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Supporting farmers in agro-ecological transition: a systems perspective of regenerative grazing in Wales.

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Dedication

This thesis is dedicated to my children, Wilfred and Bronwen, for whom I hope this thesis might contribute to the restoration of the natural world in some small way; for their futures, and the benefit of all future generations. It is also dedicated to my dear Dad, who passed away in June 2023.

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Abstract

Since the 1950s (post World War II), the intensification of farming has eroded the natural capital base underpinning it; resulting in declining soil health, biodiversity loss, and the depleted nutrient density of food. Regenerative farming offers a way to tackle these challenges, whilst promoting profitable, resilient farming; reducing societal vulnerability to climate change, and enhancing the wider benefits of farmed land as well as food production. This research has explored the transition to regenerative farming from a systems perspective. It has focused specifically on regenerative grazing in grassland systems where there is lower adoption compared to arable systems in the UK. The research draws upon insights from in-depth interviews with nine farmers (beef, sheep and dairy), mostly located in Wales. It focuses on farmers who are in the process of transitioning to regenerative grazing, rather than those who are firmly established in it.

The research has set out a conceptual system which illuminates the numerous factors influencing the farmer transition to regenerative grazing. Deep-dives into farmer experiences of four areas of this system: land agreements, land rights, changing mind-sets and accessing knowledge; shed light on how they are shaped by farming context and farmer agency. The research has shown that farmers are taking different journeys towards regenerative grazing that is unique to their given context: some are demonstrating agency in terms of 'what they believe they can do'; whereas some in terms of 'what they are able to do' and 'what they are permitted to do'. The systems focus has explored whether the factors influencing farmer transition to regenerative grazing are enabling or constraining within each given context, and how these factors interact in a dynamic, responsive socio-ecological system unique to a given farmer setting. This has highlighted eight areas for policy and practitioner intervention, with the goal of scaling-up agro-ecological change towards regenerative grazing in the UK. These are: land agreements, land rights, transition payments, training support and advice, government campaign, public procurement, payments for outcomes and policy. Each has been critically appraised from a systems thinking and resilience perspective, using an 'intervention strategy' proposed by this research. The data suggests that most of the missing links are in social, policy, and market systems which if re-instated, will help restore nature's natural feedbacks – regenerating our sanctuary – thereby boosting the resilience of all social, economic and institutional systems contained therein.

Overarchingly, this research has highlighted that system intervention (whether policy or practitioner-led), should pro-actively promote 'enabling' *conditions* for farmers (rather than prescribe specific measures with particular outcomes per se); so that farmers themselves may make their own changes towards regenerative grazing within their own 'feasibility space' (the

conceptual space within which farmers feel that can take action). This means in practice, removing constraints that are affecting farmer agency across, for example, land rights, land agreements; as well as promoting enabling conditions via, for example advice, placements, support and training. In this way, intervention should focus on enhancing farmer 'feasibility space'. The research has suggested that paying farmers alone will not free up farmer propensity to make change towards regenerative grazing, within the existing socio-ecological system constraints in which many farmers operate. Similarly, some well-intentioned policy and practitioner measures are currently unintentionally constraining farming change in some contexts. As such, the finding is not just how policy and practitioners can do more, but also about how they can stop doing less.

The research has drawn from the socio-ecological systems, resilience and rural sociology literature. Specifically, the systems perspective of complex socio-ecological catchment challenges taken here, has shed light on the tension between multiple catchment goals and their interdependencies. Understanding from a systems perspective, complementary to more conventional ways of addressing complex catchment problems, will ultimately help to facilitate change to regenerative grazing at scale.

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Abbreviations

AHA Agricultural Holding Act

BNG Biodiversity Net Gain

CAS Complex adaptive system

ELMS Environmental Land Management Scheme

FBT Farm Business Tenancy

NN Nutrient Neutrality

SES Socio-ecological system

SFS Sustainable Farming Scheme

SFS Sustainable Farming Scheme

Chapter 1 Introduction

Society is facing unprecedented challenges, globally, in terms of climate change, biodiversity loss, population growth, natural disasters, disease outbreaks, political change and the effects this is having upon food security, public health, economic performance and mass immigration (MEA, 2005; UKNEA, 2011; IPCC, 2019; OECD, 2020; HM Government, 2022). Farming is considered one of the main contributors to biodiversity loss, soil degradation, water pollution and climate change (DeLong et al., 2015; Rippke et al., 2016; Horton, 2017; Withers et al., 2019).

The way society uses and manages land has a critical role to play in addressing, and adapting to, these challenges. Transformational change in UK farming is urgently needed, as farming practices are degrading ecosystems in the UK and the land's ability to provide multiple outcomes, including long-term food security (Norton et al. 2024). Neither is change happening at the scale and pace required (Norton et al. 2024).

In the UK, the rural landscape has long received attention in terms of how it is used and managed for public good. For thousands of years, we have influenced natural processes by how we use the land: such as, clearing woodlands for crops and pasture (Reid et al., 2021) and the effect of this on changing water, carbon and nutrient cycles. Indeed, all of the UK's rural landscape is now affected by human activity in some way, whether directly via agriculture or indirectly via climate change (Hayhow et al., 2019).

Historically, society's management of rural land has largely focused on providing goods which directly benefit people (e.g. growing timber, food). However, the intensification of farming in the post World War II (WWII) period to feed a growing population, has gradually led to changes in the natural cycles underpinning it (nutrient, water and carbon cycles) resulting in declining soil health, biodiversity loss, and depleted nutrient density in food. It is only in recent decades that society has started to look at the rural landscape in terms of the indirect, perhaps more hidden, services it provides – for example as a store for carbon and water, in cleaning our water and air, and as a home for wildlife (MEA, 2005; UKNEA, 2011; HM Government, 2018; Dasgupta, 2021; HM Government, 2023). This change in policy focus and public discourse, is in response to greater awareness around the causes and effects of climate change, biodiversity loss and flood risk, which are now being felt here in the UK.

