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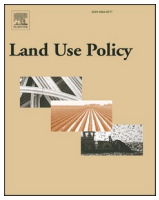

Sustainability strategies and stakeholder management for upland farming

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ABSTRACT

Upland farming provides important benefits to society. To retain these benefits, measures to encourage farms to adopt practices that balance economic, environmental and social aspects of sustainability are required. This study used survey data from a sample of farms located in less-favoured areas in Northern England to identify the trade-offs between the three dimensions of farm-level sustainability and the impacts of farm behaviours on them, including diversification, participation in agri-environmental policies and stakeholder management. Results showed that farm businesses may face a trade-off between improving economic and environmental performance through their decisions about participating in agri-environmental schemes and that strengthening relationships with some stakeholders is critical for achieving sustainability. This suggests that future policy design may simultaneously improve three dimensions of sustainability by promoting environmental conservation activities through non-economic incentives and by encouraging farm businesses to build good working relationships with their stakeholders.

1. Introduction

Uplands, which are often relatively economically disadvantaged areas, make an important contribution to biodiversity, landscape character, cultural heritage, and amenity (Reed et al., 2009a). Many of the benefits that they provide to society are public goods arising as by-products of agricultural management (Santos et al., 2016). Grazing livestock is the main form of agriculture in upland areas in the UK and plays an important role in terms of the local environmental but also in maintaining traditional upland farming communities (Bernués et al., 2011). For example, in rural England, agriculture is an important sector in terms of the number of enterprises and people employed, although its share of gross value-added is relatively small (DEFRA, 2020a). Maintaining the sustainability of upland agriculture has various implications for society, including the ability of land managers to deliver public goods, the income and employment it generates, and its contribution to human well-being.

A number of policies have been implemented to support agriculture in less-favoured areas (LFAs) and compensate for the associated disadvantages in production conditions. In the UK, an advanced country in terms of policy support for LFAs, the initial policy objective was to encourage the continuation of traditional agriculture in the uplands by supporting farmers' incomes (Caskie et al., 2001). Later, concerns around the overproduction of some agricultural outputs and a growing interest in environmental protection led first to the introduction of agri-environmental schemes (AESs) to promote environmentally friendly activities by farmers and subsequently to the decoupling of direct payments from production.

The reforms described above were implemented in the UK through the Common Agricultural Policy and led to some improvements in the sustainability of agriculture, encouraging a shift towards more environment-friendly farming, while at the same time maintaining farmers' incomes. However, many farms in LFAs regularly run at a loss and are not economically viable without direct payments from the government (Barnes et al., 2016; Hubbard et al., 2019). In England, following the withdrawal of the UK from the EU, direct payments to farmers are being phased out and the main source of government support in the future will be through AESs, including a number of new Environmental Land Management (ELM) schemes being introduced from 2022. While these new schemes will support farm incomes and the delivery of public goods, the extent to which they will contribute to the sustainability of upland farms in the north of England is, as yet, unclear.

Assessing the sustainability of agriculture at the farm level is crucial when designing and evaluating policies that contribute to sustainable

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agriculture and facilitate sustainable behaviour on the farm (Alkan Olsson et al., 2009; Lebacq et al., 2013). Although many studies on the factors and incentives of the adoption of AESs offer insights for improving the design of policies that are attractive to farmers (e.g. Ruto and Garrod, 2009; Lastra-Bravo et al., 2015) and that effectively enhance farmer behavioural changes (e.g. Ingram et al., 2013; Sutherland et al., 2012a), it is also necessary to further investigate the outcomes of farmer behaviours under these schemes in order to inform the design of policies that progress agricultural sustainability.

Sustainability assessment generally involves evaluation of the performance of initiatives or organizations using a process or tool to provide evidence to support decision- and policy-makers (Singh et al., 2009; Pope et al., 2004). In agriculture, researchers have developed various tools and indicators for sustainability assessment to identify more sustainable agricultural practices or systems and to evaluate whether policies can progress sustainable agriculture (Kelly et al., 2018; O'Donoghue et al., 2016; Ryan et at., 2016; van Calker et al., 2005; Van Cauwenbergh et al., 2007; Zahm et al., 2008). Although several tools have been tested to determine whether they are useful as decision support tools for farmers based on their self-assessment (de Olde et al., 2016), considering the objectives of the tools, researchers and policy-makers are considered to be the main practitioners of sustainability assessment.

Sustainability assessment must cover the three dimensions of sustainability in the assessment (Elkington, 1997). It is also important to recognise in such assessments that some components of the three dimensions of sustainability are not substitutable: for example, multifunctional ecosystem services cannot be replaced by better business infrastructure (Dyllick and Hockerts, 2002). Similarly, assessment must take account of the potential for irreversible losses to occur, where species, habitats, cultures, and traditional practices that are lost cannot be recovered (Dyllick and Hockerts, 2002).

Another challenge for researchers in the empirical assessment of sustainability is to capture the interrelationship between the three dimensions of sustainability. The various components of sustainability influence each other through diverse processes (Dyllick and Hockerts, 2002), and their complex interrelationships must be considered and understood when assessing sustainability (Binder et al., 2010; FAO, 2014; Sulewski et al., 2018; von Wirén-Lehr, 2001). Any quantitative analysis of the interrelationships between the three dimensions of sustainability in agriculture requires a large sample of farms to be studied to ensure that there is sufficient coverage of the heterogeneity of sizes, enterprises, and management practices observed across enterprises (Ripoll-Bosch et al., 2012).

However, only a relatively small number of quantitative studies have explored the interrelationships between the different dimensions of sustainability at farm level (Schader et al., 2016; Sulewski et al., 2018). In addition, some studies that have examined interrelationships quantitatively (Latruffe et al., 2016a; Schader et al., 2016; Sulewski et al., 2018) do not discuss policies or management to mitigate the trade-offs between the different dimensions of sustainability that they have observed. To obtain answers that will help to address the problems of sustainability, it is necessary to consider the factors that influence the different dimensions of sustainability, as well as the interrelationships over time between those dimensions. Once the impacts of the factors that affect sustainability have been identified, effective intervention measures for farm businesses can be discussed. If the impacts of previous sustainability conditions on current sustainability are understood, then any factors that act as barriers and need to be addressed as a priority can be identified.

A third challenge for the empirical assessment of sustainability at the farm level is the lack of exploration of the influence of stakeholder management by farms. A stakeholder is defined as 'those groups without whose support, the business would cease to be viable' or 'any group or individual that can affect or be affected by the realization of an organization's purpose' (Freeman et al., 2010). As the definition suggests, stakeholders are actors who influence the achievement of a company's objectives and, by inference, their sustainability. Many studies on corporate sustainability consider stakeholders as fundamental (Hörisch et al., 2014), and empirical results for the manufacturing and service industries have shown that building successful relationships with stakeholders enhances corporate sustainability (Berman et al., 1999; Sharma and Henriques, 2005; Wagner, 2015). The implication of these studies is that the sustainability of the firm can be supported by satisfying the needs of its stakeholders, and this may also apply to farm businesses.

Many studies have shown that relationships between farmers and between farmers and advisors influence the adoption of sustainable practices through changes in farmer attitudes, effects of shared social norms and cultural capital (e.g. Mills et al., 2017; Sutherland et al., 2012b), knowledge exchange (e.g. Ingram et al., 2016; Ingram and Morris, 2007), and collaboration and coordination (e.g. Riley et al., 2018; Westerink et al., 2017). These studies highlight the importance of stakeholder relationships for the sustainability of farm businesses. However, the stakeholder perspective in this study differed from that of previous studies. While farm relations were considered as given conditions that influence farm behaviours, the concept of stakeholder management adopted here refers to a firm's behaviour to satisfy the needs and expectations of its stakeholders to ensure its sustainability (Garvare and Johansson, 2010). In this sense, until this study, the importance of stakeholder management for the sustainability of farm businesses had not been thoroughly explored.

The aim of this study is to understand the interrelationships between the three dimensions of agricultural sustainability, focusing on the behaviours and performance of farm businesses, and to explore in more detail the approaches that are effective in enhancing agricultural sustainability. In so doing, we aim to identify the interrelationships between the three dimensions of sustainability at different points in time and the impact of common factors on these three dimensions. We also aim to assess the impact of stakeholder relationships on sustainability.

This study focuses on grazing farms located in LFAs in Northern England. These farms are characterised by low economic performance and a crucial role in providing environmental goods. By examining the trade-offs between the economic and environmental dimensions of sustainability and the factors contributing to this, we can make recommendations for the design of the next generation of AESs in England. In addition, in LFAs, the social dimensions of sustainability, such as the impact of agriculture on well-being and the question of succession on farms, are important. However, the impact if these issues on sustainability is not well understood. This study will examine the role of improved stakeholder relationships in achieving agricultural sustainability and identify the potential for better stakeholder management to improve sustainability. This study generated a unique quantitative data set at the farm level, which was used to explore the relationships between some of the factors identified above as being likely to influence the three dimensions of sustainability over time.

The following section reviews the literature on farm-level sustainability and builds a conceptual model reflecting the causal relationships between the three dimensions of sustainability and various farm-level factors. Section 3 describes data selection, analysis, and the conceptual model. Section 4 presents the estimation results and Section 5 provides a discussion of the research questions. Finally, Section 6 presents the conclusions and limitations of this study.

2. Conceptual framework

2.1. Farm-level sustainability

There is no precise definition of sustainability in agriculture (Schaller, 1993), and a variety of sustainability concepts with different indicators and ranges of spatial and temporal coverage have been proposed (Hansen, 1996; Hayati, 2017; Latruffe et al., 2016b; von

Wirén-Lehr, 2001). Using the existing definitions and assessment methods of agricultural sustainability, we established an assessment method for agricultural sustainability from spatial, normative, and temporal perspectives corresponding to this study's objectives. The spatial perspective of the sustainability assessment of agriculture covers a range of scales from a single plot of farmland to the regional, industrial, and international levels. This study aims to identify measures to achieve sustainable agriculture at the level of the farm business, and therefore assessed sustainability from two perspectives: the survival of the farm (e.g. its financial situation and the availability of human resources), and its broader contribution to society (e.g. its impact on environmental conservation and local community development).

Specifically, using the definition of corporate sustainability proposed by Dyllick and Hockerts (2002) as a guide, we define the sustainability of a farm as meeting the needs of a farm's direct and indirect stakeholders without compromising its ability to meet the needs of future stakeholders. This definition is useful for farm-level sustainability for the following reasons. First, it incorporates the three dimensions of sustainability – economic, environmental, and social – and follows the basic principles of sustainable development, simultaneously pursuing various goals. Second, this definition makes sense at the farm level, rather than at the sectoral or regional level. Third, by focusing on the needs of stakeholders, the definition encompasses two important sustainability concerns (Alkan Olsson et al., 2009; Hansen, 1996): the survival of the farm and its contribution to the environment and society. Moreover, the normative perspective of sustainability assessment implies a choice of goals and indicators for assessing sustainability. This study aims to understand the trade-offs made at farm level between the three dimensions of agricultural sustainability, as well as the factors that influence them, and will go on to discuss possible policies and actions that may enhance agricultural sustainability. To achieve this objective, an evaluation framework that includes economic, environmental, and social dimensions and captures their interrelationships is required (Alkan Olsson et al., 2009; Binder et al., 2010; Kelly et al., 2018).

Regarding setting goals and indicators for assessing agricultural sustainability, de Olde et al. (2016) presented a structure for sustainability indicators and summarised their characteristics based on the Sustainability Assessment of Food and Agriculture systems (SAFA) guidelines (FAO, 2014). Sustainability assessment tools generally have three- or four-level structures, with the highest level being the economic, environmental, and social dimensions and the lowest level being measurable variables. The economic dimension of agricultural sustainability is often measured as the economic viability of farms or agriculture, and profitability, liquidity, stability, productivity, durability and self-sustainability have all been used as evaluation indicators (Latruffe et al., 2016b; Lebacq et al., 2013; Spicka et al., 2019). We used profitability as an indicator of economic sustainability because it is one of the most commonly used parameters. We also used the degree of dependence on subsidies as an indicator of autonomy in economic sustainability, considering the high dependence on subsidies of farms in LFAs.

Regarding the environmental dimension of agricultural sustainability, previous studies have proposed a variety of indicators to evaluate sustainability, but little effort has been made to integrate indicators (Latruffe et al., 2016b). Lebacq et al. (2013) reviewed various indicators of environmental quality and classified them under input management and quality of natural resources. The former includes nutrients, pesticides, non-renewable resources, and land management; the latter includes emissions of greenhouse gases and acidifying substances; biodiversity; and physical, chemical, and biological soil quality. Because this study focused on the relationships between farm behaviours and sustainability outcomes, the quality of natural resources was used as the sole indicator of the environmental quality of the farm, with input management treated as a farm behaviour that contributes to sustainability.

The social dimension of sustainability has been divided into two levels: external social sustainability, referring to the demands of society in general, and internal social sustainability, which refers to the survival of farms (Lebacq et al., 2013; van Calker et al., 2005; Van Cauwenbergh et al., 2007). Internal social sustainability includes the quality of life and physical and mental well-being of the farmer, his/her family, and employees (Lebacq et al., 2013; Van Cauwenbergh et al., 2007; Mills et al., 2021). Specific indicators have included working conditions, education, community participation, accessibility to social infrastructure and physical and mental health (Mills et al., 2021; Van Cauwenbergh et al., 2007). Maintaining socioemotional wealth (SEW), meaning non-economic satisfaction, is an important objective, especially for the survival of family farms (Glover and Reay, 2015). Succession planning or intergenerational succession are also essential issues determining a farms' survival (Barnes et al., 2016). As family farm behaviours for survival are motivated by passing SEW components to a successor (Ingram et al., 2013; Glover and Reay, 2015), SEW and succession may be interrelated when considering farm survival; in other words, achieving internal social sustainability. Therefore, although not included in the existing sustainability indicators (e.g. Hayati, 2017; Latruffe et al., 2016b; Lebacq et al., 2013), we consider succession as an indicator of internal social sustainability. External social sustainability includes multifunctionality, acceptable agricultural practices, and product quality (Lebacq et al., 2013). Specific indicators include the quality of rural areas, such as landscape character and cultural heritage, ecosystem services, environmental impacts, animal welfare, and food security and safety (Lebacq et al., 2013; Van Cauwenbergh et al., 2007). As external social sustainability is determined by the needs and concerns of stakeholders and society, the definition of this dimension is constantly changing (Lebacq et al., 2013; van Calker et al., 2005; Van Cauwenbergh et al., 2007). In addition, there can be an overlap with environmental sustainability indicators. External social sustainability includes ecosystem services as a component of multifunctionality and environmental impacts as a component of acceptable agricultural practices (Lebacq et al., 2013). In consideration of this, we did not evaluate external social sustainability in the sustainability assessment, instead concentrating on internal social sustainability. Based on the above, we evaluated succession, the working environment, and farmers' mental well-being as indicators of social sustainability. We selected specific sustainability indicators for the survey based on a selection procedure informed by insights from previous studies that have used these indicators for measuring sustainability, as explained in further detail in Section 3.2.

