature of social sustainability does not lend itself towards measurement by conventional scientific methods, as opposed to environmental sustainability analysis. Instead, analysis of the social aspects of sustainable development requires more of a community-focused, qualitative measurement approach, which embraces wellbeing and addresses contemporary societal challenges. Over the past number of years, much of the research surrounding sustainable development has focused upon addressing ecological damage and impacts of climate change, which in turn have directed much of the focus of targeted sustainability policies.

2.2. Policies for sustainable development

A primary objective of the Brundtland Commission and the preceding United Nations World Commission on Environment and Development was to devise pragmatic proposals to alleviate sources of environmental and ecological degradation, working within the remit of sustainable development. The Brundtland Report emanated from this Commission, and highlighted three fundamental components of sustainable development, namely environmental protection, economic growth and social equality (Idowu et al., 2013) and outlined the importance of embracing and understanding each component in order to achieve optimum sustainability. The Brundtland Report set the stage for subsequent global environmental policy reforms and sustainability developments over the past three decades. One such event included the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janerio, known colloquially as ‘The Earth Summit’, which amassed scientists and political leaders from 179 countries with a focus upon the impacts of human-induced socio-economic activities on the environment. A primary objective of the Earth Summit was to develop an international cooperation strategy to address the pertinent environmental and developmental issues impacting the planet, and recognised that balancing economic, environmental and social dimensions to achieve sustainability required substantial changes to consumer, production and energy practices. ‘Agenda 21’ was a key output of this conference, an ambitious programme of action which highlighted the need for novel investment strategies to achieve overarching sustainable development in the new century. Key recommendations from this programme included the improvement of living standards for those in need, new ways to preserve natural resources and contemporary approaches to develop a more sustainable economy for all (United Nations, 1992).

The turn of the century saw one of the first key policy frameworks for sustainable development with ‘people’ as its core focus. The Millennium Development Goals (MDG’s), derived from the UN Millennium Declaration, came into force in 2000 with the objective of combatting poverty, hunger, illiteracy, environmental degradation and discrimination against women by 2015. Eight goals, with 21 measured objectives comprised the MDG's, with all UN member states and 22 additional international organisations committing to achieving these goals over its 15 year timeframe. The MGD's succeeded in part; Way (2015) reported that extreme poverty declined significantly over the past twenty years, child mortality rate declined by more than half, and 91% of children in developing countries are enrolled in primary level education. Furthermore, 2.1 billion people gained access to improved sanitation, while the elimination of ozone-depleting chemicals saw a drastic improvement in the ozone layer compared with its condition in 1990 (ibid, p. 7). However, progress of the MDG's has been highly variable across different developing regions and countries, with some achieving nearly every one of the eight goals, and others very few (Sachs, 2012).

In September 2015, UN member states adopted the 2030 Agenda for Sustainable Development (Transforming our World), a plan for sustainable action for people, planet and prosperity on a global scale. Comprising a suite of over-arching sustainable development goals (SDGs), this framework aims to obtain global sustainable development by 2030, with a commitment towards eradicating poverty and promoting equality (Matthews et al., 2020a). Succeeding many of the objectives set by the MDG's, the SDGs consist of seventeen 'global goals', comprising 169 targets, which aim to tackle contemporary global challenges, predominantly in the areas of sustainable development, promotion of environmental considerations and gender equality. The SDGs are interlinked, and as such, successful implementation of the goals requires a holistic approach that recognises a system of interacting components as opposed to individual goals in isolation, to balance any trade-offs between economic, environmental and social sustainability (Scown and Nicholas, 2020).

Several of the SDGs are inherently connected with agriculture and food production, such as SDG 2: Zero Hunger, SDG 8: Decent work and SDG 15: Life on land. This places a particular onus on the global agricultural sector to align its sustainability objectives with those of the SDGs, a notable challenge given the need of the sector to provide food for a projected global population of 9.7 billion people by 2050. The agricultural sector plays a particularly important role in regards to achieving the SDG's owing to the benefits it provides which must be balanced against potential social and environmental harm caused by its operations (Scown and Nicholas, 2020). Proactive initiatives must be taken to accelerate the transition to a more sustainable food and agricultural production system, one which can ensure food security, support economic opportunities and social wellbeing while protecting the environment (FAO, 2014). In the next section, an overview of sustainable agriculture and policy is discussed in further detail.

2.3. Sustainable Development and Agricultural Policy

The UN's Food and Agriculture Organisation (FAO) defines sustainable agriculture as:

'*The conservation and management of the natural resource base and the orientation of technological and institutional change in such as manner as to ensure the attainment and continued satisfaction of human needs for present and future generation. Such development (in agriculture, forestry and fishing, etc.) conserves land, water, plant and animal genetic resources, environmentally non-degrading, technically appropriate, economically viable and socially acceptable.*'

In their 2014 report on building a common vision for sustainable food and agriculture, the FAO expanded upon this definition and established five principles to assist in the advancement towards sustainable food and agriculture, which recognised the importance of embracing each pillar of sustainability. The formation of these five principles is due in no small part to the current 'unprecedented confluence of pressures' being exerted upon global agriculture in terms of poverty and hunger, land and water scarcity, unsuitable diets, the effects of climate change and the loss of biodiversity (FAO, 2014). These five principles include 1: Improving efficiency in the use of resources is crucial to sustainable agriculture, 2: Sustainability requires direct action to conserve, protect and enhance natural resources, 3: Agriculture that fails to protect and improve rural livelihoods, equity and social well-being is unsustainable, 4: Enhanced resilience of people, communities and ecosystems is key to sustainable agriculture and 5: Sustainable food and agriculture require responsible and effective governance mechanisms.

The European Commission's 'Sustainable Agriculture and Rural Development Policy' highlights the objectives of the Commission towards sustainable agriculture in developing nations: '*Creating a sustainable agricultural development path means improving the quality of life in rural areas, ensuring enough food for present and future generations and generating sufficient income for farmers'* (European Commission, 2017e).

In the following section, an examination of EU agricultural policy is presented, starting with the Common Agricultural Policy.

2.3.1. Agriculture and Rural policy development in Europe- The Common Agricultural Policy

Since its inception in 1962, the Common Agricultural Policy (CAP) has steadily evolved to respond to EU societies changes and needs, providing a central and connecting role amongst different food system dimensions, such as environmental protection and support for rural development (Recanati et al., 2019). The CAP holds court as the EU's preeminent agricultural policy, constituting a system of income and market support systems for the agriculture and rural development sectors (Oireachtas, 2018). Finance for the CAP is provided through two funds, which form part of the EU general budget, which in itself is financed by Member States (MS) based on their Gross National Income (GNI). The CAP is comprised of a two pillar structure, pillar one and pillar two, which divide elements of the policy. Pillar one measures comprise market, trade, and income policies, the latter of which primarily come in the form of direct payments (Tangermann and von Cramon-Taubadel, 2013). These measures are determined and entirely financed at EU level by the European Agricultural Guarantee Fund (EAGF) and as such apply equally to each MS. The importance of direct payment in bolstering and supporting farm incomes cannot be understated, indeed the vulnerability of the agricultural sector to external factors such as market price variation and adverse weather events can severely fluctuate income. As such, these payments contribute a significant proportion of income to many European farmers and are tantamount in maintaining farm finances.

The European Union's rural development policy comprises the second pillar of the CAP, as part of the Agenda 2000 reform. This policy outlines three overarching priority objectives for European rural development; 1, to foster agricultural competitiveness; 2, to ensure sustainable management of natural resources and climate action and 3, to achieve balanced territorial development of rural economies and communities, including the creation and maintenance of employment (Negre, 2020). Numerous strategic priorities are set out to aid the EU in attaining these objectives, such as the promotion of social inclusion, poverty reduction and economic development in rural areas, fostering knowledge transfer across agriculture, as well as enhancing farm competitiveness and viability (Eurofound, 2019). Rural development policy is implemented through individual multiannual programmes devised by each member state, purposefully designed to address the specified state (or region). Co-financed in part by the European Agricultural Fund for Rural Development (EAFRD) and local and national funds, each state programme is bound to a menu of measures supplied by the Commission, detailed within the rural development regulation (EU) No 1305/2013 (Negre, 2020). Such measures include 'Farm and Business development' (Article 19), which includes start-up business aid for young farmers, support for non-agricultural activities, and the development of small farms.

The revitalization of rural villages and services comprises an additional measure (Article 20) with a focus upon investing in local basic services and broadband infrastructure, as well as protecting and restoring the cultural heritage inherent within rural villages (Council of the European Union, 2013).

2.3.2. Evolution of the CAP

The policies of the CAP have evolved over time, however, its five overriding objectives have remained consistent since its outset, (i) to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilization of the factors of production, in particular labour; (ii) to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture; (iii) to stabilize markets; (iv) to assure the availability of supplies; (v) to ensure that supplies reach consumers at reasonable prices (Tangermann and von Cramon-Taubadel, 2013). While these stated objectives remain its cornerstone, periodic updates and reforms to the CAP require additional and more specific objectives for effective implementation. Most recent reforms to the CAP have been cognisant to the issues of sustainable farming practices and rural development. The 2013 reform aimed to promote competitiveness, sustainable practices, innovation, growth in rural areas and to better link financial resources to the productive use of land (Oireachtas, 2018). Most notable within this reform was the inclusion of a 'greening' payment alongside the basic payment scheme, which sought to promote more environmentally sustainable practices amongst producers by conditioning support on the respect of environmental standards.

The ability of the CAP to evolve to contemporary challenges impacting agriculture while maintaining support to the family farm model is vital in ensuring sustainable progress across the agricultural and rural sector. In line with the outcomes and recommendations of the Cork 2.0 Declaration of 2016 'A better life in rural areas', which discussed the trajectory of pillar 2, the European Commission committed to enshrining the objective of rural prosperity into future policies, with emphasis upon natural resource preservation, sustainable development and promoting generational renewal (Eurofound, 2019 , Negre, 2020). Additional priorities for a more modernised CAP were set out in a 2017 communication; 'The Future of Food and Farming', which identified three key objectives for the CAP post-2020. In addition to fostering a smart and resilient agricultural sector, and contributing to EU environmental and climate targets, the strengthening of the socio-economic fabric of rural regions was earmarked as a key strategic target necessary to future proof the CAP (European Commission, 2017a).

The latest reform of the CAP, termed CAP 2023-2027 has embraced sustainability to an even greater extent and aims to foster a sustainable and competitive agricultural sector that can continue to support European farmers, respond proactively to current and future challenges, and promote prosperity across rural regions. In collaboration with new agri-food and biodiversity strategies, (discussed further in next section), proposals and goals for the CAP 2023-2027 centre around the three pillars of sustainability: 1- Economic goals- Securing a fair deal and stable economic future for European farmers, 2; Environmental goals- Setting higher ambitions for environmental and climate action, and 3. Social goals- safeguarding agriculture's position at the heart of Europe's society.

To assist the CAP in achieving these overarching and broad ambitions, a modification to the original guiding principles was necessary, and ten reworked objectives for policy have been established: 1. Ensure a fair income for farmers, 2. Increase competitiveness. 3. Rebalance the power in the food chain, 4. Climate change action, 5. Environmental care, 6. Preserve landscapes and biodiversity, 7. Support generational renewal, 8. Foster vibrant rural areas, 9. Protect food and health quality and 10. Knowledge and Innovation.

CAP 2023-2027 highlights a resolve by policy to better incorporate and address issues surrounding social sustainability impacting European farms and rural regions. Several of its modified objectives, namely supporting generational renewal, preserving landscapes and biodiversity, an aim to promote and develop more vibrant rural areas, and the need to protect food quality and health standards fall within or overlap with social sustainability and thus require measures and indicators to assess the success and progression of implementation.

2.3.3: Looking beyond agriculture: Europe's long-term vision for rural areas

Evolving societal demands, the opportunities of the green economy, the possibilities made available by digital technology, the consequences of the COVID-19 pandemic, and the growth of teleworking have refocused attention on rural areas as places of wellbeing, security, eco-living, and new opportunities for social and economic renewal (European Commission, 2021). To this end, the European Commission have launched an initiative to map out the future of rural areas across the EU, incorporating the feedback of rural residents and businesses. Through this group effort, the Commission has developed an all-encompassing action plan to help make rural areas stronger, more connected, resilient and more prosperous by 2040. (European Commission, 2022). Further to the European Commission's long-term vision for rural areas, the Rural Pact seeks to create a framework for cooperation and engagement across a variety of stakeholders at the EU, national, regional, and local levels. Aligned with this is the EU Rural Action Plan, which in addition to fostering territorial cohesion and improving infrastructure, aims to leverage the role of sustainable agriculture and diversified economic activities. This Rural Action Plan is positioned with four flagship initiatives, (i) The creation of an innovative ecosystem, where local communities will be empowered to facilitate social change, (ii) the development of sustainable rural mobility strategies, (iii), the improvement of resilience from environmental, climatic and social perspectives, and (iv) the support of economic diversification.

2.3.4: Our Rural Future: A framework for the development of Rural Ireland

Our Rural Future provides a framework for the development of rural Ireland for the five-year period 2021-2025. The purpose of this policy is to ensure the wellbeing of all citizens and to promote a coordinated approach to rural development. It seeks to promote increased community participation, to prepare rural areas for technological, demographic, and environmental change, and to address the diversity of challenges and opportunities facing rural areas informed by analysis, data, and consultation (Rialtas Na hEireann, 2021). A series of thematic objectives have been established to aid in the implementation of this policy:

1. Optimising the opportunities for rural communities from high speed broadband
2. Supporting improved quality employment and career opportunities in rural areas
3. Assisting the regeneration, repopulation and development of rural towns and villages.
4. Enhancing the participation, leadership and resilience of rural communities.
5. Enhancing public services in rural areas
6. Supporting a Just Transition to a climate neutral economy.
7. Supporting the sustainability of Agriculture, the Marine and Forestry.
8. Supporting the sustainability of island and coastal communities

The thematic objectives of these rural development policies strive for balanced regional development and strengthened rural economies and communities. It is important to recognise the role of agriculture in this regard, and how the development of more sustainable farming practices can assist in enhancing the sustainability for the wider rural community.

2.4. Promoting sustainability in agriculture- The European Green Deal and Farm to Fork strategy

The European Green Deal (EGD) aims to make Europe the first carbon-neutral trading bloc in the world by 2050, while boosting the competitiveness of European industry and ensuring a fair and just transition for the regions and workers affected. Decoupling economic growth from resource use is a key objective of the EGD, as it maps out a sustainable and inclusive strategy for advancing the EU economy and improving people's quality of life and standards of care for nature. The EGD sets out a schedule for delivery of key policy and legislative objectives for 2020-2021, in addition to amending overall EU emission reductions targets, proposing an increase to a 50% - 55% reduction in greenhouse gas (GHG) emissions by 2030 against 1990 baseline emissions, from the current target of a 40% reduction. This current GHG reduction target is divided across the EU emissions trading system (ETS) and non- ETS sectors, with considerations for the land use, land-use change and forestry (LULUCF) sector (Oireachtas Library and Research Service, 2020). A central element to the EGD is the need for more sustainable agricultural production, one which minimizes farming's environmental footprint and protects biodiversity and nature, and the Farm to Fork strategy forms the basis of this objective.

The Farm to Fork strategy aims to accelerate and support a just transition to a more sustainably conscious food system, which promotes environmental, health and social benefits for European farmers and consumers alike. Reducing the dependence on pesticides and antimicrobials, reducing biodiversity loss and improving farm animal welfare are just some elements key to driving forward more sustainable agricultural practices. The strategy is fundamental to the EC's agenda to achieve the UN SDGs, and provides a backdrop for member states to rally their agriculture and fisheries industries for preparation towards the EGD 2050 climate targets, and identifies the need to expand the remit of the FADN to the Farm Sustainability Data Network (FSDN), in order to facilitate the collection of additional sustainability indicators.

Whilst the Farm to Fork strategy emphasises aspects of environmental and economic sustainability, the Biodiversity Strategy reflects concerns for the maintenance of traditional farming practices that are central to the reproduction of important habitats and ecosystems. The Farm to Fork strategy emphasises key issues impacting food systems in the EU, and highlights core elements for a sustainability strategy in food systems, namely circular economy, improved pest management and more integrated nutrient management plans (European Commission, 2020). It acknowledges the need to promote better animal welfare standards, and investment in broadband infrastructure in rural areas to aid in mainstreaming precision farm technologies and improving the quality of life for residents.

2.4.1 Monitoring and evaluating the CAP

Whether the CAP has adequately addressed the SDG's with its policy remit to date is arguable, indeed, much criticism of late has been levied at the CAP's lacklustre approach to coordinating its sustainability objectives with those of the SDG's, and a failure to provide a measurable framework to assess specific contributions of the CAP to the SDG's (Matthews, 2020). Given that the SDG's are not legally binding and that no strict obligations are set for their implementation, it is necessary for member states and other actors to formalise the targets of the SDG's within policies and actions to ensure their successful achievement. Scown and Nicholas (2020) identified several priority areas for European agricultural policy which could help align with the objectives of the SDG's. A key recommendation was the development of policy indicators for numerous SDG's which are lacking representation with the CAP, a social one being SDG 3: Good Health and Wellbeing. The authors highlighted the need to incorporate indicators to measure the health and wellbeing of farmers, particularly mental health and the assessment of farm workplace accidents.

As the CAP post-2020 specifies that the European Green Deal and its Farm to Fork strategy aim to improve sustainability across the agricultural sector, which are fundamental in helping the CAP achieve the SDG's, more work is required to devise a methodology integrating sustainability and SDGs with an indicator set to measure and monitor progress. This includes social indicators to assess the wellbeing of farmers, while several of the reformed CAP objectives require social indicators to measure their progress and implementation, namely in matters of generational renewal and the promotion of rural viability.

The Common Monitoring and Evaluation Framework (CMEF) was devised by the EU to monitor the implementation of CAP policies, and to evaluate it in its achievements towards its stated objectives. A CAP performance report is published by the CMEF twice during the seven-year cycle of the CAP, and examines the performance of the CAP in areas of viable food production, sustainable management of natural resources and climate action, and balanced territorial development. The CMEF highlighted inefficiencies in data collection, and identified challenges faced by many member states to collect appropriate data, and a lack of evaluation procedure to identify the true impact of policy on outcomes.

A plan to transform the CMEF to the Performance Monitoring and Evaluation Framework (PMEF), a more performance-based delivery model, reflects a change in emphasis in the CAP from a current focus on compliance towards the achievement of specific objectives. Moreover, each MS will be required to provide an update on the progress towards CAP objectives through an annual performance report, providing information on completed output and expenditure, as well as distance to targets set for the entire period, expressed as values of result indicators (European Commission, 2018).

2.5. Measuring Sustainability- The Farm Accountancy Data Network and Sustainability Indicators

To assist policy in the pursuit of sustainable development, the establishment of indicators is imperative to monitor progress. Sustainability indicators are quantifiable and determinable attributes of a system that are related to its sustainability. They are statistical constructs that support decision-making by revealing trends in data that can then be used to develop policy measures or to analyse the effects of policies already implemented (Dillon et al., 2016). Sustainability indicators are required to be scientifically valid, empirically sound, be both measurable and verifiable, and be derived from a robust and readily updated dataset (Ryan et al., 2016). For the agricultural sector, the ability to measure sustainability at the farm level, as opposed to more overarching national or global levels, is particularly advantageous. The individual or farm level is the legal unit for legislative purposes and is the most common level at which policy directives are set, and as farmers operate at this scale it makes for more effective implementation of sustainable actions. Moreover, measuring sustainability at the farm level increases the spatial accuracy of indicators, providing a more cogent analysis of sustainability standards (Kelly et al., 2018). Farm-level indicators also provide the ability to benchmark farm-level performance, facilitating opportunities for farmers to compare and improve farm efficiency, profitability and sustainability performance. Furthermore, sustainability indicators are necessary to evaluate the effectiveness and monitor the progress of national and EU agricultural policies. Consequently, policymakers require relevant and pertinent indicators reflective of current policy objectives, and as such, may require more contemporary indicators to be developed and measured.

Research and knowledge sharing are crucial elements in enabling policymakers to devise tailored advisory services to assist farmers in advancing progress on biodiversity ambitions and to overcome the challenges faced in reducing the carbon footprint of the sector. Consequently, the Farm to Fork strategy has proposed that the FADN be expanded to further take account of sustainability metrics in the form of the FSDN. The FADN collates data on an annual basis from each MS, for the determination of incomes and business analysis for agricultural holdings (Buckley et al., 2015). Currently, the annual sample contains approximately 1,000 variables covering over 80,000 farms, representing a population of about 5,000,000 farms in the EU and 90% of the total agricultural production (Kelly et al., 2018). A key strength of the FADN is the provision of a harmonised platform for the collection of directly comparable farm statistics by each MS. Supported by a rigorous data management and validation infrastructure, this coordinated methodology negates any issues surrounding cross-country comparisons, as each MS utilises analogous measures and units. The longitudinal nature of the collected data permits the FADN to consider and forecast retrospective and future trends (Kelly et al., 2018) although to date, owing primarily to its financial perspective, much of these determinations have focused upon economic considerations for the agricultural sector. Consequently, the FADN dataset is more conducive to the assessment of economic sustainability than that of environmental or social, although some national initiatives have utilised a supplementary survey facility within the FADN to create a bank of national farm level social indicators, measuring vulnerability and isolation in Ireland (Hennessy et al., 2013, Dillon et al., 2010) and devising proxy food safety and animal welfare indicators in the Netherlands (Dolman et al., 2014). Nonetheless, indicators to assess the social dimension of sustainability remain limited in their conceptualisation within the 'core' FADN, hindering a holistic assessment of agricultural sustainability.

As EU agricultural policies evolve and as targeted objectives for more sustainable production systems are set, the FADN must expand the remit of variables collected, and become more conducive to integrating and developing new environmental and social variables. Previous studies by Herrera et al. (2016c), Poppe and Vrolijk (2016), and Vrolijk et al. (2016) demonstrated the ability of the FADN to expand upon its financial scope and utilise its robust collection methodology to develop new and relevant social sustainability indicators for its core dataset. This requires a coherent definition of farm level social indicators, which can measure societal factors such as farmers lifestyle, contribution to rural employment, and animal welfare (Kelly et al., 2018). The Commission has therefore committed to transforming the FADN to the FSDN, demonstrating its support for improved sustainable farming practices across MS.

2.6. Defining the research question- Measuring social sustainability on Irish farms

Agriculture occupies a central tenet within the Irish economy, and it is inextricably woven into the fabric of Irish rural life. The family farm model dominates the ownership structure across Irish farms, with farm holder age averaging 58 years (Donnellan et al., 2020). Approximately 5% of Irish farm holders were under the age of 35 in 2016, slightly less than the European average of 6% (European Commission, 2017b). The agri-food sector is Ireland's largest indigenous sector, with exports in food, drinks and forestry estimated to be worth over €13.5 billion in 2017 (Joint Committee on Agriculture, 2018). The sector employs over 137,000 people directly, totalling nearly 300,000 when indirect jobs are included.

The Irish Teagasc National Farm Survey (NFS), is conducted on an annual basis, and fulfils Ireland's statutory obligation to provide farm-level financial and production data to the European Commission's FADN. Data is collected from approximately 900 farms, with each farm assigned a weighting factor to ensure results are representative of the national farm population. Since 2013, the NFS has led the charge on assessing national farm level sustainability, devising a range of economic, environmental, social and innovation sustainability indicators from both core and supplementary FADN data, (see Figure 2.1) and publishing regular reports on the sustainability status of Irish farms (Buckley and Donnellan, 2020, Buckley et al., 2019a, Lynch et al., 2016, Hennessy et al., 2013). We now discuss the NFS social sustainability indicators in more detail.

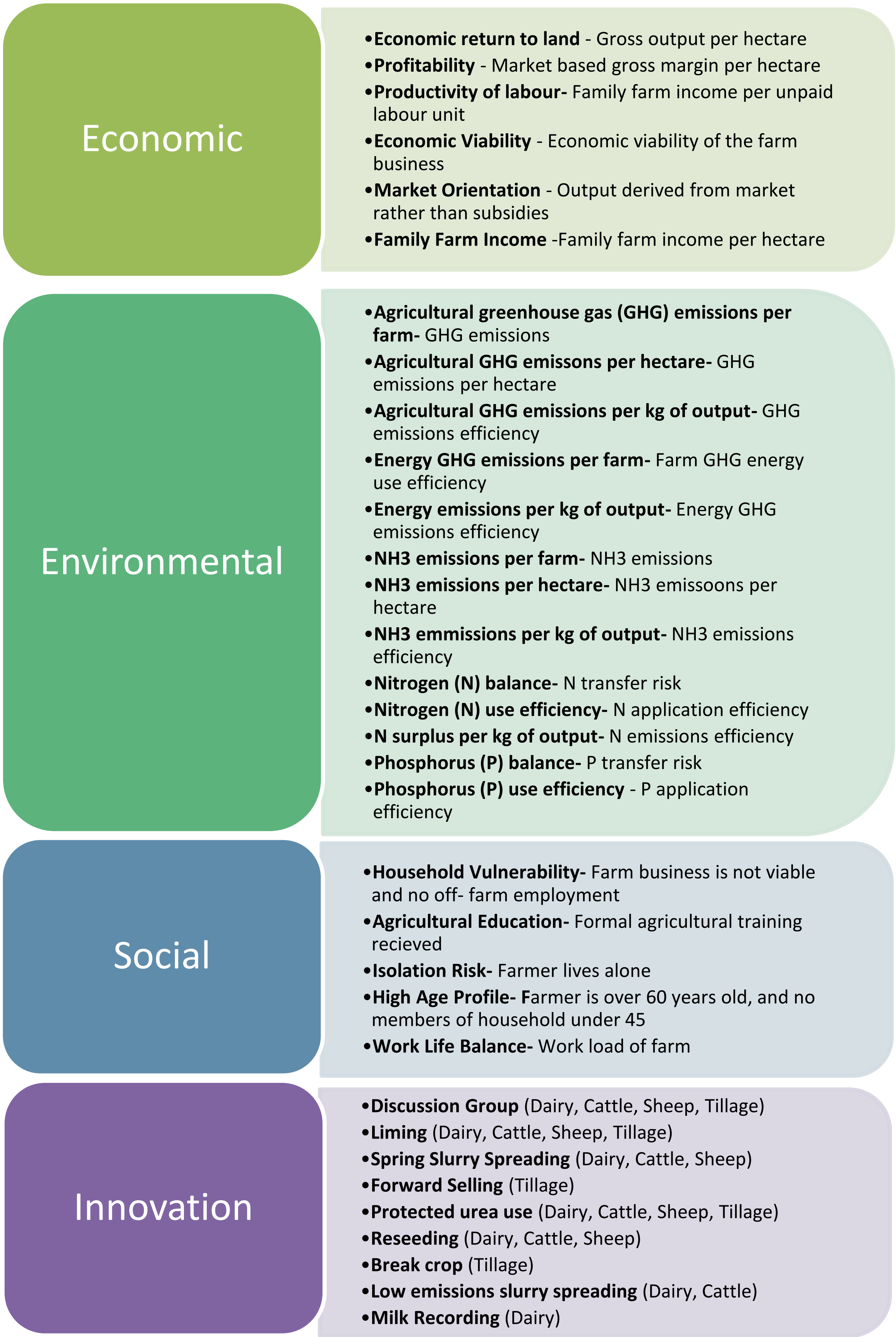

Figure 2.1 Teagasc National Farm Survey (NFS) Sustainability Indicators (Buckley and Donnellan, 2020)

Social Sustainability. The NFS produces a number of farm-level social sustainability indicators derived from its annual data collection, gauging farmers quality of life through quantifying social life dimensions which are not determined by economic activity (Dillon et al., 2016, Hennessy et al., 2013). These indicators evaluate farmer's quality of life through indicators which assess farmer's risk of isolation, (if they live alone), and identify farmers as 'high age profile' if they are over the age of 60, with no member of the household under 45 years of age. The NFS also considers agricultural education as a factor pertinent for social sustainability, as formal agricultural training can have an influence on farm management decisions. The work-life balance indicator is derived from the number of hours worked by the farm holder on the farm, while the household vulnerability indicator is closely associated with economic sustainability and defines a farm household as vulnerable if the farm business is not economically viable, and neither the farmer nor farmer's spouse is employed off-farm.

While these indicators provide key social sustainability metrics for NFS farms, they are limited by the range of suitable farm level data available to extract from the FADN dataset, one which is primarily suited to the collection of economic information, and more recently, environmental. This issue has been identified within NFS sustainability research, indeed, in their examination of farm level sustainability indicators assessed within the NFS, Ryan (2016) determined the range and depth of social indicators could be enhanced to assess the impact of farming in rural areas, such as its contribution to employment and future prospects, and rural networks. The NFS recognises the importance that lies in assessing and evaluating the social sustainability and wellbeing of Irish farms. If farming is not socially sustainable, individuals may seek to exit the sector, or there may be a dearth of people willing to succeed farmers when they retire. Furthermore, as farming is often the predominant economic activity in rural areas, the social impacts of farming are vitally important in maintaining employment and social wellbeing in the broader rural community (Buckley et al., 2019a). Recent work within the NFS sought to expand its knowledge base and report on the viability and sustainability of small farm enterprises. The NFS Small Farm's Survey (SFS) Report provided additional socio-economic farm-level data for a range of farms excluded from the primary NFS dataset (Dillon et al., 2017). Defined by their output, (less than €8,000 per annum), 61% of these small farms were categorised as cattle enterprises, with the remaining 39% comprising sheep holdings. A particular focus of the survey sought to examine the social wellbeing of small farm holders and found that the risk of isolation increased with farmer age, while half of the respondents reported limitations in their ability to access public transport. From a rural viability perspective, small farms can provide a source of economic activity in more disadvantaged rural areas often bereft of other employment opportunities, although the overall productivity of labour may be an issue. Furthermore, such farms can contribute positively to the non-farm rural economy, by maintaining landscapes and farm practices that would not otherwise be cultivated.

In addition to providing sustainability data on a cohort of small and socially diverse farms, the SFS demonstrated that vital socio-demographic data could be readily and routinely collated within the FADN dataset. This bolsters the notion that the FADN retains the ability to effectively transform from its traditional finance function to that more cognisant of farm sustainability.

Owing to data limitations within the current FADN framework, the collation of more subjective and personal data, such as queries relating to farm succession and planning for intergenerational farm transfer, physical and psychological health questions and off farm income figures are not currently considered with the core NFS, which has resulted in a lack of representative social indicators available to assess farmer wellbeing and future farm sustainability. In addition, issues pertaining to social sustainability matters beyond the farm household, such as farm animal welfare and the viability of the local community are not currently assessed within the scope of the NFS and the core FADN, further hindering the ability of this farm level dataset to comprehensively provide a determination of agricultural sustainability.

2.7. Conclusion

For farmers in the EU and elsewhere, the emergence of sustainability as a core policy objective has represented a huge, indeed it is hard to overstate, change in the focus and design of agriculture, food and rural policies. The FADN has proved useful in the development of economic and, more recently, environmental indicators measuring the overall status and contribution to the attainment of sustainability policy objectives. To date, there has been more limited use of the core FADN to assess and evaluate the social sustainability of agriculture reflecting challenges in designing, incorporating and implementing the collection of appropriate indicators (Dillon et al., 2016). While the Teagasc NFS led the charge on utilizing the FADN dataset to devise a bank of quality of life indicators, these are constrained by the availability of appropriate farm level data within the FADN, and as such, these social sustainability indicators are insufficient in their current format to adequately assess broader sociological matters, such as farmer wellbeing and generational renewal. Moreover, the social dimension of agricultural sustainability extends beyond the farm household, to matters including farm animal welfare assessment and local community and rural viability. The current FADN database, and by extension, the Teagasc NFS does not incorporate indicators to assess farm animal wellbeing and community viability, matters which have been identified as key themes of agricultural social sustainability (Kelly et al., 2018, Ryan et al., 2016, Lebacq et al., 2013) and objectives within the CAP 2023-2027 and the Farm to Fork strategy of the EU Green Deal (European Commission, 2020).

There exists a fundamental need to analyse and develop the social aspect of agricultural sustainability, indeed, there is a growing demand for data on agricultural sustainability amongst policymakers and researchers in order to evaluate the CAP regarding its cross-compliance, greening and rural development measures. At this point, there is a lack of appropriate farm level data available for the assessment of agricultural social sustainability within the EU FADN and Teagasc NFS. Topics related to the environment, animal welfare, innovation and technology are particularly important for future policy evaluation, and as such require data from social sustainability metrics (Poppe and Vrolijk, 2016). Moreover, the CAP requires data on farmer wellbeing to address inadequacies existing between its objectives and those of the UN SDG's (Scown and Nicholas, 2020). The transition of the FADN to the FSDN demonstrates commitment on the part of the EU towards the advancement of a more sustainably focused assessment of European agriculture. Monitoring the impact of the Farm to Fork strategy and forthcoming biodiversity strategies require sustainability indicators more cognisant of contemporary issues impacting the agricultural sector, such as climate change, food safety and security, biodiversity loss and societal and rural wellbeing. The FADN retains the ability to benchmark farm performance across regional, national and sectoral averages, thus enabling comparative farm analysis across a wider geographical perspective. Consequently, the development of more socially focused indicators will assist in future-proofing the evolving FADN, and help to ensure a successful progression to the FSDN.