Despite decades of collaborative initiatives in the UK to address these issues through rural land management (e.g. Catchment Sensitive Farming, Countryside Stewardship, Catchment Based Approach), the UK is still facing considerable problems including soil loss, water pollution,

flood risk and biodiversity decline (Hayhow et al., 2019). These catchment initiatives, as valuable as they are, have been skirting the edges of the challenges that society faces.

Interest in regenerative farming, an agro-ecological approach to farming based on six core principles (Brown, 2018), has swelled in recent years in the UK; spearheaded by farmers (e.g. Groundswell, FAI Farms, Green Farm Collective), corporates (e.g. Nestle, Muller, McDonalds), financiers and pension funds (e.g. M&G, Wiltshire Pension Fund, Regenerate Outcomes), the academic and third sectors (e.g. Connecting People and Landscapes in a Changing Climate project). Investors are seeking returns from regenerative farming, corporates are beginning to in-set the benefits of regenerative farming within their supply chains (e.g. carbon), lenders are starting to de-risk their farm assets driven by financial disclosure pressures, and water companies are starting multi-million pound, multi-catchment innovation programmes in regenerative farming. The transition has begun and in light of the changing agri-environment policy, and emergence of private sector led regenerative farming programmes; this is a key time to consider whether investment and payments to farmers alone is sufficient to enable the transition to regenerative farming in Wales, and the UK more broadly.

It is within this context, that the role of regenerative farming in resolving these societal challenges has come to the fore: profitable farming which provides nutritious food whilst protecting and restoring the natural world (and the goods, services and protection this provides) (Rhodes, 2017; Wagner et al. 2023). Some see farming as a significant contributor to the problem (e.g. greenhouse emissions, poor water quality, increased flooding); whereas others see it as a vital part of the solution (Sakadevan and Nguyen, 2017). Recollection of the American 'Dust Bowl', less than one hundred years ago, is part of the driver for change to restorative farming practices in the US (Koman et al. 2023), where much of the literature, and forefront in thinking regarding regenerative farming originates. Understanding the experiences of farmers who are experimenting in regenerative farming in the UK, is of particular importance to understand, and is little covered in the rural sociology literature in the UK (Wagner et al. 2023).

Regenerative farming shares commonality with the agroecology movement, both seeking to restore soils and ecosystems via more sustainable and ecologically sensitive farming practices (Luján Soto et al., 2020; Schreefel et al., 2020; Giller et al., 2021). However, agro-ecology places greater emphasis upon transformational social and political change via land rights and grass-roots empowerment of those with less access to land for sustainable food production (Altieri, 2012; Rosset and Altieri, 2017). Whilst regenerative farming, as a movement, shares many common ecological goals with agro-ecology, some suggest it has more of a restorative

focus, rather than solely a sustainability aim; and that it has less of a political and social agenda (Tittonell et al. 2022).

1.1 Research focus

Due to the raised profile of regenerative farming in the UK, and significant upswing in interest in its potential as a means of tackling pressing societal challenges; there is value in researching this further (Newton et al. 2020; Wagner et al. 2023). This is of particular importance as coverage of the topic in rural sociology literature is limited in the UK (Wagner et al. 2023). In the last five years, there has been an increase in scientific papers addressing the discourse around how to define regenerative farming (see Chapter 2), but less attention given to why and how farmers are making the change to regenerative farming in the UK (see Chapter 3).

Understanding the experiences of farmers transitioning to regenerative farming in the UK, is of particular importance in light of the UK and Welsh Government's changing agri-environment policy; the upswing in investor interest in this area (Newton et al. 2020), and the transformation needed in the farming sector to deliver security in a broader suite of nature's goods and services as well as food production (i.e. clean water, clean air, nutritious food, carbon storage, disease regulation, biodiversity). Supporting farmers in navigating this change is fundamental to society's future welfare. Crucial to this is understanding, is what pathways are farmers following to change? What enables them, or holds them back, along the way? How are farmers influencing their journey to make it smoother?

Researching regenerative farming will add to published scientific literature in agro-ecology, socio-ecological systems and rural sociology. Currently, the scientific literature regarding farmer transition to regenerative farming, in grassland systems in particular, is relatively unexplored (Wagner et al. 2023), particularly from a 'systems thinking' and resilience perspective (see Chapter 3).

The literature tends to be dominated by reductionist methods (positivist paradigm) which although informative, runs the risk of focusing on particular aspects (e.g. carbon, farmer categorisations), rather than an appreciation of the system it is part of as a whole (see Chapter 4). A systems perspective could provide new insights (Wagner et al. 2023, Waterton et al. 2015; Norton et al. 2024).

Chapter 2 Background

This section gives an overview of the changes in agricultural policy and farming practices in the UK in the last century, and the problems this has created whilst providing abundant food. It then explores the discourse around regenerative farming and its definition in scientific literature, as well as its relationship to agro-ecology. Finally, this section gives an overview of farming statistics, agri-environment policy and take-up of regenerative farming, in the Welsh context.

2.1 Historical context of farming in the UK

2.1.1 Food production above all else

Changes in Europe during the last century, particularly post WWII, focused farming on the need to supply affordable and abundant food (Knickel et al., 2017; Burchardt et al., 2020). The Agriculture Acts (1947, 1957 and 1967) and entry into the EEC/EU and Common Agricultural Policy (CAP) (1973), ensured farming production was publicly supported via subsidies, market reform and tariff barriers. Despite the cost to taxpayers, farming subsidies were publicly justified in light of post-war population growth and communism fears (Schiere, Darnhofer and Duru, 2012; Burchardt et al., 2020).

Aside from farming subsidies, the intensification of farming was also enabled by the 'green revolution' (Norman, 2002), abundant cheap fossil fuels (Knickel et al., 2017), the deregulation of financial markets and liberalisation of trade markets (globalisation) which generated vast amounts of agri-tech investment, propelling farming forward into the 20th century. Eventually, this all led to over-production, generating 'butter mountains' and 'milk lakes' in the 1980s in Europe (Burchardt et al., 2020) at a time when famine ravaged other parts of the world (Live Aid, 1984).