Finally, the temporal perspective of sustainability assessment refers to the period of time over which sustainability is assessed. As agricultural sustainability depends on many interdependent factors that change over time, there is a need for a dynamic analytical framework (Ripoll-Bosch et al., 2012; von Wirén-Lehr, 2001). As this study aims to assess sustainability as a consequence of behaviours on the farm, we set a time range that captures dynamic changes over time so that we can detect any causal relationships between factors and outcomes.

The next section reviews previous research on the possible interrelationships between the three dimensions of farm-level sustainability and the impact of farm behaviours on sustainability and presents the analytical framework for the study. To clarify what previous studies have demonstrated or suggested regarding relevant research topics, we also conducted a comprehensive review of the literature regarding the influences of the past sustainability and farm behaviours on farm-level sustainability in the UK uplands.

2.2. Relationships between the three dimensions of sustainability

The literature provides a wide variety of perspectives on the interrelationships between the three dimensions of sustainability. First, past economic sustainability has been found to influence current and future economic, environmental and social sustainability. For example, Glover and Reay (2015) show that economically disadvantaged farms attempt to survive by expanding their business or borrowing money;

however, it is not easy to overcome low economic performance because of the risks associated with business expansion and repayments and this has a negative impact on future sustainability. This causality can be understood as a form of path dependency where the performance of the farm business is affected by past decisions (Sutherland et al., 2012a), a phenomenon that several empirical studies have observed (Hadley, 2006; Vigani and Dwyer, 2020).

Other studies have demonstrated the impact of economic sustainability on social sustainability. The economic status of a farm influences the working environment and SEW (Glover and Reay, 2015), living conditions (Wojewódzka-Wiewiórska et al., 2020) and the possibility of succession on the farm (Glauben et al., 2009; Mann, 2007; May et al., 2019; Sutherland, 2010). Economic sustainability can also affect environmental sustainability. For example, economically successful farms are more likely to implement the additional investment required for environmental measures because they are more likely to already have the appropriate infrastructure and are better able to manage risks (Dwyer et al., 2007). Farms that owe their economic success to the adoption of intensive methods are less likely to participate in AESs because of the greater opportunity costs of participation (Defrancesco et al., 2008; Dupraz et al., 2003; Ruto and Garrod, 2009; Wilson and Hart, 2000).

Second, evidence of existing environmental sustainability may influence future economic, environmental, and social sustainability. For example, Tilman et al. (1996) showed that better soil conditions lead to better biological diversity, and the converse is also true. Long-term environmental management and its perceived benefits engender more positive attitudes towards maintaining conversation activities (Ingram et al., 2013; Sutherland et al., 2016). Environmental sustainability may also lead to an increase in economic sustainability, in terms of profitability, when environmentally friendly activities increase farm income through cost savings and access to higher unit price markets (Dwyer et al., 2007). However, environmental sustainability may reduce economic sustainability by reducing self-reliance. Farms that participate in AESs often have a smaller income from farming and a greater reliance on subsidies (Cullen et al., 2021). In this case, they may become more vulnerable to changes in agricultural support policies (Hubbard et al., 2019) and their economic sustainability in terms of self-reliance may be reduced. Environmental sustainability may also influence social sustainability. Farmers who already conduct environment-friendly farming, may wish to preserve farm survival by continuing their existing methods of farming (Ingram et al., 2013) and Willock et al. (1999) show that the environmental and quality of life goals of farmers are positively correlated. In addition, several studies have shown that having a successor is associated with participation in agri-environmental activities (Defrancesco et al., 2008; Ruto and Garrod, 2009), although these studies did not demonstrate a causal link.

Third, past social sustainability may influence current and future economic, environmental and social sustainability. Past social sustainability can affect future social sustainability because, in family farm businesses, activities that preserve SEW lead to high SEW on the farm (Glover and Reay, 2015). In addition, case studies showing that working hours affect the amount of time farmers spend interacting with neighbours and on group activities (Dwyer et al., 2007), or showing that farmers' living conditions are linked to their psychological security (Wojewódzka-Wiewiórska et al., 2020) also help to explain the causal relationship between past and future social sustainability. Social sustainability may influence economic sustainability because of farmer attitudes toward intergenerational succession. For example, farms that have a successor or are making succession plans are more likely to be economically viable (Barnes et al., 2020; Barnes, 2022), while many farmers with no plans for succession not seek measures to improve productivity (Sutherland, 2010; Morris et al., 2017). Social sustainability may influence environmental sustainability because farms with low labour availability are less likely to introduce new activities because they do not have the time to plan and implement them (Dwyer et al., 2007). Furthermore, farm managers tend to adopt AESs based on the value of the contract or investment that they are willing to pass on to their successors (Ruto and Garrod, 2009; Wilson and Hart, 2000). In addition, the maintenance of farmer traditions and values determines their approach to farming (Ingram et al., 2013; Sutherland et al., 2012a). However, whether the farming methods employed are environmentally friendly depends on whether or not the farmer's traditional values are linked to environmental conservation (Ingram et al., 2013).

2.3. Stakeholder management

This study considers stakeholder management by farms as a factor of the farms' sustainability. In the context of corporate sustainability, stakeholder management refers to activities that meet the needs and expectations of stakeholders who provide resources and support that are essential for firms (Garvare and Johansson, 2010). The influence of stakeholder management on corporate sustainability can be explained by the fact that stakeholders can stop providing the resources necessary for firms, if those firms fail to satisfy their needs (Frooman, 1999; Garvare and Johansson, 2010). Moreover, stakeholder demands are a factor in facilitating firms' environmental and social activities (Henriques and Sadorsky, 1999; Wagner, 2015). Although a wide range of stakeholders may influence a farm's sustainability, the number of stakeholders included in a stakeholder analysis depends on how the stakeholders are identified and the purpose of the analysis (Reed et al., 2009b). In addition, when examining farm performance differences from a management perspective, as in this study, only those stakeholders who are most likely to be affected should be considered (Reed et al., 2009b). Based on previous studies and discussions with farmers and researchers in the target area, we selected family members, employees, suppliers, buyers, landlords, farmers' groups, and advisors as stakeholders who provide essential resources to the farm and can have a significant impact on its economic, environmental, and social performance. We did not include consumers and citizens because, considering the characteristics of the meat industry of the UK, where supermarket retailers dominate the market (Francis et al., 2008; Mylan et al., 2015), farms are less likely to benefit from relationships with citizens and consumers than they are from those with buyers. The sustainability of farms can be influenced by the actions of citizens who express their support for, or opposition to, agricultural policy reforms. However, such relationships are indirect, and the contributions that citizens can make to farm sustainability are limited. For example, when voting, at either a national or local level, it is unlikely that most citizens will prioritise manifesto promises relating to agriculture. The stakeholders selected for this study can be classified into three categories according to the resources they provide and the needs they require to be fulfilled: internal, value chain, and public stakeholders (Wagner, 2015), shown in Table 1. The impact of stakeholder management on sustainability can be assumed depending on stakeholders' resources and needs.

Internal stakeholders, such as family members and employees, provide human resources, such as the labour, knowledge, and skills

Table 1
Stakeholders' classification, resources and needs.

Classification	Examples	Resources by Stakeholders	Needs and wants of Stakeholders
Internal Stakeholder	Family members, Employees	Labour, Knowledge, Decision-making role	Farm Income, Working conditions
Value chain Stakeholder	Buyers, Suppliers	Buy farms' products, Sell inputs for farming, Information on market prices	Lower price and higher quality of the products, higher price of the supplies
Public Stakeholder	Farmers groups, Landlords, Advisors	Information, Knowledge, Advice, Farmland	Positive externalities by farming

necessary for farm activities, and farm businesses need to provide a satisfactory level of income, working environment, and SEW for them. Therefore, how internal stakeholders are managed may significantly affect economic and social sustainability. For example, farm businesses sometimes compromise profitability to preserve SEW for themselves or family members (Glover and Reay, 2015). In addition, increasing involvement in farm activities and decision-making motivates young farmers and makes them less willing to leave the farm (May et al., 2019). Moreover, stakeholder relationships with internal stakeholders may affect environmental sustainability because farms with reliable and skilled employees or family workers are more willing to adopt environmentally friendly activities (Dwyer et al., 2007). Similarly, some farmers see AES participation and conservation activities as measures to provide income and work for employees (Sutherland, 2010). According to a DEFRA survey, almost half of LFA grazing farms in England that have innovated or intend to innovate according to a DEFRA survey, stated that their families encouraged or helped with their innovations (DEFRA, 2019c).

Stakeholder relationships with value chain stakeholders, such as buyers and suppliers, can be assumed to significantly impact on economic sustainability, as they contribute to the development of favourable sales and supply channels for farm businesses. For example, the profitability of agricultural businesses varies depending on their choice of where they sell agricultural products (Bauman et al., 2018; Lee et al., 2020; Yagi and Garrod, 2007). There are grazing farms within the study area with multiple sales channels, including retailers, farmers' markets, and the Internet (Ilbery and Maye, 2005; Yagi and Garrod, 2007). As grazing agriculture generally requires the purchase of feed from outside the region to increase livestock productivity (Marini et al., 2011), establishing stable relationships with suppliers can enhance a farm's economic sustainability. On the other hand, some studies suggest that higher feed self-sufficiency increases farm profitability and has cost advantages (Bernués et al., 2011; Ripoll-Bosch et al., 2012). In addition, management approaches to value chain stakeholders may influence environmental sustainability because farms' environmental activities may be effectively enhanced through the development of relationships with people and groups outside of the farming community (Arnott et al., 2021), such as the development of organic products or the supply of organic animal feeds.

Public stakeholders in this study include farmers' groups, advisors, and landowners who can influence farm businesses' decisions and are interested in, and influenced by, the public goods produced by farming activities. Therefore, management approaches to public stakeholders may influence environmental sustainability. The agricultural community, including farmer groups and advisors, may promote farm businesses' environmental activities by influencing farmers' values or beliefs and providing information, knowledge and suggestions for participation in AESs (Dwyer et al., 2015; Mills et al., 2017; Riley, 2016; Sutherland et al., 2012b; Wilson and Hart, 2000). Although these suggest positive effects on environmental performance, Arnott et al. (2021) showed that farmers who adopt conservation activities over and above the requirements of the AESs, tend to have weaker relationships with the farming community than others, suggesting that stronger relationships with conventional farmers may prevent farmers from adopting to more nature-friendly practices. Public stakeholders may also have an impact on economic and social sustainability. For example, most farmers are willing to collaborate or share information with other farmers to improve their businesses (Dwyer et al., 2015), and participation in farmer groups allows farmers to conduct their businesses more effectively and economically (Arnott et al., 2021; Dwyer et al., 2007). Furthermore, these opportunities promote young farmers' identity formation and participation in farm decision-making, increasing the likelihood that successors will remain on the farm (May et al., 2019). In addition, almost half of the LFA grazing farms in England that have innovated or intend to innovate have stated that other farmers encourage or help them with innovations that promote sustainability (DEFRA, 2019c).

2.4. Other factors

Agri-environmental policies aim to increase the supply of public goods by providing economic incentives for environmental management (Caskie et al., 2001; DEFRA, 2019a; Santos et al., 2016). In principle, participation in AESs is voluntary for farmers and landowners (Lastra-Bravo et al., 2015). Farmers who participate in AESs introduce activities to enhance environmental benefits and receive payments that motivate them and compensate them for their associated costs (European Court of Auditors, 2011). Therefore, participation in AESs is a farm behaviour that possibly affects sustainability. For example, in studies that have examined the factors that influence the adoption of AESs (e.g. Lastra-Bravo et al., 2015; Ruto and Garrod, 2009; Wilson and Hart, 2000), the impact of participation in AESs on economic and environmental performance has been inconsistent. When adopting AESs, farm businesses need to engage in activities to meet scheme requirements, so agri-environmental policy participation behaviour may positively influence environmental sustainability. Westbury et al. (2011) conducted a quantitative analysis and showed that participation in AESs by LFA farms has no impact on environmental performance in England. Jones et al. (2016) also showed that participation in AESs has no significant effect on the risks to wildlife and of soil erosion in LFAs. This may reflect that, while long-term participation in AESs can improve farmers' knowledge of conservation (Riley, 2016), some farms implement environmental management without participating in AESs (Coyne et al., 2021; Mills et al., 2018; Sutherland, 2010). While there is empirical evidence of the negative impacts of participation in AESs on economic performance (Blazy et al., 2015; Udagawa et al., 2014), studies shows that, within EU countries, the impact on agricultural income varies from country to country (Arata and Sckokai, 2016). These inconsistent results may be due to differences in institutional objectives, specific environmental activities, and the implementation history of AESs in different countries (Arata and Sckokai, 2016). In LFAs in England, AES payments are associated with higher profits but are not associated with profit persistence (Vigani and Dwyer, 2020), possibly because AES participation improves economic viability by providing additional income (Morris et al., 2017; Sutherland, 2010) but may subsequently decrease income by restricting a farm's ability to respond to market changes (Sutherland, 2010) or by reducing their motivation to make their business more profitable (Morris et al., 2017). In addition, AES participation may influence social performance because participation in AESs can lead to the formation of new social networks (Mills et al., 2010) and enhance farmer well-being (Saxby et al., 2018).