The next chapter will examine in further detail the methodology and composition of varying social indicators adapted within agricultural sustainability assessments across Europe and beyond as well as proposing a framework for the development of more robust social sustainability indicators for Irish agriculture.

Chapter 3. Towards a better measurement of the social sustainability of Irish agriculture

Brennan, M., Hennessy, T. & Dillon, E. 2020. Towards a better measurement of the social sustainability of Irish agriculture. *International Journal of Sustainable Development*, 23, 263-287. DOI: 10.1504/IJSD.2020.115229

Abstract

There exists a need to analyse and develop the social aspects of agricultural sustainability. Distinct gaps between agricultural policy priorities and the data infrastructure needed to develop metrics for policy evaluation at the farm level exist, particularly regarding the social dimension of sustainability. This paper aims to examine the current social sustainability frameworks in operation across Europe and beyond, with a view towards expansion using Irish Farm Accountancy Data Network (FADN) data from the Teagasc National Farm Survey. A stakeholder consultation process, featuring policymakers, farm data recorders, academic researchers amongst others, highlighted pertinent concerns regarding the social sustainability of agriculture. Issues such as farmer stress, work/life balance, generational renewal and the viability of rural areas featured as priority concerns. Issues such as these have been identified as key areas of concern within the new Common Agricultural Policy which supports the continued development of specific indicators of social sustainability.

3.1. Introduction

There is a growing narrative that the global food system is flawed. Issues such as the impact of food production on the environment, animal welfare, global food security, value sharing along the supply chain, and food waste are now in common parlance (Wheeler and Von Braun, 2013, Lang and Barling, 2012). In response to these concerns, consumers are turning to more sustainable diets and are as such demanding better information on the sustainability status of farming and food production (Garnett et al., 2013).

Sustainability has been a core focus of global and national policies for some time, originating from the Brundtland Commission in 1987. The term remains notoriously difficult to define with over seventy different definitions in use (Diazabakana et al., 2014). Nonetheless, there is general agreement that sustainability encompasses three main pillars; economic, social and environmental and progress has been made in terms of measurement (Van Calker et al., 2005, Dillon et al., 2016). The United Nations (UN) Sustainable Development Goals put sustainable global development to the forefront, with nine of the seventeen goals directly or indirectly connected with agriculture (Euractiv, 2016, Knickel et al., 2018). Within the European Union (EU), sustainability is a central tenet of the Common Agricultural Policy (CAP) and rural development policy generally (European Commission, 2017d). Minimising the negative impact of agriculture on the environment is a key objective of the CAP as reflected in cross compliance and greening policies, whilst the multifunctional nature of farming and the social and cultural contribution of farmers to rural areas is also acknowledged.

In response to consumers' growing demand to understand more about the sustainability of food production (Kirwan et al., 2017) and policy makers' desire for additional data to monitor and evaluate sustainability policies, there has been a proliferation of research measuring agricultural sustainability. Through the use of indicators, agricultural sustainability has been assessed through a series of economic, environmental and social metrics developed at the farm level and more recently across the food supply chain (Marsden and Smith, 2005, Yakovleva, 2007). However, the main emphasis of these assessments has primarily been on addressing bio-physical issues in the environment with other aspects of sustainability being relatively more neglected (Janker et al., 2019). Vallance et al. (2011) discuss how social measurement of sustainable development has often been amalgamated within the discourse of economic development. As a result, the analysis of social sustainability has received less attention than that of economic and environmental dimensions (Gaviglio et al., 2017, Kelly et al., 2015).

In this paper we argue the need for improved social sustainability measurement for agriculture, and focus in particular at the farm level in Ireland. For centuries, agriculture has occupied a central tenet within the Irish economy, and it is inextricably woven into the fabric of Irish rural life. Like their European counterparts, modern Irish farmers now face new and contemporary challenges towards their livelihoods, in areas such as climate change, energy costs and rural depopulation (European Commission, 2019c). It is imperative therefore that sustainability measures are developed to address evolving challenges impacting the agricultural sector.

A public consultation regarding the modernisation and simplification of the CAP post- 2020 was undertaken in 2016 (European Commission, 2017d). This process highlighted public interest in matters regarding socio-economic development in rural regions, namely rural employment, tourism, farm multifunctionality and cultural heritage. The assessment of animal welfare and protection was also highlighted as a pertinent social issue requiring measurement, and additional topics suggested by the participants included measures to assess consumer awareness regarding food policy issues, quality control on agri-food products, subsidy support for younger farmers and the promotion of generational renewal. A 2018 report reviewing the sustainability of the Irish agri-food sector identified generational renewal as a key socio-economic challenge for European farming, (Joint Committee on Agriculture, 2018), with only 6% of EU farm holders aged 35 years or younger (Department of Agriculture, 2018)

The CAP post 2020 will potentially direct more support toward the public goods produced by farmers, such as their contribution to biodiversity and the viability of rural areas (often bereft of other economic activity), as well as the protection of culture and heritage (Hennessy et al., 2018b) and as such verifiable measures of the social impacts of food production are required.

Following an extensive literature review, we present a framework to measure social sustainability at the farm level in Ireland and test this framework using a mixed methods approach including a series of in-depth interviews with key stakeholders.

3.2. Background

In its broadest sense, social sustainability relates to people, and has been defined by Black (2004) as *'the extent to which social values, social identities, social relationships and social institutions can continue into the future'*. The emphasis of many sustainability assessments over the past two decades has primarily been on environmental considerations, and consequently, social measurement has often been combined within the pillar of economic development (Vallance et al., 2011). As a result, relatively little literature is available on the topic of evolving social sustainability indicators for agriculture, in comparison to the advancement of economic and environmental indicators (Lebacq et al., 2013, Bournaris and Manos, 2012). This dearth of literature has been attributed to the supposed 'impracticability' of social sustainability (Van Calker et al., 2007), the broad connotation of the word 'social' (Littig and Griessler, 2005), its subjective character (Latruffe et al., 2016b) and to the differences in perceptions of social sustainability between farmers and other societal groups (Gaviglio et al., 2017).

Within the limited existing research on social sustainability, indicators have been defined as being internal or external (Van Calker et al., 2005, Van Cauwenbergh et al., 2007). Internal measures are farmer oriented including individual and farm family well-being, while external measures are community oriented relating to the values, concerns and demands of the wider rural society. Owing to the prevailing family farm ownership structure existing across the EU, (CSO, 2016), work life and private life of the farm holder and farm family can become intertwined (Janker et al., 2019), necessitating a more holistic and thorough assessment of quality of working life (Gosetti, 2017). Internal measures address issues such as the working conditions for the farmer, their families and any employees (Van Calker et al., 2005), wellbeing, both physical and psychological, and education levels of the farm family. Van Cauwenbergh et al. (2007) further distinguished between physical and psychological well-being. The physical well-being of the farmer concerns relevant labour conditions and any associated health impacts, whereas the psychological aspects of well-being encompass issues relating to education, gender equality, autonomy, access to infrastructure and activities, integration and participation in society, both from a professional and a social perspective. The demographic viability of farm households is another important internal measure and the need for generational renewal has been well established as a key indicator of agricultural sustainability both within and outside the EU (Lillywhite et al., 2012, Fourrié et al., 2013, Van Calker et al., 2007, Wrzaszcz, 2014).

External social sustainability measures include, amongst other things, societal concerns regarding the impact of agricultural production and farming practices upon the wellbeing of human and animal welfare (Sydorovych and Wossink, 2007), the contribution of farmers to rural economies and communities, and the role of farmers in protecting cultural and heritage capital (Fourrié et al., 2013, Van Calker et al., 2005, Van Cauwenbergh et al., 2007, Hediger and Knickel, 2009, Lebacq et al., 2013, Šūmane et al., 2018).

The public good generated by local farming activity to rural areas has been recognised through policy determinations over the past two decades, in particular focusing upon environmental public goods, such as the protection of biodiversity and maintenance of adequate water quality

(Ciaian and y Paloma, 2011). In addition, agricultural processes can also contribute towards societal public good in rural areas, through agri-food provision and protection of cultural heritage (Maciejczak and Zakharov, 2011, Maier and Shobayashi, 2001), as well as utilising and helping to maintain the rural socio-economic infrastructure (Dillon et al., 2016). At this point, there is growing awareness that factors impacting farm family wellbeing and their quality of life, rural viability and farm animal welfare need more robust and definite representation within the sustainability framework, in order to ascertain a more holistic view of sustainable agriculture to better inform society (Bacon et al., 2012, Ryland, 2015). With this in mind, this paper aims to develop a social indicator set suitable for the Irish agricultural production system, in which these topics of farm family wellbeing, animal welfare and rural viability are addressed.

3.2.1. Literature Review

Using the concepts of internal and external measures of social sustainability, a literature review was conducted in order to identify studies that have previously defined farm-level indicators of social sustainability. Online research databases provided access to a catalogue of peer reviewed papers discussing agricultural sustainability, therefore keywords which referred to topics of agricultural social sustainability, indicator development and sustainable development were employed to refine the scope of the study. Table 3.1 provides an overview of the studies reviewed, and demonstrates the various metrics developed and designates them as either having internal or external attributes.

Table 3.1. Attributes used in the literature to assess farm level social sustainability

Internal indicators of Social Sustainability	Ireland (Hennessy et al., 2013, Dillon et al., 2017)	U.K (Lillywhite et al., 2012)	France (Lebacq et al., 2013) (Fourrié et al., 2013)	Belgium (Van Cauwenbergh et al., 2007)	Germany (Ehrmann and Kleinhanß, 2008)	Netherlands (Van Calker et al., 2007, Van Calker et al., 2005)	Pan-EU (Herrera et al., 2016a)	Italy (Gaviglio et al., 2017)	Poland (Wrzaszcz, 2014)	Spain (Batalla et al., 2014) (Arandia et al., 2011)	New Zealand (Hunt et al., 2014)	Quebec, Canada (Parent et al., 2013)
High Age Profile	X							X				
Household Vulnerability	X											
Quality of life/ Work Life Balance	X	X	X	X	X		X	X	X	X	X	X
Education Level	X	X	X	X	X		X	X	X	X		
Isolation Risk	X		X									
Succession Planning		X	X			X	X		X	X	X	X
External Indicators of Social Sustainability												
Animal Welfare		X	X			X		X		X		
Food Quality & Safety			X	X	X	X		X	X	X	X	
Multifunctionality			X			X	X	X	X		X	X
Access to services	X			X							X	
Heritage and Culture			X	X				X	X	X	X	
Stakeholder consideration & Consumer queries				X	X	X	X			X	X	

3.2.2. Internal Indicators:

Work-life balance and quality of life assessment: All of the studies reviewed examined the quality of working life of the farm holder. Many of these studies include an assessment of the total hours worked on the farm, (Hennessy et al., 2013, Parent et al., 2013, Lillywhite et al., 2012, Arandia et al., 2011). Eluding to the interconnection of both work and personal life of the farm holder, several other studies (Gosetti, 2017, Janker et al., 2019) attempted to develop overall life quality and level of autonomy indicators. Parent et al. (2013) evaluated the former through assessing farmer satisfaction with their role, stress levels experienced and the social supports available. Herrera et al. (2016a) outlined a series of self-reported indicators reflecting quality of life and autonomy in decision making for a sample of farms across ten EU Member States, while Arandia et al. (2011) measured the ability of Spanish farmers to make their own decisions.

Education level of the farmer: Several of the studies identified farmer education and on-going training as a relevant indicator of internal social sustainability. In this regard, the level of agricultural education attained by the farmer and/or members of the farm family can demonstrate potential future productivity improvements (Kelly et al., 2015). In addition to working conditions and quality of life, Lebacq et al. (2013) recognised education as a reflective attribute of farmer wellbeing, and categorised education into three levels: professional experience, the attainment of a diploma and/or continuous training. Wrzaszcz (2014) surveyed farmers on their planned participation in various forms of education, with the majority reporting the need to develop their vocational qualifications. Furthermore, the level of education attained by members of a farm household can indicate likelihood of farm succession, with members with third level education 30% less likely to take over the dairy farm than members with a second level education alone (Hennessy and Rehman, 2007).

Succession Planning: The CAP continues to support the position of the family farm in Europe. Family farming is seen to be important to the social fabric of rural areas and to power sharing in the supply chain. Succession and generational renewal is critical to the long-term survival of family farms and is therefore important from a social sustainability perspective and features in many of the studies reviewed. Parent et al. (2013) examines four components of succession, designed to analyse all aspects of the succession process from examining the continuity value of the farm holding, establishing the presence of a successor for the farm, preparing and planning for retirement and farm succession integration. A number of other studies developed similar indicators of succession (Lillywhite et al., 2012, Hunt et al., 2014, Arandia et al., 2011, Herrera et al., 2016a).

High Age profile: Within the context of social sustainability, the demographic profile of a farm household can be indicative of farm and rural viability, and thus characteristics such as age should be a primary consideration for the development of the agricultural sector (Gaviglio et al., 2017). Hennessy et al. (2013) also included age profile as a measure of social sustainability, defining a high age profile household as one in which the farmer is aged 60 years or older, with no member of the household aged under 45 years of age.

Isolation risk of farmer: Isolation in rural areas is another oft-cited societal concern. Two of the studies reviewed identify isolation risk as a social indicator of farmer wellbeing. Lebacq et al. (2013) classify isolation within the internal ‘quality of life’ attribute, reflecting the impact social isolation can have on farmer wellbeing. Hennessy et al. (2013) measures isolation risk as whether or not the farmer lives alone.

Household Vulnerability: Hennessy et al. (2013) defines a farm household as vulnerable if the farm business is not viable, and neither the farmer nor spouse is employed off farm.

3.2.3. External Indicators

Food Quality and safety: This indicator of external social sustainability was evident in a large number of the studies (Van Calker et al., 2005, Lebacq et al., 2013, Van Cauwenbergh et al., 2007, Ehrmann and Kleinhanß, 2008, Gaviglio et al., 2017, Arandia et al., 2011, Hunt et al., 2014). Consumer awareness of sustainably produced agricultural food products is growing and impacting purchasing patterns, (Vanhonacker et al., 2008), with the quality of agri-food products being identified as a proxy for the quality of the agricultural practices utilised (Wrzaszcz, 2014). In addition, several authors discussed the options afforded by food quality certification schemes (Ehrmann and Kleinhanß, 2008, Fourrié et al., 2013, Hunt et al., 2014). These accreditation schemes, such as organic certification, place of origin labelling or the Bord Bia 'Origin Green' sustainability programme (operating in Ireland), provides a means for certified farms to demonstrate their commitment towards safe and sustainable agri-food production (Bord Bia, 2015).

Multifunctionality of farms: The multifunctional role of farming, that is going beyond the role of primary food production to include the production of public goods was identified as an important social attribute in several studies (Fourrié et al., 2013, Van Calker et al., 2007, Gaviglio et al., 2017, Wrzaszcz, 2014, Parent et al., 2013, Hunt et al, 2014). The capacity of farmers to contribute towards their local economy and community was identified by Parent et al. (2013) where representative indicators measured farmer's contribution to local services and their social contribution. The importance of farm multifunctionality and diversification was discussed by Gaviglio et al. (2017), but was considered more from an economic rather than social perspective and discussed the importance of farm diversification as a method for resilience, allowing farmers to attain income from an alternative product or enterprise, such as agro-tourism or educational farms.

Heritage and culture: Many studies refer to the role of farmers as stewards of culture, heritage and traditional farming practices and many attempted to measure this contribution (Wrzaszcz, 2014, Lebacq et al., 2013, Van Calker et al., 2005, Hunt et al., 2014, Gaviglio et al., 2017). Gaviglio et al. (2017) considered how the aesthetic quality of rural buildings and farm landscapes influenced the social aspect of sustainable agriculture, owing to the subjective externalities in rural areas. In their assessment of sheep farming in Northern Spain, Batalla et al. (2014) highlighted the significance of tradition and heritage on the viability of sheep farming systems in the region. In this study, various indicators were implemented to assess the dimension of tradition and landscape, such as the examination of pasture practices, farmer's use of local knowledge and natural resources, and their general care of the environment. It is also important to consider the function delivered by generational renewal in the support of heritage and culture on farms. Supporting the next generation of farmers to sustain not only the land, but also the traditional customs and practices of family farming, is crucial. Through the transfer of specialised information and knowledge from one generation of farmers to the next, it is possible to preserve traditional farming techniques and local customs (BurrenLife, 2010). Generational renewal and farm succession are acknowledged by policy as fundamental drivers in bolstering the socio-economic fabric of rural regions, (Eurofound, 2019, European Commission, 2017e), particularly in addressing the issue of an ageing farm population (Leonard et al., 2017a, Cush and Macken-Walsh, 2016). Supporting generational renewal on European farms is one of the ten objectives of the CAP 2023-2027, and is seen as a critical component in promoting farm-level sustainability and limiting the danger of rural population decrease connected with it. As a result, it is reasonable to view generational renewal as a key factor within the heritage and cultural dimension of community wellbeing, as well as an intrinsic component of farmer wellbeing.

Stakeholder consideration and consumer perception: Several case studies highlighted the importance of constructing positive relationships between stakeholders/consumers and farm producers, with effective communication between both groups seen as a vital component of agricultural sustainability. Hunt et al. (2014) discussed how recognising stakeholder values and choices can help to benefit the wellbeing of local communities as well as food producers within New Zealand, through assessing the level of social cohesion within the value chain. Ehrmann and Kleinhanß (2008) also discussed the importance of stakeholder communication to further enhance the sustainable management of agriculture in Germany. A public relations indicator exists with the German agricultural society's (DLG) assessment system, where participating farms are scored on their involvement in local communication networks, and their engagement with non –governmental organisations, (NGOs).

Animal welfare: The inclusion of animal welfare assessment within the remit of external social measurement was common in many of the studies, (Van Calker et al., 2007, Lebacq et al., 2013, Lillywhite et al., 2012, Arandia et al., 2011). Van Calker et al. (2007) and Lebacq et al. (2013) considered two aspects of animal welfare measurement; animal welfare and animal health assessment. In the most general terms, animal health refers to absence of disease or pathology in the animal, while the welfare of animals relates to the relationship of the animal with its environment, its comfort level, its access to food and clean water and its ability to express natural behaviours (Nicks and Vandenheede, 2014). Van Calker et al. (2007) considers both aspects of animal health and animal welfare as pertinent measures for assessment, and utilises the term 'acceptable agricultural practices' as an umbrella indicator for both. Arandia et al. (2011) linked five indicators in their assessment of animal welfare: animal health, frequency of visits by the farmer to the animals, freedom of movement of animal when stabled, quality of housing and duration on pasture.

Access to services: The availability of public and social services within rural regions can be indicative of viability, and can therefore be considered a reflective attribute of external social sustainability (Van Cauwenbergh et al., 2007). Two case studies outlined in Table 3.1 utilised 'access to services' as a social indicator. In an assessment of the sustainability status of small farms in Ireland, Dillon et al. (2017) examined access to local services such as post offices, Garda (police) stations, banks, public transport and medical services. Access to social amenities such as pubs or social clubs was also assessed. Van Cauwenbergh et al. (2007) considered access to services as an indicator reflecting the wellbeing of the community, assessing whether the farm family's access to and use of social amenities is deemed acceptable.

From an analytical perspective, each of these indicators can assist researchers and policy makers to put a quantitative measure on the subjective matter of social sustainability. Understanding the dynamics that exist between the wellbeing of the farm, the viability of its rural community and societal considerations in matters regarding sustainable agri-food production is fundamental in order to successfully measure social sustainability (Dillon et al., 2016, Ryan et al., 2016).

Building on approaches reviewed in the literature, as discussed above, this paper aims to develop a framework to measure agricultural social sustainability at the Irish farm level. Indicators were chosen according to their overall suitability to the Irish context. The proposed framework, see Figure 3.1, draws on the concept of internal and external indicators, with a further 'wellbeing' sub-division established. Categorised within internal social sustainability, indicators reflecting farmer wellbeing include the work-life balance of the farmer, house hold vulnerability, their risk of isolation, the age profile of the farmer, the level of education attained and whether a succession plan or a successor has been established. Indicators comprising external social sustainability have been divided between animal wellbeing and community wellbeing. The contribution of farms to their local economy, through the delivery of agri-food products, use of local services and creation of employment opportunities is an indicator reflecting community wellbeing. Other wellbeing indicators include the implementation of food safety and sustainability certification standards, and consideration of stakeholder and consumer perceptions. The ‘access to services’ indicator assesses the availability of both public and private services in the local vicinity, reflecting the viability of the rural community, while measures taken by farmers to protect the regional landscape and farming traditions are assessed through the ‘heritage and culture’ indicator.

In light of increasing consumer demand for transparency on farm animal welfare standards, and the significant increase in Irish milk production following EU milk quota removal in 2015, it is expedient that measures to assess farm animal welfare are developed. A number of indicators are proposed for example, somatic cell count, which can be inferred as a general indicator of animal health (European Commission, 2017f), in addition to records of antibiotic use and herd mortality rates. Assessment of the age and quality of animal housing may be used as an indicator for the evaluation of animal comfort, while the duration of grazing reflects the opportunity of the animal to express natural behaviour and is of relevance for the Irish grass based livestock production system.

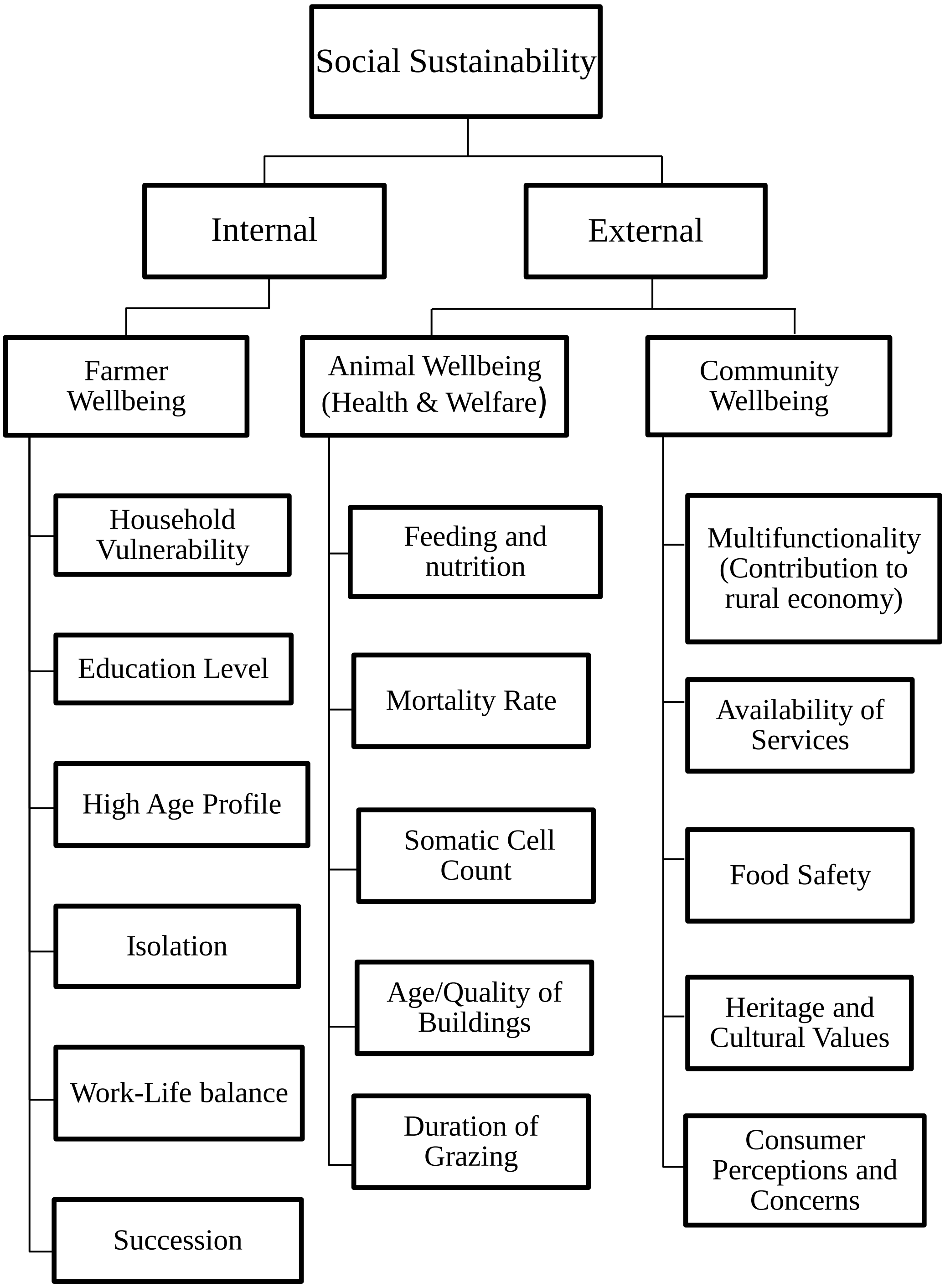

Figure 3.1. Index of proposed indicators of social sustainability for Irish farms, derived from literature review and international sustainability initiatives

***Source: Author's own*.**

In order to ensure that relevant indicators are selected, and to collate a truly representative suite of social indicators for Irish agriculture, a stakeholder consultation process was conducted to validate the series of indicators outlined in Figure 3.1.

3.3. Methodology

Stakeholder consultation is a common component in many studies developing sustainability indicators, for example (Puhakka et al., 2014, Kelly et al., 2015, Herrera et al., 2016b, Fraser et al., 2006, Van Calker et al., 2007, Gaviglio et al., 2017) and is used to eliminate issues arising from one-sided 'top-down' management and policy developer decisions, and to facilitate a process of participation, allowing stakeholders to identify locally relevant indicators (Fraser et al., 2006). For the purposes of this study, a series of in-depth interviews were undertaken to assess the usefulness of the proposed social sustainability framework from a policy, consumer and societal perspective in the Irish setting.

These interviews were conducted with stakeholders representing a variety of sectors invested in agricultural and rural affairs, such as representatives of the Irish food industry, (dairy processors, a consumer insight group, a food exporting body), farmer representative groups, policy makers, sustainability officers in food companies, farm survey data collectors and academic experts from Irish and EU institutions. In total nineteen subjects were interviewed.

Stakeholders were selected on the basis of their expertise and knowledge regarding the various stages of the agricultural production system. Table 3.2 lists the stakeholder groups interviewed, along with the number and their country of operation. These interviews were conducted between November 2017 and May 2018, and contact with stakeholders was initiated by email and the interview conducted subsequently in most cases face to face and where not possible by phone. The objective of these stakeholder interviews was to provide validation and feedback on the selection of proposed sustainability indicators and to contribute specialist knowledge towards public policy requirements, rural environment, the food industry, consumer needs and community development. Five of the nineteen stakeholders interviewed were academic experts based outside of Ireland, in various European research institutes and universities, specialising in the areas of agricultural sustainability, and/or rural development. This pan-European consultation broadened the perspective of the indicator analysis, and invited discussion on the various social indicators used internationally. In addition, these stakeholders provided insight on the list of potential sustainability indicators outlined, and views on the feasibility and the policy relevance of adapting such new social sustainability indicators within Ireland.

Table 3.2. Stakeholder groups consulted regarding their knowledge and insight into social sustainability, with number of stakeholders interviewed from each group in brackets.

Group	Reference Code	Country/ies	Description
Agricultural Policy & Farm Representative (2)	F.R	Ireland	Farm family representative and government advisor in agri-food sustainability
Farm Data Collectors (2)	D.C	Ireland	Teagasc National Farm Survey data recorders
Academic Researchers, IRL (2)	A.R (IRL)	Ireland	Professor of farm animal welfare, researcher of animal welfare indicator development
Rural Development (3)	R.D	Ireland	Rural Development Officers, Rural agricultural management and conservation, and social support groups
Academic Researchers, EU (5)	A.R (EU)	United Kingdom (2) Poland The Netherlands Germany	Rural development and conservation managers, coordinators of FADN systems, contact persons from FADN research institutions
Food and dairy processors, and sustainability officers (5)	P.S.O	Ireland	Sustainability officers, representatives of a dairy processing and milk cooperative , food safety and quality officer

A mixed-methods approach, allowing for the application of both qualitative and quantitative research methods (Creswell, 2013) was selected for data collection due to the broad and subjective nature of social sustainability. Concurrent data collection methodology was chosen for the stakeholder interviews as both qualitative and quantitative data could be collected simultaneously, with the qualitative aspect given predominance over the quantitative. All stakeholders were presented with the qualitative questions first, followed by the quantitative statements. Each of the nineteen interviews were voice recorded, and were transcribed by the author.

The qualitative aspect of the stakeholder survey was semi-structured consisting of seven open ended questions (contained in Appendix 1), designed to ascertain the stakeholders' knowledge of current social sustainability indicators, in addition to inviting discussion on social challenges, concerns for rural viability and recommendations on indicator development. Following the mixed method research procedure adapted by Puhakka et al. (2014) and Herrera et al. (2016b), the qualitative analysis involved the application of coding to each transcription, resulting in the identification of primary themes. The characterisation of a theme was determined by the number of occurrences of a topic, or particular aspect of social sustainability, throughout the interviews. Primary themes were identified through the streamlining of the various topics that emerged, which sub-categorised individual and related themes into a common, manageable principal theme (Puhakka et al., 2014, Stenger et al., 2014).

The quantitative component of the survey comprised two sections of ranking statements (contained in Appendix 2). Utilising the quantitative procedure of the mixed methods approach adapted Puhakka et al. (2014) and Carlyle et al. (2012) these statements provided a means for interviewees to rank both the usefulness and importance of measuring current social issues impacting agricultural sustainability. The first set of statements asked the stakeholders to list, by order of usefulness, nine different measures of social sustainability, where 9 was assigned to the measure they judged to be the most useful with 1 being least useful. These measures were derivative of the internal and external aspects of agricultural social sustainability, as discussed by (Lebacq et al., 2013, Van Calker et al., 2005, Latruffe et al., 2016b, Diazabakana et al., 2014, Herrera et al., 2016a, Arandia et al., 2011). The second section was comprised of twenty-five statements, which reflected the varying social perceptions surrounding agricultural sustainability. Following the methodical approach adapted by Puhakka et al. (2014), each statement reflected a specific social aspect or current issue impacting agriculture, as derived from the literature review. A 7 point Likert agreement scale was employed, and stakeholders were tasked with scoring these statements depending upon their level of agreement with them (1=strongly disagree, 7= strongly agree). A descriptive analysis was conducted in IBM SPSS 24 on these 25 agreement scores, with the median score used as the measure for central tendency as the Likert scale variables are classified as ordinal (Sullivan and Artino Jr, 2013). The observation of the median agreement scores demonstrates the level of agreement the interviewees held with each of the 25 statements, and in particular, which statements proved to have the highest level of agreement or disagreement.

3.4. Results

In this section, themes arising from the qualitative coding processes from the interviews are presented, in addition to an overview of the level of agreement/disagreement with the specific ranking statements presented.

3.4.1 Qualitative Analysis: The main themes emerging from the qualitative aspect of the stakeholder interviews can be categorised as relating to Farmer, Animal and Community wellbeing; these were:

- Farmer's mental health and wellbeing
- Social isolation
- Succession
- Animal Welfare
- Rural policies and development,

Associated sub-themes were disclosed during the coding process, and were amalgamated into overarching primary themes, based upon their affiliation and relationship to the primary themes. Similarly, some of the themes are inter-related, in particular issues relating to farmer wellbeing, isolation and succession. Animal welfare is quite specific with relevant policy measures considered at a more macro level. The primary themes and associated sub-themes are illustrated in Figure 3.2.