In response, a process began of separating farming subsidies from production (e.g. introduction of milk quotas, removal of headage payment) and the eventual introduction of the Single Basic Payment in 2005, which linked payment to the area of farmed land, rather than farming production (this in turn led to other problems in terms of inequality between large and small landowners). Also around this time the 'set-aside' policy was introduced, whereby habitat creation was encouraged on areas of marginal farm land (Burchardt et al., 2020).

2.1.2 Hidden costs

The intensification of farming in the UK led to extensive areas of drained land (including peatland areas), widespread tillage and use of synthetic chemical fertilizers, herbicides and

insecticides, larger fields and hedge removal, and large areas of exposed soil (Cole et al., 1993; Lal, 1997; Bruce et al., 1999). In the 1960s, the UK Government even provided grants for hedgerow removal and wetland drainage (Natural England, 2012).

These practices break down fragile soil fungal networks and microbiological communities which provide the vital service of transporting and recycling a broad array of nutrients (which support plant growth and provide natural resilience against disease), in exchange for carbon (sequestered from the air via crops and pasture) (Asghari and Cavagnaro, 2011). Without this vital network of exchange, crops and pasture require more and more synthetic chemical inputs to substitute the loss of nutrients available to plants from the soil. These synthetic chemicals further exacerbate the loss of soil nutrients, replacing a whole spread of micro-nutrients essential for human health, with just a few – nitrates, phosphates, potassium; resulting in increasing costs to the farmer, and poorer nutrition in food. The change in systemic properties, including feedbacks and function, at this soil system level, seems to share commonalities with systemic change, experienced in nested and scaled systems, elsewhere in the physical and social world. This is explored further in Chapters 4 and 8.

The intensification of farming has thus led to the dependence of farming on externally sourced, largely fossil fuel derived, manufactured chemical inputs (Knickel et al., 2017) creating profit for a small number of multi-national companies and their investors. The consequence has been the disconnection of farming from its natural resource base and exposure to volatile global energy and commodity prices.

Public concern of the environmental effects of intensive farming in the UK began to grow significantly in the 1970s and 1980s (Carson, 1962; Brassley, 2018). Various policy and legislative steps in the 1980s and 1990s began to introduce protection for areas of nature importance (i.e Wildlife and Countryside Act 1981; Wildlife Enhancement Scheme 1994; Environment Act 1995) and various agri-environment schemes were widely implemented in the 1980s (Environmentally Sensitive Areas 1987-1994; Countryside Premium Scheme 1989; Countryside Stewardship Scheme 1991). However, CAP Pillar 1 subsidies for farm production continued, and no steps were taken to wean farming off its dependency on fossil fuel derived synthetic chemicals; likely due to pressure upon Government from investors in the fossil fuel industry. The UK's first mainstream agri-environment scheme, offered to all farmers in England, was Environmental Stewardship, implemented in 2005 as part of the CAP Pillar 2. For the first time, farmers were paid to adopt more environmentally friendly practices in addition to 'setting aside' marginal areas of production for habitat creation; representing the first time

that agricultural policy formally recognised the multi-functional nature of farming (not just food production) (Morris et al. 2017).

Wales has had devolved responsibility for EU funding and for rural policy since 1999. From 2005, Wales started to separate from CAP, guided by several Wales-focused Rural Development Programmes (Morris et al. 2017). Initially, agri-environment support was mainly provided through the Tir Gofal and Tir Cynnal schemes (2007-2013), which was then consolidated into the Glastir scheme since 2014.

Despite the changes outlined above, farming in the UK on the whole continues to erode soils, pollute waterways, exacerbate flooding, decrease biodiversity, reduce air quality and emit carbon emissions (Blackstock et al., 2010; Power, 2010; Zhang et al., 2007; Lawton et al., 2010; JNCC, 2010). For example, "farming is now the most significant source of water pollution and of ammonia emissions into the atmosphere in the UK. It accounts for 25% phosphate, 50% nitrate and 75% sediment loadings in the water environment, which harms ecosystems" (HM Government, 2018:38). This has increased other economic costs in the UK for example via increased water treatment costs, flood damage costs and health care costs borne to the UK tax payer (Posthumus and Morris, 2010; Branson, 2014).

The UK Government recognises that these environmental costs incur significant economic costs and is actively changing the discourse around how we measure economic performance in the UK. The 2021 Dasgupta Review (Dasgupta, 2021:2,4) commissioned by HM Treasury, states that "our economies – are 'embedded' within Nature, not external to it" and that "Nature needs to enter economic and finance decision-making in the same way buildings, machines, roads and skills do". It goes on to say that "Nature's worth to society – the true value of the various goods and services it provides – is not reflected in market prices because much of it is open to all at no monetary charge. These pricing distortions have led us to invest relatively more in other assets, such as produced capital, and underinvest in our natural assets." (Dasgupta, 2021:2). Are we now learning the lesson from measuring economic performance solely on market traded goods, when so much more affects economic performance and societal well-being?

2.1.3 Rising to the challenge

2.1.3.1 Government Policy

The Environment Act, 2021 mandates many of the UK Government's ambitions as set out in the 25 Year Environment Plan (HM Government, 2018). For the first time, this includes a legal duty to halt wildlife decline in the UK by 2030. Other relevant highlights include a requirement for all developments to deliver a 10% Biodiversity Net Gain (BNG), including Nationally

Significant Infrastructure Projects (which will include private payments to farmers for habitat restoration). The Act sets out the requirement for Local Nature Recovery Strategies in England which will map out areas of focus for nature recovery, which will spatially align with relevant tiers in Environmental Land Management Scheme (ELMS).

The devolved nature of the broader Welsh policy context, which places a legal duty upon public bodies in Wales to safeguard natural resources for future generations (Well-being of Future Generations Act (2015), Environment (Wales) Act (2016), and Planning (Wales) Act (2015) – see Appendix 5); has given Wales more power in designing its own agri-environment scheme, the Sustainable Farming Scheme (SFS). It has sought to find the balance between incentivising more sustainable farming practices (which prioritise climate change mitigation, water and biodiversity outcomes) alongside food production, food security and farm profitability.