Agri-environmental policies have changed regularly, significantly affecting farm businesses' sustainability. However, this study does not consider the impacts of agri-environmental policy reform. Instead, we focus on the behaviour of farm businesses under the agri-environmental policy pertaining at the time of the study. Thus, the impact of AESs in this study depends on the characteristics of the policy in force for grazing farms in England during the study period, from 2014 to 2020. During this period, the Basic Payment Scheme (BPS) and AESs were the most common sources of external funding for farms in England (DEFRA, 2019c). The BPS was implemented under pillar 1 of the CAP and comprised area-based payments for farms with at least 5 ha of land which met specific animal and public health, welfare, and environmental standards, supplemented by an additional Greening Payment for farms meeting specific broad requirements, including crop diversification, ecological focus areas, and permanent grassland (DEFRA, 2019a, 2019c; Rural Payment Agency, 2019). In terms of AESs under pillar 2 of the CAP, the Countryside Stewardship (CS) scheme was first implemented in England in 2015 (DEFRA, 2019c). CS consisted of two levels of schemes, the Mid-tier Scheme and the Higher-tier Scheme, and Other Capital-only grants, including Hedgerows and Boundaries Grants (DEFRA, 2020c).

Diversification, which can be classified into agricultural and farm diversification (de Roest et al., 2018; Ilbery, 1991), is expected to improve the economic performance of farm businesses and help develop local economies and employment (Barnes et al., 2015). Agricultural diversification can increase economic performance stability by reducing dependence on specific markets (Barnes et al., 2020, 2015; de Roest et al., 2018; Hadley et al., 2006; Vigani and Dwyer, 2020). In addition, some studies show that farm diversification has a positive impact on farm profits (Barnes et al., 2015; de Roest et al., 2018). Certain agricultural diversification activities may also affect environmental performance through contributing to greater biodiversity and improving landscape features (Gaskell et al., 2010). In addition, farm diversification may increase social sustainability because in some cases it is related to the pursuit of quality-of-life goals or to preserving traditions and identity (Morris et al., 2017).

The characteristics of farm businesses, such as farm size and the age of farm managers, have been considered in many empirical analyses as factors and have been shown to influence economic, environmental, and social sustainability. For example, the size of a farm has been observed to have a positive impact on economic performance, as larger farms capture economies of scale by spreading their fixed costs, reducing sourcing costs per unit, and coping with unstable climatic conditions by investing in new equipment (Barnes et al., 2020). In addition, larger farm businesses are more likely to engage in environmental conservation activities because they have greater decision-making flexibility, larger incentives for land-based payments, and are more likely to have ecologically important lands that are subject to AESs (Lastra-Bravo et al., 2015; Ruto and Garrod, 2009; Wilson and Hart, 2000). In addition, larger farms are more likely to have successors because owning more land usually means a higher value of inherited assets and greater potential for business development (Glauben et al., 2009) and also provides sufficient work and income to allow successors to participate in the farm business (Sutherland, 2010). Farms with older managers tend to manage their land in less intensive ways leading to a lower impact on the environment (Marini et al., 2011) and are more likely to have a successor (Glauben et al., 2009).

2.5. Framework for this study

Based on the literature review, we developed an analytical framework to empirically explore the interrelationship between the three dimensions of sustainability and the factors influencing them, as shown in Fig. 1. Arrows from past sustainability to current sustainability reflect the concept of path dependency, which refers to situations where previous conditions strongly determine current performance (Sutherland et al., 2012a; Barnes et al., 2016). The framework also reflects empirical studies exploring the effects of stakeholder management on firm performance (Agle et al., 1999; Berman et al., 1999; Galbreath, 2006; Hillman and Keim, 2001; Sharma and Henriques, 2005) indicated by the arrow from stakeholder management to current sustainability. Arrows from AES participation, diversification, and farm characteristics reflect quantitative studies exploring the influences of farm behaviours and characteristics on sustainability-related performance, such as technical efficiency (Hadley, 2006; Vigani and Dwyer, 2020), economic viability (Barnes et al., 2020, 2015), and environmental management (Westbury et al., 2011).

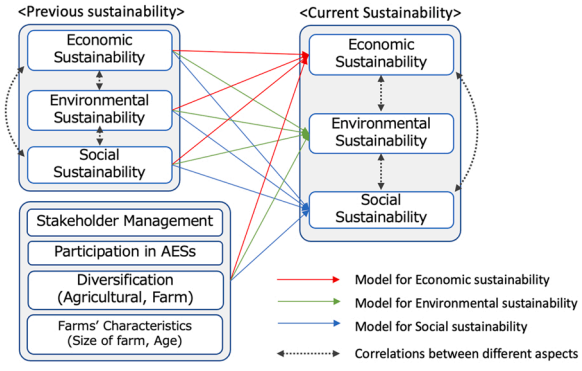

Fig. 1. Analytical Framework.

The framework sees interrelationships between the three dimensions of farm-level sustainability as having a temporal dimension, where sustainability performance in the previous period affects current sustainability. We cannot infer practical implications from the correlations between different dimensions of sustainability at the same point in time because they are a mixture of results determined by previous sustainability, farms' behaviours, and farms' characteristics. Moreover, we have no idea from the correlations about which sustainability dimension we should deal with first or which management activities should be enhanced. By empirically exploring the impact of past sustainability and farm management on current sustainability, this study helps to identify how the trade-offs between different sustainability goals reflected in many farm decisions occur over time, which dimensions of sustainability we need to address as a priority, and how important stakeholder management is for farm-level sustainability. Other contributions include identifying the impact of participation in AESs, diversification, farm size, and farm managers' ages on the sustainability of LFA farms in Northern England.

3. Materials and methods

3.1. Data

A self-fill questionnaire was developed and distributed to obtain data for quantitative analysis. The questionnaire included questions on farm-level sustainability, stakeholder management and diversification, participation in AESs, farm size, and farm manager age. Questionnaires were mailed to 1000 farms located within LFAs in Northern England (Northeast, Northwest, Yorkshire and Humber). To select these farms, we first created a list of farms with their names, addresses, and postcodes from telephone directories found on the Internet. We then introduced the postcodes and LFAs boundaries into a GIS and extracted the farms within the LFAs until the number of extracted farms was 1000. We received 248 responses, and 174 that had no missing indicators were used in the analysis. To check the sample's representativeness, we compared it to LFA grazing farms in England reported in government statistics in terms of farm area, livestock units, age of principal farmers, and AES participation, as shown in Table 2. Although the sample included farms of various sizes, it had a higher proportion of larger farms and a lower proportion of small farms than the population of LFA farms in England. Thus, the mean livestock units in the sample are larger than those of LFA farms in England. There were no apparent differences between the sample and the population regarding the age of the principal farmers and the proportion of farms participating in AESs. Considering this, the results of this study may more accurately reflect the behaviours and outcomes of larger farms in the population. Larger farms have a high share of farmland in England – LFA farms over 100 ha comprise 75% of LFA farmland (DEFRA, 2022). This suggests that they have a more significant impact on the rural economy, environment, and society; therefore, the sample in this study is appropriate for considering farm-level sustainability. However, it should be noted that the results of this study might not be applicable to smaller farms.

3.2. Questionnaire design

The first step in designing the questionnaire was indicator selection. The choice of sustainability indicators is an important process that has a significant impact on results (Latruffe et al., 2016a; Lebacq et al., 2013). In this process it is important to reflect on the context of the study and to incorporate stakeholder opinions (Herrera et al., 2016; Lebacq et al.,

Table 2
Characteristics of sample and survey areas.

		Farms in the sample (2019/20)	LFA grazing farms in England[a] (2019/20)
Number of farms	Sum	174	6842
	North West	36	2363
	North East	91	1035
	Yorkshire and the Humber	47	1337
Proportions of farms by the farm size	0–99 ha	34%	55%
	100–199 ha	24%	23%
	200–299 ha	11%	8%
	Over 300 ha	31%	14%
Average Livestock Units	North West	184.1	80.2
	North East	171.2	116.6
	Yorkshire and the Humber	176.9	75.8
Proportions of farms by the age of the principal farmer[b]	20–34	5%	3%
	35–44	9%	7%
	45–54	22%	21%
	55–64	32%	30%
	Over 65	33%	40%
Proportion of farms participating in AESs		68%[c]	66% [± 5%][d]

[a] Statistics of LFA grazing farms in England were retrieved from the Farm Business Survey, DEFRA.

[b] As the categories used in the survey for the age of the principal farmers were different from those of the Farm Business Survey (FBS), we reclassified and aggregated the sample corresponding to the categories of FBS, assuming that the samples were evenly distributed within each category.

[c] Farms participating in AESs in the sample had participated in either the Mid-tier or Higher-tier of the Countryside Stewardship Scheme from 2014/15–2019/2020.

[d] Proportions of farms in the population participating in AESs from the population were taken from the Farm Practice Survey 2018, DEFRA. The figure in square brackets indicates a 95% confidence interval.

2013; Ripoll-Bosch et al., 2012). In addition, including as many sustainability indicators as possible is desirable, though the costs of collecting the information need to be considered carefully (Kelly et al., 2018). Therefore, in this study, indicators were selected based on those that had been proposed in the literature and were then classified into the three sustainability dimensions that had been used in previous studies (Hayati, 2017; Latruffe et al., 2016a; Lebacq et al., 2013), taking into account the opinions of experts and farmers in the target area and the potential burden for respondents. First, initial lists of indicators were created for each of the three dimensions of sustainability. Second, each indicator was evaluated based on its importance to farmers and its measurability. This was done by five experts who had significant knowledge of farming in Northern England, along with two owners of LFA farms in the survey area. Third, we excluded indicators judged by the experts to be of low importance or hard to measure. Fourth, considering the themes that the indicators covered and the burden on respondents, three indicators were selected for each of the three dimensions.

Profitability, the most commonly used indicator of economic efficiency, savings, representing stability, and low reliance on subsidies, representing self-reliance, were selected as economic sustainability indicators. Grazing farms in LFAs in England are highly vulnerable to reductions in direct payments, as the average farm production income is negative, and they depend on direct payments for much of their income (Hubbard et al., 2019). Thus, low dependence on subsidies is an important indicator of economic sustainability. Barnes et al. (2020) used farm viability with a 50% subsidy removed from farm income as one of the criteria for assessing economic viability. Indicators of environmental sustainability comprised ground conditions, natural habitat, and biodiversity. These reflect that soil erosion and biodiversity loss are problems caused by overgrazing. The latter two indicators also reflect the English policy context, which prioritises nature recovery and public goods delivery (HM Government, 2018). The social indicators included succession, holidays, and isolation. These indicators reflect the LFA context, where succession is a challenge and farmer isolation is an important issue. While the indicators in this study reflect the context of LFA grazing farms in Northern England and include a broader range of themes, we do not include environmental aspects at a global level, such as greenhouse gas emissions, or external social aspects, such as social responsibilities and public concerns that the agricultural sector must consider. Although these are important aspects of agricultural sustainability and can have a direct relationship with the decision-making of individual farmers, these are difficult for farmers to self-evaluate as outcomes of their behaviours in the questionnaire unless they have the chance to receive feedback from a specialist in environmental impact assessment.

Questions relating to each indicator of sustainability required farm owners to rate the condition of their farm compared to other farms in the region on a five-point Likert scale (much better/higher, better/higher, same, worse/lower, and much worse/lower). Some studies have shown that managers' self-assessments of economic or environmental performance have validity (Dess and Robinson, 1984; Murillo-Luna et al., 2008; Sharma, 2001; Wagner, 2015). Although several social sustainability indicators of agriculture have been proposed (e.g. FAO, 2014; Lebacq et al., 2013; Zahm et al., 2008), few studies have measured farm-level social sustainability (Mills et al., 2021). However, farm owners can generally assess whether successors have been identified and the possibility of succession (Barnes et al., 2020; Ruto and Garrod, 2009), and the questionnaire includes a self-assessment of overall life satisfaction and quality of life using a Likert scale (Willock et al., 1999; Röös et al., 2019; Wojewódzka-Wiewiórska et al., 2020). We used a relative evaluation procedure that takes the average farm in the region as the relative reference value. An alternative to this is the absolute evaluation procedure that compares pre-defined tolerances or thresholds as absolute reference values (de Olde et al., 2016; von Wirén-Lehr, 2001). However, arriving at a clear definition of the absolute reference values of each indicator and the self-assessment of such absolute values by farmers is difficult, so the more straightforward relative assessment was adopted for this study.

Our study aimed to examine the relationship between sustainability at different times, so the questionnaire contained questions about sustainability over time asking about both the current period (2019/2020) and the situation five years previously (2014/2015). This study also aimed to determine the impact of farm activities on sustainability; thus, questions about activities, such as participation in AESs, livestock numbers, and diversification activities, were asked for the two time points. Questions about stakeholder management used a five-point Likert scale (always, often, sometimes, occasionally, not at all) to enquire whether farmers built relationships with each of the following stakeholder groups based on: family members, employees, sales partners, suppliers, landowners, and the farming community (advisors and farmers' groups). Questions about family and employees explored the extent to which the farmers had allocated decision-making authority over the previous five years. Questions about buyers, suppliers, landowners, and farming communities asked to what extent the farmers had strengthened relationships over those years.

3.3. Measures

Variables for the three dimensions of sustainability, both at the time of the survey and five years before the survey, were calculated as the sum of the three standardised indicators belonging to each of the three dimensions. This study focuses on examining and simplifying the complexity and trade-offs between the components of the three dimensions of sustainability to increase inter-comparability with other studies that have assessed the three dimensions of sustainability. In addition, as the importance of the components in the composite indicator of sustainability depends on the internal and external environment of the farm (Barnes et al., 2015), it may not be possible to determine

Table 3
Definition and descriptive statistics of sustainability indicators.