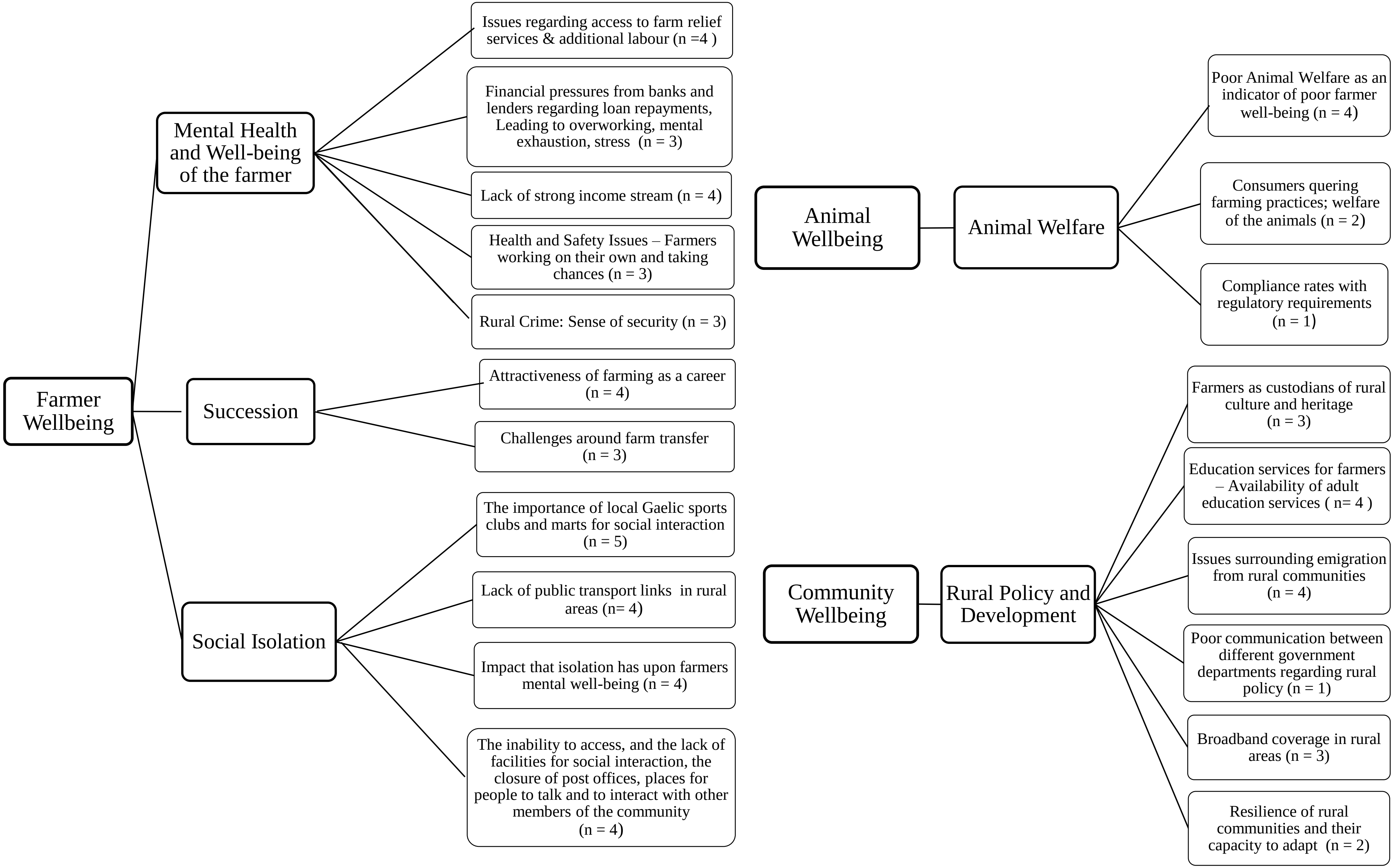

Figure 3.2. Themes extracted from the qualitative section of the stakeholder interviews; divided between Farmer, Animal and Community wellbeing (n= no of stakeholders who cited sub-theme)

The first theme, *Farmers' Mental Health and Wellbeing* was a principal concern for most stakeholders. These sub-themes included the effect of financial pressure on farmer wellbeing and issues such as inclement weather, fodder shortages and market developments. The timing of the data collection may be a factor here given the very difficult weather conditions in Ireland during winter 2017 and spring 2018 with much concern around fodder availability and farmers' associated stress levels. Other stressors cited by the interviewees included the effect that loneliness may have on the mental wellbeing of farmers, (R.D & F.R), in particular for those who live alone in isolated areas, (D.C & R.D). Aligned with this is the issue of health and safety and the fact that as many farmers work alone they may be more likely to take risks, or become complacent regarding their own safety. As to why this may be the case, one interviewee cited mental and physical exhaustion on the part of the farmer; "*lack of hours in the day to get the work done*" (F.R). It is noteworthy that in an Irish context the dairy sector has undergone immense structural change since the abolition of EU milk quota in 2015, with milk production increasing by 38% in the period 2014 to 2018 (CSO, 2019b).

Incidences of rural and agricultural crime were also mooted as a considerable stressor. The closure of rural Garda (police) stations was cited by a number of stakeholders as having an adverse impact on the sense of security of residents in particular regions (R.D & F.R).

The issues surrounding *farm succession* emerged as the second theme from the qualitative component of this research, with the topic referenced by nine of the nineteen stakeholders. Various issues regarding farm succession and generational renewal were discussed, notably the idea that many farmers' children may have no interest or desire to continue running the family farm (F.R, D.C & P.S.O). Potential reasons put forward in this regard included the lack of a strong stable income stream (R.D), the perception of a poor work-life balance (D.C), more attractive job prospects elsewhere and the lack of interest in pursuing an agricultural career (P.S.O & A.R- EU), as well as more generally the lack of social amenities in rural areas (R.D

& A.R- IRL). The concept of succession may also prove to be a sensitive issue for many farmers to discuss with their children or potential heirs despite the efforts of many stakeholders to normalise the topic (Conway et al., 2017). Farmers may feel a sense of vulnerability or a loss of identity when considering succession, especially in cases where the farmer has worked and lived on the farm their entire life:

> ”*Could the farmer feel vulnerable about where he's going to be left? Putting pressure on farmers regarding succession and transfer, it's fraught with tension. Look at well-being, how much of that disintegrates because of pressure to transfer?*” (R.D).

Several interviewees also discussed the issues surrounding generational renewal on farms and the knock-on effect this is having upon the vitality of rural communities (R.D & P.S.O). This underlines the holistic nature of agricultural sustainability and implications for the wider rural community.

While the challenges and issues surrounding succession planning and generational renewal were deliberated primarily by the Irish stakeholders, two of the European academic researchers discussed how the issue of succession is gaining strength and recognition within European agricultural policy and research given an aging farm population.

The third theme which emerged from the interviews was the issue of *Social Isolation* amongst farmers. This was closely associated with several of the sub-themes extracted from Theme 1 (farmer wellbeing), in particular focusing on the impact that isolation may have on farmers' wellbeing. This underlines the entwined nature of these issues.

> *"There's a reluctance to talk about mental health, and like that, isolation contributes to having poor mental health"* (R.D)

This was a common concern amongst the stakeholders, with many referencing aspects of social isolation as a primary concern and a particular social challenge facing Irish farming and rural communities more generally (R.D & P.S.O). As had arisen in the discussion of farmer wellbeing, several of the interviewees discussed the impact of the closure of various public amenities within rural communities as well as the deterioration of public transport links (F.R & R.D). As such, the existence of these facilities and structures were concluded to be an integral component of rural life, providing opportunities for social interaction, in addition to its primary service role.

> *"A lot of them too are very dependent on post offices for banking or paying bills. There are worries like that as well, what they would consider essential services being taken away from them"* (A.R- IRL).

Alongside this, the importance attributed to sports clubs and livestock marts were mentioned by some, providing an opportunity for social interaction for many, particularly those who may be somewhat isolated in their location, or for those living alone (R.D, P.S.O & D.C).

The fourth theme to emerge from the interviews related less to the individual and more generally to *rural development policy*. Various sub-themes contributed to this primary theme, notably issues around supporting the farm business e.g. poor quality broadband in rural areas. Several interviewees directly referenced this issue (R.D, F.R & P.S.O). Other sub- themes that were discussed by the interviewees included the youth emigration rates within rural communities and a subsequent reduction in the availability of additional farm labour.

> *"If you have really good agri-business in an area, it does keep the community together; it keeps jobs in the area"* (P.S.O).

The concept of farmers being custodians of rural culture and agricultural heritage (Wilson et al., 2013, Koohafkan and Altieri, 2011) was put forward by three of the interviewees (A.R-EU, R.D & D.C). Here, the interviewees discussed how farmers contribute to the protection and enhancement of rural regions, through assisting in the maintenance of the rural landscape and through their participation in various agri-environmental schemes. The potential loss of specific cultural and rural knowledge from one generation of farmers to the next was also cited as a concern amongst the interviewees, with consideration towards the movement of younger generations from rural areas (P.S.O & R.D). The education services available to farmers emerged as an additional sub-theme within this primary theme, with four interviewees referencing this particular topic (R.D, P.S.O, A.R-IRL & A.R-EU). The interviewees discussed the importance of continued up-skilling amongst farmers, and the availability of adult education services in rural regions.

Several of the stakeholders discussed the issue of animal welfare, and examined the notion of it having a connection with the mental wellbeing of the farmer (D.C, R.D, F.R & P.S.O). It was the opinion of these interviewees that most farmers would categorise the health and comfort of their animals as an absolute priority, and would invest more time and consideration into ensuring the good health and welfare of their animals than they would their own health. Furthermore, these interviewees were of the opinion that any deviation from this standard, where farmers failed to uphold good welfare consideration of their animals, may in fact be inferred as a sign of poor farmer wellbeing. One stakeholder discussed their concerns regarding compliance rates with minimum regulatory requirements for farm animal welfare, and how non-compliance may pose a reputational risk towards the agri-food industry (A.R-IRL).

3.4.2. Quantitative Assessment: The first set of quantitative statements asked the stakeholders to rank, in order of usefulness, a series of nine social sustainability measures, where 9 was assigned to the most useful measure, and 1 to the least useful. The average score for each measure was calculated, and is graphically displayed in Figure 3.3. ‘Farmer wellbeing – physical and psychological’, was ranked as the most useful measure, with the majority of the interviewees ranking it as their first choice. ‘Succession and young farmer development’ was ranked in second place, with ‘farmers’ sense of security’ ranked in third place. ‘Multifunctionality of the farm’, ‘access to services’, ‘animal welfare’ and ‘social outlet availability’ were ranked in fourth, fifth, sixth and seventh place, respectively, with measures reflecting ‘food security’ and ‘consumer preferences’ ranking in eighth and ninth position. These results are in line with the findings from the qualitative analysis in terms of the prioritisation of themes. The second set of quantitative statements sought to determine the level of agreement the stakeholders held with various assertions of farm level social sustainability. Simple statistical analysis was conducted, and the results complement several of the themes derived from the qualitative analysis, most notably in access to high speed broadband in rural regions, the availability of additional labour for farmers, transport links and sense of security in rural areas.

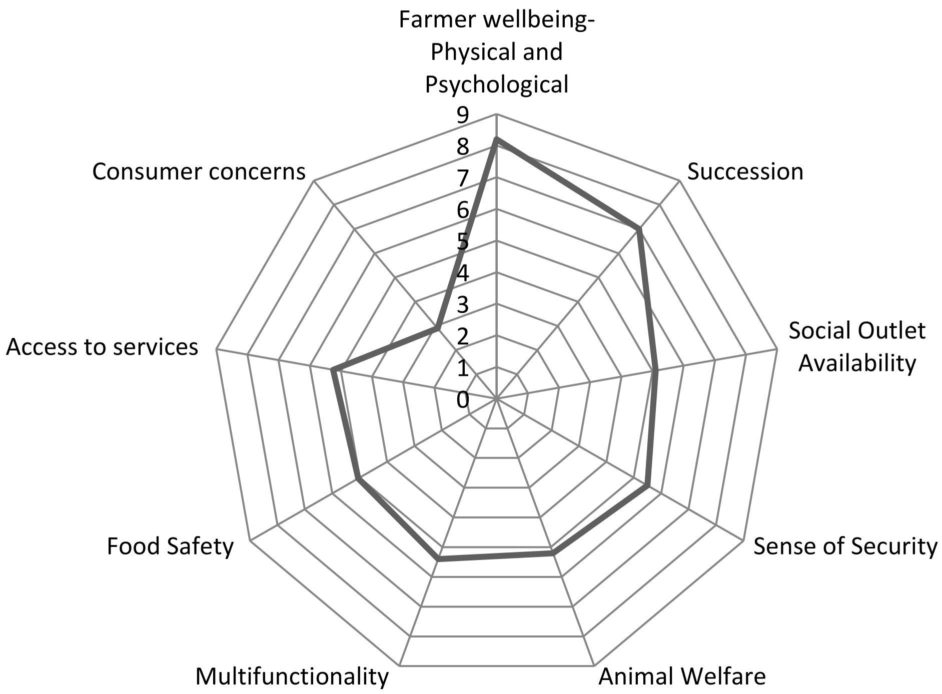

Figure 3.3. Stakeholder opinion on most important social sustainability measures for development and assessment (9= most useful, 1= least useful)

3.5. Discussion and Conclusions

The objective of this study was to propose a method of measuring social sustainability at the farm level, through the identification of individual indicators which sufficiently represent current trends with regard to agricultural sustainability. A stakeholder consultation process assisted in determining the most pertinent social issues impacting agriculture and rural development in an Irish context primarily. Utilising a framework which segregates the internal and external social attributes of sustainability into farmer, animal and community wellbeing, it was possible to design a stakeholder consultation process to inform and validate the prioritisation of thematic areas and the final identification of potential farm level indicators.

This three-pronged approach to wellbeing allowed for the identification of specific topics of concern amongst the stakeholders to emerge, most notably with regard to issues of farmer wellbeing and farm succession. These topics were regarded as high priority issues amongst the various stakeholders, as evident from both the qualitative themes and the results from the ranking statements. Concerns were also raised regarding the continued viability of many public services operating in rural communities, and the ability of farm families to access such services. In addition, stakeholders expressed concern regarding succession planning and generational renewal for rural communities more broadly. Many of the emerging themes demonstrate the holistic nature of agricultural sustainability, and the circular relationship which exists. The availability of services in rural areas and how this could affect farmers' sense of wellbeing was also raised. The intrinsic link between different aspects of social sustainability, and how one aspect may inadvertently be affected by the absence of another demonstrates the fundamental need to expand and develop relevant measures to ascertain a better understanding of farm level sustainability.

The current CAP 2014-2020 outlined several long term and broad ranging sustainability objectives within its remit, including a strategy to enhance rural development across member states. Building upon this objective, the CAP post-2020 aims to strengthen the socio- economic fabric of rural areas, through targeted objectives which focus on supporting generational renewal and vibrant rural areas, as well as ensuring a fair income for farmers and preserving landscapes and biodiversity. Moving forward, some work is required to link the sustainability of agriculture with activities in the wider rural economy, including those not directly involved with agriculture.

The development of sustainability metrics remains an iterative process. As the demand grows for additional data to measure agricultural sustainability it is imperative that indicators evolve to adequately assess all dimensions, including social. The framework proposed here will assist in guiding the development of relevant social indicators for agriculture. In an Irish context, each of the selected indicators will assist in measuring specific attributes of social sustainability which are deemed significant for Irish agriculture, notably farm family wellbeing and generational renewal, animal welfare assessment and rural viability. While the scope of this indicator set is primarily focused on assessing the social sustainability of Irish agriculture, its overarching framework lends itself to a broader policy assessment across countries.

As this thesis progresses, these dimensions of agricultural social sustainability; farmer wellbeing, animal wellbeing and community wellbeing are addressed in further detail. In the following chapter, an evaluation of dairy cow wellbeing is conducted, which is set against the backdrop of the recent expansion of the dairy industry in Ireland.

Chapter 4. Embedding animal welfare in sustainability assessment: An indicator approach

Brennan, M., Hennessy, T. & Dillon, E. 2021a. Embedding animal welfare in sustainability assessment: an indicator approach. *Irish Journal of Agricultural and Food Research*, 60 129-141. DOI: 10.15212/ijafr-2020-0133

The previous chapter introduces a framework that provides a more nuanced perspective to the established 'internal' and 'external' dimensions of agricultural social sustainability and contends that this pillar of sustainable development can be more effectively determined from an assessment of farmer, animal, and community wellbeing. This chapter focuses on the animal wellbeing dimension of this framework, and exclusively on the wellbeing of dairy cows. The elimination of EU dairy quotas in 2015 was one of the most significant policy changes affecting Irish agriculture in the recent past (Läpple et al., 2022) indeed the phasing out and eventual abolition of quotas allowed many Irish dairy farmers to significantly expand milk production for the first time since quotas were introduced in 1984 (Kelly et al., 2020). Consequently, it is important to ascertain whether this policy reform has had any discernible impact on the wellbeing of dairy cows, and ergo, on the social sustainability of dairy systems.

Abstract

In line with growing consumer interest in sustainable food production, a number of farm-level sustainability indicator studies have been published in recent years. Despite the importance of animal welfare, many such frameworks fail to adequately take account of it, mostly due to difficulties in accessing suitable data. This paper demonstrates that it is possible to develop indicators of animal welfare that can be embedded within a wider sustainability framework using a representative farm-level dataset such as the EU Farm Accountancy Data Network

(FADN) for Ireland, the Teagasc National Farm Survey. The paper presents a set of sustainability indicators for dairy farms in Ireland for the 2014-2017 period and examines the impact of policy reform on sustainability performance. Headline results show that welfare standards on dairy farms in Ireland have remained stable over the period despite the considerable intensification of the dairy sector following EU milk quota removal. Furthermore, dairy farms that have expanded herd size significantly have improved welfare standards more than farms that have not increased production. An analysis of synergies and trade-offs between the various aspects of sustainability reveals that positive correlations exist between welfare standards and economic and environmental performance. The analysis facilitates the identification of win-win farm level strategies that can be adopted to improve economic, environmental and animal welfare outcomes. The framework developed here presents opportunities for evaluating policy impacts at the farm level on various aspects of sustainability. The use of the FADN demonstrates the capacity to extend such an approach across the EU.

4.1 Introduction

The concept of sustainability is at the core of contemporary food and agricultural policy. The goal of the EU Common Agricultural Policy (CAP), to continue to foster sustainable food production, is clearly reflected in the recent Green Deal and Farm to Fork strategies, which aim to make food systems fair, healthy and environmentally friendly. Indeed, the latter highlights the importance of the evaluation, and revision of existing animal welfare legislation, and the further collection of data to assess the sustainability of farming more broadly. In line with legislation, there is a growing demand for practical and scientifically valid assessments of animal welfare in order to safeguard and address gaps, while satisfying the public's request for increased transparency. Indeed, over 80% of European citizens have cited animal welfare as a serious concern, believing that the welfare of farm animals should be better protected (European Commission, 2016a).

Arising from market and political interests, a plethora of indicator-based assessments of the sustainability of food production have emerged (Soldi et al., 2019, Bonisoli et al., 2019, Ryan, 2016, Van Asselt et al., 2014, FAO, 2014). Although such studies typically include indicators of the economic, environmental and social performance of farms and/or food production, animal welfare is often inadequately addressed, as highlighted in a recent review by (Brennan et al., 2020). Those studies that did address animal welfare utilised combinations of various resource and animal-based measures and tended not to be based on nationally representative datasets (Lillywhite et al., 2012, Arandia et al., 2011, Van Calker et al., 2005).

Traditionally, farm animal welfare has been assessed using resource-based measures reflecting welfare standards through management or environmental attributes, such as access to water or housing conditions (Phythian et al., 2019, Battini et al., 2014). More recently, animal based measures, which have the ability to directly measure the welfare status of livestock, have been recognised as a more effective method (Phythian et al., 2019). One of the prominent welfare assessment methodologies to adopt the animal based approach was the Welfare Quality protocol, (WQ) (de Graaf et al., 2017). The WQ protocol outlined four main welfare principles; good feeding, good housing, good health and appropriate behaviour, with associated criteria and animal based metrics by which to assess them, such as somatic cell count (SCC), mortality rate and body condition score (Blokhuis et al., 2010). These four principles have similar objectives to the ‘Five Freedoms’ (FAWC, 2009) and are predominately measured at animal level, and thus are considered a useful guide for the measurement of animal welfare (EFSA, 2012). However, as the collection of such animal-based data is not feasible on a large, nationally representative scale, the utilisation of routinely collected data to assess the quality of herd management and animal welfare on farms has also been explored as a more practical alternative (Warner et al., 2020, Nyman et al., 2011).

De Vries et al. (2011) identified numerous variables of routine herd data (VRHD), categorised across management, milk production and milk composition categories, and compared these with established welfare indicators (WI), to identify associations between the two assessments. The VRHD included variables such as milk yield, somatic cell count (SCC), fat, protein, mortality, access to pasture and housing systems. De Vries et al. (2011) concluded that many routinely collected herd variables had value in estimating dairy cow welfare. De Vries et al. (2014) reported that for most welfare indicators, routinely collected herd data can operate as a pre-screening tool for the detection of dairy herds with severe welfare problems. This was further supported by Brouwer et al. (2015) who reported that routinely collected data, such as mortality rates and bulk tank SCC, displayed a significant association with animal based measures such as the general health impression of the dairy cow, including rumen fill and body condition. Brouwer et al. (2015) concluded that an objective monitoring system, based on routinely collected data served as a better diagnostic tool for detecting dairy herds with poor welfare health status than quarterly farm visits by the herd veterinary practitioners. However, ongoing challenges in defining and developing appropriate animal welfare indicators from routinely collected data have contributed to the dearth of animal welfare indicators in broader sustainability studies and variation in the legitimacy of different animal-based measures across welfare assessments (Winckler, 2019).

In the design of appropriate indicators, the multidimensional nature of sustainability and animal welfare is such that multiple variables using different scales may need to be assessed. To simplify interpretation, multi-dimensional indicators can be aggregated into a single indicator, termed a composite indicator (CI) (Talukder et al., 2017). Intended to simplify complex information, CI's are now widely implemented within policy analyses and sustainability assessments, combining data on individual measures or indicators into a single index (Nardo et al., 2005). The WQ protocol utilized CI's to develop a welfare index, based upon numerous animal based measures at the herd level (de Graaf et al., 2017), with a subsequent study developing a composite health indicator (De Vries et al., 2013). In their assessment of herd welfare, Warner et al. (2020) devised a composite indicator from routinely collected herd level data from dairy farms in Canada.

The objective of this paper is to update an existing suite of farm-level sustainability indicators, developed using data from the Irish Farm Accountancy Data Network (FADN), to include a measure of animal welfare on Irish dairy farms, in order to test the relationship between welfare and other aspects of sustainability, and to record welfare changes through time. The analysis was conducted on data over a four year period from 2014 to 2017. This was a period of dramatic structural change on Irish dairy farms, in preparation for, and during the aftermath of EU milk quota removal after three decades. Post-quota, milk production has increased by approximately 50% to date, with growth in both herd numbers and milk yield per cow across farms. The sector is therefore an interesting case study in which to explore herd management and assess animal welfare. While animal based measures are not available through the dataset existing herd level data are instead used to identify suitable variables and develop a composite welfare indicator, which can act as a diagnostic tool for the detection of dairy herds with poor welfare status and can monitor progress during a period of intensification and expansion.

Previous sustainability assessments at the farm level in Ireland can be found in Dillon et al. (2016), Ryan et al. (2016) and Dillon et al. (2010), although animal welfare is not considered in these studies. This paper aims to fill that gap by investigating animal welfare and herd management on Irish dairy farms during a period of particular structural change, building on and complementing previous work. This approach facilitates an assessment of welfare, and how it relates to wider sustainability metrics (economic, environmental and social). This paper addresses a number of research questions; (i) can expert-validated metrics of animal welfare be developed from a routinely collected, nationally representative dataset as part of a wider sustainability framework, (ii) how do measures of animal welfare relate to other indicators of agricultural sustainability indicators, and (iii) how does policy reform (i.e. abolition of milk quota) and subsequent production intensification impact on animal welfare standards. The following section of this paper describes the methodological approach used in the development of a composite indicator of animal welfare and the data utilised. There follows an overview of results and a general discussion of same, the limitations of the study are then discussed and final conclusions drawn.

4.2 Materials and Methods

An adapted version of the OECD (2008) model for the development of sustainability indicators is used in this paper to identify appropriate variables and to develop a composite indicator of dairy cow welfare. The model for the development of such composite indicators is presented in Figure 4.1.

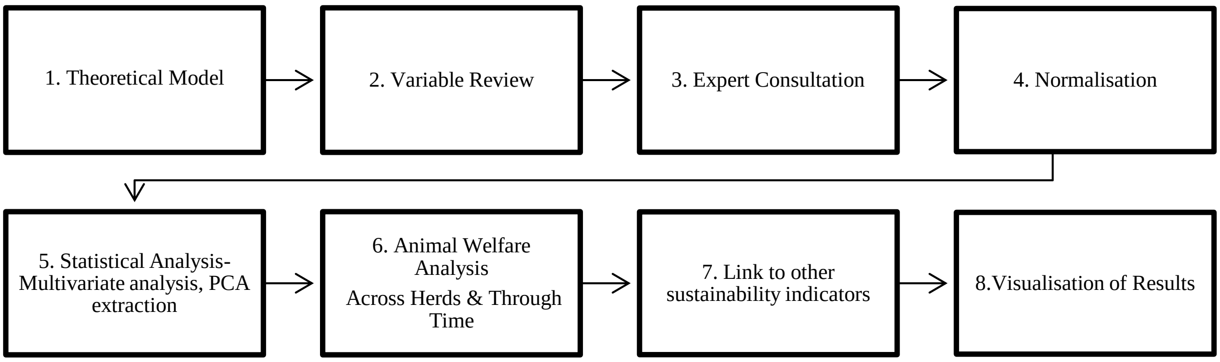

Figure 4.1. Methodological approach to the development of a composite welfare indicator
Source: Adapted from (OECD 2008)

4.2.1. Theoretical Model

The theoretical model to inform variable selection is drawn from Warner et al. (2020) and De Vries et al. (2011) who utilised routinely collected herd data, similar to the data available for this study, in their assessments of farm management and animal welfare. De Vries et al. (2011) three important dimensions of animal welfare; (i) production intensity (ii) milk production and composition and (iii) management and facilities, and relevant variables were chosen to reflect these. Such data informed the selection of variables for our purposes. A brief overview is contained in the following paragraphs.

Herd mortality rate, in particular amongst younger animals, is one of the most pertinent methods to assess health status as it provides an insight to potential instances of diseases or insufficient animal husbandry (Seppä-Lassila et al., 2016, Ortiz-Pelaez et al., 2008). For our purposes, calf mortality is identified as the variable most appropriate to represent herd health. While calf mortality rates may be considered a coarse measure of welfare, in herd situations it can reveal the state of animal welfare at a group level (Seppä-Lassila et al., 2016). Common causes of calf deaths include gastrointestinal disorders, which account for 40% of deaths within the first six weeks, and pneumonia, which predominately impacts housed calves (Teagasc, 2017b). In addition to their physical housing environment, dairy cow welfare and behaviour can be impacted by stocking rates (Wang et al., 2016). As such, stocking rate is also included as a variable important for the measurement of production intensity and is an interesting metric given the dramatic growth in Irish milk production in recent years.

Access to sufficient clean water and nutritious food is one of the most pertinent components of any animal welfare assessment. While animal-based indicators such as body condition score, conducted through a visual assessment, are optimal, they are not always feasible. As such, routinely collected variables can be used as proxies. Therefore, management based metrics, such as total milk constituents can be used to reflect herd nutrition which has a significant impact on milk composition and quality (Markert, 2017). Assessing fluctuations in milk constituents, namely fat and protein, can indirectly inform the farmer to potential metabolic health issues, such as sub-clinical ketosis (Hanuš et al., 2017, Jenkins et al., 2015). Moreover, low milk yields can result from an unbalanced diet, namely one which has low dry matter intake (Teagasc, 2016). The SCC of milk is also a leading indicator of intra-mammary infection as the leukocytes, which comprise the majority of somatic cell material, increase as an immune response to the presence of a mastitis causing pathogen (Sharma et al., 2011). These variables are taken into consideration in our welfare assessment of Irish dairy herds.

The provision of sufficient animal shelter ensures protection in times of adverse weather conditions. Dry, well bedded and draught free housing are important factors for the health of dairy calves (Lorenz et al., 2011), particularly regarding their susceptibility to bovine respiratory disease, namely calf pneumonia (Earley et al., 2004). In Ireland, housing types consist of primarily slatted cubicle houses, followed by straw bedded sheds, with the former associated with superior health due to the ease of cleanliness afforded by the slatted system. Moreover, the age and quality of animal housing can be indicative of the comfort level experienced by farm animals (Kelly, 2017). Analysing expenditure on dairy cow housing can be revealing of the level of modernisation of the system, and is of particular relevance considering the recent intensification of milk production in Ireland (Teagasc, 2019). The availability of space and the opportunity for animals to graze and express natural behaviours is also imperative for good welfare standards. Pasture based cows have been shown to exhibit less agonistic behaviour than confined cows (Mee and Boyle, 2020). In this paper, average days at grass is a key indicator of adequate herd management and animal welfare. Access to pasture may also alleviate hoof disorders and lead to less incidences of lameness compared to cattle in a housed system (Olmos et al., 2009). Furthermore, there are several health benefits associated with outdoor grazing; a reduction in observed cases of mastitis, lameness, hoof pathologies and mortality levels compared with cows on continuously housed systems (Mee and Boyle, 2020, Arnott et al., 2017).

4.2.2. Variable Review

The Teagasc National Farm Survey (NFS), part of the EU FADN is the dataset employed to assess dairy cow welfare in this analysis. The survey collects detailed financial and production data from a nationally representative sample of approximately 900 Irish farms on an annual basis. Each farm is assigned a weighting factor to reflect the national farm population using weights from the Central Statistics Office. Primarily utilised to assess the financial situation on farms, the scope of the survey has been broadened over time, to collect data additional to that required in FADN, to develop a sustainability framework encompassing indicators of economic, environmental, social and innovation sustainability (Ryan et al., 2016). Economic indicators available through the survey include the economic return to land, productivity of labour, market orientation and economic viability. The environmental indicators include greenhouse gas emissions, nitrogen and phosphorus use, and social indicators include agricultural education of the farmer, the demography of the household, isolation risk and work-life balance. A detailed description of the approach is available most recently in Buckley et al. (2019b). Due to the constraints of the dataset, the scope of the indicators is limited to the herd level. In line with the approach utilised by Warner et al. (2020) and De Vries et al. (2011) to assess herd welfare status, the following eight variables were proposed for the indicator development; (i) stocking rate, (ii) dairy calf mortality, (iii) fat to protein ratio, (iv) somatic cell count, (v) milk yield, (vi) days at grass, (vii) buildings investment and (viii) housing type.

4.2.3. Expert Consultation

The proposed variables were reviewed by five animal welfare experts employed across Irish and international research institutes. Experts were asked to evaluate the proposed variables in terms of their suitability to effectively represent dairy cow welfare, and secondly, to propose additional or alternative variables that are available within the dataset. In consensus with the recommendations outlined by Bertocchi et al. (2018) and EFSA (2012) three of the five experts noted the absence of animal-based measures, however they also acknowledged the trade-offs required when attempting to measure animal welfare along with a broader set of sustainability indicators, and the practical alternative provided by routinely collected herd data.

In summary, the expert evaluation identified a number of key factors regarding the proposed welfare variables. Dairy calf mortality and the expansion of the national hard at a sectoral level was identified as a particular welfare challenge impacting the Irish dairy sector at present, in addition to lameness and specifics regarding the age and suitability of animal housing to accommodate expanding herds.

Identifying very low protein or high fat content in milk was confirmed as an acceptable method to indicate potential metabolic risks in dairy cows at a national herd level, in addition to utilising SCC readings as a method to interpret udder health. The provision of appropriate animal bedding was identified as an attribute conducive to heightened welfare levels.

The majority of experts agreed that access to pasture provided an opportunity for animals to express natural behaviours, noting the potential of restricted animal movement to contribute towards the development of pathologies. Issues were raised about investigating antibiotic use on Irish dairy farms, however the scope of the dataset inhibited the identification of appropriate variables at present. Antibiotic use in agriculture is of particular relevance given forthcoming

EU legislation concerning a move from blanket to selective dry cow therapy. Work is ongoing in terms of collecting data of this nature on farms on a wide scale. This step served as a validation exercise for the variables chosen for this analysis.

4.2.4. Indicator Selection

Following the expert consultation, the proposed variables were extracted from a balanced dataset for the period of 2014-2017 and are presented in Table 4.1. The dataset contains 250 dairy farms (per year) that returned a full set of data over for the four-year period.