Increasingly, policies are beginning to be based on this wider appreciation of the multi-functionality of our landscapes. For example, UK Government policy goals for the uplands has shifted away from land use primarily based on agricultural output, towards a greater emphasis upon environmental and amenity value (Lowe and Ward 2007; Condliffe 2009; Dwyer 2010; in Short & Dwyer 2012). Wales is at the forefront of this change in thinking, having fully recognised in its 2016 Environment (Wales) Act, the multitude and integrated nature of societal benefits reaped from the natural environment. In Section 6 of the Act, Natural Resources Wales (NRW) and other public bodies are required to seek, not only to maintain, but to promote ecosystem resilience defined as: "the capacity of ecosystems to deal with disturbances, either by resisting them, recovering from them, or adapting to them, whilst retaining their ability to deliver services and benefits now and in the future" (Welsh Government, 2023b). This recognises the five key aspects with respect to ecosystems, recognised in Welsh policy as the building blocks of resilience:

- Diversity
- Extent
- Condition
- Connectivity
- Adaptability.

NRW anticipates that targeting interventions based on these aspects, will improve ecological resilience, and reduce the risks of crossing undesirable thresholds (Elliot, 2018). This approach based on resilience, which recognises the interconnections between catchment processes, is

different to the traditional, more reactive responses in the management of natural resources witnessed in other parts of the UK (Elliot, 2018).

2.1.3.2 Agri-environment schemes

Agricultural policy in the UK was dominated by the CAP (1973) for over forty years. Following the UK's departure from the European Union in 2020 and phasing out of the Basic Payment Scheme (BPS), the UK Government has set out its future vision for the UK environment in its '25 Year Environment Plan' (HM Government, 2018). This sets out the "need to replenish depleted soil, plant trees, support wetlands and peatlands, rid seas and rivers of rubbish, reduce greenhouse gas emissions, cleanse the air of pollutants, develop cleaner, sustainable energy and protect threatened species and habitats" (HM Government, 2018:6). It introduced the new ELMS in England which will "incentivise and reward land managers to restore and improve our natural capital and rural heritage" (HM Government, 2018:37). The Welsh Government is similarly introducing the SFS. Both schemes are based upon paying farmers to deliver a broader array of goods and services which will benefit the UK public (e.g. storing water, storing carbon, increasing biodiversity).

ELMS (in England) will comprise of three categories:

- Sustainable Farming Incentive. This will pay for farming activities that deliver environmental benefit, e.g. soil management plans, reducing bare ground, growing green cover crops over the winter, and establishing herbal leys. This replaces the BPS but will be a lot less per hectare and so private markets are expected to offer a supplement for farmers
- Countryside Stewardship. This will pay for targeting habitats in specific locations to where they are needed most. There will be an extra incentive for land managers to collaborate across local areas to deliver greater impact

  Landscape Recovery. This is the most ambitious element of ELMS aimed at long-term, large-scale ecosystem recovery projects of 500ha to 5000ha. Defra has awarded a share of £12m in funding to 22 Round 1 Land Recovery Projects between 2022 and 2024 covering at least 40,000ha. Two further rounds are planned.

Linked to ELMS, the UK Government is funding farmer-led exploration and research into finding private market alternatives to subsidies. Defra's Natural Environment Investment Readiness Fund (Rounds 1 and 2 granted, another round 3 in 2024) is aimed and providing seed funding to ultimately draw in private investment to environmental credit markets and Landscape Recovery schemes in the UK, to supplement the changes in agri-environment payments e.g. Regenerate's financial model, supporting farmers to transition to regenerative farming, secured Round 1 NERIF funding and recently secured M&G investment of £150m to scale up.

In Wales within SFS, farmers will be able to sign up for four different layers of commitment, and receive capital and/or revenue payments accordingly as follows:

- Minimum - legal requirements applicable to all farms in order to get basic payment
- Universal – capital payment, advice and technical support for all participants in the scheme to be introduced in 2025
- Optional – revenue and/or capital payment, advice and technical support to undertake additional actions most appropriate for the given context
- Collaborative – revenue and/or capital payment, advice and technical support for working at scale with other farmers.

Whilst the Welsh Government is in the final stages of setting out the SFS (its final consultation was published on 14th December 2023), there seems to be close alignment between what is proposed, with regenerative farming (although regenerative farming is not specifically stated). For example, this includes the requirement for farmers in the 'universal' to do soil testing, and a focus on soil health in the 'optional' scheme e.g. "improve soil biology (diverse planting, graze and rest practices, minimum or no till), supplement applied nitrogen with nitrogen fixing plants (establishing mixed swards, planning rotations, cover cropping) and establish leys and crops with varied rooting profiles (establishing mixed swards, crop rotations, cover cropping)" (Welsh Government, 2023a:49). Indeed, the Welsh Minister for Rural Affairs, Lesley Griffiths, states *"The urgency of the climate and nature emergency cannot be overstated. Its effects are impacting on our ecosystems, altering the very fabric of our world, and pose significant threats to our agricultural and food systems … I see the Sustainable Farming Scheme as the start of a long-term programme to support our agricultural industry. Together, let us embark on this journey of shaping policies that secure our food production systems, keep farmers farming, safeguard our environment, and address the urgency of the climate and nature emergency."* (Welsh Government, 2023a:6).

2.1.3.3 Ecologically sensitive farming projects and initiatives

Alongside agri-environment schemes in both England and Wales, and long standing Government initiatives such as 'Catchment Sensitive Farming' in England; many projects and initiatives have sought to promote agro-ecological farming practices. This may be part of sector specific capital programmes targeting specific outcomes (e.g. the Water Industry National Environment Programme targeting water pollution), or Natural Resources Wales and the Environment Agency's Flood Risk Management capital programmes. It may also comprise large scale collaborative initiatives e.g. United Utilities' 'Sustainable Catchment Management Programme' (SCaMP), or more local, catchment specific initiatives such as 'Slowing the Flow at

Pickering,' a partnership project led by Forest Research (flood risk focus) or the 'South Pennines Grassland Project' led by Lancashire Wildlife Trust (wildlife focus).