Sustainability Dimensions	Variables	Definition and description of question	Mean	Std. Dev.
Economic Sustainability		Five-point Likert scale reflecting answers by farmers to the questions asking them to rate their farm's **ECONOMIC** performance compared to other local farms for each of the following on a scale of 1–5: Much higher (5), Higher (4), Same (3), Lower (2), Much lower (1)		
	Profitability	Profitability (How much money your farm makes compared to other similar local farms (e.g. size, livestock, facilities and labour)	3.10	0.651
	Savings	Savings for updating facilities, equipment and livestock	2.94	0.788
	Self-reliance	Reliance on subsidy as an income source[a]	2.80	0.891
Environmental Sustainability		Five-point Likert scale reflecting answers by farmers to the questions asking them to rate their farm's **ENVIRONMENTAL** performance compared to other local farms for each of the following on a scale of 1–5: Much better (5), Better (4), Same (3), Worse (2), Much worse (1)		
	Natural habitat	Condition of natural habitat	3.70	0.638
	Biodiversity	Diversity of fauna and flora	3.55	0.725
	Ground	Natural ground condition	3.44	0.709
Social Sustainability		Five-point Likert scale reflecting answers by farmers to the questions asking them to rate their farm's **SOCIAL** performance compared to other local farms for each of the following on a scale of 1–5: Much better (5), Better (4), Same (3), Worse (2), Much worse (1)		
	Successor	Ability to identify a successor	3.26	1.315
	Holiday	Ability to take the holiday when you want to	2.47	1.176
	Isolation	Engagement with local community	3.20	0.719

[a] In the analysis, the ratings are reversed because a higher reliance on the subsidy means lower self-reliance.

whether one component always has higher importance than other components. Therefore, we assumed that all the components had similar importance for sustainability in order to evaluate various farm survival strategies as adaptations to the internal and external environment.

The respondents rated the stakeholder management variables on the same five-point Likert scale described earlier. Previous studies have commonly used a Likert scale to capture stakeholder responses and attitudes (Agle et al., 1999; Alt et al., 2015; Berman et al., 1999; Sharma and Henriques, 2005; Wagner, 2015). The variable for participation in AESs is the sum of four dummy variables representing participation or non-participation in each of the four schemes in which farmers can voluntarily decide to participate. Two diversification variables are included, one representing business diversification and the other representing agricultural diversification. The variable for farm size is livestock units, calculated in the same way as in the England Farm Business Survey. The variable for principal farm manager's age is a six-point ordinal scale. The definitions and the descriptive statistics of these variables are given in Tables 3 and 6, and the descriptive statistics and correlation coefficients for the three dimensions of sustainability are given in Tables 4 and 5.

3.4. Empirical model

To explain the impact of sustainability in the past and the decision-based behaviour of farm businesses across the three dimensions of sustainability, a multiple regression analysis was conducted based on three models using the three dimensions of sustainability at the time of the survey as dependent variables. The models are written as:

$$y_{i20} = \alpha + \beta_i y_{i15} + \gamma_i X + \varepsilon \quad (1)$$

where y_{i20} are the three dimensions of sustainability at the time of the survey, y_{i15} are the three dimensions of sustainability five years before the survey, i represents the dimension of sustainability, α is the intercept, X is a vector of variables for farm behaviour and characteristics, β is a vector of regression coefficients of X, and ε is the error term. A key objective of this study is to explore the impact of stakeholder management on sustainability. However, the multiple regression models described above can only estimate the independent impact of each aspect of stakeholder management on sustainability as a regression coefficient. This coefficient excludes the impact of stakeholder management towards multiple stakeholders on sustainability, such as the adoption of bottom-up decision-making processes within farm businesses. Thus, the model above may underestimate the impact of individual stakeholder management on sustainability. To confirm whether underestimation occurred, we used models with a smaller number of stakeholder variables. Since stakeholder management towards family and employees or the management towards buyers and suppliers may sometimes be designed and conducted simultaneously, variables with a smaller p-value of the estimated regression coefficient in each category (internal stakeholder and value-chain stakeholder) were excluded. The relative magnitude of the impact of each explanatory variable on sustainability was compared using standardised regression coefficients.

To identify the relationship between the three dimensions of sustainability at the same point in time, the correlation coefficients of the three dimensions of sustainability, both at the time of the survey and five years before the survey, were calculated. In addition, partial correlation coefficients for sustainability at the time of the survey were calculated by controlling the variable sets used as explanatory variables in Model (1).

4. Results

4.1. Model fitting results

The results of the multiple regression analysis are shown in Table 8. Calculating the goodness-of-fit indices (AIC and BIC) for the all-inclusive (Models 1, 3, and 5) and restricted (Models 2, 4, and 6) models of the stakeholder variables, the latter showed better values. This result indicates that stakeholder management variables in the same category have a common effect on sustainability and that their inclusion in the model simultaneously underestimates the impact of individual stakeholder management on sustainability. Therefore, the remainder of this study interprets the estimation results from the restricted model. The variance inflation factor (VIF) was calculated to check for multicollinearity. The VIFs for all explanatory variables were less than 2, suggesting that multicollinearity was unlikely to occur. From the adjusted R-squared from the estimation results, 42.6% of economic sustainability, 50.4% of environmental sustainability, and 62.6% of social sustainability were explained by the explanatory variables included in the estimation. This study's adjusted R-squared seems reasonable compared with similar analyses that used farm-level sustainability as the dependent variable (Barnes et al., 2020; Piedra-Muñoz

Table 4
Descriptive statistics and correlations of the three dimensions of farm-level sustainability.

	Mean	Std. Dev.	1	2	3
1 Economic Sustainability	0.00	2.216	1.000		
2 Environmental Sustainability	0.00	2.366	-0.023	1.000	
3 Social Sustainability	0.00	1.960	0.276**	0.038	1.000

** $p < 0.01$.

et al., 2016). The F-test for R is significant at the 0.1% level in all three estimation results, so at least one or more variables explaining each dimension of sustainability are included in each model.

4.2. Impacts of past sustainability on present sustainability

The estimated values of the standardised coefficients of the explanatory variables in the multiple regression analysis represent a positive impact on sustainability when the value is positive, a negative impact on sustainability when the value is negative, and a greater impact when the absolute value is larger. All three dimensions of past sustainability significantly influence the same dimensions of sustainability. Past economic sustainability significantly and negatively affects environmental sustainability but has no significant impact on social sustainability. Past environmental sustainability significantly and negatively affects social sustainability but has no significant impact on economic sustainability. Past social sustainability significantly and positively affects economic sustainability but has no significant impact on environmental sustainability.

4.3. Impacts of farm behaviours and characteristics on sustainability

Regarding the impact of stakeholder management on sustainability, strengthening the decision-making role of family members has a positive impact on social sustainability but no significant impact on economic and environmental sustainability. However, it may negatively affect environmental sustainability, as the p-value is not significant but close to 0.1. Stakeholder management towards employees, buyers, and landlords does not significantly affect any of the three dimensions of sustainability. On the other hand, stakeholder management towards suppliers has a significant positive impact on economic sustainability but no significant impact on environmental and social sustainability. Stakeholder management towards the farming community has a significant positive impact on environmental sustainability, but no significant impact on economic and social sustainability. Participation in AESs significantly and positively affects environmental sustainability, negatively affects economic sustainability, and has no significant effect on social sustainability. Agricultural diversification has a significant positive impact on economic sustainability. However, farm diversification and farm owner age have no significant impact on sustainability. The size of the farm has a significant positive effect on economic sustainability but no significant effect on environmental or social sustainability.

Table 5
Descriptive statistics and correlations of the three dimensions of previous farm-level sustainability.

	Mean	Std. Div.	1	2	3
1 Past Economic Sustainability	0.00	2.109	1.000		
2 Past Environmental Sustainability	0.00	2.480	-0.058	1.000	1.000
3 Past Social Sustainability	0.00	1.960	0.173*	0.104	

* $p < 0.05$.

4.4. Relative importance of each variable on farm-level sustainability

Bar charts in Fig. 2., Fig. 3. and Fig. 4. show the standardised coefficients for each explanatory variable obtained from the regression analysis. The vertical axis of the graph shows the positive, negative, and relative magnitudes of the impact of each explanatory variable on each sustainability dimension. For example, among the factors affecting economic sustainability, past economic sustainability has the largest positive impact, followed by the negative impact of participation in AESs, the positive impact of farm size, diversification of the agricultural sector, and past social sustainability. Regarding the factors affecting environmental sustainability, past environmental sustainability has the largest positive impact, followed by the positive impact of stakeholder management on the farming community, the negative impact of past economic sustainability, and the positive impact of participation in AESs. Finally, regarding factors affecting social sustainability, past social sustainability has the largest positive impact, followed by the positive impact of stakeholder management on family and the negative impact of past environmental sustainability.

4.5. Correlations between sustainability dimensions

Tables 4 and 5 show the correlation coefficients between the three dimensions of sustainability at the time of the survey and the five years before the survey. The correlations between the three dimensions of sustainability at the same point in time indicate apparent relationships between them. At the time of the survey and five years before, there was a weak positive correlation between economic and social sustainability, suggesting that when comparing farms at the same point in time, farms with higher economic sustainability are more likely to exhibit higher social sustainability. In contrast, the correlations between economic and environmental sustainability and between environmental and social sustainability were close to zero, suggesting that when comparing farms at the same point in time, environmental sustainability appears to be unrelated to the other two dimensions of sustainability. Table 7 shows partial correlation coefficients between the three dimensions of sustainability at the time of the survey, controlling all explanatory variables used in the multiple regression analysis, including all variables of stakeholder management. The results of the multiple regression analysis show that there are factors influencing two different dimensions: past economic sustainability and participation in AESs. Therefore, the partial correlation coefficients between the three dimensions of sustainability show the correlation with the effects of these common factors being controlled. The partial correlation coefficient between economic and social sustainability at the time of the survey was lower and less significant than the apparent positive correlation between economic and social sustainability, suggesting that the positive relationship between economic and social sustainability is determined by past social sustainability. The partial correlation coefficient between environmental and social sustainability at the time of the survey is larger and more significant than the apparent positive correlation between environmental and social sustainability. This suggests that the relationship between environmental and social sustainability should be positive, but decisions to participate in AESs and past environmental sustainability have weakened the positive relationship.

5. Discussion

This section examines the following. First, based on the results of the multiple regression analysis, the validity and novelty of the results and their policy implications are discussed. Second, we discuss the appropriate methods to capture trade-offs and synergies, between the three dimensions of sustainability in LFA farms in Northern England and the measures required to balance them.

Table 6
Explanatory variables other than variables of the previous sustainability.

Categories	Variables	Definition and description of question	Mean	Std. Dev.
Characteristics of farms	Livestock Unit	Total LU (livestock unit) of farm	170	188.3
	Farmer's Age	Age of the principal farm manager on six scales ranging from 1 (20–30 years) to 6 (> 70 years)	4.28	1.176
Diversification	Agricultural-Diversification	Change of the share of LSU of the livestock sectors other than the largest livestock sector in total LSU from 2014/15–2019/2020	-0.00	0.127
	Farm-Diversification	Change of the number of businesses[a] conducted by farm from 2014/15–2019/2020	1.12	1.631
Agri-environmental scheme	AESs Participation	Number of AESs[b] that farm has participated in during 2014/15–2019/2020	1.96	1.088
Stakeholder Management		Five-point Likert scale reflecting answers by farmers to questions asking about their stakeholder relationships over the last five years: Always (5), Frequently (4), Sometimes (3), Occasionally (2), Never (1).		
	Strengthen Family Decision	Have you assigned decision-making roles to the other family members?	2.53	1.298
	Strengthen Employee Decision	Have you assigned decision-making roles to the other employees?	1.82	1.015
	Strengthen Buyer Relationship	Have you strengthened existing sales channels (for example, regular personal interactions (formal or informal), making contracts or changing production methods to suit buyers' needs)?	2.52	1.220
	Strengthen Supplier Relationship	Have you strengthened existing or potential relationships with suppliers of feed or forage (for example, regular personal interactions (formal or informal) or making contracts)?	2.76	1.186
	Strengthen Landlord Relationship	Have you strengthened existing or potential relationships with landlords?	2.27	1.361
	Strengthen Farming Community Relationship	Have you made and improved relationships with groups or experts to get information about farming technology or policy (for example, participate in farmers' group or regular interactions with neighbouring farmers or advisors)?	2.88	1.273

[a] Direct marketing, produce-processed food, selling wool/skins/hides, tourism, tourist accommodation and catering, sport and recreation, solar energy, wind farms, other sources of renewable energy, letting buildings or land for farming use, letting buildings or land for non-farming use
[b] Greening of BPS, Mid-tier Scheme of CS, Higher-tier Scheme of CS, Hedgerows and Boundary Grants of CS.

5.1. Sustainability factors

The multiple regression analysis includes a range of factors considered in previous studies to be important at the farm level. This reflects the strategic behaviours of farm businesses based on their internal and external environments and provides a detailed description of the reality of the business, as well as an assessment of the relative importance of each factor, as shown in Fig. 5. This study also examines the extent to which past sustainability determines current sustainability and the impact of stakeholder management on sustainability, which has rarely been examined for firms in the agricultural sector.

However, this study does not include factors that have gained more attention in recent studies, such as the organizational capability and entrepreneurial orientation of farm businesses (Dias et al., 2021, 2019a, 2019b; Yoshida et al., 2019). Nevertheless, as responding appropriately to stakeholder demands can be seen as one component of organizational capabilities (Wagner, 2015), the impacts of stakeholder management may somehow include the impacts of organizational capabilities or entrepreneurship. In addition, the impact of farms' location and farmers' beliefs and skills, which rarely changed at the two points in time when sustainability was assessed, may be included in the past sustainability variables.