Table 4.1. Selected animal welfare variables over balanced NFS dataset, 2014 - 2017

Variable (n=1,000)	**Unit**	**2014 Average* (Std. deviation)**	**2015 Average* (Std. deviation)**	**2016 Average* (Std. deviation)**	**2017 Average* (Std. deviation)**	**% Change 2014-17**
Stocking rate	Livestock units per hectare	2.05 (0.5)	2.01 (0.5)	2.08 (0.52)	2.08 (0.47)	+1.5%
Calf mortality rate	%	10 (12.4)	11.2 (13.1)	11.8 (11.8)	10.1 (11.3)	+1%
Fat to protein ratio	%	1.18 (0.04)	1.16 (0.11)	1.19 (0.07)	1.19 (0.04)	+0.8%
Milk yield	Litres per cow	5,214 (937)	5,489 (907)	5,361 (938)	5,422 (1015)	+4%
SCC	'000 cells per ml	202 (78.25)	174 (63.63)	168 (66.72)	160 (72.8)	-21%
Investment in housing per cow	€	86 (245.5)	70 (211.13)	67 (243.9)	89 (289)	+3.5%
% with slatted housing	%	92.4 (17.5)	92.6 (17.6)	92.6 (17.6)	92.7 (16)	+0.3%
Days at grass	Days per year	252 (22.3)	245 (24.7)	247 (25.1)	245 (25.8)	-3%

*reflects weighted average for population Standard Deviation in parentheses

4.2.5. Normalisation

As the variables identified measure different concepts and use different scales, it is necessary to normalise and bring the individual variables to a common scale. Normalisation is performed across the 4 year period using the MIN-MAX approach (OECD, 2008) whereby the lowest value for each variable is subtracted from the value for a given observation and divided by the range of the dataset for that indicator. Indicators are then scaled from 0 to 100, with 0 indicating the poorest performance in the sample for the specific variable in any given year and 100 indicating the best performance.

4.2.6. Statistical analysis

Analysis was conducted on the normalised variables using a multi variate analysis in SPSS, with Principal Component Analysis (PCA) utilised as the extraction method. This multi-variate statistical procedure allows for trends or patterns within variables to be observed, helping to identify correlations between data points (Eriksson, 2018). Warner et al. (2020) utilised the PCA procedure on routinely collected herd data in the development of a composite welfare index for benchmarking dairy farms in Canada.

The primary component derived from the PCA accounts for the maximum volume of total variance in the observed variables, the second component generated is correlated with some of the observed variables which are not correlated with the first component, and any subsequent components relaying a progressively smaller amount of variance (O'Shea et al., 2018). Applying the PCA, a five component solution was derived, which contributed cumulatively to the overall variance by 69%, and which contributed individually to the overall explanation of the variance by more than 10%, in line with the standard practice outlined within the OECD framework (Table 4.2). Orthogonal rotation was performed to maximise the sum of the squared loadings to better determine how the data correlates with each principal component. An initial test using Promax variation to provide a component correlation matrix determined no value exceeding 0.32, other than the factor correlating with itself. This indicates that the factors in the analysis were uncorrelated, and therefore an orthogonal rotation was utilised. The rotated pattern factor demonstrated the loadings of variables on each component, where a weighting factor of 0.5 or higher constituted loading on a specific component (Table 4.3).

The first component (PC1) had high loadings of SCC, milk yield and per cow building investment, the second component had high loadings of days at grass and stocking rate, with fat protein ratio, slatted housing and mortality rate loading on components three, four and five respectively (Table 4.3). The Kaiser-Meyer-Olkin measure of Sampling Adequacy (KMO = 0.540) met the minimum threshold (>0.50) for effective analysis, and the statistical significance of the Bartlett's test of sphericity [P<0.001] indicated that the sample size and the data were adequate for conducting PCA.

The weights used for capturing the contribution of each component within the CI was determined by the proportion of variance recovered by each component in the total variance, computed from the results in Tables 4.2 and 4.3 (Davidescu, 2017). Squaring the loadings in Table 4.3 defined the proportion of the total unit variance which is explained by the principal components, while the aggregation was determined by assigning weights to each of the components equal to the proportion of the explained variance in the dataset (OECD, 2008). For this analysis, the variance explained by the first component over the total variance, 1.25, equates to 0.23 of the total variance, i.e. 0.23 = 1.25 / (1.25+1.12+1.10+1.03+1.01) and so forth for the remaining components. The CI, termed the Dairy Cow Welfare Index (DCWI) was thus determined as: (PC1*0.23) + (PC2*0.20) + (PC3*0.20) + (PC4*0.19) + (PC5*0.18).

Table 4.2. Empirical results of the principal component analysis

Total Variance Explained

Component	Initial Eigenvalues Total	% of Variance	Cumulative %	Extraction Sums of Squared Loadings Total	% of Variance	Cumulative %	Rotation Sums of Squared Loadings Total	% of Variance	Cumulative %
1	1.42	17.78	17.78	1.42	17.78	17.78	1.25	15.66	15.66
2	1.09	13.66	31.44	1.09	13.66	31.44	1.12	13.97	29.63
3	1.04	13.03	44.47	1.04	13.03	44.47	1.10	13.78	43.41
4	1.00	12.43	56.90	1.00	12.43	56.90	1.03	12.89	56.30
5	0.96	11.96	68.86	0.96	11.96	68.86	1.01	12.56	68.86
6	0.94	11.72	80.58						
7	0.86	10.77	91.36						
8	0.69	8.65	100.00						

Extraction Method: Principal Component Analysis.

Eight components generated as eight variables examined (somatic cell count (SCC), milk yield, investment in housing per cow, days at grass, stocking rate, fat to protein ratio, % slatted housing, calf mortality rate). The PCA displays (i) the eigenvalue under the 'Total' column, which is a measure of the variance that is accounted for by the component, (ii) the % of variance explained by the component, and (iii) the cumulative % of variance explained.

Table 4.3. Rotated component matrix with component loadings

	PC1	PC2	PC3	PC4	PC5
SCC	.706				
Milk yield	.585				
Investment in housing per cow	.611				
Days at grass		-.622			
Stocking rate		.756			
Fat to protein ratio			.902		
% with slatted housing				.905	
Calf mortality rate					.990

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization.a
a. Rotation converged in 6 iterations.

This CI was examined across the balanced farm set (n=250) over the four years 2014- 2017, where each farms' annual DCWI score was compared across the time period. Following this, an analysis of DCWI scores across farms which were categorised by their levels of output increase post-quota was undertaken. According to the dataset, the average increase in milk production in 2017 compared with 2014 was 23 percent. In order to analyse the impact of this production expansion, farms in the dataset are stratified on the basis of the change in milk production levels over the period. Using the average increase in production (23 percent) as a reference point, 3 strata are identified; **non-expanders** (11% of the sample), those who did not increase production in 2017 compared with output in 2014, **moderate expanders** (43% of the sample), those who increased production by 23 percent or less in 2017 compared with output in 2014, and **significant expanders** (46% of the sample), who increased production by 24 percent or more in 2017 compared with 2014 levels.

In addition to analysing dairy cow welfare over time and across farms, it is also interesting to consider how it relates to other aspects of the farm, namely whether any synergies or trade-offs exist between cow welfare and economic or environmental performance of the farm business. In order to interpret this, three established sustainability[1] indicators, two economic (dairy gross margin and income per labour unit), and one environmental (kg of greenhouse gas per kg of milk produced, measured in line with the Intergovernmental Panel on Climate Change (IPCC) methodology for the determination of emission indicators across farm systems) (Table 4.4) were extracted from the Teagasc NFS suite of sustainability indicators (Buckley et al., 2019a) and a correlation analysis undertaken with the DCWI. While this analysis does not attempt to relay a comprehensive interpretation of any trade-offs existing between dairy cow welfare and overall farm level sustainability, it may instead provide a cursory overview to any synergies

[1] A combination of both NFS core indicators (economic) and an NFS sustainability indicator (environmental) used for the analysis

present between welfare levels and different aspects of sustainability. The results of each of these analyses are outlined in the next section.

Table 4.4. Descriptive statistics for selected economic and environmental sustainability indicators

	2014 Mean *(Std. Deviation)* N= 250	**2015** Mean *(Std. Deviation)* N= 250	**2016** Mean *(Std. Deviation)* N=250	**2017** Mean *(Std. Deviation)* N=250
Dairy gross margin	88,991 *(43,095)*	83,334 *(46,126)*	72,504 *(42,971)*	120,724 *(79,353)*
Income per labour unit	54,396 *(27,597)*	52,272 *(33,473)*	44,316 *(29,849)*	71,249 *(41,435)*
Kg of GHG per kg of milk produced	0.76562 *(0.12199)*	0.72383 *(0.11777)*	0.7394 *(0.12494)*	0.72096 *(0.11291)*

4.3. Results

Generating a composite indicator of welfare (DCWI) from the herd level variables (SCC, dairy calf mortality rate, stocking rate, milk yield, days at grass, fat/protein ratio, investment and slatted housing percentage) permitted an efficient method of analysing dairy cow welfare. In this section, we examine the scores of the DCWI (i) over time, (ii) by milk output expansion in 2017 compared with 2014, and (iii) with additional sustainability indicators, across the balanced farm set. Boxplots were utilised to display the data and to facilitate the visualisation of the statistical distribution of the DCWI scores. [2]

[2] Boxplots divide a dataset into quartiles, with the body of the boxplot representing the interquartile range (25th percentile to 75th percentile) with the median dividing the box. Ends of whiskers represent the maximum and minimum values. Outliers are represented by circles beyond the whiskers, with extreme outliers identified by stars.

4.3.1. Dairy Cow Welfare Indicator (DCWI) over time

Annual DCWI scores were compared for each of the 250 farms within the balanced dataset over the 4 year period, 2014 to 2017, and these scores are visually represented in Figures 4.2 and 4.3. Little difference is observed between the DCWI scores over the time period, with marginal fluctuations in average DCWI discernible in Figure 4.2. The range and distribution of scores have also remained somewhat consistent, as displayed by the boxplots in Figure 4.3. This result suggests that welfare standards across the balanced farm set have remained relatively static over the time frame.

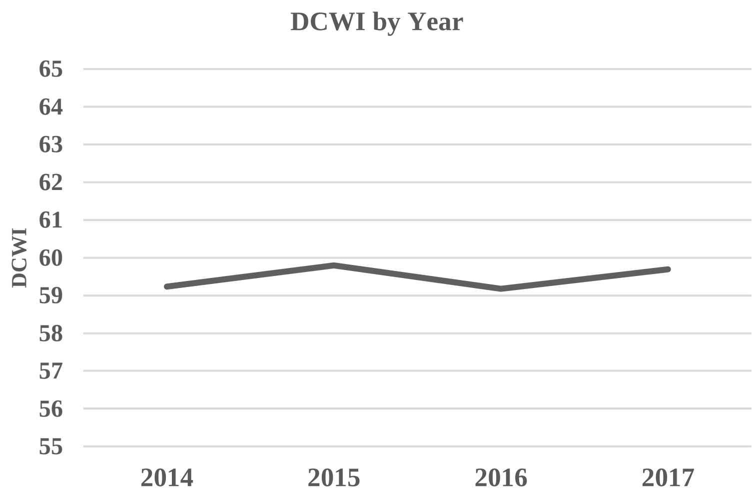

Figure 4.2. Mean DCWI scores for balanced farm set 2014-2017

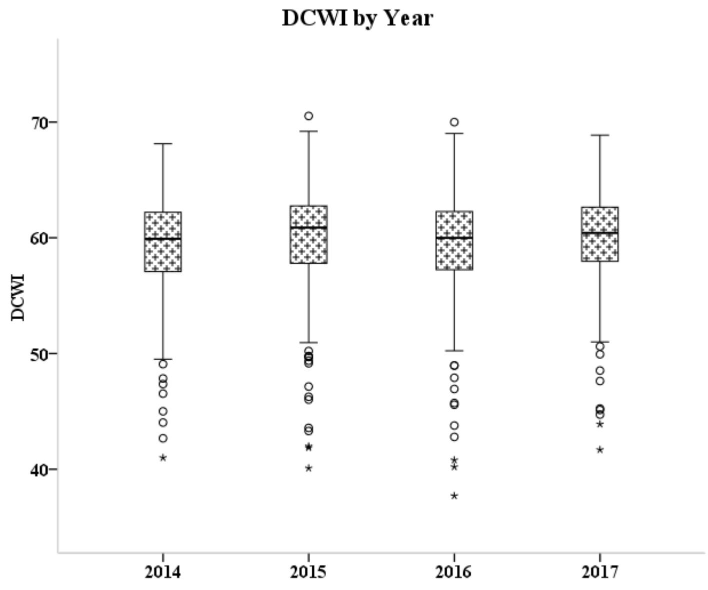

Figure 4.3. Box and whisker plots of the DCWI for balanced farm set 2014-2017.
See footnote 2 for interpretation of results.

4.3.2. DCWI by production levels

The dairy cow welfare performance (as defined by a selection of relevant variables) of the three cohorts; non-expanders, moderate expanders and significant expanders, as determined by their proportion of milk output in 2017 compared with their 2014 output, is visually presented in Figures 4.4 and 4.5. There is a number of interesting points of note. Firstly, the significant expanders are starting from a better cow welfare position in terms of their average performance in comparison to the other groups, (Figure 4.5). This cohort records a wider distribution of their DCWI scores in 2017 compared with their 2014 scores, as observed by the boxplots in Figure 4.5. The non-expanding group demonstrate a marginal decline in mean DCWI scores in 2017 compared with 2014 scores, the only group to record a decrease, while the moderate expanding cohort of farms recorded a small improvement in mean DCWI scores and recorded a wider distribution of scores over the time period. Overall, the evidence suggests that as farms have expanded production, the routinely collected variables used within this composite welfare indicator have demonstrated improvement.

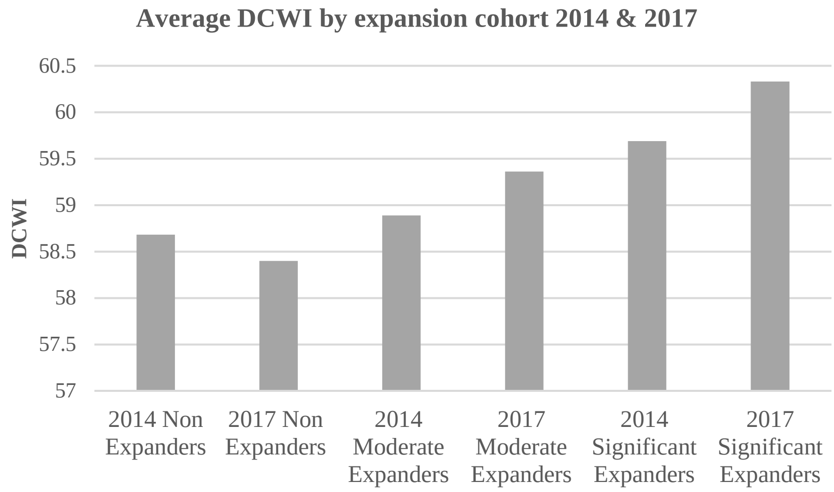

Figure 4.4. Mean DCWI scores by farm expansion cohort, for the years 2014 and 2017

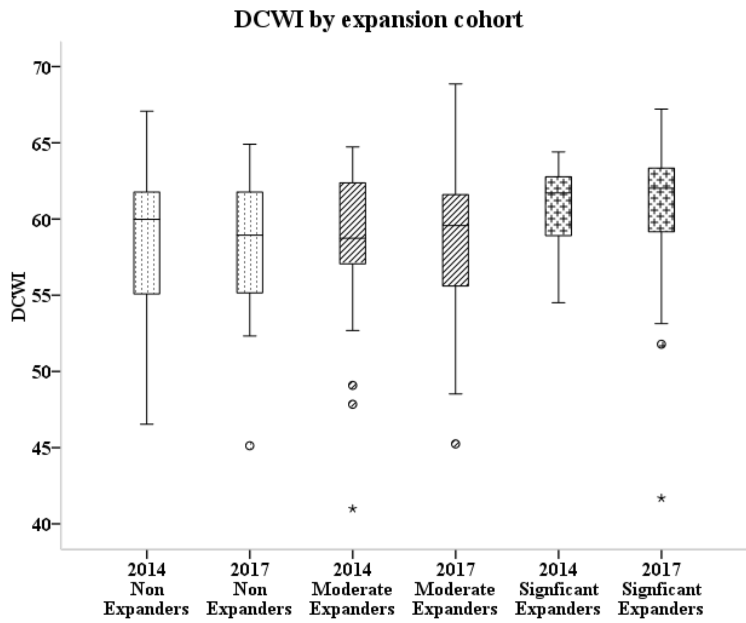

Figure 4.5. Box and whisker plots of DCWI by farm expansion cohort, for the years 2014 and 2017. Refer to footnote 2 for interpretation of results.

4.3.3. Trade off and synergies with additional indicators

Table 4.5 demonstrates the results of the correlation analysis between the DCWI, the carbon footprint, measured as kg of greenhouse gas emissions per kg of milk solids, and the economic indicators, dairy gross margin and income per labour unit. The coefficients reveal that the relationships are significant and positive in relation to economic performance but negative in relation to environmental. In other words, as profitability per hectare and per labour unit increase, higher DCWI scores are recorded. Analysis between greenhouse gas emissions and DCWI yielded a significant negative correlation over three of the analysed years, indicating that as the GHG emissions intensity of milk production declines, an improvement is observed in welfare levels. This may be indicative of higher technical efficiency on such farms. The evidence suggests that win-win strategies are available to farmers and that through efficient management of resources they can increase farm profit, reduce the carbon footprint of each unit of milk produced and improve cow welfare standards.

Table 4.5. Pearson's Correlation Coefficients with Composite Indicator – DCWI and sustainability indicators

Variables:	DCWI 2014	DCWI 2015	DCWI 2016	DCWI 2017
Dairy gross margin (N=250)	0.118	0.200**	0.182**	0.232**
Income per labour unit (N=250)	0.139*	0.154*	0.094	0.260**
Kg of GHG per kg of milk produced (N=250)	-0.167**	-0.167**	-0.081	-0.162*

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

The relationship is further examined by comparing the economic and environmental performance in 2017 of the top, middle and bottom performing farms from a dairy cow welfare perspective. The positive relationship between economic performance and dairy cow welfare is evident, with the top performers from a cow welfare perspective also delivering the highest margins, which is graphically demonstrated by the boxplot in Figure 4.6. This finding is further enforced in Figure 4.7 where farm income per labour unit is also positively correlated with DCWI scoring, reflecting greater welfare standards.

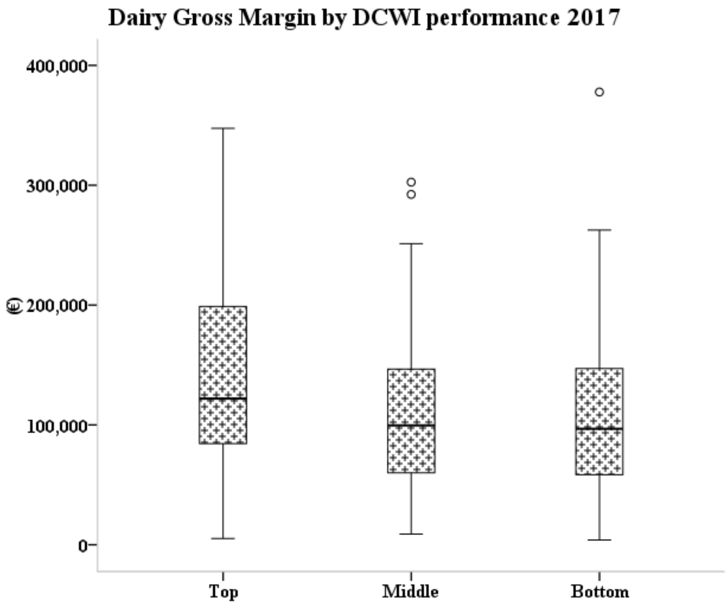

Figure 4.6. Comparison of top, middle, and bottom performing DCWI by Dairy Gross Margin, 2017. Refer to footnote 2 for interpretation of results.

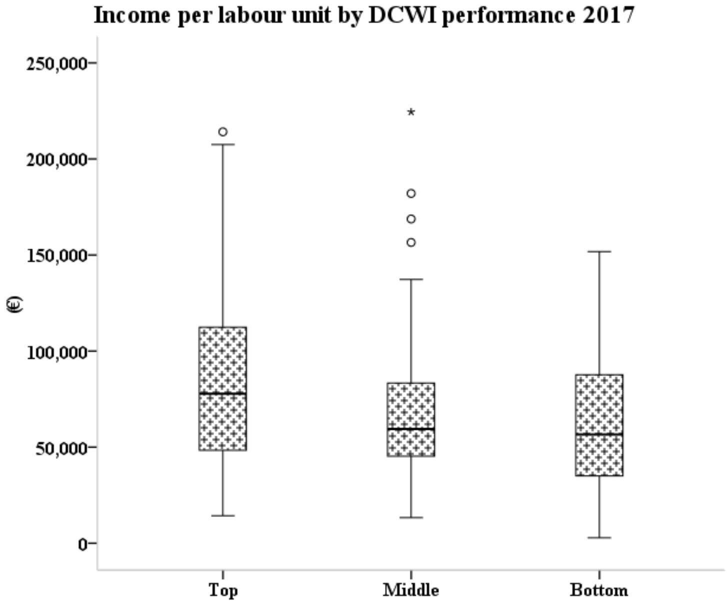

Figure 4.7. Comparison of top, middle, and bottom performing DCWI by farm income per labour unit, 2017. Refer to footnote 2 for interpretation of results.

Finally, the relationship with carbon footprint is negative, suggesting that the top performing farms from a dairy cow welfare perspective also have a lower carbon footprint. This is displayed in the boxplots contained in Figure 4.8, which demonstrates that the top performing DCWI farms record lower levels of greenhouse gas emissions per kg of milk produced compared with the other cohorts. This is a win-win result which suggests that farms can deliver higher farms profits, while protecting animal welfare and reducing their GHG emissions intensity of production.

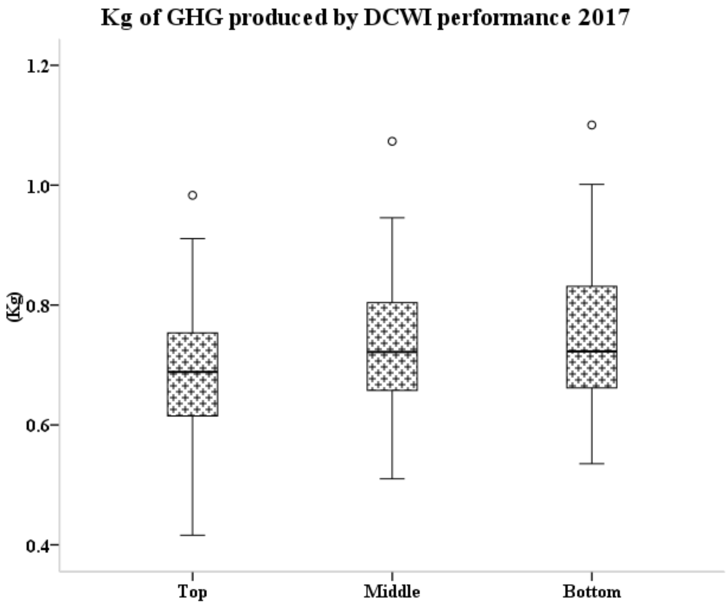

Figure 4.8. Comparison of top, middle, and bottom performing DCWI by kg GHG per kg milk produced 2017. Refer to footnote 2 for interpretation of results.

4.4. Discussion

This paper presents a number of interesting findings in relation to the impact of milk quota removal on animal welfare performance on dairy farms in Ireland, and provides a template to investigate the effect of other relevant policy reforms. In anticipation of the milk quota abolition in 2015, many dairy farmers in the preceding years sought to expand their herd, with dairy cow numbers increasing annually, from 1,070,800 in 2010 to 1,432,700 in 2017(CSO, 2020). This analysis indicates that dairy farms that have significantly expanded production levels since 2014 have recorded improved dairy cow welfare standards on their farms, as supported by the DCWI scores across the different expansion cohorts as seen in Figures 4.4 and 4.5. This finding is in keeping with research by Hansen and Østerås (2019), which through the development of a welfare index, found a positive association between animal welfare and farm expansion. They report that farmers who opted to expand their production were more satisfied with their income and working day, tended to be more optimistic and determined to continue production, in comparison to non-expanding farmers. They hypothesize that this optimistic attitude towards expansion has a positive influence on the quality of stockmanship implemented by the farmer, and with the addition of an equitable work life balance has a positive impact on animal/herd welfare standards.

Our analysis is also indicative of a significant and positive relationship existing between dairy cow welfare and the economic performance of the farm. The results showed that both in the baseline situation and through time, more profitable farms recorded higher composite welfare scores. This finding is in line with Robichaud et al. (2019), which reported a positive association between good cow welfare levels and improved productivity and longevity, which was reflected in greater economic margins at the farm level. Robichaud et al. (2019) demonstrated that profitability margins per cow were significantly lower in farms with higher incidences of welfare issues, namely knee lesions, while positive associations were established between increased milk yield and reduced prevalence of hoof disorders. This corroborates an earlier study of Barnes et al. (2011) which found that farm economic performance improved with reducing levels of lameness, and stipulated that a clear and positive relationship exists between farm animal welfare and technical efficiency. Hansson et al. (2011) reported that the most efficient dairy farms were characterised by lower incidences of mastitis, which adversely impacts milk yield and carries considerable remediation costs. Consequently, reducing incidences of mastitis can help advance the economic efficiency of dairy farms, alongside improving overall herd health. This speaks to the advantages of applying routinely collected herd data, such as SCC, in the development of composite welfare indicators, which allows for a cost effective comparative analysis between welfare and various aspects of sustainability.

On a further positive note, the analysis revealed that the carbon footprint of milk production was significantly and negatively correlated with animal welfare standards, as DCWI scores were higher across farms which generated lower greenhouse gas emissions per kg of milk produced, as evident by the correlation analysis in Table 4.5 and the boxplots in Figure 4.8. This suggest that win-win farm-level strategies are available to farmers. Through the adoption of appropriate management practices, technologies and investment in farm facilities, farmers can reduce their carbon footprint, improve farm incomes and enhance animal welfare standards. Further analysis of the data presented in this paper would facilitate the identification and quantification of such win-win strategies. A key policy recommendation arising from this analysis is that farmers should be supported in identifying and applying the appropriate practices and policies for their farms to achieve this optimal outcome. One such practical application includes the adoption of identified technologies under the Teagasc Marginal Abatement Cost Curve (MACC).

Numerous studies exist which assess various aspects of cow welfare on Irish farms, such as impacts of bedding mat types on the welfare of beef cattle (Earley et al., 2017), comparing rubber to concrete pathways on dairy cow hoof health (Boyle et al., 2007) and the effect of space allowance on housed cattle (Keane et al., 2017). These studies provide an in-depth assessment of individual welfare issues, and therefore utilise specifically collected data. This is the first study in an Irish context to utilise routinely collected nationally representative data to address animal welfare.

4.4.1. Limitations on the use of CI

It should be noted that the dairy cow welfare indicator developed in this paper is only reflective of the variables used in its construction. While each of the herd level variables which comprise the DCWI (SCC, dairy calf mortality, stocking rate, milk yield, days at grass, fat/protein ratio, investment and slatted housing), provide information on different aspects of herd welfare and management, the lack of animal based measures limits the ability of the DCWI to provide an all-encompassing assessment of welfare. As many of these variables are efficiency and productivity based, such as milk yield, the positive correlations with economic performance may not be surprising. The use of composite indicators can provide a herd level overview of animal welfare (Veerasamy et al., 2011), although the approach is not without criticism (Sandøe et al., 2019, Veissier et al., 2009). In particular, the inclusion of certain variables may not be reflective of overall welfare. If data availability was not a limitation, it would be most insightful to expand the variables used to include other measures of welfare such as lameness, antibiotic use etc.

The EU's Farm to Fork strategy (2020), which is at the heart of the European Green Deal, aims to accelerate the transition to a sustainable food system. It emphasises the need to reduce greenhouse gas emissions, protect biodiversity and ensure high animal welfare standards. To achieve these strategic goals, it is imperative that baseline indicators, based on nationally representative, routinely collected data, are established and that the impact of policy reforms on these key sustainability indicators are monitored and evaluated over time. While many farm-level sustainability assessments exist, our literature review suggests that animal welfare has been somewhat neglected. The sustainability framework developed in this paper has shown that it is possible to develop effective animal welfare indicators using a representative farm dataset such as the FADN. Furthermore, it has been demonstrated that animal welfare standards can be tracked through time and embedded in a broader sustainability framework thus allowing for the assessment of synergies and trade-offs with other sustainability indicators. One of the key recommendations arising from this paper is that the FADN should be used to develop a comprehensive assessment of farm level sustainability including animal welfare. Additional data collection may be required in some countries in order to facilitate this, but as shown for Ireland the richness of the analysis that is possible justifies the activity. Furthermore, the measurement of sustainability will play a key role in the future trajectory of the FADN, as it looks towards its adaption to the Farm Sustainability Data Network, allowing it to embrace a wider overview of sustainable farming practices across Member States.

4.5. Conclusion

This study sought to assess welfare levels on Irish dairy farms through the development of a composite welfare indicator, utilising routinely collected herd data. Overall, the results of this study indicate that welfare has remained relatively stable across the 2014 to 2017 period, and that the recent expansion of the sector has not adversely impacted this composite welfare indicator. While societal interest regarding the potential effects of intensive farming on welfare standards are welcome, and enquiry is encouraged, it is positive to observe that in this circumstance, expansion of the Irish dairy industry has not impeded standards of animal welfare as measured with routinely collected herd level variables. Rather, farms that opted to significantly increase milk output demonstrated improved welfare standards over the study period. Furthermore, no adverse compromises were found between farms recording higher DCWI scores and additional sustainability indicators, with top DCWI performing farms recording improvements across economic and carbon footprint indicators.

The development of the composite welfare indicator within this study streamlined various health and welfare indicators into a single holistic welfare measure, with the capacity to compare data with additional measures of sustainability. The scope of these welfare indicators comprising the CI, estimated at a herd level, have been dictated by the availability of relevant data. Evolving topical issues, such as antibiotic usage will necessitate additional variables for inclusion within the FADN. While it is acknowledged that animal-based indicators are more insightful than herd-level indicators, which due to data restriction are more limited, we argue that the insights provided by linking animal welfare indicators to a broader set of sustainability indicators for a sample of representative farms for a prolonged period of time have offset many of the limitations. Furthermore, the utilisation of established herd level indicators within the CI permits time series analysis across each farm in the survey, facilitating the identification of welfare trends across the different expanders. This broadens the remit of these indicators beyond individualistic performance measures, and compared with economic and environmental indicators, can help in attaining future agri-food policy objectives, contributing to a more holistic assessment of farm sustainability.

This chapter has demonstrated that the NFS and the FADN datasets retain the ability to contribute to the measurement of animal wellbeing within the agricultural social sustainability framework devised in Chapter 3. Moving forward, the following two chapters of this thesis concentrate on the farmer wellbeing component of this framework, starting with an analysis of a stress identification survey in Chapter 5, where the prevalence of stress and the identification of specific farm-level stressors were determined.

Chapter 5. Weather, workload and money: Determining and evaluating sources of stress for farmers in Ireland

Brennan, M., Hennessy, T., Meredith, D. & Dillon, E. 2021b. Weather, Workload and Money: Determining and Evaluating Sources of Stress for Farmers in Ireland. *Journal of Agromedicine*, 1-11. DOI: 10.1080/1059924X.2021.1988020

As outlined in Chapter 1, there is a growing recognition for the need to examine overall wellbeing and quality of life within agricultural sustainability assessments, for a more holistic and representative determination of farm level social sustainability (Ryan et al., 2016). As such, the development of a wellbeing framework in Chapter 3, composed of indicators that help to measure social sustainability from the more nuanced farmer, animal and community wellbeing perspective help to address this knowledge gap. Moreover, critical factors affecting farmers' social sustainability were identified from the stakeholder consultation carried out in Chapter 3. The majority of the stakeholders were concerned about the effects of financial stress on farmers' mental health and wellbeing, as well as the effects of other stressors, such as poor weather, market forces, time constraints and workload, and social isolation. This chapter delves further into these issues, and seeks to identify the sources and prevalence of stress affecting farmer's wellbeing.

Abstract

The demands of modern farming can place substantial stress upon the farmer, adversely impacting their wellbeing. This study identifies both the prevalence of stress and assesses the demographic, farm and social characteristics that impact the incidence of stress.

We report the results of a survey of a nationally representative sample of farm enterprises in Ireland undertaken in association with the Teagasc National Farm Survey (NFS) in 2018, which saw 736 questionnaires completed by farm operators. Frequency analysis is used to report the primary sources and prevalence of stress. A probit model is developed identifying and quantifying the factors that impact the incidence of stress.

57% of farmers reported experiencing stress resulting from their farm work. Key sources of stress included ‘poor weather’, (47%), ‘workload’ (32%) and ‘financial’ concerns (28%). The results of the probit model establish that the effect of age on the incidence of stress is significant, positive and non-linear, indicating that as farmers get older they are more likely to experience stress but at a declining rate. Operating a sheep farm system, as opposed to any other type of farm system, reduces the probability of stress. Working off-farm also reduces the probability of stress by 0.097 other things being equal.