Other initiatives promoting agro-ecological farming in the UK, are academic led receiving research council funding, as well as public funding e.g. the UK Government funded the 'Sustainable Intensification Research Platform' (2014-2017), a productivity focused research programme working closely with LEAF (Linking Environment And Farming) to improve the integrated economic, environmental and social performance of UK farms. Other public funded examples include 'the GREAT project' which is helping farmers to change to regenerative farming in Gloucestershire. Large landowner examples include the National Trust and the Duchy of Cornwall; both leading trials in sustainable farming practices. Whilst these are not specifically examples of regenerative farming, there is cross-over in principles, practices and outcomes incentivised with public and charitable payments. There are numerous other examples not listed here, but the key points being a) the drivers have come from different sectors and desired outcomes, and b) they have all been mainly public or charitably funded via various grant programmes.

There are many similar private funding led initiatives including leading supermarkets (e.g. Waitrose), global fast food restaurants (e.g. MacDonalds) and global retailers (e.g. Guinness, General Mills, Patagonia) who are facilitating change to regenerative farming practices in their supply chains and directly with farmers. Perhaps often overlooked is the contribution of farmers themselves, whether it be regenerative farming pioneers in the UK (e.g. Knepp Castle Estate, Fir Farm, Fernhill Farm, Waltham Place Farm); farmer-led initiatives (e.g. Green Farm Collective, Wales' Pontbren group) and farming networks (e.g. the Pasture for Life Association, Agricology, Sustainable Food Trust, LEAF and Nature Friendly Farming Network) to the movement promoting more sustainable farming practices in the UK.

In the eight years since this research began, there has been a significant upswing in interest in agro-ecological farming in particular regenerative farming (Newton et al. 2020). This has included notable mainstream media coverage on various programmes and podcasts (e.g. BBC 'The Archers', BBC 'Countryfile'); coverage in an international film, 'Kiss the Ground' shown on Netflix, and more recently 'Six Inches of Soil'; as a topic featured regularly in mainstream broadsheets (e.g. The Guardian, The Times); and the subject of bestselling books (e.g. Isabella Tree's 'Wilding: The Return of Nature to a British Farm').

The transition to more regenerative farming practices seems to be more progressed in arable farming in the UK, than perhaps in grassland systems. There is a sense of a large farming-led movement, at events such as Groundswell and the Oxford Real Farming Conference (although

attendance at such events does not necessarily mean participation in regenerative farming). The transition is being urged on by global market price increases and volatility (e.g. energy, fertilizer etc.), volatile market access, and removal of basic payments; as farmers are finding it increasingly difficult to stay viable in a context of increasing costs, and an eroding natural resource base.

Most recently, regenerative farming is now a topic increasingly linked to climate- and nature-related financial disclosure, ESG (Environment, Social, Governance) reporting and Scope 1, 2 and 3 emissions monitoring; as large corporates, institutional investors including pension fund portfolios (e.g. Aviva) are looking to de-risk their investments (e.g. Oxbury Bank) and investable opportunities to off-set their (and of those they fund) residual carbon emissions at scale. Innovate investment mechanisms (e.g. the UK Nature Impact Fund managed by Finance Earth and Federate Hermes) are providing a means to readily do this, particularly where they are linked in to markets for other benefits from regenerative farming such as BNG (for biodiversity off-setting) and Nutrient Neutrality (NN) (for nitrate and phosphate off-setting) markets in the UK.

2.2 Conceptualising agro-ecology

The FAO (2018) describes agroecology as an integrated ecological and social approach, consisting of principles that are adopted in the design and management of more sustainable food and agricultural systems. Agroecology focuses on the social and economic aspects of food systems, in seeking to optimise the interactions between plants, animals, humans and the environment. Although definitions vary (Wezel et al., 2009), in essence, agroecology is “an approach to agriculture that attempts to reconcile environmental, sustainability and production goals by emphasising the application of ecological concepts and principles to the design and management of agricultural systems” (Lampkin et al., 2015:viii).

As noted in the introduction (Chapter 1), regenerative farming shares commonality with the agroecology movement, both seeking to restore soils and ecosystems via more sustainable and ecologically sensitive farming practices (Luján Soto et al., 2020; Schreefel et al., 2020; Giller et al., 2021). However, arguably, agroecology places greater emphasis upon transformational social and political change via land rights and grass-roots empowerment of those with less access to land for sustainable food production (Altieri, 2012; Rosset and Altieri, 2017). Having said that, recent work by Wagner et al. (2023:9) suggests that regenerative farmers may equally have transformative aspirations stating “the mob grazing movement in Britain (and worldwide) represents a bottom-up innovation by practitioners. Notably, in contrast to top-down innovations driven by agribusiness, this innovation is not primarily aimed at increasing

the overall outputs of the farming operation, but constitutes a natural solution for improving the balance between inputs and outputs, thus ensuring an economically viable bottom line and long-term environmental sustainability… mob grazing is not just adopted as a nature-based solution for growing more grass and for producing high quality beef but is seen by farmers themselves within a wider context that also involves ambitions to sustain a complex interdependent system, and to manage it for social, environmental and economic benefits.".

Others focus on a more functional definition of agroecology with less emphasis on the political and social transformative element, possibly to mask its revolutionary stance. For example, the UK Land Use Policy Group describe agroecology as an "approach emphasising ecological principles and practices in the design and management of agroecosystems that integrates the long-term protection of natural resources as an element of food, fuel and fibre production" (Lampkin et al. 2015:9). This, more functional definition, is support by Nicholls, Altieri and Vazquez (2016), drawing on Altieri (1999), who say that, agroecology is about farming working more with nature, so that diverse biological processes work for farming and vice versa; for example with regard to recycling nutrients, regulating local hydrological processes, and disease resilience. The emphasis is on greater diversity in farming systems, will optimise natural processes such as nutrient cycling and biological activity (Altieri 1999).

The FAO (2018) highlights the revolutionary focus of agroecology, saying it seeks to transform food and agricultural systems, addressing the root causes of problems via holistic and long-term solutions; rather than just tweaking the practices of unsustainable agricultural systems. This is endorsed by Toffolini et al. (2019:3) who suggest that agroecology turns the modernist approach to intensive farming on its head: from one of control and eliminating risk, to one that relinquishes "the illusion of control" and instead works with the uncertainty inherent in agro-ecological systems (Toffolini et al., 2019).