5.1.1. Past sustainability performance

The positive impact of past economic sustainability on current economic sustainability suggests that farms achieving high profitability and savings have a greater accumulation of tangible and intangible resources that enable the implementation of effective businesses and continuously generate higher economic performance (Barney, 1991; Dias et al., 2021). The negative impact of past economic sustainability on environmental sustainability shows that even in LFAs where extensive grazing is predominant, economically successful farms risk lower incomes if they practice environmentally friendly farming practices (Defrancesco et al., 2008; Dupraz et al., 2003; Ruto and Garrod, 2009; Wilson and Hart, 2000). The lack of a significant impact of past economic sustainability on social sustainability is not consistent with the argument that the better economic performance of farms leads to higher life satisfaction for farmers or smoother successions (Glover and Reay, 2015; May et al., 2019; Sutherland, 2010; Wojewódzka-Wiewiórska et al., 2020). This suggests that high economic performance is not related to better working conditions and that relatively high economic performance in the survey area may not necessarily be attractive to successors. Therefore, for LFA farms in Northern England, improved economic performance may not always improve social sustainability.

The positive impact of past environmental sustainability on current environmental sustainability shows that farms that exhibit high environmental performance are more likely to conserve the environment over the longer term. Therefore, an effective way to improve environmental sustainability is to increase support for farms that are currently not fully engaged in environmental protection activities. This is the strategy currently being pursued in England with the recent introduction of new agri-environment schemes, such as the Sustainable Farming Incentive. The lack of a significant impact of past environmental sustainability on economic sustainability suggests that high environmental performance has been achieved in ways that do not affect farm income or dependency on subsidies, rather than on activities that reduce the number of livestock and compensate for reduced farm income through subsidies (Hennessy and Rehman, 2008), which would result in reduced economic viability. However, considering that farm conservation activities potentially lead to cost savings and access to higher value-added markets (Dwyer et al., 2007), and that higher levels of environmental technology can lead to improved profitability (Piedra-Muñoz et al., 2016), there may be opportunities for LFA farms in Northern England to develop production techniques, marketing, and food value chains that simultaneously improve environmental and economic performance. The negative impact of past environmental sustainability on social sustainability is difficult to explain because there are few studies on this topic.

Table 7
Partial correlation coefficients of the 3 dimensions of the farm-level sustainability.

	1	2	3
1 Economic Sustainability			
2 Environmental Sustainability	-0.007		
3 Social Sustainability	0.127+	0.129+	

+ $p < 0.1$.

Table 8
β coefficients of explanatory variables for the 3 dimensions of the farm-level sustainability.

	Economic Sustainability		Environmental Sustainability		Social Sustainability	
	Model1	Model2	Model3	Model4	Model5	Model6
Past Economic Sustainability	0.471***	0.470***	-0.146**	-0.159**	-0.072	-0.075
Past Environmental Sustainability	0.064	0.062	0.621***	0.605***	-0.089*	-0.087+
Past Social Sustainability	0.127+	0.132*	-0.05	-0.049	0.739***	0.747***
Livestock Unit	0.125+	0.137*	-0.039	-0.047	0.012	0.025
Farmer's Age	-0.057	-0.056	-0.017	-0.026	-0.024	-0.026
Agricultural Diversification	0.112+	0.119+	0.056	0.066	0.029	0.034
Farm Diversification	-0.088	-0.084	0.044	0.050	-0.051	-0.052
Policy Participation	-0.138*	-0.127*	0.117+	0.100+	-0.032	-0.020
Strengthen Family Decision	-0.087	-0.071	-0.087	-0.110+	0.136**	0.138*
Strengthen Employee Decision	0.059	-0.061	0.028			
Strengthen Buyers Relationship	0.022	0.060	0.062			
Strengthen Supplier Relationship	0.124	0.139+	0.040	0.032	-0.019	0.018
Strengthen Landlord Relationship	-0.026	-0.092	0.020			
Strengthen Farming Community Relationship	0.064	0.057	0.162*	0.156*	0.042	0.056
R^2	0.429	0.426	0.514	0.504	0.630	0.626
Adjusted-R^2	0.379	0.387	0.471	0.470	0.597	0.601
F-test	8.530***	10.911***	12.016***	14.957***	19.337***	24.660***
AIC	208.408	203.430	202.910	200.533	89.885	85.713
BIC	255.794	241.339	250.296	238.442	137.271	123.621

Standardized coefficients are showed in the table.
+ $p < 0.1$
* $p < 0.05$
** $p < 0.01$
$df_1 = 14$, $df_2 = 159$ for model 1, 3 and 5. $df_1 = 11$, $df_2 = 162$ for model 2, 4 and 6

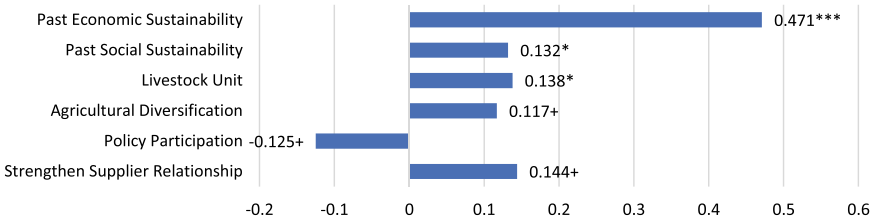

Fig. 2. Standard coefficients of factors of economic sustainability.

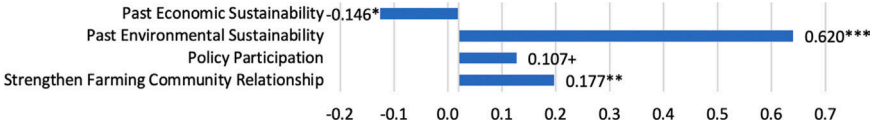

Fig. 3. Standard coefficients of factors of environmental sustainability.

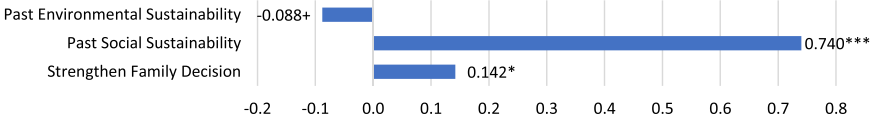

Fig. 4. Standard coefficients of factors of social sustainability.

Possible explanations are as follows: the labour necessary to implement environmental management (Dwyer et al., 2007) may worsen the working environment on farms, and increased environmental performance may enhance farm owners' attachment to farming and their identity as farmers, factors which are both strongly linked to farmers' motivations for environmental conservation activities (Mills et al., 2017), and in turn, this strengthening of attachment to the farm may prevent them from passing it on to their successors (Kirkpatrick, 2013).

The positive impact of past social sustainability on current social sustainability indicates that a farm's succession plans, working environment, and good SEW tend to persist over time. In addition, the positive impact of past social sustainability on economic sustainability indicates that, as previous studies have suggested, through good succession planning and community involvement, medium- and long-term business planning and capital accumulation on farms can be enhanced, enabling them to operate their businesses more effectively (Barnes et al., 2020; Dwyer et al., 2007). Therefore, support to enhance the working environment and life satisfaction of farmers, family members, and employees (May et al., 2019; Wojewódzka-Wiewiórska et al., 2020) is important for promoting farm businesses' economic sustainability. The lack of a significant impact of past social sustainability on environmental sustainability may reflect the fact that the influence of participation in AESs on succession varies from farm to farm (Ruto and Garrod, 2009; Wilson and Hart, 2000). Also, human resources are an important factor

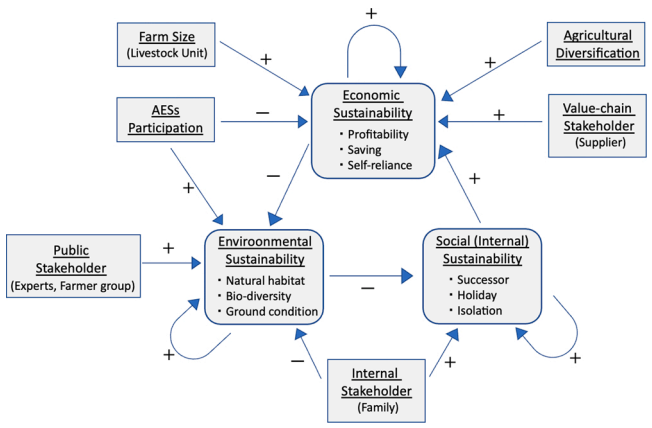

Fig. 5. Structural model of farm-level sustainability and behaviour based on the significant (10%) coefficients estimated by model 2, model 4 and model 6 in Table 8.

in implementing conservation activities (Dwyer et al., 2007), and farmers are sometimes not willing to engage in conservation activities owing to the associated labour requirements and on the impact this will have on their working conditions.

5.1.2. Stakeholder management

Stakeholder theory suggests that by using the relationship between a business and stakeholders as the unit of analysis for determining the objectives of businesses and formulating strategies, managers can connect business and ethics and manage a business to create greater value for both business and stakeholders (Parmar et al., 2010). Empirical analyses of businesses in industries other than agriculture show that, although stakeholder management is a critical factor in sustainability, building relationships with individual stakeholders does not always have a positive impact on economic, environmental, and social sustainability (Agle et al., 1999; Berman et al., 1999; Galbreath, 2006; Hillman and Keim, 2001; Sharma and Henriques, 2005).

Our study shows that stakeholder management by farm businesses is an essential factor in sustainability, but stakeholder management does not always have a positive impact on sustainability in LFAs in Northern England. This suggests that applying stakeholder theory to farm businesses can be a useful approach when designing measures to promote sustainable agriculture. In addition, as the impact of stakeholders is assumed to vary depending on the characteristics of the industry, region, and business (Berman et al., 1999), further empirical study can inform effective stakeholder management according to local context and location conditions.

The positive impact of strengthening family decision-making roles on social sustainability may be because decisions that maintain SEW on the farm and improve the well-being of the farm family are likely to be chosen (Glover and Reay, 2015) or that successors who participate in decision-making are more willing to stay on the farm (May et al., 2019). The lack of impact on economic sustainability from strengthening the decision-making role of family members, suggests that there have been no negative side effects linked to decisions focusing on SEW and the working conditions on farms and ignorance of the economic conditions of farms (Glover and Reay, 2015). The negative impact of strengthening family decision-making on environmental sustainability suggests that environmental activities may not be perceived as attractive to family members or successors. Strengthening the decision-making role of employees had no significant impact on any of the three dimensions of sustainability.

From the above, it can be argued that stakeholder management towards internal stakeholders in LFA farms in Northern England mainly influences sustainability through SEW, which is passed on from generation to generation on farms. However, some farm managers may see family members and employees merely as labour and fail to utilise them fully as human resources (HR) for effective environmental conservation activities and business development. Thus, we recommend that farm managers improve their organisational capabilities through participating in effective HR management and education programmes. In addition, although it has been shown that the implementation of environmental conservation activities is strongly linked to the identity and beliefs of farm owners (Mills et al., 2017), the impact and role of family interests and involvement in environmental conservation activities have not been sufficiently explored. Given this opportunity, agri-environmental policy instruments could be designed to provide more motivation for family members and employees to become involved, perhaps through increasing opportunities for skills development or networking.

The lack of a significant impact on economic sustainability from strengthening relationships with buyers may reflect farmers' lack of trust in distributors, retailers, and commercial customers, their concerns about the risk of becoming more dependent on them (Cox et al., 2007; Ilbery and Maye, 2005), and their difficulties in engaging in direct marketing (Uematsu and Mishra, 2011). The positive impact of strengthening relationships with suppliers on economic sustainability, suggests that building relationships with feed suppliers can contribute to better economic performance, as fluctuations in feed costs have had a significant impact on profitability and costs in the region (DEFRA, 2020b, 2019b). Thus, improved food supply chains that enable direct or differentiated marketing and support for feed suppliers to provide feed at a stable price could be an effective measure to improve the economic sustainability of LFA farms in Northern England. Furthermore, as consumers become increasingly concerned about environmental issues, enhancing relationships between farmers, buyers, and suppliers in the value chain can be expected to have a positive impact on environmental sustainability.

The positive impact of developing relationships with farming communities around environmental sustainability indicates that local expertise can provide valuable resources for adopting and improving environmental management, as shown in previous studies (Lastra-Bravo et al., 2015; Mills et al., 2018, 2017; Polman and Slangen, 2008; Westerink et al., 2017). On the other hand, the finding that developing relationships with the farming community has little significant impact on economic and social sustainability may have several explanations. For example, some farmers may prefer friendships with non-farmers (Dwyer et al., 2007); neighbouring farmers' negative attitudes towards the future of farming may have discouraged successors from staying on the farm (May et al., 2019); or perhaps some communities may not have developed influential farmer groups and networks. Although strengthening relationships with landlords does not have a significant impact on sustainability, it can affect the introduction of diversification activities by farm businesses (Maye et al., 2009), participation in AESs (Defrancesco et al., 2008; Ruto and Garrod, 2009), and the adoption of direct marketing practices (King et al., 2017). Future studies should explore the potential influence of these activities on sustainability.

5.1.3. Participation in AESs

The negative impact on economic sustainability and the positive impact on environmental sustainability of participation in AESs are consistent with the findings of previous studies (Blazy et al., 2015; Udagawa et al., 2014). These studies show that farms participating in AESs tend to improve their environmental performance, while reducing farm income and increasing their dependence on subsidies.

5.1.4. Diversification and farm size, owners' age

The positive impact of agricultural diversification on economic performance is consistent with previous research (Barnes et al., 2015), suggesting that specialisation in particular livestock is a less effective

strategy than reducing risk by diversifying revenue sources from a wider variety of livestock (de Roest et al., 2018). On the other hand, the lack of significant impact of farm diversification on economic sustainability suggests that good business practices, such as the effective use of farm resources, reduction of market risks, and exploiting the higher added value of niche markets, may not have been adopted (de Roest et al., 2018).

The positive impact of farm size on economic sustainability is consistent with previous studies (Barnes et al., 2015; Coppola et al., 2020), suggesting that larger farms have a higher potential for economic growth. However, the impact of farm size on environmental and social sustainability is not significant, suggesting that large farms do not always have an advantage in the creation of public goods, succession, and farmers' livelihood satisfaction. The lack of impact of farm owners' ages on sustainability is consistent with previous research (Barnes et al., 2020; Westbury et al., 2011), suggesting that a farmer's age does not determine the sustainability of their farms.