The findings highlight variance in the levels of stress reported by farmers by age and farm system and, consequently, the need to develop targeted supports that take consideration of differences within the population of farmers and farm enterprises.

5.1. Introduction

Globally, farming has long been the focus of concerns regarding environmental and economic sustainability (Janker and Mann, 2020). In recent years, greater attention has been given to identifying, measuring and understanding social sustainability aspects of farming including issues impacting farmers’ quality of life and wellbeing (Miller and Aherin, 2018, Lunner Kolstrup et al., 2013). Despite a general perception that farming is a healthy occupation, farmers in many countries have been found to have relatively unhealthy lifestyles resulting in high levels of, particularly, cardiovascular disease and early mortality (van Doorn et al., 2017, Demos et al., 2013). In addition, farmers and farm workers have been found to experience high levels of stress and relatively low levels of wellbeing, two key indicators of occupational social sustainability (Jain et al., 2018, OSHA and Occupational Safety Health Administration, 2016). This is reflective of the demanding nature of farm work combined with farming cultures that generally emphasises tenacity, self-reliance, and resilience leading to many farmers prioritising farm productivity over self-care (Cush and Macken-Walsh, 2018, Laoire, 2005). Internationally, greater consideration of farmer wellbeing has seen the emergence of a body of literature in recent decades that seeks to identify and assess sources and attributes of those working on farms negatively affected by stress (Kallioniemi et al., 2016).

5.1.1. Sources of Stress:

Sources of stress, or ‘stressors’ include chemical or biological agents, environmental conditions, stimulus or events that trigger stress (Johnson et al., 1992). Such stressors can be external (adverse physical conditions or stressful psychological environments) or internal (physical or psychological), and can manifest as acute (short term) or chronic (long term) (Lobley et al., 2004). A review of the literature identified a large number of occupational factors likely to impart stress upon those working in the farming sector, including ‘financial pressures’ (Daghagh Yazd et al., 2019, Truchot and Andela, 2018, Kallioniemi et al., 2016, Kearney et al., 2014, Bryant and Garnham, 2013), ‘poor weather’ and the inability of farmers to control for such occurrences (Daghagh Yazd et al., 2019, Kearney et al., 2014, Alpass et al., 2004), ‘farm workload’, including longer working hours and increased workloads at peak times (Daghagh Yazd et al., 2019, Lunner Kolstrup et al., 2013, Ang, 2010, Firth et al., 2007), availability of ‘additional labour’ (Brennan et al., 2020, Ang, 2010), occurrences of poor animal health (Daghagh Yazd et al., 2019, Garnefski et al., 2005), compliance with government regulations (Daghagh Yazd et al., 2019, Alpass et al., 2004, Booth and Lloyd, 2000) ‘farm succession’ (Brennan et al., 2020) and decline in the sense of security in rural areas (Brennan et al., 2020).

5.1.2. Attributes of farmers experiencing stress:

Another important, albeit sometimes overlooked factor influencing farmer wellbeing are the intrinsic attributes of farmers who experience occupational stress. The socio-demographic characteristics of the farmer can influence their experience of occupational stress. Several studies have sought to identify the prevalence of occupational stress across different farm populations, with particular consideration given to younger farmers (Torske et al., 2016), and with an almost exclusive focus on the dairy sector (Rudolphi et al., 2020, Kallioniemi et al., 2016, Lunner Kolstrup et al., 2013, Alpass et al., 2004, Deary et al., 1997).

The age of the farmer and their susceptibility to stress has been considered in a number of papers, with a general consensus that although younger farmers experience higher levels of stress overall (Daghagh Yazd et al., 2019), the type of occupational stressors experienced can vary by age cohort (Torske et al., 2016, Lunner Kolstrup et al., 2013). Furthermore, the role of education has been found to influence stressor outcomes with Logstein (2016) demonstrating an association between higher overall stress amongst farmers with primary or secondary education only compared to those with tertiary qualifications. Whilst farm finances and levels of debt have been identified as significant stressors impacting farmers (Daghagh Yazd et al., 2019, Truchot and Andela, 2018, Kallioniemi et al., 2016, Kearney et al., 2014, Bryant and Garnham, 2013), the presence of off-farm employment may play a role in alleviating stress and anxiety for farmers (Haugen and Blekesaune, 2005, Rye, 2001). In addition to generating additional income, Fjeldavli and Bjørkhaug (2000) reported that farmers engaged in employment off farm reported fewer problems associated with social isolation and loneliness than farmers who did not have an off farm job. Within the literature considering the level or experience of stress amongst different groups of farmers there is a notable focus on the prevalence of stress impacting farmers with dairy enterprises, e.g. Kallioniemi et al. (2016) reported that 42% of dairy farmers in Finland experienced stress as a direct result of their work, while Deary et al. (1997) reported that dairy farmers recorded the highest prevalence of stress relating to time pressure across all farm systems in the UK.

Our review of the literature demonstrates that workers within the agricultural sector are exposed to a wide range of occupational stressors, many of which are beyond their control that can inflict mental stress (Truchot and Andela, 2018, Bennett, 2016). We have also reflected on the role of the intersection between social, economic and farm enterprise characteristics in shaping how individuals experience and respond to different types of stressor(s). This review draws attention to a significant gap in the literature, i.e. the evaluation of the sources of stress and attributes of those that experience stress and how these vary by farm type or system. Indeed, for a more holistic understanding of stress, it is prudent to examine the socio demographic situation pertaining to those which experience it (Cheon et al., 2020). This information is fundamental to the development and targeting of measures to support farmers and farm workers manage occupational stressors.

To this end, this study focuses exclusively on farmers who have experienced stress resulting from the operation and management of their farm enterprise. While previous studies have examined aspects of occupational wellbeing for farmers in Ireland, such as the identification of workplace injury risk factors (McNamara et al., 2020) and health status (Van Doorn et al., 2020, van Doorn et al., 2017), limited research has been conducted to date examining the incidences and sources of stress. Farms in Ireland are generally owned and operated by families with little, if any, additional hired labour. We seek to advance understanding of the level of variance in the experience of occupational stress, rather than stressors associated with personal aspects of farmer’s life, e.g. familial stress or health issues, by farmers with different types of farm enterprises and control for a variety of demographic and enterprise related characteristics, such as age, farm size and farm system.

5.2. Data and Methodology

Between the months of June and September 2018, 736 stressor identification questionnaires were completed by farm operators across four enterprise types; dairy (n=273), beef (n=314), sheep (n= 101) and tillage (i.e. arable farms) (n= 48), a response rate of 83.5%. This data were collected through the Teagasc National Farm Survey (NFS) in 2018. The Teagasc NFS, which operates as part of the EU Farm Accountancy Data Network (FADN), fulfils Ireland's statutory obligation to provide farm level financial and production data to the European Commission, collecting data from approximately 900 farms annually. Each farmer participating in the survey provided their informed consent for the use of such data for research purposes. Primarily utilised to assess the financial situation on farms, the scope of the survey has been broadened over time to develop a sustainability framework encompassing indicators of economic, environmental and social sustainability (Hennessy et al., 2013). A detailed description of the survey and its evolution is available in Buckley et al. (2019a). A supplementary survey accompanies the core survey and provides researchers the opportunity to collect data on emerging farm level issues. The research team associated with this paper were successful in applying to the survey to have a small number of additional questions associated with occupational stress and wellbeing included in the 2018 supplemental survey. Our questions sought to determine whether farmers experienced stress from any aspect of their farm business within the past 5 years. If so, this was followed up with a list of potential sources of stress (See question 7 in Appendix 4) identified from the literature review, with respondents indicating which (if any) stressors applied to their circumstance. In addition to these occupational factors we also sought to assess the potential impact of broad social changes shaping farm and rural communities. Based on the literature review, two additional questions were posed; the first assessed farmers on sense of personal security and whether it had changed over the past five years; whilst the second considered levels of social isolation with respondents asked to indicate their frequency of contact with persons outside their farm household, i.e. (i) daily, (ii) two or three time per week, (iii) once per week or less.

The data collected from the survey were combined with variables describing the demographic, farm and social characteristics of the respondent (Table 5.1). These characteristics were identified in the literature referenced earlier as potentially influencing responses to and experience of stress.

Table 5.1. Socio-demographic attributes with potential to influence stress

Indicator	**Variable**	**Unit**
Demographic Characteristics	Age	Farmers age in years
	Agricultural Education	Agricultural training received
Farm Characteristics	Farm System	Dairy, Beef, Sheep, Tillage
	Intensity of production	Gross Output per labour unit
	Farm income	Annual Family Farm Income (FFI) €
	Closing Loans	Closing balance of loans €
Social Characteristics		
Work life balance	Total hours worked per week on & off-farm	Hours worked by the farmer
	Off farm employment	Indicator variable identifying farmers that also work off the farm
Isolation	Limited contact	Indicator variable identifying farmers that do not meet someone outside of their household daily
	Isolation Risk -Farmer lives alone	Indicator variable identifying farmers that live alone
	Change in sense of security	Indicator variable identifying farmers that reported a deterioration in their sense of security.

N = 736

The demographic characteristics variables included farmers' age and education level. The squared term of age was also included to test the linearity of age and a potential life-cycle effect wherein the probability of stress varies over time. An indicator variable indicating whether the farmer has formal agricultural education was included to test the hypothesis that agricultural education better prepares farmers for a career in farming and should thereby reduce their vulnerability to stress, other things being equal.

The farm characteristics variables included in the model relate to the system and intensity of production. Farms were categorised into four farming systems based on the main output; dairy, beef, tillage and sheep. Farm system was coded as an indicator variable and the sheep farm system was used as the reference category in the model. Intensity of production or farm activity was measured by the level of output in thousands of euro generated by each labour unit on the farm, i.e. total farm gross output per labour unit.

A number of farm financial variables were included in the model to test the impact of income and debt on the probability of stress. Family farm income (FFI), in thousands of euro, and its squared term were included in the model as was outstanding debt/loans. FFI is the return from farming for family farm labour, land and capital, calculated on an annual basis.

The social characteristics included the total number of hours worked (on and off-farm), and the presence of an off-farm job. Three isolation variables were included in the model. The limited contact variable is an indicator equal to one if the farmer does not meet someone from outside of their household on a daily basis. Similarly, the living alone variable is an indicator equal to one if the farmer lives alone. Finally, the security variable is an indicator equal to one if the farmer perceives that their sense of security in their own home has deteriorated in the previous five years. Collectively the isolation variables are hypothesised to be associated with an increased probability of stress.

5.2.1. Empirical Analysis

The incidence of stress was measured as a binary variable, equal to one if the farmer experienced stress and zero otherwise. Given that the stress variable is binary, a dichotomous choice probit model was the analytical framework used to quantify the factors impacting on the binary variable.

We assumed;

$$Prob\ (O_i=1 \mid x_i) = F\ (x_i\beta)$$

where F was some normal distribution function bound by the [0,1] interval, i.e. $0 \leq F(x_i\beta) \leq 1$ to satisfy the probability properties. If we assumed F to be a probability distribution then Equation 1 can be estimated using a probit model. The probit model is estimated using the maximum likelihood procedure. Where the effect (β) of a vector of explanatory variables, x, on the probability of stress (p_i) is estimated. The estimated coefficient corresponding to an explanatory variable measures its influence on the probability of stress. All variables that are hypothesised to affect the incidence of stress as identified in the literature, see Table 5.1, were included as independent variables in the model. Significance testing was conducted to establish whether such variables had a significant association with incidence of stress.

The probit model was run using Stata version 16 and the survey data was weighted using the iweight command and robust standard errors were run using the vce(robust) command. When the weighting factors are applied, the sample of 736 farms represents a population of 74,456 Irish farms[3]. VIF tests confirmed that multicollinearity was not evident with all variance inflation factors less than 3.31 and the mean variance inflation factor was 1.63. Average

[3] The weighting procedure is agreed with the Farm Accountancy Data Network of the EU and uses data the periodic census of agriculture in Ireland operated by the Central Statistics Office (CSO).

marginal effects were estimated using the margins, dydx(*) command. The results of the model are presented in the next section.

5.3. Results

Before presenting the results of the statistical model to determine the farm and farmer characteristics that are associated with a higher probability of stress we first describe the prevalence of self-reported sources of stress amongst farmers in Ireland.

5.3.1. Self-Reported Stressors

The data reveal that 57% of the farmers surveyed reported experiencing stress or anxiety as a result of their farming work over the past 5 years. The figure was highest amongst dairy farmers, almost three-quarters of whom reported being stressed. The most frequently occurring source of stress was ‘poor weather’, (47%), followed by ‘workload’ (32%) and ‘financial’ worries (28%) (Table 5.2).

Table 5.2. Distribution of self-reported stressors by farm system

Stress	**% distribution All farms *(n=736)***	**% distribution Dairy** *(n = 273)*	**% distribution Beef** *(n = 314)*	**% distribution Sheep** *(n= 101)*	**% distribution Tillage** *(n = 48)*
Stress reported	57	74	57	38	55
Stressor Identified					
Financial	28	34	27.5	23	26
Poor weather	47	65	46	29	48
Workload	32	54	28	28	14
Security	9	10	10	6	6
Isolation	4	5	3	2	4
Labour access	4	11	3	2	5
Succession	4	4	3	4	6
Animal health	11	17	11.5	5	1
Scheme compliance	10	10	9.5	13	16
p values		$p < .001$	$p < .001$	$p < .001$	$p < .001$

Two thirds of dairy farmers cited poor weather conditions as a source of stress in addition to workload (54%) and financial pressures (34%). Additionally, securing access to labour was more prevalent as a source of stress amongst dairy farmers, with 11% citing it as a stressor, a notable finding in light of the removal on limitations on milk production i.e. quotas, and subsequent expansion through greater farm intensification of the sector in Ireland. Similar findings were made in relation to beef farmers with regard to sources of stress, with 57% experiencing stress resulting from their work. This group reported inclement weather conditions as the primary stressor (46%), followed by workload (28%) and financial pressures (27%). 55% of tillage farmers reported stress from their work, and similar to dairy and beef enterprises, identified poor weather as the preeminent stressor (48%), followed by financial pressures (26%), with anxiety around compliance with regulations highest in this sector, at 16%. Sheep farmers reported the lowest overall stress levels of any enterprise (38%) although similar to tillage farmers, stress around compliance with regulations was significant amongst this group (13%). Concern regarding farm succession planning was highest amongst tillage farmers, at 6%.

5.3.2. Probit Model

All of the variables that were hypothesised to impact the probability of a farmer experiencing stress were included in the probit model and are reported in Table 5.3.

Table 5.3. Descriptive analysis of the socio-demographic variables included in probit model of farmer stress

Variable *N=736*	**Descriptor**	**Frequency (N)** *(% Distribution)*	**Mean** *(Std. Dev)*
Dependent Variable			
Stress	Binary variable =1 if farmer has experienced stress in past 5 years	470 *(57)*	
Independent variables			
Demographic			
Age	Farmer's Age measured in years		58 *(11)*
Age Squared	Age*Age		3,523 *(1,298)*
Agricultural Education	Binary variable =1 if farmer has completed some formal agricultural education	453 *(51)*	
Farm			
Dairy System	Main system of farming=1 if dairy	273 *(19)*	
Beef System	Main system of farming=1 if beef	314 *(59)*	
Tillage System	Main system of farming=1 if tillage	48 *(7)*	
Sheep System	Main system of farming=1 if sheep	101*(15)*	
Farm Intensity	Annual Farm Gross Output €'000 per labour unit		70.97 *(66.49)*
Farm Income	Annual Family Farm Income (FFI) €'000		24.29 *(34.07)*
Farm Income squared	Income*Income €'000		1,750 *(5360)*
Loans	Closing loans €'000		23.48 *(77.57)*
Social- Work Life balance			
Total Hours Worked (including off-farm)	Total hours worked by the farmer in the year both on and off-farm		2,162 *(801)*
Off-Farm Employment	Binary Variable =1 if farmer is also employed off farm	167 *(30)*	
Social-Isolation			
Limited contact	=1 if farmer does not meet someone from outside the household daily	266 *(28)*	
Living Alone	=1 if farmer lives alone	114 *(20)*	
Sense of Security in the Home	=1 if farmer feels their sense of security has declined in the last 5 years	256 *(34)*	

The results of the model (Table 5.4) provide further insight into the factors associated with a farmer experiencing stress and can also be viewed as means of validating the responses to the self-reported data around sources of stress. Table 5.4 illustrates the estimated coefficients, a test of significance, the marginal effect (of a unit change in each explanatory variable on the probability of participation) and a goodness of fit measure. The Wald test suggests that the model is significant (p<0.01). Variables with a positive coefficient increase the probability of farmer stress while those with a negative coefficient decrease such probability.

Table 5.4. Probit Model of Farmers' Experience of Stress

Variable *(N=736)*	**Coefficient**	**Z-Statistic**	**Marginal Effect**
Constant	-3.077		
Age	0.1077**	2.42	0.038
Age^2	-0.0010**	-2.64	-0.0037
Agricultural Education	0.2648*	1.98	0.0954
Dairy System	0.5911**	2.90	0.2131
Beef System	0.4750**	2.59	0.1712
Tillage System	0.4896*	1.79	0.1765
Intensity of production	-0.0018*	-1.76	-0.0006
Farm Income	0.0013	0.33	0.0005
Farm $Income^2$	0.00007	0.33	0.000002
Loans	0.00189*	2.05	0.0006
Total Hours Worked	0.00008	0.92	0.000032
Off-Farm Employment	-0.2715*	-1.67	-0.097
Limited Contact	0.1035	0.78	0.0371
Living Alone	-0.0108	-0.07	-0.0039
Sense of Security	0.1029	0.8	0.0371
Wald = 56.90** Pseudo R^2=0.0780			

Results indicate that the effect of age on the incidence of stress is significant, positive and non-linear. Formal agricultural education increases the probability of stress by 0.095, others things being equal. Although all variables were tested for multicollinearity and were within an acceptable range, it is possible that education may be reflecting some unobserved personal effects.

Relative to the sheep farming system, operating any other farm system is associated with a statistically significant increase in the probability of stress. For dairy farming the probability increases by 0.21. Similarly the probability of stress increases by 0.17 and 0.18 for beef and tillage farmers respectively. Other variables that are also significant but to a lesser degree, include intensity of production, off-farm employment and farm debt. Intensity of production is negatively significant, implying that as the output per labour unit increases the probability of stress declines. This suggests that the profit associated with the additional work offsets the impact of workload on stress. The impact of off-farm employment is also negative and significant implying that having an off-farm job reduces the probability of stress, albeit the marginal effect is very low at 0.09. The effect of loans is positive and significant upon the experience of stress, as expected, implying that the more indebted the farmer, the greater the likelihood of stress.

FFI is not statistically significantly associated with the probability of stress. A number of model specifications including interaction variables were tested during the course of the analysis and FFI was not significant in any other specification. Finally, variables measuring isolation were not significant, nor was a reduced sense of security in one's home.

5.4. Discussion

The results from the self-reported stressor dataset demonstrate that over half of the farmers surveyed experienced stress or anxiety from their farm operation within the previous five years, varying in prevalence across the different enterprise types. This figure appears to compare unfavourably with those employed in other sectors of the Irish economy; in 2015 17% of the Irish workforce reported experiencing occupational stress, with 27% experiencing high subjective job stress (i.e. consistent stress explicitly linked to work situation), with those employed in the health sector most likely to experience stress or anxiety (18%), and those occupying technical and associate professional roles (20%) (Russell et al., 2018). The results also highlight variation in the prevalence of both internal and external sources of stress impacting farmers. The identification of poor weather as the predominant source of external stress amongst farmers is anticipated, particularly as Ireland was impacted by a number of extreme weather events across 2018. The early onset of damp winter conditions in the latter months of 2017 impacted the capacity to harvest second cut silage, and coupled with earlier than anticipated cattle housing dates, adversely impacted the levels of winter fodder stock on many farms (Dillon et al., 2018). Heavy snowfall and low ground temperatures resulted in delayed grass growth of approximately one month compared with average years, and this combined with the extended cattle housing period, contributed to a substantial fodder shortage over the winter/spring period. While mild weather conditions in late spring brought some reprieve and facilitated grass growth, exceptionally high temperatures and low rainfall levels in June and July resulted in drought conditions for much of the country, halting grass growth once again. Such drastic weather conditions, coupled with the need to extend housing periods, and disruption to grass growth cumulated in extensive additional feed expenses for farmers, with concentrate feed expenditure increasing by 34% (Dillon et al., 2019). This may also provide a rationale for the identification of 'financial pressures' as a significant internal stressor within the self- reported stressor dataset.

According to the self-reported data, stress relating to workload was most prevalent amongst dairy farmers. This is to be expected, in light of the rapid expansion of the sector following the removal of EU milk quotas in 2015. As a result, both dairy output and average herd size have increased significantly in Ireland over the past 5 years (Dillon et al., 2019) and over two thirds of dairy farmers reported working in excess of 45 hours per week. Dairy farms tend to be larger and more labour intensive than the other farm systems in Ireland, and duties, such as milking, are time bound which can contribute to stress. The expansion of the dairy sector in recent years and its consequential increase in workload was identified by Kallioniemi et al. (2016) as a primary source of internal stress amongst dairy farmers in Finland, in addition to external stressors relating to EU agricultural policy and societal perception. McNamara et al. (2020) reported an association between the risk in the occurrence of farmer workplace injury and long on-farm working hours.

Utilising a probit analysis, the results demonstrate that as farmers get older they are more likely to experience stress, but at declining rates. This is consistent with Torske et al. (2016) which reported that depressive symptoms amongst farmers increased with age, while Daghagh Yazd et al. (2019) highlighted that the typology of farm related stressors varies across different age groups, with younger farmers more likely to experience higher incidences of stress from debt related issues, while stressors relating to poor health increased with age.

The probit analysis shows that the probability of experiencing stress is higher for farmers working in the dairy, beef and tillage sector compared with sheep farmers, and this tallies with the results from the self-reported stress dataset. In addition, the analysis indicates that higher levels of indebtedness are associated with an increased probability of stress. In their study of farm level stressors, Kearney et al. (2014) observed that over two thirds of farmers reported a high debt load as a significant source of stress. External factors beyond the control of the farmer, such as poor weather or fluctuations in market prices can adversely impact farm cash flow, and can place additional pressure upon farmers to ensure debt repayment obligations are met.

The finding that the probability of experiencing stress increases with the attainment of formal agricultural training may appear counter intuitive, as one may expect such farmers to be better prepared to address adversarial events. While there appears to be an association between higher overall stress amongst farmers with primary or secondary education only compared to those with a third level education (Logstein, 2016), specific research investigating associations between agricultural education and stress levels is lacking in the literature. Heanue and O'Donoghue (2014) reported that both yield and intensity of output for livestock farmers in Ireland are affected positively and significantly by attending agricultural college and by achieving an agricultural certificate. It stands to reason therefore that such farmers with specialised agricultural training seeking to optimise their production output may be more susceptible to work related stress.

The model also demonstrated that farmers who held off farm employment were significantly less likely to experience stress from their farm operations. Haugen and Blekesaune (2005) and Rye (2001) reported that farmers engaged in off farm employment reported higher life satisfaction levels than other occupational groups, and experienced lower levels of social isolation and loneliness than farmers who did not have off farm employment. Indeed, it may not be the attractiveness of the off farm work in improving the subjective quality of life per se, but rather the ability to 'escape' the various challenges related to modern farming, such as working conditions, social isolation and loneliness (Rye, 2001, Fjeldavli and Bjørkhaug, 2000). Moreover, the opportunity presented by off farm employment in diversifying the income stream may also be a factor in reducing overall stress levels, as it can help to ameliorate risks to farm income posed by external forces (Jetté-Nantel et al., 2011, Mishra and Sandretto, 2002).

5.4.1. Limitations and further research

While the probit model was limited to measuring internal variables within the dataset, it revealed some inconsistencies between the typology of stressors reported by the farmers with the internal farm characteristics. Neither could the model account for the effect of some unobserved heterogeneity with regard to particular farmer characteristics. A particularly interesting finding from the probit model was the lack of statistical significance with family farm income. While farmers identified financial pressures as a pertinent stressor, and the probit model determined that the probability of experiencing stress increased with debt load, no significance was determined between the level of FFI attained and probability of experiencing stress. This disassociation between results may be attributed to the accounting method by which FFI is calculated within the NFS. This variable provides an aggregate income figure, and as such, intermittent fluctuations in cash flow, which may represent a source of stress, are not readily captured within the dataset. Furthermore, FFI is not inclusive of additional household income, such as earnings generated from off farm employment or spousal income. As FFI is not wholly representative of farm household finances, it stands to reason that financial stress which is independent of farm income may be a factor. As such, additional financial variables such as total household income and an assessment of cash flow may provide a more accurate determination of the farm financial situation. Further research assessing the prevalence of stress with additional farm level financial variables is therefore recommended.

While the additional survey facility within the NFS provided a robust method of gathering data on farm level stress and its sources, its one time collection limits the analysis to a single year. Moreover, owing to the subjective nature and timespan permitted for the reporting of the self-identified stressors, participant recall is recognised as a study limitation. Furthermore, the conventional FADN survey methodology is not overly conducive to collating data on social sustainability, particularly in consideration of more sensitive issues, e.g. personal health or the quality of social relations. The development of the proposed Farm Sustainability Data Network as identified within the EU Farm to Fork strategy (Matthews et al., 2020a) highlights the need to strengthen capacity in this regard and indicators more cognisant with farm level social sustainability are necessary. With this in mind, and given the prevalence of various internal and external stressors identified within the self-reported stress dataset, this study recommends the inclusion of an annual stress inventory within the core NFS and FADN dataset. Identifying recurring stressors will assist policy makers in developing strategic wellbeing supports for farmers whilst also taking into consideration the variance of stressors impacting different farm sectors, and to improve resilience.

A key finding from this research is that farmers' experience of stress is conditioned by a number of socio-demographic and farm enterprise factors. Further work is required to examine how such stress manifests, and how it may be mediated through resources and supports. One such framework which could provide a practical approach to address these issues is the Stress Process Theory (SPT). This model proposes that stress may diminish a person's sense of mastery, placing that person at risk of outcomes that undermine their wellbeing (Aneshensel and Mitchell, 2014). The SPT differentiates between three elements of stress; sources, (such as chronic stressors) outcomes (physical or mental health issues) and mediators (coping skills or social supports). The model conceptualises stress as being mediated by intermediary processes that either enhance or diminish the capacity to respond to stress, and by a number of social and economic resources (Aneshensel and Mitchell, 2014) i.e. it takes into consideration the individual level experience of stress and its impacts. The provision of social supports (community) and enhancing capacity (individual) are the primary interventions associated with the SPT. The results from this research indicate that not only should such supports to manage stress be made routinely available but that specific interventions be developed for application with particular populations, e.g. younger farmers who are in the process of developing their enterprises or those experiencing the negative impacts of external forces, e.g. weather and climate, on their wellbeing. Moreover, further studies are recommended to examine the attributes of farmers who experience occupational stress compared with those that don't; indeed such research will help to identify key skills or supports that could form the basis of future farm worker wellbeing programmes.

5.5. Conclusion

This study adopts a novel approach of combining self- reported stressors and statistical analysis to identify the prevalence of farm related stress and describe the attributes of those impacted. These results corroborate the literature identifying poor weather, workload and financial pressures as key stressors, as well as the increased probability of dairy farmers experiencing stress compared to operators of other farm systems. These findings demonstrate that occupational stressors impacting farmer wellbeing are multi-faceted, influenced by both internal and external pressures, and vary by enterprise type and demographic factors. To date, many farm assessments have focused predominately on economic and financial perspectives, lacking information on alternative societal factors and inferring a somewhat arbitrary interpretation of standards of wellbeing. Moving forward, it is imperative that wellbeing measurement is given the same consideration and recognition in farm assessments as that afforded to economic measures, in order to provide a more holistic wellbeing perspective overall. Farm assessment surveys, such as the FADN, need to be refined and adapted to gather more comprehensive data on socially sensitive topics, particularly in the context of farmers' physical and psychological health.

While an examination of occupational stress is a vital aid in helping to determine adverse pressures on farmers' wellbeing, it is also important to examine additional subjective and objective factors that may also influence farmer's sense of wellbeing, such as work/life balance and generational renewal. In the following chapter, a composite index is developed which assesses indicators representative of different dimensions of farmer wellbeing; namely farm continuity, community and social connections, and farmer comfort, to provide a more holistic interpretation of wellbeing and social sustainability.

Chapter 6. Beyond farm income: Assessing multiple dimensions of social sustainability amongst a nationally representative sample of farmers in Ireland

Brennan, M., Hennessy, T., Dillon, E., & Meredith, D. 2022. Beyond farm income: Assessing multiple dimensions of social sustainability amongst a nationally representative sample of farmers in Ireland.

This paper is currently under revision for resubmission to *Sociologia Ruralis*.

The development of social sustainability indicators for agriculture, which incorporate the measurement of farmer, animal, and community wellbeing, are necessary to support more efficient monitoring and progress towards EU policy goals. From a farmer wellbeing perspective, it is beneficial to investigate subjective and objective aspects that may influence their sense of wellbeing, such as work-life balance, prevalence of occupational stress and plans for generational renewal. This chapter develops a composite index that examines indicators representative of several dimensions of farmer wellbeing, namely farm continuity, community and social connections, and farmer comfort, in order to provide a more holistic understanding of wellbeing and social sustainability.

Abstract

Economic and environmental sustainability of food production has long been a concern within European public and policy discourses. In recent years and particularly following the publication of national and EU climate strategies, attention has turned to social dimensions of sustainability. A knowledge gap exists between agricultural policy priorities and data

infrastructure to evaluate social sustainability issues, particularly regarding farmer sustainability. This study aims to address this gap through the development of a Farmer Sustainability Index (FSI), a composite index comprising three dimensions: farm continuity, community and social connections, and farmer comfort. Farm level socio-demographic data was extracted from both core and supplementary EU Farm Accountancy Data Network (FADN) data from the 2018 Teagasc National Farm Survey (NFS) in Ireland. Statistical analysis was undertaken to compare the distribution of FSI and the individual dimension scores for farms across three socio-demographic variables; farm system, farmer age cohort and region. The FSI results demonstrate that cattle farmers, farmers over 60 years of age, and those residing in regions with poorer infrastructure experience lower levels of sustainability in comparison to other farmers, while the variation in FSI dimension scores identify numerous sustainability risks to farms with differing socio-demographic constructs. It is important for agricultural policy to be cognisant to these differences and the relational nature of these risks, to meaningfully address matters pertaining to sustainability, and the FSI provides an effective tool to assist policy makers in this regard.

6.1.Introduction

The EU Farm to Fork strategy aims to accelerate and support a fair transition to a more sustainable food system, one which promotes environmental, health and social benefits for European farmers and consumers alike (European Commission, 2019a). Reflecting this goal, the Common Agricultural Policy (CAP) 2023-2027 has embraced sustainability to greater extent than heretofore. This is reflected in the development of a range of initiatives that seek to foster a sustainable and competitive agricultural sector that supports European farmers to respond proactively to current and future challenges, and promotes prosperity across rural regions. One such initiative is the transformation of the Common Monitoring and Evaluation

Framework (CMEF), which monitors the implementation of CAP policies, to the Performance Monitoring and Evaluation Framework (PMEF), to a more performance-based delivery model. This represents a significant change in emphasis of the CAP from a current focus on compliance towards the achievement of specific objectives (Matthews et al., 2020b). Reflecting the changing focus of the CAP and shift towards performance monitoring the Farm Accountancy Data Network (FADN) will take account of sustainability metrics in the form of a Farm Sustainability Data Network (FSDN). The FADN collates data on an annual basis from each member state through nationally representative surveys of farm enterprises for the determination of incomes and business analysis for agricultural holdings (Buckley et al., 2015). A key strength of the FADN is the provision of a harmonised platform for the collection of directly comparable farm statistics by each member state, one supported by a rigorous data management and validation infrastructure, thus making the FADN the primary monitoring instrument used to evaluate agricultural policies in the EU (Vrolijk and Poppe, 2021). The evolution of the FADN to the FSDN represents a fundamental shift in its focus and purpose, one which is currently oriented towards understanding the economics of food production, to one more cognisant and supportive to sustainable farming practices. Measuring the sustainability of agriculture with FADN infrastructure is achievable, primarily due to its harmonised structure, albeit it would need to broaden its scope of data collection to address evolving policy needs (Kelly et al., 2018). Currently, the FADN dataset is more conducive to the assessment of economic sustainability than that of environmental or social, although some national initiatives have utilised a supplementary survey facility within the FADN to create a bank of farm level social indicators, measuring vulnerability and isolation in Ireland (Hennessy et al., 2013, Dillon et al., 2010) and devising proxy food safety and animal welfare indicators in the Netherlands (Dolman et al., 2014). Nonetheless, indicators to assess the social dimension of sustainability remain limited in their conceptualisation within the 'core' FADN, hindering a holistic assessment of agricultural sustainability. Therefore, new and evolved social sustainability indicators are necessary to facilitate more effective monitoring and progress towards agricultural policy objectives, and to aid in the successful transition of the FADN to the FSDN (Brennan et al., 2020). To this end, our paper seeks to develop a composite index which assesses several aspects of social sustainability and applies this to Irish FADN data to provide a measure of overall social sustainability before assessing farm system variations. In the next section, we provide a contextual background on the recent progression of social sustainability measurement within the EU agricultural sector, and discuss a theoretical framework for the formulation of a farmer sustainability index.