The FAO (2018) developed its '10 Elements of Agroecology' between 2015-17 based on the seminal literature on agroecology by Altieri's (1995) and Gliessman's (2015). These ten elements are:

- *Diversity*, acknowledging that biodiversity contributes to a range of production, socio-economic, nutrition and environmental benefits;
- *Synergies*, to enhance multiple ecosystem services;
- *Efficiency,* producing more with less natural resources;
- *Resilience*, have a greater capacity to recover from disturbances;
- *Recycling,* more production with lower economic and environmental costs;

- *Co-creation and sharing of knowledge*, agroecology depends on context-specific knowledge
- *Human and social values*, the aspirations and needs of those who produce, distribute and consume food at the heart of food systems;
- *Culture and food traditions,* supporting healthy, diversified and culturally appropriate diets;
- *Responsible governance;* at all scales
- *Circular and solidarity economy,* that create an enabling environment for producers and consumers to reconnect around innovative solutions for living within our planetary boundaries.

Whilst there are multiple forms of agroecology including ecological intensification (de Molina and Casado, 2017) and ecological modernisation (Horlings and Marsden, 2011), the commonalities between agro-ecology and systems thinking is clear through the FAO ten elements above. This will be reflected upon throughout this research.

2.3 Towards regenerative farming practices

Within the broader conceptualisation of agroecology as set out above, Cusworth and Garnett (2023) describe three varying definitions of regenerative farming:

- *Practices*, these orientate around (1) minimising soil disturbance; (2) maintaining soil cover; (3) fostering diversity; (4) keeping living roots in the soil; and (5) integrating livestock into arable systems (Cherry, 2020; in Cusworth and Garnett, 2023)
- *Outcomes,* these include increasing soil organic carbon, species abundance and diversity, soil water capacity and nutrient content, fungal and mycorrhizal communities (Newton et al., 2020)
- *Mindset,* adaptive, generative, and open-ended sense of regeneration, regenerative farming as a restorative practice *(*Giller et al*., 2021).*

Whilst Cusworth and Garnett's 2023 paper is useful, specifically covering different understandings of the term regenerative farming, and acknowledging it is the start of a conversation as to what regenerative farming is; it lacks in two key respects:

1) A consideration of regenerative farming as a set of common *principles* which defines an *approach* to farming. This comes through in earlier, farmer-led literature and discussion on the topic (e.g. Brown, 2018) and Newton et al.'s (2020) paper regarding definitions of regenerative agriculture, which refers to regenerative farming *processes*. For example, take minimising soil disturbance, listed as a practice above by Cusworth

and Garnett (2023). This is a principle, which can be achieved through different practices (e.g. leaving stubble in over winter, no tillage, direct drilling, no dig horticulture). The point of principles, is that they do not stipulate what farming practices are best (and what is meant by best) in any one place, for any given farming system, in any given context. No one farmer farms in exactly the same way as another. A move away from the prescribed management of farming practices, to principles and processes, is more apparent in the regenerative farming discourse.

2) Acknowledgement of the time taken to progress towards more regenerative farming practices, rather than an inference of either/or. Again, Newton et al. (2020) hint at this when they refer to 'process-based definitions' of regenerative agriculture whereby a farmer adopts one or more agricultural principles (and by inference may continue on their journey to adopt more).

Newton et al. (2020) analyse the scientific literature and find a tendency either towards 'process-based definition' of regenerative agriculture, or an 'outcome-based definition', or a mix of the two. Process-based refers to the inclusion or exclusion of one or more agricultural principles; whereas outcome-based on one or more agricultural outcomes e.g. carbon (Newton et al. 2020).

Interestingly, Newton et al. (2020) point out that process-based definitions must be fairly ambivalent about proving outcomes, without absolute proof that enacting a process, or principle, will always result in an outcome. Cusworth and Garnett (2023:7) endorse this saying "adaptive, generative, and open-ended sense of regeneration is arguably incompatible with, or irrelevant to the priorities of many of the purely commercial and political actors entering the regenerative space who need robust definitions to underpin their regenerative strategies".

This highlights the crux in clashing world views underpinning regenerative farming, and agro-ecological approaches (which aim to live with uncertainty, picking up on Cusworth and Garnett's *Mindse*t definition above) as opposed to the prevalence of more conventional positivist world views (that seek to control, eradicate uncertainty), that can only make decisions (e.g. allocation of investment), upon near absolute certainty (allowing for minimal risk); which, we are finding with the natural world is less and less possible. The move to regenerative mindsets, is arguably challenging the whole basis upon which we make decisions in our current economic system.

For the purpose of this research, a more principles before outcomes, or 'process-based definition' of regenerative agriculture is adopted (as per Newton et al. 2020).

Irrespective of which definition of regenerative farming is adopted, *principles*, *practices or outcomes*, the lines are blurred between regenerative farming, and other types of ecologically sensitive farming such as permaculture, conservation agriculture, carbon farming, sustainable farming; they all very much support working more closely with nature. As such, it is challenging to draw out specifically how regenerative farming is different. Arguably, however the main difference is that regenerative farming places an emphasis upon 'restoring' natural processes rather than sustaining or conserving them per se (Cusworth and Garnett's 2023), and focuses more on principles, rather than prescribed measures, which may vary in practice given the context.

2.3.1 Regenerative farming principles

The principles of regenerative farming are given in Figure 2.1 P as developed by pioneering regenerative farmers such as Gabe Brown (Brown, 2018) and promoted by farmer-led initiatives such as Groundswell in the UK. These principles are part of a 'holistic' approach for managing the farm system, which seek to guide the deployment of farming practices in any given farming context. The approach and principles are in theory applicable anywhere in the world, but the selection of practices, and the way in which they are applied, will depend on context.