5.2. Trade-offs, synergies, and the three dimensions of sustainability

The following sections discuss measures that can be used to balance the sustainability dimensions of LFA farm businesses in Northern England based on the results of this study and provides a rationale to ensure the validity of the above claims.

5.2.1. Balancing economic and environmental sustainability

The analysis reported above suggests that trade-offs exist between environmental and economic sustainability. Specifically, farm businesses that were economically successful in the past have consolidated this success and moved towards lower environmental performance. By contrast, farms that participate in AESs show improved environmental sustainability but weaker economic performance, with lower farm incomes and an increased reliance on subsidies. These are consistent with previous observations of farm behaviours in the UK uplands by several authors (e.g. Ingram et al., 2013; Morris et al., 2017; Sutherland, 2010). If farmers do not perceive the need to change their existing farming systems in response to trigger events, such as succession or policy reform, this trend may continue following the path dependence of farm businesses (Sutherland et al., 2012a). In this case, we would see increased differentiation of farms in the survey area into those with high economic and low environmental sustainability, and those with high environmental but low economic sustainability. This second group of farms, while more economically vulnerable, plays a greater role in the delivery of public goods and their survival can be supported by payments from Defra's new Environmental Land Management schemes that are designed to promote the increased delivery of a variety of public goods (DEFRA, 2020d).

To maintain a balance between economic and environmental sustainability in the future, it is necessary to identify the factors that contribute to the decline in environmental performance in farm businesses that achieve high economic performance. It is also important that future schemes are designed to target these farms to promote their ability to deliver public goods without compromising their economic sustainability. This could include introducing technologies that contribute to cost-saving and lower environmental impacts, developing supply chains where the environmental benefits produced by agricultural production are converted into a higher added value of products (Coyne et al., 2021; Mylan et al., 2015), or by expanding diversification activities, such as renewable energy production, that provide environmental benefits but also make a profit (Sutherland et al., 2016).

On the other hand, the observation that past environmental sustainability does not seem to have a negative impact on current economic sustainability suggests that implementing environment-friendly activities does not have to result in lower economic performance. With the halving of the Basic Payment to farmers in England by 2024 and its withdrawal by 2027 (DEFRA, 2020d), many farmers are likely to become increasingly reliant on payments from a new generation of agri-environment schemes that use public money to pay for public goods (Bateman and Balmford, 2018) to ensure their economic viability. Future agri-environmental policies should seek to reduce this reliance on subsidies to promote farmers' environmental conservation behaviour and encourage the use of other non-economic incentives, such as stimulating participation in farming networks and improving advisory services (Lastra-Bravo et al., 2015; Mills et al., 2017). The fact that many farmers are concerned about the environment (Wilson and Hart, 2000) and that many farms undertake environmental management not supported by payments (Mills et al., 2018) confirms the potential importance of non-economic incentives to work in conjunction with subsidies to deliver a blended approach to public good delivery.

5.2.2. Balancing economic and social sustainability

The relationship between the economic and social sustainability of LFA farms in Northern England was weak but significantly positive in both 2014/15 and 2019/20, suggesting that some synergies exist between economic and social sustainability. However, the results of the multiple-regression analysis show that past social sustainability positively affects both economic and social sustainability but that past economic sustainability does not significantly affect current social sustainability, suggesting that the relationship between economic and social sustainability is not synergistic. Improved social performance leads to better economic performance; however, the reverse is not true. Therefore, measures primarily aimed at income support for farms or increasing business efficiency cannot be expected to spill over into better social sustainability; in contrast, support for farms' social dimensions may lead to better economic performance. This proposition is understandable considering the positive influence of succession planning on the economic viability of farms (Barnes et al., 2020; Barnes, 2022), the difference between a sufficient income level for farmers who intend to retire in the near future, the level of income attractive to their successors (Marini et al., 2011) or sufficient to hire successors (Sutherland, 2010), and the possibility that business expansion could be associated with an increase in stress and mental health problems (Glover and Reay et al., 2015; Wojewódzka-Wiewiórska et al., 2020). Therefore, direct support for the social sustainability of farms is essential; for example, support for the creation of systems that enable smooth succession and improve working conditions for family members and employees.

5.2.3. Balancing environmental and social sustainability

The relationship between the environmental and social sustainability of LFA farms in Northern England was not significant in either 2014/15 or 2019/20; however, the results of the multiple-regression analysis suggest that farm businesses face a trade-off between environmental and social sustainability. In addition, stakeholder management of family members has a significant positive impact on social sustainability.

Possible explanations of a conflict between environmental conservation activities and the satisfaction of family members and successors include farm owners' attachment to their farms, which is strongly linked to environmental conservation and prevents succession (Kirkpatrick, 2013). Membership to AESs requires a binding contract that many farmers do not want to pass on to their successors (Ruto and Garrod, 2009), and successors are also worried that such voluntary agreements will limit their decision-making in the future (Sutherland, 2010). In addition, conservation activities and subsidies are sometimes seen to be not a good way to preserve family livelihood and farm survival (Ingram et al., 2013). Whichever explanation is correct, unless agri-environmental activities are positively addressed not only by farm owners but also by their successors and family members, farm owner turnover and family opposition may make it challenging to guarantee long-term environmental sustainability.

6. Conclusions

Resolving trade-offs between different sustainability goals is vital to achieve sustainable agriculture; however, there have been insufficient empirical analyses to inform effective policy design and farm decision support. In addition, the role of stakeholder management in sustainable agriculture has yet to be fully explored.

In this study, we conducted a questionnaire survey of LFA farms in Northern England and quantitative data analysis to understand the relationship between the three dimensions of sustainability at different points in time and the impact of various factors, including stakeholder management, on sustainability. The results show that past sustainability has an influence on current sustainability and that factors common to different dimensions of sustainability may be responsible for the trade-offs sometimes faced by farm businesses. Past social sustainability is found to have a significant and positive influence on economic sustainability. However, the reverse is not found. These results imply that providing direct support to improve the social sustainability of farms may be important and could potentially serve as a means to promote economic growth in farm businesses. Regarding relationships between economic and environmental sustainability, the former is found to determine the latter, though the opposite relationship is found to be insignificant. This suggests that trade-offs occur in economically successful farms that practise less environmentally friendly farming to help them achieve improved economic performance. More significantly, our findings revealed that participation in AESs has a significantly negative impact on economic sustainability, despite having a positive effect on environmental sustainability. This suggests that prior participation in AESs may have led to trade-offs between economic and environmental performance. The results of this study show that stakeholder management is a critical factor in determining farm-level sustainability and that its impact on sustainability varies according to the type of stakeholder. For example, environmental sustainability was found to improve as the result of farmers' efforts s to strengthen their relationships with farmer groups and experts. However, environmental sustainability fell as the result of efforts to strengthen family decision roles, though this has a positive impact on social sustainability. These results suggest that future agri-environmental policies should not only offer incentives to farm owners but also encourage them to improve their networks and recognise the needs of their successors and families. Therefore, efforts to achieve sustainable agriculture should promote the design and implementation of policy support that can help to develop effective relationships between farmers and their stakeholders.

There are few limitations to this study. The sustainability indicators cover a limited range of issues regarding sustainability, reflecting the need to reduce the burden on farmers completing the questionnaire. The selection of indicators may have influenced the results, which indicated that social sustainability and stakeholder management were crucial to understanding the development pathway of farm businesses towards sustainable agriculture. However, these indicators depend on farmer self-assessment and could be improved later in qualitative studies. For instance, if the indicators for stakeholder management could have identified the heterogeneity of relationships and the quality of management to improve relationships by considering different farmer groups, or the amount or quality of resources that farms provide to their stakeholders, then results could have identified that of stakeholder management had other, more significant, impacts on sustainability. It is worth noting that some stakeholders who were not explicitly considered in our study may still play a vital role in determining the sustainability of farms. It may be worthwhile to explore their importance in future studies. Our analysis did not find that enhancing the relationships with buyers has had a significant impact on farms' sustainability, but some farmers are attempting to establish direct and short supply chains to improve control over their businesses and mitigate market risks (Dubois, 2018; Kneafsey et al., 2013). Future qualitative studies that investigate farms' relationships with citizens and consumers from this perspective could yield significant insights into stakeholder management that could promote economic viability and self-reliance in farming.

CRediT authorship contribution statement

Garrod Guy: Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Yagi Hironori:** Funding acquisition, Methodology, Supervision, Writing – review & editing. **Ogawa Keishi:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The data that has been used is confidential.

References

Agle, B.R., Mitchell, R.K., Sonnenfeld, J.A., 1999. Who matters to ceos? An investigation of stakeholder attributes and salience, corpate performance, and ceo values. AMJ 42, 507–525. https://doi.org/10.5465/256973.

Alkan Olsson, J., Bockstaller, C., Stapleton, L.M., Ewert, F., Knapen, R., Therond, O., Geniaux, G., Bellon, S., Correira, T.P., Turpin, N., Bezlepkina, I., 2009. A goal oriented indicator framework to support integrated assessment of new policies for agri-environmental systems. Environ. Sci. Policy 12, 562–572. https://doi.org/10.1016/j.envsci.2009.01.012.

Alt, E., Díez-de-Castro, E.P., Lloréns-Montes, F.J., 2015. Linking employee stakeholders to environmental performance: the role of proactive environmental strategies and shared vision. J. Bus. Ethics 128, 167–181. https://doi.org/10.1007/s10551-014-2095-x.

Arata, L., Sckokai, P., 2016. The impact of agri-environmental schemes on farm performance in five E.U. member states: a DID-matching approach. Land Econ. 92, 167–186. https://doi.org/10.3368/le.92.1.167.

Arnott, D., Chadwick, D.R., Wynne-Jones, S., Dandy, N., Jones, D.L., 2021. Importance of building bridging and linking social capital in adapting to changes in UK agricultural policy. J. Rural Stud. 83, 1–10. https://doi.org/10.1016/j.jrurstud.2021.02.001.

Barnes, A.P., 2022. The role of family life-cycle events on persistent and transient inefficiencies in less favoured areas. J. Agric. Econ. https://doi.org/10.1111/1477-9552.12506.

Barnes, A.P., Hansson, H., Manevska-Tasevska, G., Shrestha, S.S., Thomson, S.G., 2015. The influence of diversification on long-term viability of the agricultural sector. Land Use Policy 49, 404–412. https://doi.org/10.1016/j.landusepol.2015.08.023.

Barnes, A.P., Sutherland, L.-A., Toma, L., Matthews, K., Thomson, S.G., 2016. The effect of the common agricultural policy reforms on intentions towards food production: evidence from livestock farmers. Land Use Policy 50, 548–558. https://doi.org/10.1016/j.landusepol.2015.10.017.

Barnes, A.P., Thomson, S.G., Ferreira, J., 2020. Disadvantage and economic viability: characterising vulnerabilities and resilience in upland farming systems. Land Use Policy 96, 104698. https://doi.org/10.1016/j.landusepol.2020.104698.

Barney, J., 1991. Firm resources and sustained competitive advantage. J. Manag. 17, 99–120. https://doi.org/10.1177/014920639101700108.

Bateman, I.J., Balmford, B., 2018. Public funding for public goods: a post-Brexit perspective on principles for agricultural policy. Land Use Policy 79, 293–300. https://doi.org/10.1016/j.landusepol.2018.08.022.

Bauman, A., Thilmany McFadden, D., Jablonski, B.B.R., 2018. The financial performance implications of differential marketing strategies: exploring farms that pursue local markets as a core competitive advantage. Agric. Resour. Econom. Rev. 47, 477–504. https://doi.org/10.1017/age.2017.34.

Berman, S.L., Wicks, A.C., Kotha, S., Jones, T.M., 1999. Does stakeholder orientation matter? The relationship between stakeholder management models and firm financial performance. Acad. Manag. J. 42, 488–506. https://doi.org/10.2307/256972.

Bernués, A., Ruiz, R., Olaizola, A., Villalba, D., Casasús, I., 2011. Sustainability of pasture-based livestock farming systems in the European Mediterranean context: synergies and trade-offs. Livest. Sci. 139, 44–57. https://doi.org/10.1016/j.livsci.2011.03.018.

Binder, C.R., Feola, G., Steinberger, J.K., 2010. Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. Environ. Impact Assess. Rev. 30, 71–81. https://doi.org/10.1016/j.eiar.2009.06.002.