6.2.Contextual Background

There has been an unbalanced approach towards research and policy development across the economic, environmental and social pillars of sustainability. Whilst environmental and economic concerns have formed the focus of much research there is a deficit in regards to the social aspect of sustainable development (Brennan et al., 2020). The focus on economic, and more laterally environmental sustainability reflects the theoretical, conceptual and measurement challenges associated with the social sustainability measurement owing in part to its perceived fluidity and subjective character (Wojewódzka-Wiewiórska et al., 2020, Lebacq et al., 2013). That said, more recent progress resulted in the emergence of a literature critiquing the dominance of ecological, environmental and economic perspectives by highlighting and conceptualising the centrality of human (societal) behaviours to the attainment of overall sustainability objectives (Åhman, 2013, Boström, 2012, Vallance et al., 2011). Indeed, Vallance et al. (2011) suggest that it was this unbalanced operationalisation of sustainability policies and the resulting social resistance to or rejection of them, that prompted greater consideration of social sustainability.

Whilst agriculture within the EU has experienced somewhat of an ‘indicator explosion’ in regards to economic and environmental sustainability indictors, with the development of indicator-based assessment methods, at farm, farm enterprise, and regional levels, the measurement of social sustainability remains somewhat of a nascent activity (Wojewódzka-Wiewiórska et al., 2020). Rationale for the historical lack of analysis into the social sustainability assessment for agriculture has been attributed somewhat to difficulties pertaining to its subjective nature, although work of late has sought to overcome these issues and expand the assessment of social sustainability for the agricultural sector through more subjective and qualitative metrics (Brennan et al., 2020, Wojewódzka-Wiewiórska et al., 2020).

The EU FADN, traditionally constructed to record the economic performance of farms, has more recently been expanded to take account of environmental indicators e.g. fertilizer use However, there has been somewhat limited application to date of the FADN to assess and evaluate the social sustainability of agriculture, although some member states (Ireland, Netherlands) are progressing this research through their national surveys (Brennan et al., 2020, Poppe and Vrolijk, 2016, Herrera et al., 2016b, Herrera et al., 2016c). Brennan et al. (2020) reported the results of qualitative research undertaken with farmers and rural policy stakeholders with a view to the design of relevant social sustainability indicators within an augmented FADN. What emerges from this analysis are numerous areas of overarching concern; in addition to matters surrounding *animal well-being*, *occupational wellbeing* capturing concerns with occupational stress, workload and isolation experienced by the farm community; *community viability* relating to access to and quality of public services and; perceptions of security, and *familial legacy* as represented by the inter-generational transfer of the farm assets.

Each of these is tied to the maintenance of farming practices, rural community and familial attachment to both the occupation and place in the face of significant social, cultural, economic and policy/governance changes. This points to a nuanced perspective of what is required to maintain the social sustainability of a farm and farming practices, highlighting the need for additional indicators beyond those most commonly used, e.g. demographic, if we are to fully understand current and evolving standards of social sustainability, and indeed, effectively monitor progress. From an animal welfare perspective, research on determining levels of dairy cow welfare with a composite index has been conducted (Brennan et al., 2021a) and so this study focuses on matters impacting the occupational wellbeing and quality of life components of social sustainability for farmers.

6.2.1. Measuring wellbeing- Moving beyond GDP

Over the past number of decades, quality of life (QOL) measurement has evolved from a singular, monetary frame of reference, most commonly determined from Gross Domestic Product (GDP), to one more considerate of its multidimensional construct, reflecting the needs of the individual, community and wider society (Exton and Shinwell, 2018). The measurement of QOL refers to an individual's well-being and mental state in an expansive multidimensional concept, and as a result may be experienced and perceived differently depending upon the individual's situation, as it reflects personal and social factors such as age, location and culture (Petrosillo et al., 2013). While GDP growth is crucial for achieving numerous socio-economic objectives, such as the eradication of extreme poverty and the financing of social programmes and public investment, it is more of a tool to help progress different socio-economic goals, rather than as a final goal in itself (Exton and Shinwell, 2018). While GDP is widely utilized as a measure of economic production, a dearth of tangible well-being indicators has resulted in GDP being commonly equated with societal progress. This has resulted in a flawed, yet commonly overlooked evaluation of societal well-being and sustainability; indeed GDP fails to capture essential elements of living standards, such as social connections, health and leisure time, it does not reflect inequalities and fails to reflect the potential impact increased economic production may have upon natural resources (Exton and Shinwell, 2018). It is necessary therefore to move beyond GDP as an all-encompassing measure of well-being and social sustainability, and to identify indicators better suited to determining standards on societal well-being and QOL.

6.2.2. Theoretical framework

Building on the research of Brennan et al. (2020), which identified key aspects of social sustainability pertinent to the farming sector, including personal wellbeing, familial legacy and succession, and rural community, this paper aims to contribute to a more grounded understanding of agricultural and rural sustainability through the development of a farmer sustainability index, with reference to a range of socio-economic contexts, as demonstrated in the farmer QOL wellbeing index of El-Osta (2014). Interpreting the level of social sustainability and investigating the differences between levels of sustainability across farm types and regions can be ascertained through the assessment of numerous subjective and objective indicators, and as such, a synthetic or composite index combining different indicators can provide an analytical method to assess levels of wellbeing and sustainability. Intended to simplify complex information, composite indexes are now widely implemented within policy analyses and sustainability assessments, combining data on individual measures or indicators into a single index (Nardo et al., 2005).

With this in mind, a comprehensive assessment of current farmer, rural and societal wellbeing and sustainability indexes and frameworks was conducted, with the purpose of identifying representative indicators ideally suited for the interpretation of farmer sustainability. Ten indexes and frameworks were reviewed in total, three which were specific to the assessment of farmer wellbeing (Wojewódzka-Wiewiórska et al., 2020, El-Osta, 2014, El-Osta, 2007) with the remaining seven assessing human wellbeing and the sustainability of rural populations. An overview of these indexes and frameworks, including their sectoral application, dimensions and indicators is available to view in full in Appendix3, and in the following section, key indicators and dimensions from these indexes and frameworks, congruent to the social sustainability concerns of farmers outlined in (Brennan et al., 2020) are discussed in more detail.

6.2.3. Indicators and dimensions of farmer social sustainability

In this section, we identify indicators within the selected frameworks and indexes which are best suited to provide data on different aspects of farmer social sustainability. While the content within each of these frameworks and indexes are not limited to the selection of indictors discussed, we focus our attention to a range of indicators which have the ability to relay information on a specific aspect of sustainability, cognisant to the societal concerns outlined within Brennan et al. (2020) and which have representative indicators within the NFS/FADN dataset.

Income. The connection between quality of life and financial health is identified within many of the indexes and frameworks examined for this study (Wojewódzka-Wiewiórska et al., 2020, Abreu et al., 2019, Michalos et al., 2011). While progress has been made to modify the evaluation of social sustainability beyond measures which are solely determined from GDP, income and economic status remain a pertinent factor within a holistic sustainability assessment. Wojewódzka-Wiewiórska et al. (2020) examined both an objective financial indicator (farm income from FADN database) and a subjective indicator (farmers self-evaluation of their socio-economic status) comprising the dimension of 'economic situation' within their assessment for farmers quality of life in Poland. Within the 'Economy' dimension of their rural development index, Abreu et al. (2019) examine average monthly earnings, in addition to examining the proportion of agricultural workers with off farm employment. The Canadian Index of Wellbeing, which measures human wellbeing, incorporates numerous financial indicators within a 'Living Standards' dimension, including the median family income, and the percentage of respondents in a low income bracket.

Business Continuity. Preparing for the security of one's future can be an important consideration for personal wellbeing and sustainability, indeed anxiety or concern surrounding future stability can have a significant impact on present wellbeing (Cummins et al., 2021). From a farming perspective, plans to continue farming or increase production may be indicative to the level of confidence and optimism farmers have in their work, conversely farmers suffering elevated levels of psychological distress and poor wellbeing are more likely to exit farming (Waldman et al., 2021), in addition to older, more educated farmers without an established successor (Dong et al., 2016). However, indicators to measure aspects of future security, such as employment objectives or plans for retirement are limited within the indexes examined, with only a single index addressing this matter. Within its seven dimensions, the Australian Personal Wellbeing Index, which measures human wellbeing, includes a variable examining participant's satisfaction with their plans for their future security, a term which can comprise monetary aspects including job security and new employment opportunities, financial stability and plans for retirement (International Wellbeing Group, 2013).

Generational Renewal. Although Wojewódzka-Wiewiórska et al. (2020) made reference to the issue of intergenerational farm transfer with farm viability and quality of life, the presence of a potential farm successor was not considered within the indexes and frameworks examined for this study, which, we postulate, is essential to the maintenance of the family farm model and influential to the viability of the rural community. The identification of a farm successor is a key factor in the trajectory of the farm business, where changes are most likely to occur, either though revitalisation and farm investment, or by disbandment (Zagata and Sutherland, 2015). Fischer and Burton (2014) discuss the 'succession effect', whereby farmers with an identified successor tend to invest and develop resources in anticipation of transfer, and farms lacking a potential successor more likely to disinvest and hold a passive management style. Moreover, the financial viability of the farm enterprise may be influential regarding the succession potential, and consequently, the continuity of the farm itself. Larger farms are more likely to transferred within the family, as they can provide better prospects for successors and more likely to generate secure earnings, supporting the financial attractiveness of farming compared to off farm employment (Suess-Reyes and Fuetsch, 2016).

***Isolation*.** Farming as an occupation is characterised by an independent and self-reliant modus operandi, one in which the farmer often works individually, or with the help of family labour. Consequently, social isolation, loneliness and lack of social relationships have been identified as pertinent mental health risk factors for those working within the agricultural sector (Daghagh Yazd et al., 2019). Moreover, farmers who live alone may be susceptible to the adverse impacts of social isolation, indeed the Teagasc National Farm Survey identifies farmers as an 'Isolation Risk' if they reside alone (Ryan et al, 2016). Although a specific indicator assessing the proportion of the population living alone is lacking in the indexes reviewed, the Canadian Index of Wellbeing incorporates a subjective variable querying respondents on their sense of belonging within their local community (Michalos et al., 2011).

Social Interaction. The frequency of contact with others and the quality of personal relationships are decisive determinants for peoples' wellbeing, and well developed social connections can generate trust, foster reciprocity and tolerance, as well as facilitating collective action and exchanges of information in local communities (OECD, 2011b). The OECD Regional Wellbeing Framework includes a 'Frequency of social contact' indicator, which measures the proportion of population who interact with people outside their own household at least once per week (OECD, 2014). The impact of social isolation on farmer's quality of life was included within the indexes of El-Osta (2014) and El-Osta (2007) where farmers ability to access family and friends was measured through a 3 level rating scale variable (major problem/minor problem/not a problem) within 'social environment' and 'social interaction' dimensions respectively.

Off farm employment. A considerable body of work has been published on the associations between off farm employment and enhanced farmer wellbeing; Brennan et al. (2021b) reported that farmers who engage in off farm employment were less likely to experience stress from their farm operation, and Haugen and Blekesaune (2005) and Rye (2001) found that farmers who held an off farm job recorded higher life satisfaction levels than other occupation groups and according to Fjeldavli and Bjørkhaug (2000) farmers that work off farm report lower levels of social isolation and loneliness compared to farmers with no off farm employment. The availability of off farm employment was identified within several indexes as a pertinent component of both farmer wellbeing and rural sustainability. Within the socio- economic and quality of life indexes of El-Osta (2014) and El-Osta (2007) the availability of off farm employment opportunities was assessed, and in the 'Economy' dimension of their Portuguese Rural Development Index, Abreu et al. (2019) assess the proportion of the farming population with remunerated activity outside of agricultural holdings.

Access to Services. Several indexes also included indicators examining the quality of services available to both farmers and others residents living within rural regions (Wojewódzka-Wiewiórska et al., 2020, El-Osta, 2014, El-Osta, 2007, OECD, 2014). The availability of numerous public and essential services within rural regions can be indicative to its viability, indeed, perceived difficulties by residents in accessing public transport, banking or medical services can highlight deficiencies in the quality of connections in rural areas (Eurofound, 2019). Wojewódzka-Wiewiórska et al. (2020) assessed the time needed for farmers to reach different public institutions (schools, medical services, social amenities), while the OECD's Regional Wellbeing Framework incorporated four indicators within its 'Access to Services' dimension, measuring distance to hospital, share of population with unmet medical needs, ability to access public transport and broadband connection (OECD, 2014). Collomb et al. (2012) assessed the ease of ability for a rural population to access schools, medical centres and local markets, while El-Osta (2014) and El-Osta (2007), assessed the ability of farmers to access health care, shops, sources of entertainment and outdoor recreational activities.

Stress. Workers within the agricultural sector are exposed to a wide range of occupational stressors from their employment, many of which are beyond their control, that can inflict mental stress (Truchot and Andela, 2018, Bennett, 2016). Prolonged or chronic stress can adversely impact one's quality of life and mental wellbeing, and for farmers, occupational stressors can include poor weather, financial concerns and pressure from workload, which can vary in prevalence by enterprise type and demographic factors (Brennan et al., 2021b). In their index measuring farmer's quality of life, Wojewódzka-Wiewiórska et al. (2020) incorporated a stress level assessment within a 'Mental Comfort' dimension, querying farmers on their stress levels (Low, Medium High) with an inventory of occupational stressors, resulting in an average stress score.

Sense of security. Several indexes included indicators to determine the level of crime and the sense of personal safety amongst the farming and general population. An indicator assessing the levels of crime and vandalism impacting famers in their local area was included in the indexes of El-Osta (2014) and El-Osta (2007), while the Australian Personal Wellbeing Index queried recipients on their sense of personal safety (International Wellbeing Group, 2013). Within the 'Community Vitality' dimension of the Canadian Index of Wellbeing, three indicators are presented to measure perceived levels of crime amongst respondents; (i) property crime rate per 100,000 population, (ii) violent crime rate per 100,000 population and (iii), percentage who feel safe walking alone after dark (Michalos et al., 2011).

Long working hours. Working long hours as opposed to standard working hours (35-40 per week) on a regular basis can have an adverse impact upon one's work-life balance and quality of life, and excessive working hours can lead to a number of health issues, such as depression, anxiety and sleep disturbance (Hsu et al., 2019). Moreover, working in excess of 55 hours per week has been identified as a prevalent occupational risk factor by the World Health Organisation (WHO) and the International Labour Organisation (ILO) and is attributable to a large number of deaths caused by strokes and ischemic heath disease annually (Pega et al., 2021). For those working in the agricultural sector, working in excess of 50 hours per week, (either on farm or in combination with hours worked off farm) have been shown to increase the risk of suffering a farm injury (McNamara et al., 2020, Sprince et al., 2003). Classifications of what constitutes long working hours varies by country and national regulations, and occupational epidemiologists commonly group long working hours into three analytical categories; 41-48, 49-54, or >55 hours per week (Pega et al., 2021). For the purpose of this study we follow the classification for long working hours used within the OCED Better Life index and the Canadian Index of wellbeing, working 50 hours per week or more. Both these indexes measure the proportion of population with regular working hours exceeding 50 hours per week, within the respective dimensions of 'Work life Balance' (OECD, 2011a) and 'Time Use' (Michalos et al., 2011).

As previously eluded to, the content of many of these indexes and frameworks are not limited to the indicators listed above. Rather, this range of indicators addresses the occupational wellbeing, generational renewal and community viability concerns of farmers highlighted by Brennan et al, (2020), while also including key economic and socio-demographic variables, providing data for the development of a Farmer Sustainability Index.

6.3.Methodology

The Farmer Sustainability Index proposed in this paper is devised and adapted from the ten indices examined in the previous section. The data used to construct these indicators are drawn from both core and supplementary FADN data from the 2018 Teagasc National Farm Survey (NFS). The Teagasc NFS fulfils Ireland's statutory obligation to provide farm level financial and production data to the European Commission and operates as part of the FADN. Data is collected annually from approximately 900 farms, with each farm assigned a weighting factor to ensure results are representative of the national farm population. Primarily utilised to assess the financial situation on farms, the scope of the survey has been broadened over time to develop a sustainability framework encompassing indicators of economic, environmental and, more recently, social sustainability. A detailed description of the approach is most recently available in Buckley et al. (2019b). In addition to the core set of questions focusing on farm inputs, outputs and associated finances, the supplementary survey facility provides researchers the opportunity to collect additional data on contemporary or emerging issues of relevance.

Whilst the core NFS results provide data relevant to several aspects of social sustainability, e.g. socio-demographic and economic indicators, working hours, off-farm employment and farm viability, research by Brennan et al. (2020) identified other aspects of social sustainability of concern to farmers such as: (i) Farmer isolation and wellbeing (ii) Availability of and ease of access to public and rural services and (iii) Succession planning . Questions pertaining to social sustainability were included in the 2018 supplemental survey and it is these data that are utilised in the analysis presented below (See Appendix 4 further details).

Between the months of June and September 2018, 722 additional NFS questionnaires were completed by farm operators across four enterprise types; dairy (n=271), cattle (n=305), sheep (n=98) and tillage (i.e. arable farms) (n=48).[4] The core NFS provided data on numerous socio-demographic and economic indicators, such as working hours, off farm employment and farm viability.

In total, 14 indicators were extracted, and were categorised between three dimensions; *farm continuity*, incorporating (i) economic viability of the farm (ii) plans for farm business continuity and (iii) generational renewal, 2.*community and social connections* (i) isolation, (ii) interaction and off farm employment, and (iii) access to services and 3. *farmer comfort* (i) working hours, (ii) experience of stress and (iii) sense of security (See Figure 6.1).

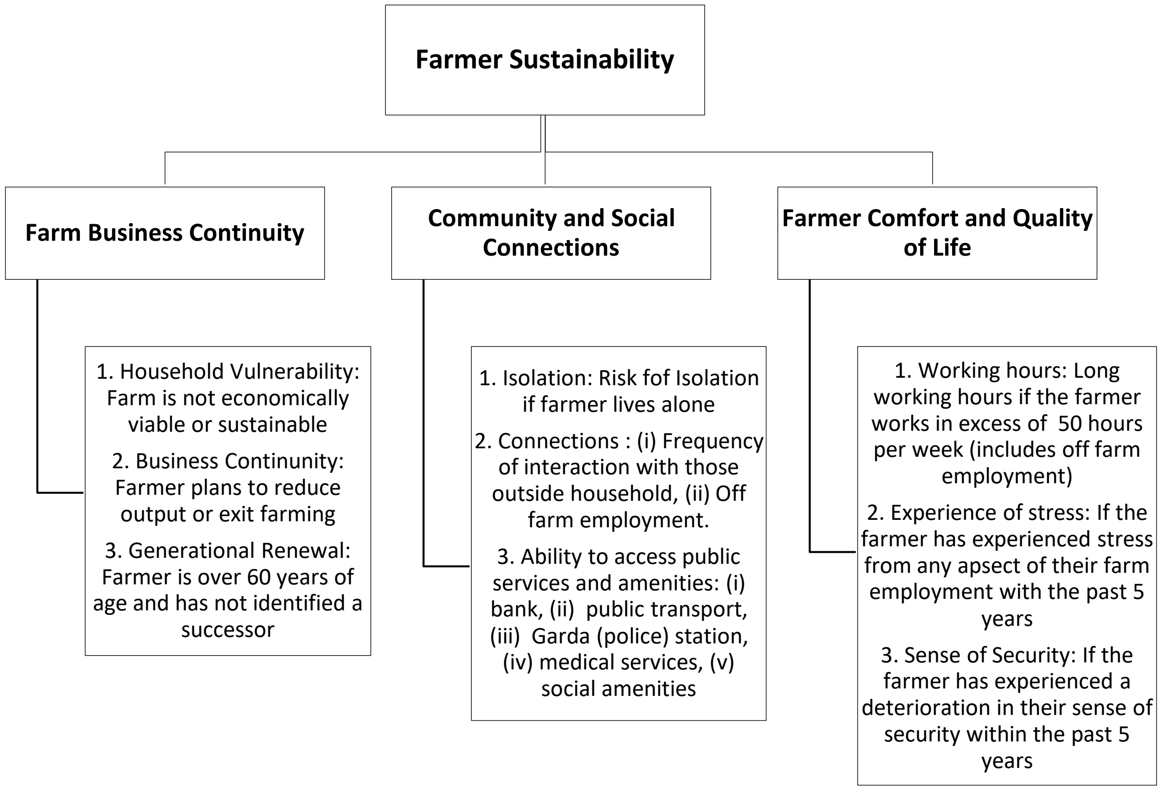

Figure 6.1. Indicators extracted from the 2018 Teagasc NFS, categorised by dimension

[4] Response rate of 82%

6.3.1. Composite Index development

Composite indices ideally measure multi-dimensional concepts that cannot be measured by single indicators alone. They are particularly suitable for the assessment of populations or sectors characterised by diversity, e.g. farm enterprises, or that attempt to measure multi-dimensional concepts such as social sustainability. This, however, presents a number of methodological challenges associated with the selection or development of indicators. Firstly, selecting appropriate and representative variables is imperative, with a balance of both objective indicators (i.e. income, off farm employment) and subjective indicators (i.e. reported rankings and / comparison to referent groups) necessary for a holistic interpretation (El-Osta, 2007). Each indicator is required to be both conceptually sound and be derived from high quality and robust data. The weighting attributed to each indicator or variable needs to reflect their relative importance within the index, with consideration given to the weighting of each indicator which can be determined through either statistical means or expert assessment, with the majority of composite indicators relying on equal weighting (EW), i.e., all indicators or variables are given the same weight (Nardo et al., 2005). The application of an unbiased aggregation technique is particularly important where the outputs are targeted towards policy development, implementation or assessment (Abreu et al., 2019).

6.3.2. Methodological approach: Construction of the Farmer Sustainability Index (FSI)

A detailed description of the indicators analysed is presented in Table 6.1. Equal weighting (EW) was assigned to each indicator across the three dimensions, and as each dimension was composed of three indicators, each indicator was assigned a weight of 0.333 (one third) within its corresponding dimension.[5]

Table 6.1. Description of the indicators included in the index, with their relative importance within each dimension

NFS Variables			Weight within Dimension
Farm Continuity		**CONT.**	
Household Vulnerable =1 If farm household is economically vulnerable			0.333
Business Continuity Risk = 1 If farmer has plans to reduce output or exit farming			0.333
Generational Renewal Risk= 1 If farmer is over 60 years of age and has not identified a successor.			0.333
Community and Social Connections		**CONN.**	
Isolation: Isolation risk = 1 If the farmer lives alone			0.333
Social Interaction (2 variables) :			0.333
(i)	Infrequent social contact = 1 If farmer has contact with people outside own household once per week or less		*(0.1665)*
(ii)	No off-farm employment =1 if farmer does not have off farm employment		*(0.1665)*
Access to Services (5 variables)			0.333
(i)	Access to bank =1 if farmer reports difficulty in accessing bank		*(0.0666)*
(ii)	Access to public transport =1 if farmer reports difficulty in accessing public transport		*(0.0666)*
(iii)	Access to Garda (police) station =1 if farmer reports difficulty in accessing Garda station		*(0.0666)*
(iv)	Access to medical services =1 if farmer reports difficulty in accessing medical services		*(0.0666)*
(v)	Access to social amenities =1 if farmer reports difficulty in accessing social amenities		*(0.0666)*
Farmer Comfort		**COMF.**	
Working hours =1 If farmer works in excess of 50 hours per week (includes off farm employment)			0.333
Experience of Stress =1 if farmer has experienced any stress from their farm business within the past 5 years			0.333
Sense of Security =1 of farmer reports a deterioration in their sense of security within the past 5 years			0.333

[5] As two of the indicators within the Community and Social Connections dimension (CONN) (i) Social Interaction and (ii) Access to Services, incorporated multiple variables (two and five variables, respectively, reflective of their multi-dimensional characteristics), the weighting of each variable was equally distributed within the indicator (0.1665 for the two variables composing the Social Interaction indicator, and 0.0666 for the five variables composing the Access to services indicator).

Equal weighting was applied to each dimension, ensuring an unbiased contribution of each to the index, and that no dimension was given precedence over another, following the approach of the OECD Better Life Index, The Human Development Index and Abreu et al. (2019)'s Rural Development Index. The binary nature of the values used to calculate the index provide a range of values between 0 and 1, with the weights of the variables adjusting the final values in the dimensions between 0.001 and 1.000. As the variables were presented in a pessimistic perspective, reverse coding was applied, with a score of 1.000 assigned to the optimum outcome, and 0.001 to the least optimal. As each indicator was extracted from the NFS database in binary format, standardisation of the data was not required. Finally, to help address issues of compensation within the index (i.e low scores in one dimension being offset by higher scores in another), the geometric mean, rather than the arithmetic mean, was used to aggregate the dimensions within the index. With the geometric mean, a farm with considerably lower values in a dimension will have its index score penalised, instead of having the final score offset by a higher score in another dimension (as occurs with arithmetic mean) (Greco et al., 2019). The underlying concept is that a high level of sustainability cannot be considered if a poor score is returned in one or more dimensions, and is an important characteristic given the equal weighting of the dimensions within the index (Abreu et al., 2019).

The aggregation of the Farmer Sustainability Index (hereafter referred to as FSI) was thus determined as:

$$\text{FSI}= \sqrt[3]{(1-CONT)}\ X\ \sqrt[3]{(1-CONN)}\ X\ \sqrt[3]{(1-COMF)}$$

Hereafter, the scores for the three dimensions will be labelled as thus: *farm continuity,* $\text{CONT}_{\text{inv},}$ *community and social connections*, CONN_{inv} and *farmer comfort*, COMF_{inv}, where inv. refers to the inverse score. Therefore, the closer the dimension scores and the FSI values are to 1.000, the higher the level of sustainability for the farmer in question.

6.3.3. Statistical Analysis

Statistical analysis was undertaken to compare the distribution of FSI and the individual dimension scores for *farm continuity* ($CONT_{inv}$), *community and social connections* ($CONN_{inv}$) and *farmer comfort* ($COMF_{inv}$) for farms across three socio-demographic variables; (i) Farm System, (ii) Farmer age cohort and (iii) Farm Regions (see Table 6.2 for descriptive analysis). Statistical analyses were performed using IBM SPSS 27, and survey data was weighted. When the weighting factors are applied, the sample of 722 farms represents a population of 73,221 Irish farms[6]. A test for normality demonstrated that the FSI and dimension scores for each of the three variables were not normally distributed, verified by means of a Kolmogorov–Smirnov test with Lilliefors Significance Correction ($p < 0.05$ for each of the three variables). Therefore, a non-parametric test, the Kruskal-Wallis H test, was selected, supplemented with post hoc Dunn's exploratory analysis with Bonferroni correction. For each statistic of the Kruskal Wallis tests, coefficient of effect size, $\eta 2$, was calculated. The results of these analyses are presented in the next section.

[6] The weighting procedure is agreed with the Farm Accountancy Data Network of the EU and uses data from the Irish census of agriculture operated by the Central Statistics Office (CSO).

Table 6.2. Descriptive analysis of the socio-demographic variables

Socio-demographic Variables		Frequency (N)	% of distribution*
Farm System	Dairy	271	19.2
	Cattle	305	58.9
	Sheep	98	15.2
	Tillage	48	6.7
Farmer Age Cohort	Young (≤ 40 years of age)	68	8.4
	Mid Age (41-60 years of age)	353	41.8
	Older (>60 years of age)	301	49.8
Farm Region	Border (Reg.1)	131	23.4
	Dublin and Mid East (Reg. 3)	73	8
	Midlands (Reg. 4)	104	14.9
	Mid-West (Reg. 5)	72	9.4
	South-East (Reg. 6)	148	19
	South-West (Reg. 7)	113	11.8
	West (Reg. 8)	81	13.5

***Weighted distribution**

6.4.Results

A Kruskal-Wallis (K-W) test was conducted to determine if there were significant differences in FSI scores and $CONTi_{nv}$, $CONN_{inv}$ and $COMF_{inv}$ dimension scores between the socio-demographic variables of (i) Farm System, (ii) Age Cohort and (iii) Farm Region. The results of these analyses are presented in Table 6.3, along with mean values and standard deviations. We first present the results of the FSI, followed by an analysis of the dimension scores for ($CONT_{inv}$), ($CONN_{inv}$) and ($COMF_{inv}$).

Table 6.3. Mean values and standard deviation (in parentheses) for the Farmer Sustainability Index and dimensions, by independent variables

	$CONT_{inv}$	**$CONN_{inv}$**	**$COMF_{inv}$**	**FSI**
All Farms	0.738 *(0.284)*	0.687*(0.188)*	0.582 *(0.301)*	0.590 (*0.234)*
Farm System				
Dairy	0.884 (*0.201)*	0.731 (*0.140)*	0.463 (*0.313)*	0.581 (*0.268)*
Beef	0.699(*0.296)*	0.666 (*0.203)*	0.573 (*0.292)*	0.566 *(0.229)*
Sheep	0.667 (*0.274)*	0.686 (*0.176)*	0.743 (*0.237)*	0.653 (*0.184)*
Tillage	0.826 (*0.221)*	0.747 (*0.174)*	0.627 (*0.307)*	0.672 (*0.224)*
K-W Test	$\chi2(3) = 6038.599$, $p < 0.001$, $\eta^2 = 0.082$	$\chi2(3) = 1388.389$, $p < 0.001$ $\eta^2 = 0.019$	$\chi2(3) = 5564.801$, $p < 0.001$ $\eta^2 = 0.076$	$\chi2(3) = 2248.720$, $p < 0.001$ $\eta^2 = 0.031$
Age Cohort				
Young	0.896 *(0.202)*	0.747 *(0.148)*	0.534 *(0.283)*	0.644 *(0.228)*
Mid	0.892 *(0.179)*	0.719 *(0.173)*	0.523 *(0.304)*	0.625 *(0.244)*
Older	0.581 *(0.281)*	0.650 *(0.199)*	0.638 *(0.290)*	0.551*(0.219)*
K-W Test	$\chi2(2) = 22950.783$, $p < 0.001$ $\eta^2 = 0.314$	$\chi2(2) = 2481.418$, $p < 0.001$ $\eta^2 = 0.034$	$\chi2(2) = 2507.360$, $p < 0.001$ $\eta^2 = 0.034$	$\chi2(2) = 4149.267$, $p < 0.001$ $\eta^2 = 0.057$
Region				
Border	0.708*(0.301)*	0.644 *(0.186)*	0.572 *(0.311)*	0.544 *(0.249)*
Dublin & Mid-East	0.779 *(0.245)*	0.713 *(0.187)*	0.533 *(0.289)*	0.597 *(0.195)*
Midlands	0.683 *(0.296)*	0.647 *(0.221)*	0.673 *(0.269)*	0.614 *(0.204)*
Mid-West	0.817 *(0.255)*	0.684 *(0.195)*	0.560 *(0.290)*	0.597 *(0.244)*
South-East	0.776 *(0.254)*	0.719 *(0.155)*	0.602 *(0.286)*	0.640 *(0.211)*
South-West	0.807 *(0.242)*	0.733 *(0.173)*	0.416 *(0.318)*	0.520 *(0.280)*
West	0.656 *(0.310)*	0.705 *(0.180)*	0.655 *(0.268)*	0.621 *(0.208)*
K-W Test	$\chi2(6) = 2587.817$, $p < 0.001$ $\eta^2 = 0.035$	$\chi2(6) = 2483.104$, $p < 0.001$ $\eta^2 = 0.034$	$\chi2(6) = 4216.903$, $p < 0.001$ $\eta^2 = 0.058$	$\chi2(6) = 1990.999$, $p < 0.001$ $\eta^2 = 0.027$

K-W test= Kruskal Wallis

6.4.1 Distribution of Farmer Sustainability Index

The distributions of FSI scores were statistically significantly different within each of the socio demographic variables analysed, ($p < 0.001$). Post hoc analysis revealed statistically significant differences in FSI scores between each farm system and each age cohort, ($p<0.001$) while significant differences were observed between the FSI and farm regions, with the exception of South-West and Border, Midlands and Mid-West and Mid-West and West.