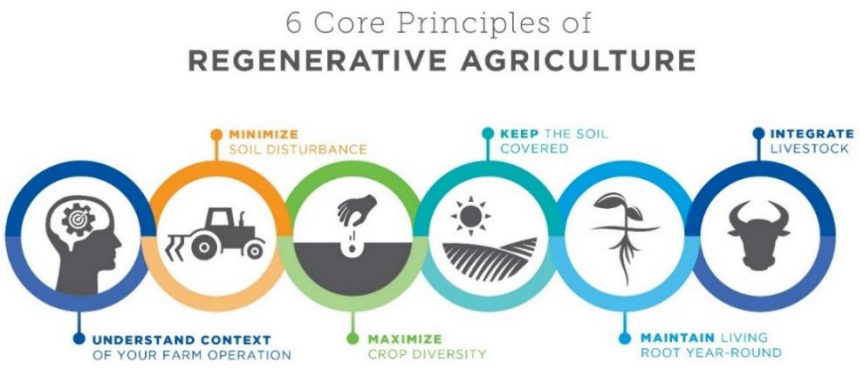


Figure 2.1 Principles of Regenerative Agriculture

(Source: General Mills, based on Gabe Brown's principles set out in 'Dirt to Soil' (Brown, 2018))

2.3.2 Mindset / holistic management

Wagner et al. (2023) observe that some regenerative farmers in the UK follow the principles of regenerative farming under the banner of 'holistic management'. This is an approach to land management that seeks to fundamentally shift the way farmers view, work and interact with

the natural environment. It is based on a systems' view of the world, one that seeks to understand the connections between natural, man-made and social systems. It starts by framing the 'whole under management' (people, businesses, resources, funds) i.e. what can be influenced, then defining the farm's 'holistic context' (vision for the farm, a 'quality of life' statement) which sets out the state of the natural environment required to create and sustain this vision. Decisions are based on an understanding of four core ecosystem processes: water cycle, energy cycle, nutrient cycle and biological cycles (Savory and Butterfield, 2016).

The approach advocates that only once the farm system is appreciated within this understanding as outlined above, should decisions be made as to what actions to take, what practices to implement and where. Once implemented, the practices are adjusted, and tested, based on continual observation of the core ecosystem processes (i.e. nature's response and impact upon farm health) and their response to the implemented practices. Causes and effects are observed, and weak links addressed (noting the integrity of the system overall is only as strong as its weakest link) (Savory and Butterfield, 2016).

2.3.3 What is regenerative grazing?

When this research began in 2016, the term 'regenerative grazing' was seemingly in less popular use in scientific literature (see Figure 3.1), by farmers, and other stakeholders involved in restoring catchment processes in England and Wales. At that time, the terms 'holistic and/or adaptive planned grazing', 'rotational and/or rational grazing', 'mob grazing' and 'cell grazing' were more commonly used (see search terms for initial literature searches in Section 3.2 at this time). Conversations with various farmers, grassland and grazing advisors, undertaken for this research in 2016-18, explored the meaning and relationship of these different terms; thus helping to refine an understanding of what grazing practices are likely to best restore soils and catchment processes, in the UK context. It was only after this initial exploration, in 2018 that this research came across the term 'regenerative grazing; coincidentally, at this time, the term seemed to appear more regularly in farming media, led by lead proponents such as Rob Havard, farming at the National Trust's Croome Court in Worcestershire, and Tim May farming at Kingsclere Estate in Hampshire. At that time (2016-18), very little had emerged in the scientific literature by way of defining 'regenerative grazing' (see Section 3.2) as such, this was developed with various grazing and grassland specialists, farmers and tested with other stakeholders (see list of stakeholders engaged at Section 5.2) to help understand what it means in the Welsh context.

This exploration of various grazing practices aimed at restoring soils alongside profitable farming, illuminated that regenerative grazing practices may be best described as existing

along a spectrum (see Figure 2.2). This starts with more conventional grazing systems on the left ('set-stock' or 'continuous' grazing), to rotational grazing systems ('paddock' or cell' grazing') in the middle, to highly rotational 'mob' grazing systems on the right of the spectrum. Wagner et al. (2023) refer to mob grazing as a type of regenerative grazing.

Figure 2.3 summarises the characteristics of the different grazing systems in the Welsh context along the regenerative grazing spectrum. In essence, moving to the right along the regenerative grazing spectrum, a farmer begins to:

- Rotate the livestock around the pasture more frequently, bunched up together, within smaller paddocks
- Use less synthetic inputs
- Incorporate longer rest periods into the grazing system for the pasture to recover (up to 60 days in an adaptive/holistic rotational grazing system, compared to 5-10 days in a conventional set-stocking grazing system).

As such, discussions with the grassland and grazing specialists, in forming this understanding, illuminated that 'regenerative grazing' is a process, and less so a status (e.g. such as 'organic'). It is a process of becoming *more* regenerative, rather than seeking some end binary status of 'regenerative' as opposed to being 'non-regenerative'. In this sense it encourages inclusivity.

In effect, discussions with the grassland and grazing specialists suggested that the most regenerative grazing systems aim to mimic the large herbivore herds, such as Bison, that co-evolved with grassland systems across Europe, prior to the enclosure of large areas of open land into small bounded field systems. The soil benefits from concentrated inputs of manure, fewer synthetic inputs and healthier microbiological communities as diverse swards being to emerge.

Figure 2.2 Grazing practices along the regenerative grazing spectrum.