Blazy, J.M., et al., 2015. Environmental and economic impacts of agri-environmental schemes designed in French West Indies to enhance soil C sequestration and reduce

pollution risks. A modelling approach. Agric. Syst. 140, 11–18. https://doi.org/10.1016/j.agsy.2015.08.009.
van Calker, K.J.V., Berentsen, P.B.M., Giesen, G.W.J., Huirne, R.B.M., 2005. Identifying and ranking attributes that determine sustainability in Dutch dairy farming. Agric. Hum. Values 22, 53–63. https://doi.org/10.1007/s10460-004-7230-3.
Caskie, P., Davis, J., Wallace, M., 2001. Targeting disadvantage in agriculture. J. Rural Stud. 17, 471–479. https://doi.org/10.1016/S0743-0167(01)00016-X.
Coppola, A., Scardera, A., Amato, M., Verneau, F., 2020. Income levels and farm economic viability in italian farms: an analysis of FADN data. Sustainability 12, 4898. https://doi.org/10.3390/su12124898.
Cox, A., Chicksand, D., Yang, T., 2007. The proactive alignment of sourcing with marketing and branding strategies: a food service case. Supply Chain Manag. Int. J. 12, 321–333. https://doi.org/10.1108/13598540710776908.
Coyne, L., Kendall, H., Hansda, R., Reed, M.S., Williams, D.J.L., 2021. Identifying economic and societal drivers of engagement in agri-environmental schemes for English dairy producers. Land Use Policy 101, 105174. https://doi.org/10.1016/j.landusepol.2020.105174.
Cullen, P., Hynes, S., Ryan, M., O'Donoghue, C., 2021. More than two decades of agri-environment schemes: has the profile of participating farms changed. J. Environ. Manag. 292, 112826 https://doi.org/10.1016/j.jenvman.2021.112826.
DEFRA, 2019a. The Future Farming and Environment Evidence Compendium. Available at: ⟨https://www.gov.uk/government/collections/the-future-farming-and-environment-evidence-compendium⟩.
DEFRA, 2020d. Farming for the future: policy and progress update. Available at: ⟨https://www.gov.uk/government/publications/the-future-for-food-farming-and-the-environment-policy-statement-2020⟩.
DEFRA, 2019c. Farm Practice Survey 2018 - England Farm business practices, soil management and cattle housing. Available at: ⟨https://www.gov.uk/government/statistics/farm-practices-survey-october-2018-current-farming-topics⟩.
DEFRA, 2020c. Countryside Stewardship Mid Tier and Wildlife Offers Manual. Available at: ⟨https://www.gov.uk/government/publications/mid-tier-and-wildlife-offers-manual-for-1-january-2020-agreements-countryside-stewardship⟩.
DEFRA, 2020a. Statistical Digest of Rural England. Available at: ⟨https://www.gov.uk/government/statistics/statistical-digest-of-rural-england⟩.
DEFRA, 2019b. Farm Business Income by type of farm in England, 2018/19. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/944348/fbs-businessincome-statsnotice-21nov19.pdf.
DEFRA, 2020b. Farm Business Income by type of farm, England, 2019/20. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1031917/fbs-businessincome-statsnotice-16dec20.pdf.
DEFRA, 2022. Numbers of commercial holdings and key land areas/livestock types by Less Favoured areas at June each year: England. Available at: ⟨https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june⟩.
Defrancesco, E., Gatto, P., Runge, F., Trestini, S., 2008. Factors affecting farmers' participation in agri-environmental measures: a Northern Italian perspective. J. Agric. Econ. 59, 114–131. https://doi.org/10.1111/j.1477-9552.2007.00134.x.
Dess, G.G., Robinson, R.B., 1984. Measuring organizational performance in the absence of objective measures: the case of the privately-held firm and conglomerate business unit. Strateg. Manag. J. 5, 265–273. https://doi.org/10.1002/smj.4250050306.
Dias, C., Gouveia Rodrigues, R., Ferreira, J.J., 2021. Small agricultural businesses' performance-what is the role of dynamic capabilities, entrepreneurial orientation, and environmental sustainability commitment. Bus. Strat Environ. 2723. https://doi.org/10.1002/bse.2723.
Dias, C.S.L., Rodrigues, R.G., Ferreira, J.J., 2019a. Agricultural entrepreneurship: going back to the basics. J. Rural Stud. 70, 125–138. https://doi.org/10.1016/j.jrurstud.2019.06.001.
Dias, C.S.L., Rodrigues, R.G., Ferreira, J.J., 2019b. What's new in the research on agricultural entrepreneurship? J. Rural Stud. 65, 99–115. https://doi.org/10.1016/j.jrurstud.2018.11.003.
Dubois, A., 2018. Nurturing proximities in an emerging food landscape. J. Rural Stud. 57, 1–12. https://doi.org/10.1016/j.jrurstud.2017.10.005.
Dupraz, P., Vermersch, D., Frahan, B.H.D., Delvaux, L., 2003. The environmental supply of farm households: a flexible willingness to accept model. Environ. Resour. Econ. 25.2, 171–189. https://doi.org/10.1023/A:1023910720219.
Dwyer, J., Mills, J., Ingram, J., Taylor, J., Burton, R., Blackstock, K., Slee, B., Brown, K., Schwarz, G., Matthews, K., Dilley, R., 2007. Understanding and influencing positive behaviour change in farmers and land managers. Available at: ⟨http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14518⟩.
Dwyer, J.C., Mills, J., Powell, J.R., Lewis, N., Gaskell, P., Felton, J., 2015. State Farming Exmoor 2015.
Dyllick, T., Hockerts, K., 2002. Beyond the business case for corporate sustainability. Bus. Strategy Environ. 11, 130–141. https://doi.org/10.1002/bse.323.
Elkington, J., 1997. "Cannibals with forks." The triple bottom line of 21st century. Choice Rev. Online 73. https://doi.org/10.5860/CHOICE.36-3997.
European Court of Auditors, 2011. Is Agri-Environmental Support Well Designed and Managed? Publications Office of the European Union, Luxembourg.
FAO, 2014. SAFA Guidelines: Sustainability Assessment of Food and Agriculture Systems, Version 3.0. Food and Agriculture Organization of the United Nations,, Rome (Available at). ⟨https://www.fao.org/3/i3957e/i3957e.pdf⟩.
Francis, M., Simons, D., Bourlakis, M., 2008. Value chain analysis in the UK beef foodservice sector. Supply Chain Manag. 13.1, 83–91. https://doi.org/10.1108/13598540810850346.
Freeman, R.E., Harrison, J.S., Wicks, A.C., Parmar, B.L., de Colle, S., 2010. Stakeholder Theory: the State of the Art. Cambridge University Press, Cambridge, New York.
Frooman, J., 1999. Stakeholder Influence Strategies. Acad. Manag. Rev. 24 (2), 191–205.
Galbreath, J., 2006. Does primary stakeholder management positively affect the bottom line? Some evidence from Australia. Manag. Decis. 44, 1106–1121.
Garvare, R., Johansson, P., 2010. Management for sustainability – a stakeholder theory. Total Qual. Manag. Bus. Excell. 21, 737–744. https://doi.org/10.1080/14783363.2010.483095.
Gaskell, P., Dwyer, J.C., Jones, J., Jones, N., Boatman, N., Condliffe, I., Conyers, S., Ingram, J., Kirwan, J., Manley, W., Mills, J., Ramwell, C., 2010. Economic and environmental impacts of changes in support measures for the English Uplands: An in-depth forward look from the farmer's perspective. Final Report to the Defra Agricultural Change and Environment Observatory programme by the Countryside and Community Research Institute and the Food and Environment Research Agency Central Science Laboratory.
Glauben, T., Petrick, M., Tietje, H., Weiss, C., 2009. Probability and timing of succession or closure in family firms: a switching regression analysis of farm households in Germany. Appl. Econ. 41, 45–54. https://doi.org/10.1080/00036840601131722.
Glover, J.L., Reay, T., 2015. Sustaining the family business with minimal financial rewards: how do family farms continue? Fam. Bus. Rev. 28, 163–177. https://doi.org/10.1177/0894486513511814.
Hadley, D., 2006. Patterns in technical efficiency and technical change at the farm-level in England and Wales, 1982–2002. J. Agric. Econ. 57, 81–100. https://doi.org/10.1111/j.1477-9552.2006.00033.x.
Hansen, J.W., 1996. Is agricultural sustainability a useful concept. Agric. Syst. 50, 117–143. https://doi.org/10.1016/0308-521X(95)00011-S.
Hayati, D., 2017. A literature review on frameworks and methods for measuring and monitoring sustainable agriculture. Technical report n.22. Glob. Strategy Tech. Rep. (Available at) ⟨https://www.fao.org/3/ca6417en/ca6417en.pdf⟩.
Hennessy, T.C., Rehman, T., 2008. Assessing the impact of the 'decoupling' reform of the common agricultural policy on irish farmers' off-farm labour market participation decisions. J. Agric. Econ. 59, 41–56. https://doi.org/10.1111/j.1477-9552.2007.00140.x.
Henriques, I., Sadorsky, P., 1999. The relationship between environmental commitment and managerial perceptions of stakeholder importance. Acad. Manag. J. 42, 87–99. https://doi.org/10.2307/256876.
Herrera, B., Gerster-Bentaya, M., Knierim, A., 2016. Stakeholders' perceptions of sustainability measurement at farm level. Stud. Agric. Econ. 118, 113–137 https://doi.org/14182106.
Hillman, A.J., Keim, G.D., 2001. Shareholder value, stakeholder management, and social issues: what's the bottom line? Strateg. Manag. J. 22, 125–139. https://doi.org/10.1002/1097-0266(200101)22:2<125::AID-SMJ150>3.0.CO;2-H.
HM Government, 2018. A Green Future: A 25 Year Plan to Improve our Environment. HMSO, London.
Hörisch, J., Freeman, R.E., Schaltegger, S., 2014. Applying stakeholder theory in sustainability management: links, similarities, dissimilarities, and a conceptual framework. Organ. Environ. 27, 328–346. https://doi.org/10.1177/1086026614535786.
Hubbard, C., Davis, J., Feng, S., Harvey, D., Liddon, A., Moxey, A., Ojo, M., Patton, M., Philippidis, G., Scott, C., Shrestha, S., Wallace, M., 2019. Brexit: How might UK Agriculture Thrive or Survive? Final Report. Newcastle University.
Ilbery, B., Maye, D., 2005. Food supply chains and sustainability: evidence from specialist food producers in the Scottish/English borders. Land Use Policy 14.
Ilbery, B.W., 1991. Farm diversification as an adjustment strategy on the urban fringe of the West Midlands. J. Rural Stud. 7, 207–218. https://doi.org/10.1016/0743-0167(91)90085-7.
Ingram, J., Morris, C., 2007. The knowledge challenge within the transition towards sustainable soil management: an analysis of agricultural advisors in England. Land Use Policy 24, 100–117. https://doi.org/10.1016/j.landusepol.2005.07.002.
Ingram, J., Gaskell, P., Mills, J., Short, C., 2013. Incorporating agri-environment schemes into farm development pathways: a temporal analysis of farmer motivations. Land Use Policy 31, 267–279. https://doi.org/10.1016/j.landusepol.2012.07.007.
Ingram, J., Mills, J., Dibari, C., Ferrise, R., Ghaley, B.B., Hansen, J.G., Iglesias, A., Karaczun, Z., McVittie, A., Merante, P., 2016. Communicating soil carbon science to farmers: incorporating credibility, salience and legitimacy. J. Rural Stud. 48, 115–128. https://doi.org/10.1016/j.jrurstud.2016.10.005.
Jones, N., Duarte, F., Rodrigo, I., van Doorn, A., de Graaff, J., 2016. The role of EU agri-environmental measures preserving extensive grazing in two less-favoured areas in Portugal. Land Use Policy 54, 177–187. https://doi.org/10.1016/j.landusepol.2016.01.014.
Kelly, E., Latruffe, L., Desjeux, Y., Ryan, M., Uthes, S., Diazabakana, A., Dillon, E., Finn, J., 2018. Sustainability indicators for improved assessment of the effects of agricultural policy across the EU: is FADN the answer. Ecol. Indic. 89, 903–911. https://doi.org/10.1016/j.ecolind.2017.12.053.
King, A.E.H., Lauri, M.B., Peter, J.T., 2017. Community-based grazing marketing: barriers and benefits related to the adoption of best management practices in grazing systems. J. Appl. Commun. 44–56.
Kirkpatrick, J., 2013. Retired farmer - an elusive concept. In: Buller, H., Furuseth, O., Gilg, A.W. (Eds.), Keeping It in the Family: International Perspectives on Succession and Retirement on Family Farms. Ashgate Publishing, Ltd, pp. 165–178.
Kneafsey, M., Venn, L., Schmutz, U., Balazs, B., Trenchard, L., Eyden-Wood, T., Bos, E., Sutton, G., Blackett, M., 2013. Short Food Supply Chains and Local Food Systems in the EU: A State of Play of their Socio Economic Characteristics., JCR Scientific and Policy Reports. European Commission.
Lastra-Bravo, X.B., Hubbard, C., Garrod, G., Tolón-Becerra, A., 2015. What drives farmers' participation in EU agri-environmental schemes?: Results from a qualitative meta-analysis. Environ. Sci. Policy 54, 1–9. https://doi.org/10.1016/j.envsci.2015.06.002.