Differences between the groups for farm system found tillage farmers had significantly higher FSI scores (Mean *(hereafter referred to as M)* =0.672, Standard Deviation *(hereafter referred to as SD)* =0.224) compared to sheep farmers (M=0.653, SD=0.184), dairy farmers (M=0.581, SD=0.268) and cattle farmers (M=0.566, SD=0.229). Although statistical significance was observed, the mean difference between each group in the farm system was quite small, as determined through the effect size ($\eta 2$ =0.031). Young farmers returned significantly higher FSI scores (M=0.644, SD=0.228), compared to farmers of middle age (M=0.625, SD=0.244) and older farmers (M=0.551, SD=0.219), with a close to medium level effect size observed ($\eta 2$ =0.057). Farmers located in the South-East region returned the highest FSI scores compared to other regions, (M=0.640, SD=0.211), followed by farmers living the West (0.621, SD=0.208), while the lowest FSI scores were attained by farmers living in the South-West (M=0.520, SD=0.280) and Border regions (M=0.544, SD=0.249).

6.4.2 Distribution of sustainability dimensions

The distributions of scores were statistically significantly different across each of the socio demographic variables analysed for each of three dimensions of the FSI, $CONT_{inv}$, $CONN_{inv}$ and $COMF_{inv}$ ($p < 0.001$ for each dimension). Post hoc analysis revealed statistically significant differences between the three dimensions and each of the groups within the farm system and each group in the age cohort ($p<0.001$), while significant differences were observed across the seven regions and each of the three dimensions, ($p<0.001$), with the exception of Dublin–Mid-East and South-East in both the $CONT_{inv}$ and $CONN_{inv}$ dimensions, and the Mid-West and Border in the $COMF_{inv}$ dimension.

$CONT_{inv}$ dimension: Dairy farmers returned the highest $CONT_{inv}$ score (M=0.844, SD= 0.201) compared to other farm systems, with farmers in the sheep sector recording the lowest continuity score (M=0.667, SD=0.274), with a medium effect size observed ($\eta2$=0.082). Both young and middle age farmers recorded similarly high scores within the $CONT_{inv}$ dimension (M=0.896, SD=0.202 and M=0.892, SD=0.179 respectively), compared to the low score calculated for older farmers (M=0.581, SD=281), with a large effect size observed ($\eta2$ = 0.314). Farmers residing in the Mid-West and South-West regions recorded the highest $CONT_{inv}$ scores (M=0.817, SD=0.255 and M=0.807, SD=0.242 respectively), with those located in the West region returning the lowest score for farm continuity (M=0.656, SD=0.310).

$CONN_{inv}$ dimension: The scores outlined in Table 6.3 demonstrate that social isolation and difficulty in accessing public and essential services was most problematic amongst farmers working in the cattle sector (M=0.666, SD=0.203), older farmers (M=0.650, SD=0.199) and farmers who reside in the Border (M=0.644, SD=0.186) or Midlands (M=0.647, SD=0.221) regions. Tillage farmers recorded the highest scores in this dimension (M=0.747, SD=0.174), along with younger farmers (M=0.747, SD=0.148) and those residing in the South-West (M= 0.733, SD=0.173) and South-East (M=0.719, SD=0.155) regions.

$COMF_{inv}$: Sheep farmers returned the highest score for farmer comfort across all farm systems (M=0.743, SD=0.237), while farmers working in the dairy sector recorded the lowest $COMF_{inv}$ score (M=0.463, SD=0.313), with a medium effect size observed ($\eta2$ =0.076). Older farmers recorded the highest $COMF_{inv}$ scores (M=0.638, SD=0.290), while middle aged farmers returned the lowest score (M=0.523, SD=0.304). With regards to farmer comfort and location, farmers residing in the Midlands and West recorded the highest $COMF_{inv}$ scores (M=0.673, SD=0.269 and M=0.655, SD=0.268 respectively), with those living in South-West recording the lowest $COMF_{inv}$ scores of all (M=0.416, SD=0.318), with a close to medium level effect size observed ($\eta2$ =0.058).

6.5 Discussion

The Farmer Sustainability Index (FSI) and those of its component dimensions demonstrate that considerable differences exist across the levels of social sustainability experienced by farmers with respect to specific socio- demographic characteristics, namely the type of farm operated, the age cohort of the farmer and the region in which they live. Drawing on the results outlined in Table 6.3, the FSI indicates that the highest level of social sustainability was recorded by farmers working in the tillage sector, by farmers under the age of 40, and by farmers living in the South-East and West regions of Ireland. Conversely, the poorest levels were associated with cattle farmers, with farmers over the age of 60 and with farmers living in the South-West and Border regions. Several factors may account for this socio-demographic disparity in social sustainability. Examining the FSI from a financial perspective, the income performance from the tillage sector has remained strong in comparison to dry stock farm systems, with tillage farmers experiencing an increase in average income in 2018, up 13 percent year on year, and second only to the dairy sector (Dillon et al., 2019). Conversely, 40 percent of cattle farm households were categorised as being economically vulnerable in 2018, that is, the farm was not financially viable and neither the farmer nor their spouse had off farm employment. In addition, 53 percent of older farmer households were categorised as economically vulnerable, in comparison to 17 percent of younger farmers and 18 percent of middle aged farmers, while 43 percent of farm households in the Border region were classified as vulnerable, the highest across all regions.

Although cattle and tillage farmers experienced similar proportions of farm level stress (55.4 percent and 56.7 percent respectively), a higher proportion of cattle farmers experienced a deterioration in their sense of security compared to tillage farmers (37.5 percent and 20.8 percent respectively) while 34 percent of cattle farmers recorded working in excess of 50 hours per week, compared with 27 percent of those in the tillage sector. Interestingly, however, risk to generational renewal was higher for tillage farmers compared to those in the cattle sector; 22 percent of tillage farmers over the age of 60 disclosed that they had not identified a farm successor, compared with 18.5 percent of cattle farmers in the same cohort.

Notwithstanding the capacity of the FSI in highlighting farms with high or low levels of sustainability, it is important also to consider the variation in scores across the different FSI dimensions, and how these differ in relation to enterprise, age and region. These scores can present a more nuanced perspective to a specific attribute of sustainability, one which considers farm continuity and generational renewal, or social interaction and access to services or occupational wellbeing and quality of life.

Dairy farmers and young and middle aged farmers returned the highest scores regarding farm business continuity, a dimension which incorporated variables examining the economic vulnerability of the household, plans for business continuity and farm succession, while sheep farmers and older farmers recorded the lowest scores. The higher scores attained by dairy farmers in this dimension is unsurprising, as dairy farms consistently return higher family farm income levels compared other farm enterprises in Ireland (Dillon et al., 2019); conversely, 48% of sheep farmers were categorised as 'economically vulnerable' in 2018. The higher scores achieved by younger and middle age farmers in this dimension is anticipated, given the distinction that farmers over the age of 60 are more likely to consider retirement in the short to medium term future, and that the variable assessing risk to generational renewal was considered only for farmers over 60 years of age with no identified successor. This also accounts for the large effect size measured within the age cohort group for this dimension.

The community and social connections dimension revealed that issues of isolation and difficulty in accessing different public services was most prevalent amongst farmers in the cattle sector, by older farmers, and farmers who reside in the Border region. This lower level of social sustainability amongst older farmers corroborate the findings of Dillon et al. (2017)

which showed that small scale farmers over the age of 60 were more likely to report difficulty accessing services than their younger counterparts, with risk of isolation also increasing with age. The geographical variation is unsurprising, given the particularly rural characteristics of the Border region, which has been challenged by socio-economic barriers and poor economic cohesiveness over many decades, compounded in part by persistent weaknesses in infrastructural development (Border Regional Authority, 2010). Such infrastructural weaknesses include inferior access to different public and essential services in comparison to more urban regions, indeed the ability to access public transport was identified as a major limitation to a positive quality of life for residents in rural areas in Ireland, as was the distance to and/or absence of health services and local amenities (Brereton et al., 2011).

Sheep farmers recorded the best levels of sustainability in the farmer comfort dimension, which assessed elevated working hours, experience of stress and deterioration in sense of security, while dairy farmers returned the lowest score. Dairy farmers experienced the highest level of occupational stress and long working hours, and were second only to cattle farmers regarding a deterioration in their sense of security, while sheep farmers recorded the highest scores for each variable in this dimension. This finding is in line with previous research examining the work life balance of farmers working in these particular sectors. Muri et al. (2020) reported that sheep farmers in Norway recorded high levels of satisfaction with their job, and that their intrinsic or non-pecuniary motivation was higher than extrinsic motivation, which suggested that sheep farmers overall are more driven by the performance of the farm related activities and lifestyle, rather than by instrumental, or financial rewards. Brennan et al. (2021b) report that that the probability of experiencing stress is higher for farmers working in the dairy, cattle and tillage sector compared with sheep farmers, and dairy farmers are more likely to experience stress from workload than other farm system. Indeed, output and average herd size have increased significantly for Irish dairy farms over the past 5 years (Dillon et al., 2019) following the removal of the EU milk quotas in 2015, with 54 percent of dairy farmers working in excess of 50 hours per week, the highest across all farm systems. Farmers over the age of 60 returned the highest values regarding farmer comfort compared to younger farmers, along with farmers residing in the Midlands and West, while farms located in the South-West region returned the lowest scores for farmer comfort by a substantial margin. Examining the constituent variables in more detail, it is observed that 54 percent of farmers in the South-West reported working over 50 hours per week, 72 percent reported experiencing stress and 48 percent reported a deterioration in their sense of security over the past 5 years, returning the poorest result for each variable across all regions.

Overall, we find that when all dimensions of the FSI are considered, cattle farmers, older farmers and those located in Border and South-West regions experience lower levels of social sustainability. Indeed, these results accentuate many of the occupational and community wellbeing concerns impacting the farming sector, as highlighted by Brennan et al. (2020). While dairy farmers attain the best scores in regards to farm continuity, they return the lowest levels of sustainability when factors relating to work life balance are considered, a finding also mirrored within the 'younger farmer' cohort. Moreover, poor levels of sustainability were recorded by farmers located in more geographically isolated regions when matters concerning farm continuity and social connections were examined. Indeed, the variation in scores within the farm continuity dimension highlight a potential risk to the continuation of the family farm in different regions and systems, in particular sheep and cattle enterprises, and farms located in the West and Midlands regions.

6.5.1. *Limitations and further research*

The FSI provides a comprehensive assessment of farmer's social sustainability, although the use of composite indices is not without its limitations. Composite indicators meet the need for consolidation, combining a plethora of indicators into a number that surmises all the information (Greco et al., 2019), although the issue of compensation can be problematic, particularly when the weight of each dimension or variable is equally contributable and provides a specific facet of information to the final index. Applying a geometric, as opposed to a linear aggregation technique for the FSI helped to negate this compensation issue. Rather than offsetting a poorer score in one dimension with a higher score in another, geometric aggregation demonstrably adjusted the final index score in line with lower results attained in any dimension. This procedure ensures that the FSI is more cognisant to the variation in scores across the dimensions, and ultimately ensures that a farm which recorded a poor result from any one of the three dimensions could not compensate their overall sustainability score with better results from another. This resulted in a more holistic and accurate sustainability assessment.

While the additional survey facility within the NFS provided a robust method of gathering data on subjective variables, (ability to access services, sense of security, experience of stress and presence of successor), its one time collection limits the analysis to a single year. The conventional FADN survey methodology is not overly conductive to collating data on farmer wellbeing and matters pertaining to social sustainability, particularly in consideration of more sensitive issues, e.g. personal health or the quality of social relations. The development of the proposed Farm Sustainability Data Network as identified within the EU Farm to Fork strategy (Matthews et al., 2020a) highlights the need to strengthen capacity in this regard and indicators more cognisant with farm level social sustainability are necessary in the context of the new CAP. With this in mind, and given the variance of levels measured across the FSI and constituent dimensions, this study recommends the inclusion of more subjective and socially motivated questions within the core NFS and FADN dataset. Identifying recurring issues impacting the social sustainability of farmers will assist policy makers in developing strategic supports for the industry, whilst also taking into consideration the variance of sustainability factors impacting different farm sectors, and will help to improve resilience.

6.5.2. FSI and Policy implications- Supporting the implementation of the new CAP

Key reforms within the new CAP aim to ensure that European farming is fair, sustainable and competitive, and several of the new objectives outlined within the reformed CAP, namely the preservation of landscapes and biodiversity, generational renewal, rural viability, and food & health resonate with the social dimension of sustainability. The CAP 2023-2027 aims to place a greater focus on fairness for those employed in the farming sector, such as targeted income support for small to medium sized family farms, redefining what constitutes an 'active farmer', and that part-time farmers or pluri-active farmers (those also employed off farm) are not unfairly excluded from support structures. A new social conditionality mechanism with the reformed CAP aims to devise directives on more transparent and predictable employment conditions for farm workers, and ensure on farm health and safety regulations are enforced (European Commission, 2019). An additional objective within the reformed CAP include promoting generational renewal, and highlights stronger supports for younger farmers, through income, investment or start-up funding supports (European Commission, 2019e). Furthermore, the CAP aims to promote employment, growth, social inclusion and local development in rural areas, and recognises the importance of addressing the rural/urban divide and issues of basic service provisions, and making rural habitation more viable and appealing for younger generations (European Commission, 2019b).

It is necessary for policymakers to examine social matters and farmer wellbeing from a holistic sustainability perspective. However for policy to meaningfully address matters pertaining to social sustainability, particularly in appreciation of its subjective nature, it may be more prudent and effective to streamline the focus and to tailor policy targets in consideration to issues impacting farmers with differing socio- demographic constructs. As evident from the FSI scores and those of its constituent dimensions, levels of social sustainability for farmers vary considerably by farm system, by age group and by region, and as such, it would be remiss of policy to overlook the underlying factors driving these differences. Specific potential risks to the sustainability of different cohorts of farmers can be readily identified from the dimension scores constituting the FSI, whether there lies a potential risk to the continuation of the family farm, or to the work-life balance of the farmer, or whether the farmer is liable to experience isolation and poor social connections, and whether these risks may be exacerbated by the farms socio-demographic structure. The socio-demographic analysis of farmer well-being complied by this study highlight key priority areas for well-being at the farm level, and demonstrates the benefits of utilising a national level assessment framework to provide data to a European level. This index, along with an examination of its more disaggregated dimensions, provides an effective tool to assist researchers and policy makers to determine underlying risk factors impacting different sectors and regions of the agricultural system in Ireland. Indeed, with minimal modifications, this FSI may be adapted for use by other territories which employ FADN/FSDN data. Furthermore, this index could also potentially assist in monitoring progress towards the newly established CAP objectives, particularly in the areas of generational renewal, rural viability and supports for small to medium farmers, and this study recommends more frequent collation of subjective indicators, namely access to services, experience of stress and plans for succession to facilitate this.

6.6 Conclusions

At this juncture, a gap exists between policy priorities and the data infrastructure required to develop metrics for social sustainability evaluation at the farm level. This study aims to address this knowledge gap, and to improve the measurement and monitoring of agricultural social sustainability, through the development of a composite index, the FSI. We find that farmers working in the cattle sector, older farmers, and those residing in regions with poorer infrastructure experience lower levels of social sustainability in comparison to other farmers. Examining the variation in the FSI dimension scores by the farms socio-demographic construct highlight numerous wellbeing and quality of life concerns existing within different farm systems, regions and age cohorts, and that high levels of sustainability attained in one element may not necessarily resonate throughout the farm system. Moreover, this index can assist in identifying potential risks to farmers, with issues relating to generational renewal and the continuation of the family farm, work-life balance, and poor social connectivity more effectively determined.

It is vital that monitoring frameworks are in place to audit the progression of EU agricultural policies, particularly for those within the evolving social realm, to ensure new policies are effectively implemented for those farmers they are designed to help. This Farmer Sustainability Index and its constituent dimensions can provide an effective method to help assess the success of policy in this regard, and can provide key social sustainability data for the planned Farm Sustainability Data Network, and the final chapter delves into this matter in greater detail. Moving forward, the following chapter of this thesis focuses on Community Wellbeing, the assessment of which will facilitate a more holistic measurement of agricultural social sustainability.

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Cartlann Taighde Oscailte Chorcaí

Brennan, M. 2022. Developing indicators of the social sustainability of farming using the Teagasc National Farm Survey. PhD Thesis, University College Cork.

Please note that Chapters 7 & 8 (pp. 142-199) are unavailable due to a request by the author.

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Chapter 9. Conclusions

9.1. Introduction

The objective of this thesis is to contribute to the measurement of social sustainability at the farm level and to expand the current suite of sustainability indicators with those more cognisant of evolving policy themes and drivers impacting Irish and European agriculture. Indicator design is an iterative process and as such, dimensions relating to both internal social sustainability (such as farmer wellbeing) and external social sustainability (such as animal health and welfare and community wellbeing) should be considered. This final chapter highlights the contribution of this thesis to the development of social sustainability indicators at the farm level, with consideration primarily given to the collection of relevant data through the EU FADN.

The following sections provide an overview of the research findings, taking account of the three dimensions of wellbeing which have emerged, namely: *farmer, animal* and *community*. Chapter 3 expands upon the internal and external dimensions of agricultural social sustainability, characterised through the works of Van Calker et al. (2005) and Van Cauwenbergh et al. (2007), and establishes a *'wellbeing'* triad to better interpret and assess the subjective nature of social sustainability. Segregating these dimensions across animal wellbeing (Chapter 4), farmer wellbeing (Chapters 5 and 6), and community wellbeing (Chapter 7) provides a more holistic and in-depth assessment of the levels of social sustainability reported across farms and by farmers and their households. At a more aggregate level, the potential trade-offs and synergies existing between the Farmer Sustainability Index (FSI) devised in Chapter 6, with a number of economic and environmental sustainability indicators are examined in Chapter 8. Arising from these findings, recommendations for data collection, policy design and future research are then presented.

9.2. Contribution of the Research

The following section provides a summary of the contribution of this research, with an overview of the main findings from each chapter presented. There follows a discussion on the implications of the research for the design of relevant policy and the additional data required. Opportunities for further research are also considered.

9.2.1. Dimensions of Social Sustainability

The subjectivity inherent within social sustainability makes measurement relatively more complex than that of economic and environmental sustainability where quantitative metrics are more evident. To mitigate this challenge, and informed by the literature, Chapter 3 categorised social sustainability into dimensions reflecting farmer, animal and community wellbeing. A stakeholder consultation process was then implemented to inform the prioritisation of relevant thematic areas and the identification of potential farm level indicators and the relevant data required. This facilitated the design of a supplementary survey relating to social sustainability which was conducted through the Teagasc NFS in 2018.

9.2.2. Animal Wellbeing

External aspects of social sustainability include broader societal concerns around the influence of agricultural production and farm management on animal health and welfare. In this regard, the recent EU Farm to Fork Strategy aims to accelerate the transition to a more sustainable food system, ensure high standards of animal welfare, facilitate a reduction in agricultural greenhouse gas emissions, and protect biodiversity. Indeed, the strategy informed several of the objectives of the CAP 2023-2027, namely climate change action, environmental care, and the need to protect food quality and health standards. Indeed these objectives relate to more than one dimension of sustainability, and overlap between environmental and social dimensions.

While the FADN does not explicitly collect animal based wellbeing measures, such as body condition score, a number of proxy wellbeing indicators (e.g. somatic cell count, days at grass, calf mortality rate etc.) exist within the dataset to enable the derivation of appropriate measures. As such, a composite indicator of dairy cow welfare (DCWI) was devised to assess welfare levels on Irish dairy farms utilising routinely collected data at the herd level. The results indicate that dairy cow welfare has remained relatively stable through the recent expansion of the dairy sector in Ireland, in preparation for and in the aftermath of milk quota abolition. In addition, the DCWI indicates that farms who opted to significantly increase their milk output from 2014 to 2017 demonstrated improved welfare standards over the period. In addition, no adverse trade-offs were observed between farms recording higher DCWI scores and economic and environmental sustainability indicators i.e. dairy gross margin, family farm income and greenhouse gas emissions, thus suggesting synergies between economic, environmental and animal welfare performance.

It is important to note that the availability of relevant data has limited the scope of the welfare measures used in the composite indicator. As a result, it is not yet possible to explore equivalent welfare standards on non-dairy farms, or indeed to develop animal based indicators for any of the livestock systems. Although it is noted that animal-based indicators are generally considered more insightful than the herd-level indicators designed here. That said, this thesis contends that the insights provided by linking animal welfare indicators to a wider set of multidimensional sustainability indicators for a representative farm sample over an extended period of time have offset many limitations. Indeed, examining the interactions between the DCWI (social) and other (economic and environmental) sustainability indicators allows for a more comprehensive evaluation of farm sustainability than would otherwise be possible. Nevertheless, in order to gain a more thorough assessment of animal wellbeing, additional data will be required for future research.

9.2.3. Farmer Wellbeing

Consultation with stakeholders, through a series of semi-structured interviews, identified a number of key priority areas relating to the social sustainability of agriculture. In relation to those aspects pertaining to farmer wellbeing, factors included physical and psychological wellbeing and concerns surrounding farm succession and generational renewal. An overview of the findings from this stakeholder engagement is contained in Chapter 3.

Data collected on farmer self-reported stressors relating to the farm business was then analysed in Chapter 5. The aim was to identify the prevalence of farm related stress on Irish farms, and investigate differences across farm systems, regions, and other farmer/household characteristics such as age profile, agricultural training etc. This resulted in the identification of key stressors such as inclement weather, excess workload and farm related financial pressures. Data analysis also indicated that dairy farmers were more likely to experience farm related stress relative to operators of other farm systems (cattle, sheep and tillage). This chapter concluded that occupational stressors impacting farmer wellbeing are multi-faceted, are influenced by both internal and external pressures, and can vary according to enterprise type and other pertinent farm characteristics and household demographic factors.

A composite index of (farmer) social sustainability (FSI), including elements of farmer wellbeing[14] was developed in Chapter 6. This provides an insight into the farmer related dimension of social sustainability through the collection and collation of metrics additional to those routinely collected through the FADN (and NFS). The index is reflective of aspects relating to: (i) *farm continuity*, (ii) *community and social connections* and (iii) *farmer comfort* (see Table 6.1 in Chapter 6 for a full description of these dimensions and the indicators analysed).

Interpretation of the FSI across farms indicate that those farmers working in the cattle sector, of older age profile, and residing in more economically disadvantaged and peripheral regions experience relatively lower levels of social sustainability in comparison to other farmers.

Composite indices are an effective tool in helping to summarise and simplify complex information, although it is also important to consider the individual components comprising the index. [15] The individual dimensions of the FSI help to identify underlying factors driving the scores, and assist in highlighting the complexities surrounding farmer wellbeing levels owing in particular to the heterogeneity of farm enterprises. As such, the analysis undertaken here reveals the variation in responses across these individual metrics and how they influence the overall index. For example, relative to other farm systems, dairy farmers returned the highest scores relating to farm business continuity, but the lowest scores with regard to work/life balance. The opposite result was observed for sheep farmers. This is reflective of the underlying economic and socio-demographic attributes of the different farm systems and farm households, and highlights the fact that the implementation of a *one size fits all* policy approach in the pursuit of improved social sustainability would have limited success.

[14] Although the collected data provides insight into farmer wellbeing, owing to the broad nature of wellbeing, and data limitations within the FADN dataset, the FSI could not provide an all-inclusive assessment on farmer wellbeing.
[15] An overview of the limitations and advantages of composite indicators is contained in chapters 4 and 6.

9.2.4. Community Wellbeing

Agriculture, by virtue of its multifunctional nature, contributes significantly to the wellbeing of local communities by providing public goods and maintaining eco-system services, as well as supporting a diverse range of auxiliary industries through the use of inputs and the production of agri-food outputs. Relatedly, the vitality of rural areas and the wellbeing of communities in turn have an effect on the viability of farms and the attractiveness of farming as a way of life. With reference to these aspects of social sustainability, *Community Wellbeing* was assessed in Chapter 7 with farm level indicators which measured (i) *multifunctionality, (ii) heritage and culture, and (iii) access to services* (see section 7.3 in Chapter 7 for an overview of these dimensions). Given the availability of data through the FADN/NFS frameworks, community wellbeing is assessed from the perspective of the farm holder and at a regional level.

More generally, the results point to the important economic influence of farmers in their communities. As is evident from the estimated expenditure analysis, (see Table 7.2 in Chapter 7) farmers contribute significantly to the local, regional and national economy. If farms located in more marginal or economically disadvantaged areas are lost, either through destocking or land abandonment, this will have serious ramifications for community wellbeing.

Results show that community wellbeing varies by region, with communities in the Border and West performing less well compared to other regions. Numerous issues may contribute to this, but the predominance of low income drystock farming in these regions is a contributing factor. Furthermore, farmers in the Border region report the greatest level of difficulty in accessing public and essential services. While maintaining the family farm can assist in sustaining community wellbeing and help preserve the legacy, culture, and agricultural traditions of rural areas, as well as quality of life, access to services and off-farm employment opportunities in these areas, it is also likely to impact young people's decision to farm. Taking all of these aspects into account, this thesis postulates that it is critical to incorporate an assessment of community wellbeing into a broader agricultural sustainability assessment, given that farming both contributes to, and is influenced by community welfare.

9.3. Trade-offs and synergies between Social, Economic and Environmental Sustainability Dimensions

An assessment of the interactions between farm level social sustainability and a number of economic and environmental indicators from the Teagasc NFS was presented in Chapter 8. A correlation analysis with the newly developed FSI and the selected indicators demonstrates evidence of trade-offs and synergies across agricultural sustainability dimensions. While the analysis demonstrates evidence of synergies existing between social and economic sustainability in particular, these differ by farm system and region. Moreover, trade-offs are observed between environmental and social sustainability for drystock farms, however this is not observed for dairy or tillage enterprises, nor in regions where these enterprises are dominant. Indeed, this further emphasises the complexity surrounding social sustainability at the farm level, as already demonstrated by the variation observed within the sub-components of the FSI across farm systems and regions.

This thesis demonstrates that while some farms may achieve *'win-win'* strategies across some dimensions of sustainability, e.g. environmental and social sustainability on tillage farms, the opportunity for farms to achieve the optimum *'win-win-win'* strategy across all three dimensions appears more challenging based on this research.

9.4. Recommendations for Policy and Data Collection

In this section, the alignment between numerous agricultural and rural policy objectives and the social sustainability indicators devised in this thesis are discussed. Firstly, it is important to understand the dynamics that exist between effective policy interventions and their target group, and the importance of representative sustainability indicators.

9.4.1. The dynamics of policy intervention

Policy indicators remain largely ambiguous with regard to their patterns of embeddedness in institutional decision-making processes (Sébastien and Bauler, 2013), therefore it is essential to comprehend the complexities surrounding the influence of policy with sustainability indicators. Research by Frederiksen et al. (2020) found that linking indicators to clear policy targets increased the likelihood of their utilisation, and policies which are supported by monitoring, reporting and dissemination systems may enhance the influence of the indicators in policy processes. Moreover, this research also highlighted the importance of clearly identifying the target group for the intended users of indicators, and the importance of proximity between to the producers and users of indicators to enhance trust and understanding for the issues at hand. Indeed, high-level objectives at a European level defined for application in the management of national programmes may satisfy required use for compliance, but may have little impact at a national level if they fail to address local priorities. This connects back to linking capital within the wider social capital concept as discussed in Chapter 2; whereas bonding and bridging social capital refer to 'horizontal' social networks and relationships, linking social capital reflects how communities are 'vertically' networked with institutions and political structures(Arnott et al., 2021). Hall and Pretty (2008) found that farmers with higher linking social capital progressed faster in their personal transition to more sustainable land management practises than farmers with low linking social capital who felt disempowered and averse to contact with government agency staff.

Aligned with this issue of poor linking capital is the matter of the generic, or '*one size fits all'* nature of agricultural policy design (NESC, 2003) which can leave farmers with little flexibility, and often prevents them utilising generations of local knowledge (Arnott et al., 2021). This, in turn, creates barriers between farmers and policy makers/researchers, further hindering the quality of linking capital. To negate this issue, policymakers must take into account the complex and deeply socialised understandings and knowledge cultures of farmers in order to comprehend their potential role in future rural management (Arnott et al., 2021, Riley, 2008). This is a key motivating factor for this body of work; the provision of more holistic indicators that measure farmer, animal and community wellbeing will enhance the assessment of social sustainability, by relaying a more representative, farm level interpretation of sustainability. Moreover, for more effective measurement, it is advantageous for policy interventions to be easily quantified; indeed many of the agricultural and rural development objectives discussed in the following sections are readily assessed through the robust data management infrastructure of the FADN and NFS datasets.

In the following sections, key recommendations for the collection of social sustainability indicators are discussed, cognisant with the societal objectives of agricultural and rural policy interventions.

9.4.2. The FADN should be broadened to better take account of social sustainability to assist in its transition to the FSDN.

A key finding from this thesis is that the development of social sustainability measures for agriculture will greatly enhance the achievement of numerous agricultural policy objectives. Many of the aims to improve the sustainability of agricultural and food production systems outlined in the CAP 2023-2027 and the EU Farm to Fork Strategy are implicitly connected to social sustainability, as such there exists a need for harmonised indicators to monitor and evaluate progress towards policy targets. A key strength of the FADN framework is the provision of a co-ordinated platform for the collection of directly comparable farm statistics by each Member State, one supported by a rigorous data management and validation infrastructure. The FADN has been instrumental in the development of economic indicators that can assist in the assessment of farm-level sustainability, and more recently, many national initiatives have utilised the FADN platform to collect additional supplementary data on environmental sustainability. The social dimension of sustainability has however been relatively neglected on a wider scale (outside of demographic data pertaining to the household, for example). This is due, in some part, to difficulties in the creation, incorporation, implementation and collection of appropriate indicators through the FADN. As highlighted throughout this thesis, the collection of social sustainability metrics can pose a challenge for data collection, given its subjective nature and to an extent, its sensitive subject matter. To mitigate this, the collection of social sustainability data necessitates a degree of trust and respect between the farmer providing the data and the data recorder collecting it (In Ireland, NFS data is collected and validated by a team of dedicated farm recorders).This thesis supports the research of Herrera et al. (2016c) and Poppe and Vrolijk (2016) finding that, with modifications, the FADN framework retains the ability to effectively assess and collect social sustainability metrics for European farms. This is notably advantageous as the FADN transitions to the FSDN.

9.4.3. The monitoring of social metrics can help to achieve the objectives of the EU Farm to Fork Strategy

The Farm to Fork Strategy aims to support an accelerated just transition to a more sustainable food system that benefits both farmers and consumers in Europe. It focuses on critical issues, in particular those relating to the environment. From a social sustainability perspective, the Farm to Fork Strategy recognises the importance of a broad range of social sustainability measures, such as promoting higher animal welfare standards, as well as investing in rural broadband infrastructure to aid in the mainstreaming of precision farming technologies and improving residents' quality of life, to mention just two. This thesis postulates that viable animal welfare indicators can be incorporated within the evolving FSDN alongside current technical performance indicators, with metrics to assess antibiotic use particularly relevant. Moreover, the inclusion of metrics to assess the availability and quality of broadband service for farmers within the FADN/FSDN dataset should be a relatively straightforward task, although differences in data collection models in different Member States need to be considered. Data relating to farm household IT use has recently been collected through the Teagasc NFS. This serves to highlight the progressive use of the FADN framework by NFS researchers to advance the sustainability assessment of agricultural systems.

9.4.4. The monitoring of social metrics will assist the CAP in achieving its agricultural and rural viability sustainability objectives: namely the preservation of landscapes and biodiversity, generational renewal, rural viability, and food & health

In addition to fostering a sustainable and competitive agricultural sector that can continue to support European farmers, the CAP 2023-2027 aims to promote prosperity across rural regions. Through the *Community Wellbeing* component investigated in this thesis, an insight into the viability of the community from the farmer's perspective (based on their reported access to services and community involvement) was possible. Assessing the quality of service provision in rural areas, as well as resident's sense of security, and indeed any improvement or decline in service accessibility over time highlights potential risks to the future sustainability of rural areas.

Generational renewal is a key policy priority for the CAP 2023-2027, which emphasises the importance of increased support for younger farmers, whether through income, investment, or start-up financing. Incorporating indicators to determine the level of succession planning amongst farmers, and progress in the achievement of same (e.g. existence of farm partnership arrangements between the incumbent and successor) can provide insight into the future sustainability of the farm and by default the local region (given the contribution of farms to the local economy). This study highlights the efficiency of incorporating indicators within the NFS dataset to measure the level of succession planning on NFS farms, and how key socio-demographic trends for generational renewal can be ascertained. Indeed, this thesis determines that a higher proportion of dairy farmers have identified a farm successor, and are more likely to consider a farm partnership arrangements, an expected outcome given the ability of dairy farms to provide a relatively good farm income. In addition, the ability of rural areas to provide off-farm employment is an important consideration for the future sustainability of drystock enterprises, given the lower average income on such farms, with many operating on a part-time basis. Moreover, the phenomenon of remote working, emerging from recent COVID 19 restrictions, has highlighted the ability for many employees to 'work from home' (WFH). Remote working and blended working arrangements may help to facilitate farm succession, by providing additional employment opportunities for farmers in more rural locations, which in turn may also help bolster the viability of rural communities. This again highlights the symbiotic relationship existing between farms and their local community, as part time employment opportunities in rural areas may help in financially supporting smaller scale farm operations. Furthermore, generational renewal on smaller scale extensive farms can help in supporting CAP objectives regarding the improvement of farm level biodiversity and maintaining landscapes in rural regions. In reference to these findings, this thesis postulates that the inclusion of indicators to assess the levels of succession planning within the FADN/FSDN is essential for the determination of farm level social sustainability.