Latruffe, L., Desjeux, Y., Justinia Hanitravelo, G.L., Hennessy, T., Bockstaller, C., Dupraz, P., Finn, J., 2016a. Tradeoffs between Economic, Environmental and Social Sustainability: The Case of a Selection of European Farms (EU FP7 Research Project FLINT, Deliverable 5.2L).
Latruffe, L., Diazabakana, A., Bockstaller, C., Desjeux, Y., Finn, J., Kelly, E., Ryan, M., Uthes, S., 2016b. Measurement of sustainability in agriculture: a review of indicators. Stud. Agric. Econ. 118, 123–130.
Lebacq, T., Baret, P.V., Stilmant, D., 2013. Sustainability indicators for livestock farming. A review. Agron. Sustain. Dev. 33, 311–327. https://doi.org/10.1007/s13593-012-0121-x.
Lee, B., Liu, J.-Y., Chang, H.-H., 2020. The choice of marketing channel and farm profitability: empirical evidence from small farmers. Agribusiness 36, 402–421. https://doi.org/10.1002/agr.21640.
Mann, S., 2007. Tracing the process of becoming a farm successor on Swiss family farms. Agric. Hum. Values 24, 435–443. https://doi.org/10.1007/s10460-007-9087-8.
Marini, L., Klimek, S., Battisti, A., 2011. Mitigating the impacts of the decline of traditional farming on mountain landscapes and biodiversity: a case study in the European Alps. Environ. Sci. Policy 14, 258–267. https://doi.org/10.1016/j.envsci.2010.12.003.
May, D., Arancibia, S., Behrendt, K., Adams, J., 2019. Preventing young farmers from leaving the farm: Investigating the effectiveness of the young farmer payment using a behavioural approach. Land Use Policy 82, 317–327. https://doi.org/10.1016/j.landusepol.2018.12.019.
Maye, D., Ilbery, B., Watts, D., 2009. Farm diversification, tenancy and CAP reform: results from a survey of tenant farmers in England. J. Rural Stud. 25, 333–342. https://doi.org/10.1016/j.jrurstud.2009.03.003.
Mills, J., Courtney, P., Gaskell, P., Reed, M., Ingram, J., 2010. Estimating the Incidental Socioeconomic Benefits of Environmental Stewardship Schemes. Final Report. Countryside and Community Research Institute.
Mills, J., Gaskell, P., Ingram, J., Dwyer, J., Reed, M., Short, C., 2017. Engaging farmers in environmental management through a better understanding of behaviour. Agric. Hum. Values 34, 283–299. https://doi.org/10.1007/s10460-016-9705-4.
Mills, J., Gaskell, P., Ingram, J., Chaplin, S., 2018. Understanding farmers' motivations for providing unsubsidised environmental benefits. Land Use Policy 76, 697–707. https://doi.org/10.1016/j.landusepol.2018.02.053.
Mills, J., Chiswell, H., Gaskell, P., Courtney, P., Brockett, B., Cusworth, G., Lobley, M., 2021. Developing farm-level social indicators for agri-environment schemes: a focus on the agents of change. Sustainability 13 (14), 7820. https://doi.org/10.3390/su13147820.
Morris, W., Henley, A., Dowell, D., 2017. Farm diversification, entrepreneurship and technology adoption: analysis of upland farmers in Wales. J. Rural Stud. 53, 132–143. https://doi.org/10.1016/j.jrurstud.2017.05.014.
Murillo-Luna, J.L., Garcés-Ayerbe, C., Rivera-Torres, P., 2008. Why do patterns of environmental response differ? A stakeholders' pressure approach. Strateg. Manag. J. 29, 1225–1240. https://doi.org/10.1002/smj.711.
Mylan, J., Geels, F.W., Gee, S., McMeekin, A., Foster, C., 2015. Eco-innovation and retailers in milk, beef and bread chains: enriching environmental supply chain management with insights from innovation studies. J. Clean. Prod. 107, 20–30. https://doi.org/10.1016/j.jclepro.2014.09.065.
de Olde, E.M., Oudshoorn, F.W., Sørensen, C.A.G., Bokkers, E.A.M., de Boer, I.J.M., 2016. Assessing sustainability at farm-level: Lessons learned from a comparison of tools in practice. Ecol. Indic. 66, 391–404. https://doi.org/10.1016/j.ecolind.2016.01.047.
O'Donoghue, C., Devisme, S., Ryan, M., Conneely, R., Gillespie, P., Vrolijk, H., 2016. Farm economic sustainability in the European Union: A pilot study. Studies in Agricultural Economics 118, 163–171. https://doi.org/10.7896/j.1631.
Parmar, B.L., Freeman, R.E., Harrison, J.S., 2010. Stakeholder theory: the state of the art. Acad. Manag. Ann. 3 (1).
Piedra-Muñoz, L., Galdeano-Gómez, E., Pérez-Mesa, J.C., 2016. Is sustainability compatible with profitability? An empirical analysis on family farming activity. Sustainability 8, 893. https://doi.org/10.3390/su8090893.
Polman, N.B.P., Slangen, L.H.G., 2008. Institutional design of agri-environmental contracts in the European Union: the role of trust and social capital. NJAS Wagening. J. Life Sci. 55, 413–430. https://doi.org/10.1016/S1573-5214(08)80029-2.
Pope, J., Annandale, D., Morrison-Saunders, A., 2004. Conceptualising sustainability assessment. Environ. Impact Assess. Rev. 24, 595–616. https://doi.org/10.1016/j.eiar.2004.03.001.
Reed, M.S., Bonn, A., Slee, W., Beharry-Borg, N., Birch, J., Brown, I., Burt, T.P., Chapman, D., Chapman, P.J., Clay, G.D., Cornell, S.J., Fraser, E.D.G., Glass, J.H., Holden, J., Hodgson, J.A., Hubacek, K., Irvine, B., Jin, N., Kirkby, M.J., Kunin, W.E., Moore, O., Moseley, D., Prell, C., Price, M.F., Quinn, C.H., Redpath, S., Reid, C., Stagl, S., Stringer, L.C., Termansen, M., Thorp, S., Towers, W., Worrall, F., 2009a. The future of the uplands. Land Use Policy 26, S204–S216. https://doi.org/10.1016/j.landusepol.2009.09.013.
Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., Stringer, L.C., 2009b. Who's in and why? A typology of stakeholder analysis methods for natural resource management. J. Environ. Manag. 90, 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001.
Riley, M., 2016. How does longer term participation in agri-environment schemes [re] shape farmers' environmental dispositions and identities? Land Use Policy 52, 62–75. https://doi.org/10.1016/j.landusepol.2015.12.010.
Riley, M., Sangster, H., Smith, H., Chiverrell, R., Boyle, J., 2018. Will farmers work together for conservation? The potential limits of farmers' cooperation in agri-environment measures. Land Use Policy 70, 635–646. https://doi.org/10.1016/j.landusepol.2017.10.049.
Ripoll-Bosch, R., Díez-Unquera, B., Ruiz, R., Villalba, D., Molina, E., Joy, M., Olaizola, A., Bernués, A., 2012. An integrated sustainability assessment of mediterranean sheep farms with different degrees of intensification. Agric. Syst. 105, 46–56. https://doi.org/10.1016/j.agsy.2011.10.003.
de Roest, K., Ferrari, P., Knickel, K., 2018. Specialisation and economies of scale or diversification and economies of scope? Assessing different agricultural development pathways. J. Rural Stud. 59, 222–231. https://doi.org/10.1016/j.jrurstud.2017.04.013.
Röös, E., Fischer, K., Tidåker, P., Källström, H.N., 2019. How well is farmers' social situation captured by sustainability assessment tools? A Swedish case study. Int. J. Sustain. Dev. World Ecol. 26, 268–281. https://doi.org/10.1080/13504509.2018.1560371.
Rural Payment Agency, 2019. Basic Payment Scheme: Rules for 2019. Rural Payment Agency, London.
Ruto, E., Garrod, G., 2009. Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach. J. Environ. Plan. Manag. 52, 631–647. https://doi.org/10.1080/09640560902958172.
Ryan, M., Hennessy, T., Buckley, C., Dillon, E.J., Donnellan, T., Hanrahan, K., Moran, B., 2016. Developing farm-level sustainability indicators for Ireland using the Teagasc National Farm Survey. Irish Journal of Agricultural and Food Research 55, 112–125. https://doi.org/10.1515/ijafr-2016-0011.
Santos, J.L., Madureira, L., Ferreira, A.C., Espinosa, M., Gomez y Paloma, S., 2016. Building an empirically-based framework to value multiple public goods of agriculture at broad supranational scales. Land Use Policy 53, 56–70. https://doi.org/10.1016/j.landusepol.2015.12.001.
Saxby, H., Gkartzios, M., Scott, K., 2018. 'Farming on the edge': wellbeing and participation in agri-environmental schemes. Sociol. Rural. 58 (2), 392–411. https://doi.org/10.1111/soru.12180.
Schader, C., Baumgart, L., Landert, J., Muller, A., Ssebunya, B., Blockeel, J., Weisshaidinger, R., Petrasek, R., Mészáros, D., Padel, S., Gerrard, C., Smith, L., Lindenthal, T., Niggli, U., Stolze, M., 2016. Using the sustainability monitoring and assessment routine (SMART) for the systematic analysis of trade-offs and synergies between sustainability dimensions and themes at farm level. Sustainability 8, 274. https://doi.org/10.3390/su8030274.
Schaller, N., 1993. The concept of agricultural sustainability. Agric. Ecosyst. Environ. Agric. Environ. 46, 89–97. https://doi.org/10.1016/0167-8809(93)90016-I.
Sharma, S., 2001. Different strokes: regulatory styles and environmental strategy in the North-American oil and gas industry. Bus. Strat. Env. 10, 344–364. https://doi.org/10.1002/bse.303.
Sharma, S., Henriques, I., 2005. Stakeholder influences on sustainability practices in the Canadian forest products industry. Strateg. Manag. J. 26, 159–180. https://doi.org/10.1002/smj.439.
Singh, R.K., Murty, H.R., Gupta, S.K., Dikshit, A.K., 2009. An overview of sustainability assessment methodologies. Ecol. Indic. 9, 189–212. https://doi.org/10.1016/j.ecolind.2008.05.011.
Spicka, J., Hlavsa, T., Soukupova, K., Stolbova, M., 2019. Approaches to estimation the farm-level economic viability and sustainability in agriculture: a literature review. Agric. Econ. 65, 289–297. https://doi.org/10.17221/269/2018-AGRICECON.
Sulewski, P., Kłoczko-Gajewska, A., Sroka, W., 2018. Relations between agri-environmental, economic and social dimensions of farms' sustainability. Sustainability 10, 4629. https://doi.org/10.3390/su10124629.
Sutherland, L.A., 2010. Environmental grants and regulations in strategic farm business decision-making: a case study of attitudinal behaviour in Scotland. Land Use Policy 27, 415–423. https://doi.org/10.1016/j.landusepol.2009.06.003.
Sutherland, L.A., Burton, R.J., Ingram, J., Blackstock, K., Slee, B., Gotts, N., 2012a. Triggering change: towards a conceptualisation of major change processes in farm decision-making. J. Environ. Manag. 104, 142–151. https://doi.org/10.1016/j.jenvman.2012.03.013.
Sutherland, L.A., Gabriel, D., Hathaway-Jenkins, L., Pascual, U., Schmutz, U., Rigby, D., Godwin, R., Sait, S.M., Sakrabani, R., Kunin, W.E., Benton, T.G., Stagl, S., 2012b. The 'Neighbourhood Effect': a multidisciplinary assessment of the case for farmer co-ordination in agri-environmental programmes. Land Use Policy 29, 502–512. https://doi.org/10.1016/j.landusepol.2011.09.003.
Sutherland, L.A., Toma, L., Barnes, A.P., Matthews, K.B., Hopkins, J., 2016. Agri-environmental diversification: linking environmental, forestry and renewable energy engagement on Scottish farms. J. Rural Stud. 47, 10–20. https://doi.org/10.1016/j.jrurstud.2016.07.011.
Tilman, D., Wedin, D., Knops, J., 1996. Productivity and sustainability influenced by biodiversity in grassland ecosystems. Nature 379, 718–720. https://doi.org/10.1038/379718a0.
Udagawa, C., Hodge, I., Reader, M., 2014. Farm level costs of agri-environment measures: the impact of entry level stewardship on cereal farm incomes. J. Agric. Econ. 65, 212–233. https://doi.org/10.1111/1477-9552.12043.
Uematsu, H., Mishra, A.K., 2011. Use of direct marketing strategies by farmers and their impact on farm business income. Agric. Resour. Econ. Rev. 40, 1–19. https://doi.org/10.1017/S1068280500004482.
Van Cauwenbergh, N., Biala, K., Bielders, C., Brouckaert, V., Franchois, L., Garcia Cidad, V., Hermy, M., Mathijs, E., Muys, B., Reijnders, J., Sauvenier, X., Valckx, J., Vanclooster, M., Van der Veken, B., Wauters, E., Peeters, A., 2007. SAFE—A hierarchical framework for assessing the sustainability of agricultural systems. In: Agriculture Ecosystems & Environment, 120, pp. 229–242. https://doi.org/10.1016/j.agee.2006.09.006.
Vigani, M., Dwyer, J., 2020. Profitability and efficiency of high nature value marginal farming in England. J. Agric. Econ. 71, 439–464. https://doi.org/10.1111/1477-9552.12351.
von Wirén-Lehr, S., 2001. Sustainability in agriculture — an evaluation of principal goal-oriented concepts to close the gap between theory and practice. Agric. Ecosyst. Environ. 84, 115–129. https://doi.org/10.1016/S0167-8809(00)00197-3.

Wagner, M., 2015. The link of environmental and economic performance: drivers and limitations of sustainability integration. J. Bus. Res. 68, 1306–1317. https://doi.org/10.1016/j.jbusres.2014.11.051.

Westbury, D.B., Park, J.R., Mauchline, A.L., Crane, R.T., Mortimer, S.R., 2011. Assessing the environmental performance of English arable and livestock holdings using data from the farm accountancy data network (FADN). J. Environ. Manag. 92, 902–909. https://doi.org/10.1016/j.jenvman.2010.10.051.

Westerink, J., Jongeneel, R., Polman, N., Prager, K., Franks, J., Dupraz, P., Mettepenningen, E., 2017. Collaborative governance arrangements to deliver spatially coordinated agri-environmental management. Land Use Policy 69, 176–192. https://doi.org/10.1016/j.landusepol.2017.09.002.

Willock, J., Deary, I.J., McGregor, M.M., Sutherland, A., Edwards-Jones, G., Morgan, O., Dent, B., Griece, R., Gibson, G., Austin, E., 1999. Farmers' attitudes, objectives, behaviors, and personality traits: the Edinburgh study of decision making on farms. J. Vocat. Behav. 54, 5–36. https://doi.org/10.1006/jvbe.1998.1642.

Wilson, G.A., Hart, K., 2000. Financial imperative or conservation concern? EU farmers' motivations for participation in voluntary agri-environmental schemes. Environ. Plan A 32, 2161–2185. https://doi.org/10.1068/a3311.

Wojewódzka-Wiewiórska, A., Kłoczko-Gajewska, A., Sulewski, P., 2020. Between the social and economic dimensions of sustainability in rural areas—in search of farmers' quality of life. Sustainability 12, 148. https://doi.org/10.3390/su12010148.

Yagi, H., Garrod, G., 2007. Profitability of Direct Marketing Farms in Less Favoured Areas (lfas): Case Studies from Northumberland, England. 16th International Farm Management Congress 1, 649–656. Available at: ⟨http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.584.9837&rep=rep1&type=pdf⟩.

Yoshida, S., Yagi, H., Kiminami, A., Garrod, G., 2019. Farm diversification and sustainability of multifunctional peri-urban agriculture: entrepreneurial attributes of advanced diversification in Japan. Sustainability 11, 2887. https://doi.org/10.3390/su11102887.

Zahm, F., Viaux, P., Vilain, L., Girardin, P., Mouchet, C., 2008. Assessing farm sustainability with the IDEA method–from the concept of agriculture sustainability to case studies on farms. Sustain. Dev. 16 (4), 271–281. https://doi.org/10.1002/sd.380.