9.4.5. The development of social sustainability metrics will help in the alignment of the CAP with the UN Sustainable Development Goals (SDG's)

Some criticism has been levelled at the poor alignment existing between the sustainability objectives of the reformed CAP (2023-2027), and those of the UN SDG's (Matthews, 2020). Scown and Nicholas (2020) identified a particular need for an indicator to assess the health and wellbeing of farmers, in order to better align the CAP with SDG Objective 3: Good Health and Wellbeing. This thesis demonstrates a methodology for incorporating wellbeing metrics into the FADN/FSDN dataset, with subjective indicators which identify a range of occupational stressors impacting farmers, and a composite wellbeing index incorporating quality of life factors (i.e. long working hours). The further development and collection of contemporary and evidence based social indicators for the evolving FSDN will assist in helping to better align the CAP with the UN SDG's.

9.4.6. The advancement of social sustainability indicators will assist in monitoring the effectiveness of rural development policy

Aligning indicators with policy objectives that go beyond agriculture and address the wellbeing of wider rural economy can also help to measure the effectiveness of various rural policy initiatives. The components of the social sustainability framework devised in this thesis, and in particular, the community wellbeing dimension, which comprise aspects of multifunctionality, heritage and culture, access to services and food safety and consumer concerns, align with many of the objectives listed in the European Commission's 2040 vision for rural areas. Aligned with this is the EU Rural Action Plan, which in addition to fostering territorial cohesion and improving infrastructure, aims to leverage the role of sustainable agriculture and diversified economic activities. This Rural Action Plan is positioned with four flagship initiatives, (i) The creation of an innovative ecosystem, where local communities will be empowered to facilitate social change, (ii) the development of sustainable rural mobility strategies, (iii), the improvement of resilience from environmental, climatic and social perspectives, and (iv) the support of economic diversification (European Commission, 2021). As highlighted in Chapter 7, the NFS and wider FADN dataset retains the ability to effectively incorporate indicators to assess farm enterprise diversification, through a determination of other gainful activities (OGA's) on the farm. Moreover, the economic contribution of farms to their local economy, through an analysis of their expenditure on services such as agricultural contracting, veterinary costs, feed purchases etc. can help in maintaining local services and the prosperity of the local community.

Determining the ability of farmers to assess a range of public and essential services in their local community can provide specified socio-demographic data on rural service connectivity to the European Commission. Indicators assessing the quality of transportation and services in rural areas, and indeed, the accessibility to high speed broadband can be readily integrated into the NFS and FADN/FSDN datasets, and can help in monitoring the effectiveness of rural mobility strategies.

The findings from this thesis also highlight methods to help determine the level of resilience in rural areas from a farm level perspective. As an objective of the long-term vision for rural areas, the Commission recognises the importance of cultural and landscape preservation for the sustainability and wellbeing of rural areas. This thesis identifies generational renewal as a key component of both farmer and community wellbeing, indeed, from a rural viability perspective; generational renewal can help in the preservation and transfer of cultural knowledge and farming traditions. Moreover, the Farmer Sustainability Index derived in Chapter 6 can infer information on the level of socio-economic resilience experienced by farm operators, from the perspectives of business continuity, social connections and quality of life.

As outlined in Chapter 2, 'Our Rural Future' provides a framework for the development of rural Ireland, and seeks to promote increased community participation, prepare rural areas for technological, demographic, and environmental change, and to address the diversity of challenges and opportunities facing rural areas (Rialtas Na hEireann, 2021).

The majority of the thematic objectives of 'Our Rural Future', namely the support of rural employment, the revitalisation of rural villages, enhancing rural community resilience and their provision of public services and digital connectivity align with the community wellbeing indicators developed in this thesis. As such, these indicators can help in monitoring the progression and the level of success of these objectives. Likewise, these wellbeing indicators can also serve to identify risks to the implementation of such measures. Querying farmers on their ability to access a range of services, including broadband provision, can help to relay key socio-demographic and spatial variations in the quality of rural public services and digital connectivity. Moreover, indicators which help to measure the multifunctionality of farms, such as their use of local suppliers and the production of agri-food outputs, as well as other gainful activities operating on the land can help to support rural employment and rural community resilience. In addition, encouraging the development of the next generation of farmers to succeed the land can help in the revitalisation of rural villages.

Embracing a more holistic assessment of farm level sustainability, one that embraces the interconnected social components of farmer, animal and community wellbeing will help in supporting an altogether more sustainable agricultural system. As outlined in this section, each wellbeing component developed in this study comprise a range of indicators that can help in the assessment of different agricultural or rural policy interventions. For a compendium of the societal objectives of these policy interventions, and the proposed indicators to help measure them, see Appendix 5.

9.4.7. Limitations of indicators to measure policy

Although this thesis has demonstrated the effectiveness of the constructed social sustainability framework for measuring the progress of policy initiatives, it is somewhat constrained by geographical factors. Regardless of the fact that the FADN contains harmonised microeconomic data from EU Member States, this study reports on data attained from Irish farms through the Teagasc NFS. Indeed, several of the social sustainability issues raised in this body of work are specific to the nature and context of Irish farms, such as the regional variation in the Farmer Sustainability Index, and factors related to Community Wellbeing. Consequently, several indicators derived from this study may be more suitable to assessing the success of policy objectives from an Irish perspective, as opposed to a European aspect. Notwithstanding the specific farm level indicators utilised, the wellbeing categorisation developed in this study provides a fundamental basis for other EU member states to develop their farm level social sustainability indicators, and is a natural progression for this study.

9.5. Further Research

The design of social sustainability indicators for agriculture is an iterative process, given its broad nature and the evolution of policy objectives. Moreover, the transformation of the CAP Common Monitoring and Evaluation Framework (CMEF) into the Performance Monitoring and Evaluation Framework (PMEF), a more performance-based delivery model, represents a shift in the CAP's emphasis away from compliance and towards the fulfilment of particular objectives. This further necessitates the development of contemporary social sustainability indicators in order to effectively measure of farm-level sustainability in a more holistic sense.

Through the course of the research, a number of thematic areas requiring for further investigation were identified. These are discussed in turn below:

9.5.1. Animal health and welfare and food safety

One such area which necessitates additional research is that regarding consumer concerns for agricultural production and food safety issues, which currently remains outside the scope of a farm level assessment of social sustainability mostly due to limitations with data. A collaboration with public opinion surveys, such as the EU Barometer, may provide insights into consumer concerns and better inform data collection needs. For example, concerns regarding antimicrobial resistance (AMR) from the use (and misuse) of antibiotics in animal treatments, has recently emerged as a serious food safety concern (Regan et al., 2021). Indeed, the CAP 2023-2027 is cognisant of such concerns, and has established an objective to enhance the response of EU agriculture to societal demands for food and health, including the production of high-quality, safe, and nutritious food in a sustainable manner, the reduction of food waste, as well as the improvement of animal welfare and the fight against antimicrobial resistance. However, to date the collection of relevant and useful data on antibiotic use has been relatively limited and consequently, the collection of such data through the evolving FSDN dataset would provide key metrics on the prevalence of antibiotic use. This would also be an important addition due to the recent introduction of updated European regulations in this regard. In addition, while this study devised a method to interpret animal wellbeing at the herd level, a more thorough assessment particularly involving animal level indicators is required. The collection of additional data, at the animal level, on welfare issues would be most useful. The greater prevalence and reduced cost of sensor technology might be of benefit in this regard.

9.5.2. Generational renewal

The CAP 2023-2027 identifies generational renewal as key policy priority, and emphasises improved support for younger farmers, whether through income, investment, or start-up financing. Additionally, the CAP intends to encourage rural employment, growth, social inclusion, and local development, and recognises the critical nature of bridging the rural/urban gap, basic service provision, and rural life becoming more viable and desirable to younger generations. The provision of supports for young farmers in Ireland’s CAP strategic plan 2023-2027, namely the Complementary Income Support for Young Farmers; (CIS-YF) recognises the importance that generational renewal and young farmer development plays in the sustainability of farm operations. Consequently, identifying barriers to generational renewal, both from the young farmer's perspective and from that of the out-going incumbent is critical to mitigate future potential challenges to farmer and community wellbeing. The inclusion of more in-depth queries within the evolved FSDN for newer entrants may shed light on additional challenges experienced by young farmers starting out in their agricultural career. Identifying key obstacles impacting new farmers prior to and during the succession process, as well as any challenges to the retiring farmer, and whether any under-lying socio-demographic factors were influential, may help in the direction of policies aimed to assist younger farmers. This thesis recommends research into this subject in the near future.

9.5.3. Connectivity

In addition to ease of access to numerous public services and amenities, the availability and quality of broadband service in rural areas is an important, if not often somewhat contentious, issue. A 2019 Irish Farmers' Association survey found that availability or quality of internet connection was the foremost barrier to further adoption of technology on farms, cited by 55% of respondents, and this barrier was highest in Border and West regions (at 60%) (IFA, 2019). Enhancing digital connectively within rural areas can facilitate improved opportunities for rural residents to work from home for numerous sectors, indeed, altered working arrangements resulting from Covid-19 lockdowns demonstrate that WFH or blended working practices are effective, and indeed are likely to remain an option for many workers. Furthermore, improving the quality of rural broadband connectivity can facilitate more effective adoption of precision technologies on farms, as identified within the Farm to Fork Strategy. As previously mentioned in section 9.4.3, the Teagasc NFS has effectively assessed access to services, including the availability of broadband, through the supplementary survey facility on an ad-hoc basis, thus providing a template for other FADN members to use and adapt. Improved digital connectivity can also improve quality of life and social connections. Overall, interpreting the quality of broadband connectively and farmers interaction with ICT (Information Communication Technology) can infer additional information to the viability of rural regions, and this thesis recommends a more regular census of same.

9.5.4. Landscape and Biodiversity

The preservation of rural landscapes and the protection and enhancement of biodiversity is a key objective of the CAP 2023-2027, and as outlined in Chapter 7, overlap between the dimensions of environmental and social sustainability. The aesthetic and ecological benefits derived from rural landscapes and biodiversity serve as a public good, and enhance the wellbeing of the community. Responsible landscape management is a critical eco-system function supplied by farmers, and improper governance and control of landscape maintenance activities such as over or under grazing of livestock can have a detrimental effect on biodiversity levels. It is necessary as the FADN transforms to the FSDN that indicators to assess the quality of, and risks to farm level biodiversity and landscapes are developed and incorporated into the framework. The Teagasc NFS has initiated research in this area, using remote mapping to identify farmland habitat biodiversity on 300 sample farms (Finn and Moran, 2020). This pilot project incorporating farmland habitats into the Teagasc NFS has strong potential application in future, and may also help inform methodological approaches for FADN/FSDN in other EU Member States.

9.6. Concluding Remarks

The emergence of sustainability as a major policy objective in the EU and beyond has constituted a massive shift in the focus and design of agricultural, food, and rural policies. The processes of agriculture impact upon, and are influenced by, economic, environmental and social elements, thus in order to make agriculture more sustainable, an understanding of the different factors impacting these elements of sustainability is necessary. This thesis contributes knowledge to the advancement of agricultural social sustainability by:

(i) identifying a need for social sustainability to be assessed from a more nuanced perspective, representative of the dimensions of farmer, animal and community wellbeing;

(ii) outlining methodologies for data collection and analysis, and identifying information gaps within the FADN framework;

(iii) providing a farm-level assessment of farmer, animal and community wellbeing for farms represented by the NFS,

(iv) examining the trade-offs and synergies between the economic, environmental and social dimensions of sustainability, and:

(v) discussing recommendations for indicator development which will better aid policy to assess the social dimension of agricultural sustainability.

Determining the factors which impact farmers' wellbeing, from monetary worries to workload and weather stresses, in addition to identifying the socio-demographic characteristics of those likely to experience lower social wellbeing can help in the formulation of more effective and targeted policies for agricultural sustainability. Assessing the wellbeing of farm animals helps in determining a more holistic measurement of social sustainability, and this study shows the potential in utilising specific technical performance indicators within the NFS and FADN datasets to infer a herd level overview of animal wellbeing on dairy farms. Cognisant of the circular relationship existing between farms and their local community, the development of indicators which assess community wellbeing from the perspective of farm households will aid policymakers in recognising possible risks to rural viability, and assist in the monitoring and evaluation of revised CAP objectives through the Performance Monitoring and Evaluating Framework.

This study also highlights that the heterogeneity of farm systems necessitates a further in-depth analysis of farm level social sustainability. Indeed, it is necessary for policymakers to examine social sustainability matters using a holistic approach. This will ensure that a clear understanding of specific factors impacting social sustainability at the farm level can be achieved. In order to meaningfully address particular issues, there may be a requirement to tailor policy to address specific social issues affecting farmers due to differing social-demographic constructs. Specific potential risks to agricultural social sustainability, such as evidence of work-life balance issues, whether the farmer is prone to isolation and poor social connections, and indeed risks to generational renewal and farm continuity can be readily interpreted from the dimensions comprising the FSI devised in this body of work. This study postulates that the FSI, together with an analysis of its dimensions, is a useful tool for researchers and policymakers to determine underlying risk factors affecting various sectors and areas of Ireland's agricultural system. Indeed, with modifications, this FSI can be adapted for use by other regions that utilise FADN data. Furthermore, this index could potentially aid in tracking progress toward the newly established CAP objectives, particularly for generational renewal and vibrant rural areas, and in future, for the measurement of food safety objectives when additional indicators on antibiotic use are available.

The transformation of the FADN to the FSDN outlines the commitment of the European Commission to enhancing sustainable farming practices across MS. This thesis finds that the

FADN possesses the ability to effectively collect contemporary indicators of social sustainability, with a particular focus on wellbeing from the perspectives of farmer, animal and community. To this end, the development of numerous indicators in this regard have been described.

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Appendices

Appendix 1: Qualitative questions posed to stakeholders for Chapter 3

1. What do you understand by the term 'Social Sustainability'?
2. Do you think that the current assessment of Social Sustainability needs to be developed for Irish agriculture?
3. How well has the social sustainability of Irish farms been researched and understood by policy makers to date, in your opinion?
4. What do you consider to be the most important social challenges facing agriculture and rural communities at present? (Focusing upon Farmer, Animal and Community Wellbeing)
5. Can you list your top 5 concerns for social sustainability and rural viability?
6. We plan to develop new social sustainability indicators under the areas of Farmer Wellbeing, Animal Wellbeing and Community Wellbeing. Is there another broad area of social sustainability which you believe should be researched further? What specifics would you consider?
7. Do you have any additional information or comments you wish to add pertaining to the topics you have discussed today? Do you have any recommendations on how you think the NFS could enhance its research into the social sustainability of Irish farms?

Appendix 2: Quantitative statements posed to stakeholders for Chapter 3

We have subdivided these areas with the following measures; Can you rank the usefulness of assessing these measures in order from 1 to 9 (9=Most Useful)

Farmer Wellbeing:

___ Farmer Wellbeing, Physical and Psychological

___ Succession and Young Farmer development

___ Social Outlet availability (pubs, sports clubs, community centres etc.)

___ Sense of Security of farmer and household

Animal Wellbeing:

___ Animal Welfare and Animal Health

Community Wellbeing:

___ Multifunctionality of farm, contribution to rural region and economy

___ Food Safety

___ Access to services (transport links, banks etc.)

___ Consumer perceptions and concerns

Part 2: Ranking statements

Please rate the following statements on a scale of 1-7, where 1 = strongly disagree, and 7 = strongly agree. Please provide a justification for your rating.

1. **Farmer Wellbeing: Physical & Psychological**

a. Farmers economic wellbeing has improved over the past 10 years ___

b. The work life balance and stressful nature of farming is impacting upon the psychological well- being of Irish farmers___

c. Farm holders have sufficient access to mental health support services ___

d. Farm holders are averse to seeking help or support from mental health services ___

e. Accidents on farms are caused primarily by farmers taking unnecessary risks ___

f. The lack of available farm labour will impact the expansion of dairy farms ___

g. The aging farm population in Ireland poses a challenge towards farm innovation and development: ___

2. **Young Farmers and farm succession:**

a. The small proportion of young farmers in Ireland is primarily due to the unwillingness of older farmers to retire ___

b. Younger farmers receive sufficient policy support to develop their livelihoods ___

c. The availability of additional off farm employment for the household (farmer and/or spouse) is imperative for small farms to survive in rural regions___
d. Younger farmers are more willing to adapt innovative technologies than older farmers ___
e. Young people are dis-incentivised towards establishing a career in farming due to perceived heavy workload/long hours___

3. Sense of Security in rural communities

a. Farmers sense of security has deteriorated over the past 5 years ___
b. The closure of Garda stations has had no impact upon the sense of security in rural communities___
c. Older farmers are more vulnerable to incidences of agricultural crime than their younger counterparts___
d. Farmers must invest in anti-theft technologies (ie CCTV, sensor floodlights, equipment marking etc) to deter potential criminal activity__

4. Animal Health and Welfare:

a. The levels of antibiotic use in Irish livestock needs to be reduced___
b. Animal welfare standards on Irish farms is generally very good/ excellent ___
c. Consumer awareness of animal welfare issues has no impact upon their purchasing of agri-food products ___
d. Consumers would be willing to pay extra for an agri-food product produced with a high level of animal welfare considerations___
e. Ireland’s natural and green image is of primary importance for global consumers of agri- food products___

5. Community and Rural Wellbeing:

a. Access to high speed broadband in rural regions is satisfactory ___
b. Irish farms are a primary contributor towards the viability of the rural economy through their provision of agri-food products and use of local services___
c. The lack of frequent public transport links in rural regions can adversely impact the mobility of older residents: ___
d. Consumers are increasingly querying sustainable farming practices ___

Appendix 3. A compilation of farmer, rural and societal wellbeing and sustainability indexes and frameworks reviewed to aid in the development of the FSI

Index	Institution/ Author	Application	Weighting	Key dimensions /domains and associated indicators	Corresponding/Proxy variables available within FADN/NFS* 2018 Additional NFS** NP- Not present
OECD Better Life Index	OECD Better Life Initiative OECD (2020)	Human Wellbeing, 34 OECD countries, including key partners such as Russia and Brazil	Equal weights applied for each indicator	11 domains (listed), with 24 indicators: Housing, Income, Jobs, Community, Education, Environment, Civic Engagement, Health, Life satisfaction, Safety, Work-Life balance.	Housing- NP Income: Family farm income (FFI)* Jobs: Off farm employment* Education: Agricultural education* Environment- NP Civic Engagement- NP Health: Experience of stress **, Access to medical services** Life satisfaction- NP Safety: Sense of security** Work-Life balance: Hours of work*
OECD Regional Wellbeing Framework – an extension of the OECD Better Life Initiative	OECD (2014)	Regional and local wellbeing for 362 regions across 34 countries	N/A. Dashboard facility displays data on indicators	9 domains (listed) with a list of potential and proxy indicators, spatially dependent. Material Conditions- Income, Jobs, housing, and Quality of life- Education, Health, Environment, Safety, Civic engagement and Access to services.	Material conditions: Income: Family farm Income (FFI)* Jobs: Off farm employment* Housing: NP Quality of life: Education: Agricultural education* Health: Experience of stress **, Access to medical services** Environment: NP Safety: Sense of security**, access to Garda station** Civic Engagement: NP Access to Services: Access to Bank/Public transport/Social amenities **
Rural Development Index	Abreu et al. (2019)	Rural Development, Spain	Equal weights- Uses geometric mean as opposed to arithmetic	4 domains (listed) with 16 indicators Population (Population density, rate of natural population increase, net migration and demographic dependency index) Social	Population : Farmer age* Population density, rate of natural population increase, net migration- NP Social: Literacy, Housing-NP

			mean to avoid a substitute effect.	(Literacy, Education level, Physician per 1,000 inhabitants, Housing quality) Economy (Off farm employment , income, per capita purchasing power, employment rate) Environment (Environmental expenditure, proportion of wastewater treated, proportion of urban waste collected, proportion of Natura 200 area)	Agricultural education* , Access to medical services** Economy: Off farm employment/employment rate*, FFI*, per capita purchasing power NP Environment: NP
Multi-dimensional Wellbeing Index	Collomb et al. (2012)	Rural Populations, Namibia.	Statistically determined weights	9 domains, (listed) with 34 indicators. Subjective Wellbeing Index (SWI), Health Core Index (HCI), Wealth Core Index (WCI), Education Core Index (ECI), Political Sphere Index (PSI), Social Sphere Index (SSI), Economic Sphere Index (ESI), Infrastructure Sphere, Index (ISI) , Natural Sphere Index (NSI)	Subjective wellbeing:: Experience of stress** Health : Access to medicals services** Wealth: FFI* Education: Agricultural Education* Political: NP Social: Frequency of interaction with those outside HH**, Access to social amenities** Economic: Off farm employment*, economic health –viable, sustainable, vulnerable* Infrastructure: Access to public transport** Natural : NP
Australian Unity Wellbeing Index- *Personal Wellbeing Index*	International Wellbeing Group (2013)	Life Satisfaction, Australia	Equal weights– summed to average score	7 to 8 domains (listed). Satisfaction with: Standards of living, Health, Achieving in life, relationships, Safety, Community connectedness, future security, *religion and spirituality –*not always applicable*	Standards of living: FFI*, economic health – viable, sustainable, vulnerable* Health: Experience of stress**, Access to medical services** Achieving in life: Agricultural education* Relationships: Martial status* Safety: Sense of security**, Access to Garda station** Community connectedness: Access to social amenities/public transport**, Frequency of interaction with those outside HH** Future security: Plans within next five years** Religion and spirituality: NP
Human Development Index	United Nations Development	Human Development, 189 countries of	Equal weights- Uses geometric mean as opposed to arithmetic	3 dimensions with 4 indicators Long and healthy life –*life expectancy at birth*	Healthy Life: Access to medical services**, Experience of stress** Access to knowledge: Agricultural education*

	Programme Roser (2014)	the United Nations (UN)	mean to avoid a substitute effect.	Access to knowledge- *(i) Expected years of schooling and (ii) average years of schooling* Standard of living- *Gross national income (GNI) per capita*	Standard of living: FFI*, economic health – viable, sustainable, vulnerable*
Canadian Index of Wellbeing	Michalos et al. (2011)	Human Wellbeing, Canada	Equal weights applied to each indicator	8 domains (listed) with 64 indicators. Community Vitality, Democratic Engagement, Education Environment, Healthy Populations, Leisure and Culture, Living standards, Time use	Community Vitality: Access to bank/public transport** Democratic engagement: Education: Agricultural education* Environment: NP Healthy populations: Access to medical services** Leisure and culture: Frequency of interaction with those outside HH**, Access to social amenities** Living standards: FFI*, economic health – viable, sustainable, vulnerable* Time Use: Hours of work*
Quality of life Indicator	El-Osta (2007)	U.S Farm households	Equal weights applied to each indicator	4 domains with 10 indicators: Labour market conditions (Availability of off farm employment) Neighbourhood quality (Outdoor recreational opportunities, Access to store/shopping, Access to entertainment, Crime and vandalism) Public and/or private services (Access to school, School quality, Access to healthcare, Access to airport) Social Interaction (Access to family and friends)	Labour market conditions: Off farm employment* Neighbourhood Quality: Access to social amenities **, Access to bank**, Access to Garda station**. Sense of security** Public and/or private services: Access to medical services**, Access to public transport** Social Interaction: Frequency of interaction with those outside household**
Socio-Economic Wellbeing Index	El-Osta (2014)	U.S Farm Household Wellbeing (combined economic and quality of life	Social: Weights determined by proportion of HH's experiencing deficit in one	Social Dimension- 5 domains with 10 indicators (listed): Employment (Access to off farm work), Health (Access to health care), Education (Access to schools and School quality), Geographic access (Access to airport) Social environment (Access to	Social dimension: Employment: Off farm employment* Health: Access to medical services** Education: Agricultural education* Geographic access : Access to public transport**

		advantage index)	item/indicator relative to total proportion of all HH's experiencing deficit in all ten items.	family & friends, Access to stores/shops, Access to entertainment, Outdoor recreational opportunities, Crime and vandalism) Economic Dimension: Composite measure of wellbeing (CWB) encompassing farm household money income and annual value of HH wealth to determine whether farm HH is economically advantaged.	Social environment: Access to social amenities **, Access to bank**, Access to Garda station**. Sense of security**, Frequency of interaction with those outside household** Economic Dimension: FFI* Economic health of farm: Viable/ Sustainable/ Vulnerable*
Quality of Life Assessment	Wojewódzka-Wiewiórska et al. (2020)	Farmers Quality of Life, Poland	N/A- No index was derived in this work, a structural equation model (SEM) was utilised to verify interdependencies between the QOL variables.	Mental comfort- Self evaluated levels of stress with numerous factors/ stressors listed. Free Time- Holidays, socialising Economic situation-Family farm income and socio economic status (self-evaluated) Living situation – Self evaluated health assessment, distance to public/social amenities and housing quality.	Mental comfort: Experience of stress **, Ability to access social amenities, ** frequency of interaction with those outside HH ** Economic situation: FFI*, Economic health of farm: Viable/ Sustainable/ Vulnerable* Living situation: Access to medical services**, Access to public transport/bank/social amenities**, housing quality- NP.

Appendix 4. Additional questions for the 2018 NFS for Farmer and Community Wellbeing assessment

1. In terms of developments on your farm, within the next 5 years, do you expect to…
   (i) be still farming as you are now
   (ii) have scaled up activity significantly
   (iii) have entered a farm partnership with a view to retirement
   (iv) Have opted to lease out short-term/long- term/long term
   (v) be still farming but with a different production system
   (vi) have scaled back activity significantly
   (vii) Be retired from farming
   (viii) Have opted to plant forestry

2. (i) Have you chosen a successor for your farm? Yes/No
   (ii) If yes, have you discussed this with them? Yes/No
   (iii) Would you and your successor consider forming a farm partnership before you retire? Yes/No/Don't Know
   (iv) Do you think your chosen successor will continue to farm?
   1 = Full-time; 2 = Part-time; 3 = Don't know

3. How often do you have contact with others (outside of your own household)?
   1 = daily basis, 2 = 2/3 times per week, 3 = once per week or less often

4. Which of the following best describes your household's ability to get access to the following amenities?
   Bank (b) Public Transport, (c) Garda (Police) station, (d) Medical Services (e) Social amenities
   (1 = great difficulty, 2 = some difficulty, 3 = easily, 4 = very easily)

5. How has your access to these amenities changed over the past 5 years?
   (1= greatly improved, 2 = improved, 3= no change,4= deteriorated, 5= greatly deteriorated)

6. Have you experienced stress/anxiety from any aspect of your farm business in the last 5 years? 1 = Yes; 0 = No

7. If yes, please select all that apply:
   (i) Financial stress e.g. farm income, cash flow
   (ii) Poor weather e.g. fodder shortage, flooding, drought
   (iii) Workload e.g. work life balance, seasonal demands (calving, lambing)
   (iv) Security e.g. crime, theft
   (v) Isolation
   (vi) Access to farm labour or managing farm labour
   (vii) Succession planning
   (viii) Animal Health e.g. TB
   (ix) Scheme compliance
   (x) Other?(please specify) ________________________________

8. How has your sense of security changed over the past 5 years?
   (1 = greatly improved, 2 = improved, 3 = no change, 4 = deteriorated 5 = greatly deteriorated)

Appendix 5: A compendium of societal objectives of agricultural and rural development policy, with proposed social sustainability indicators for policy assessment

Policy	Measures and objectives of policy interventions related to social sustainability	Social Sustainability Framework- Wellbeing Dimension	Suitable impact indicators devised in this thesis	Additional indicators/variables required/ in development
CAP 2023-2027	The preservation of landscapes and biodiversity	Community Wellbeing	Heritage and Culture- Identification of farm successor	Biodiversity indicators
	The support of generational renewal	Farmer Wellbeing Community Wellbeing	Generational Renewal- Identification of farm successor Heritage and Culture- Identification of farm successor	
	Enhance the vibrancy of rural areas	Community Wellbeing	Ability to access to a range of services Agricultural diversification - presence of Other Gainful Activities Contribution to local economy- Expenditure analysis Heritage and Culture- Identification of farm successor	
	Improve food quality and animal welfare	Animal Wellbeing Community Wellbeing	Dairy Cow Welfare Indicator (DCWI), comprised of variables examining: i) stocking rate, (ii) dairy calf mortality, (iii) fat to protein ratio, (iv) somatic cell count, (v) milk yield, (vi) days at grass, (vii) buildings investment and (viii) housing type.	Antibiotic use /Antimicrobial resistance Consumer concerns regarding agricultural production and food safety issue
EU Green Deal: *Farm to Fork Strategy*	Ensuring sustainable food production: Improved animal welfare	Animal Wellbeing	Dairy Cow Welfare Indicator (DCWI), comprised of variables examining: i) stocking rate, (ii) dairy calf mortality, (iii) fat to protein ratio, (iv) somatic cell count, (v) milk yield, (vi) days at grass, (vii) buildings investment and (viii) housing type.	Antibiotic use /Antimicrobial resistance
	Research, innovation, technology and investments: Broadband connectivity	Farmer Wellbeing Community Wellbeing		Farmer Comfort: Improving the quality of life in areas such as healthcare, entertainment and e-government Access to services: Key enabler for jobs, business and investment in rural areas
	Transition of the FADN to FSDN	Farmer Wellbeing Animal Wellbeing Community Wellbeing	All indicators and indexes developed in this thesis will aid in the transformation of the Farm	Biodiversity variables Antibiotic Use Broadband connectivity

			Accountancy Data Network to the Farm Sustainability Data Network.	Consumer concerns regarding agricultural production and food safety issues
UN Sustainable Development Goals (SDG's)	SDG Objective 3: Good Health and Wellbeing.	Farmer Wellbeing	Identification of occupational stress	
A long-term vision for rural areas: Towards a shared European vision for the year 2040 *Rural Action Plan*	Connected rural areas: Development of sustainable rural mobility strategies	Community Wellbeing	Ability to access to a range of services, including transport	Broad connectivity: Enabler for jobs, business and investment in rural areas
	Resilient rural areas: Improvement of resilience from environmental, climatic and social perspectives	Farmer Wellbeing Community Wellbeing	Farmer Sustainability Index derived in this thesis can infer information on the level of socio-economic resilience experienced by farm operators, from the perspectives of business continuity, social connections and quality of life.	
			The importance of generational renewal for 1. Young farmer development and 2. for the protection of farming cultures and traditions	Understanding barriers experienced by young farmers when starting their agricultural career
	Prosperous rural areas: Support of economic diversification	Farmer Wellbeing Community Wellbeing	Enhance the economic viability of vulnerable farm systems Agricultural diversification - presence of Other Gainful Activities Contribution to local economy- Expenditure analysis	
Our Rural Future Rural Development Policy 2021-2025 (Ireland specific)	Optimising Digital Connectivity	Farmer Wellbeing Community Wellbeing		Broadband Connectivity for 1. Farmer Comfort: Improving the quality of life in areas such as healthcare, entertainment and e-government, and 2. Access to services: Key enabler for jobs, business and investment in rural areas
	Supporting Employment and Careers in Rural Areas	Farmer Wellbeing Community Wellbeing	Generational Renewal- Support of young farmers Contribution of farms to rural economy- Expenditure analysis, use of local services. Farm diversification- Other gainful activities	Broadband connectivity: Access to services: Key enabler for jobs, business and investment in rural areas

Revitalising Rural Towns and Villages	Community Wellbeing	Ability to access to a range of services Agricultural diversification - presence of Other Gainful Activities Contribution to local economy- Expenditure analysis Heritage and Culture- Identification of farm successor	Broadband connectivity
Enhancing Participation, Leadership and Resilience in Rural Communities	Community Wellbeing	Identifying communities at risk of low social sustainability to help build resilience: Rural connectivity and access to services, levels of generational renewal, sense of security Heritage and Culture- Identification of farm successor	
Supporting the Sustainability of Agriculture, the Marine & Forestry	Farmer Wellbeing Animal Wellbeing Community Wellbeing	The indicators and indexes developed in this thesis will assist in deriving a more holistic assessment of farm level social sustainability, and facilitate in the measurement of a more nuanced perspective of farmer, animal and community wellbeing	