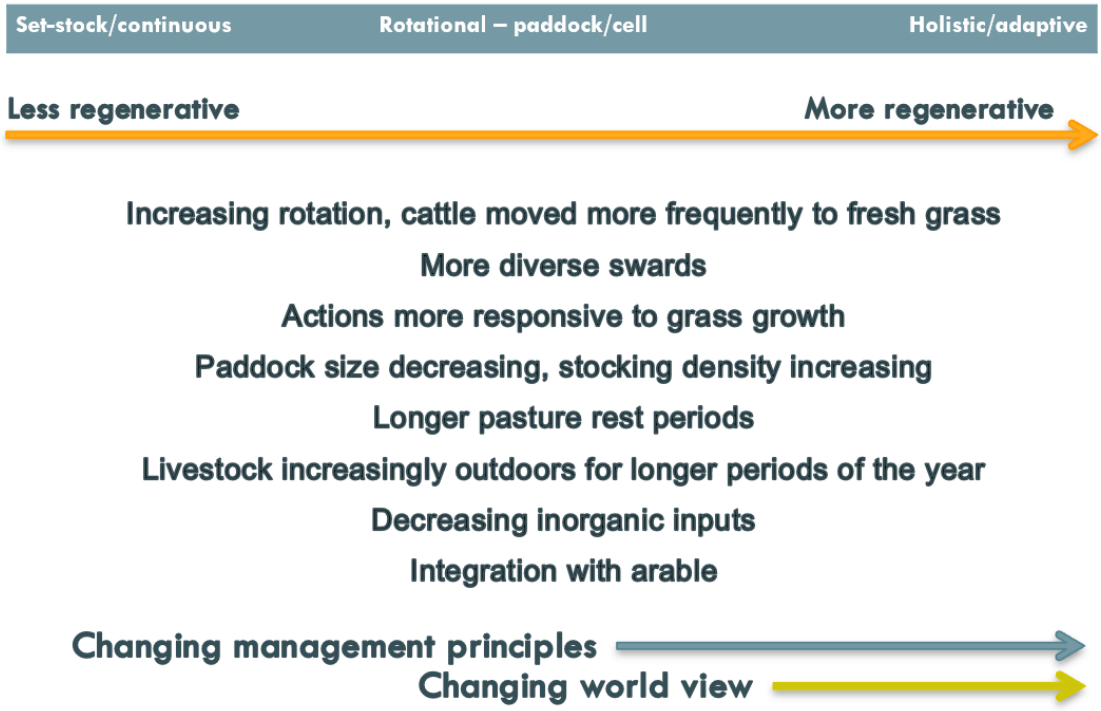


Figure 2.3 Grazing practices along the regenerative grazing spectrum in Wales (as developed with grassland and grazing specialists in Wales in 2016-2018)

Less regenerative → More regenerative

Conventional	Rotational	Rational	Holistic/adaptive
Set-stocking and continuous (relaxed rotational)	Calendar based	Cell or paddock grazing 'Technocell', 'Technograzing'	Incl. 'mob' grazing. More responsive, fewer rules.
Continuous graze 300 days of the year (10 days on, 1 day off). Rest for up to 3 days only.	0.5-7 day moves	0.5-1 day moves, longer rest (18-60 days)	As cell grazing, even longer rest, so grass locks more nutrients in soil
50-60% grass utilisation		80% grass utilisation/DM yield/ryegrass and clover	Balances grass utilisation and good soil health, but more mixed sward species
No control over sward height		Brings farm prod./profitability.	
Lacks resilience to external shocks.		Can increase stocking dens. by 30-40%, higher daily live weight gains, SOM	Riskier to animal performance, farm prod./profitability
Majority in Wales	Established in Wales, not majority though	Minority in Wales	Only know of 1 starting in 2018
		Better SOC and sward quality.	
Low management/investment	More management/investment needed	Invest in electric fencing and water troughs. Set up costs: £276-420 /ha	

A key trait of grazing management, in the most regenerative grazing systems (on the right of the spectrum), is that the farmer makes weekly, or even daily, observations of grass growth, and grazes it according to these observations in an adaptive and responsive manner (moving livestock to fresh pasture twice a day in the most regenerative grazing systems). Diverse

swards are also sowed, or permitted to emerge themselves from the natural seedbank in the soil (rather than a planted monoculture). In the most regenerative grazing systems, livestock are moved to fresh pasture twice a day; and a third of the height of the grass is left un-grazed (to help restore soil organic matter). In such systems, livestock can stay out in the fields all year round and live on a diet of almost 100% pasture (rather than circa 50% in conventional systems).

The regenerative grazing spectrum given in Figure 2.2 also demonstrates how the discussions illuminated, that about half way along the spectrum farming principles begin to change. Instead of farming being solely about productivity, or profit per cow, the farmer starts to prioritise profit per hectare. This takes the emphasis away from livestock as the resource, but instead the farmer views the land and grass production as the resource – if you optimise pasture growth, you maximise profitability. Moving further up the spectrum towards more regenerative practices, the farmer starts to view the livestock specifically as 'a tool' to restore soil health, so the soil becomes the resource (rather than the grass or the livestock). The farmer begins to prioritise the generation of healthy soil, one which self-sustains itself, in a symbiotic, mutually beneficial, relationship with the livestock. The most regenerative, or 'holistic thinking' farmers start to think in cycles (water, carbon, nutrients, energy), and the relationships between components of the system, rather than the components themselves – soil, livestock, grass, buildings; as well as the nested nature of these systems, and the shared properties of system relationships (inter and intra) e.g. the diversity of soil microbiological communities, their niche functions and exchange relationships with root exudates; and how similar system components, functions and relationships are mirrored in the farming management system, the market system (buyers, lenders etc.) and social systems (e.g. farming networks) for example. This more 'holistic' view is more associated with the most regenerative grazing spectrums. As such, this spectrum shows how farmers start to demonstrate change in mindsets, world views and ontological perspectives (e.g. systemic rather than reductionist), as well as changes in farm management principles, as well as farm practices, the more regenerative they become. As Cusworth and Garnett (2023:3) note "For some the regenerative 'journey' – a metaphor that circulates in the regenerative world – can be understood as a development from practices to outcomes to mindsets".

Other practices are integrated and undertaken alongside grazing in the more regenerative systems, including promoting sward diversity, integrating grazing with crops, good nutrient and water management. The types of practices regularly associated with regenerative farming (not just grazing) in the UK are given in Figure 2.4 .4. The practices such as no tillage and sowing cover crops, are aimed at restoring soil health, soil organic matter and soil biodiversity;

working closely with the water, energy and nutrient cycles, which in turn support a diverse and resilient ecosystem above and below ground. The approach aims to limit damaging practices such as tilling, continuous grazing, and monocultural cropping; and reduce or avoid the need for synthetic chemical inputs (fertilisers, herbicides, insecticides, medicines).

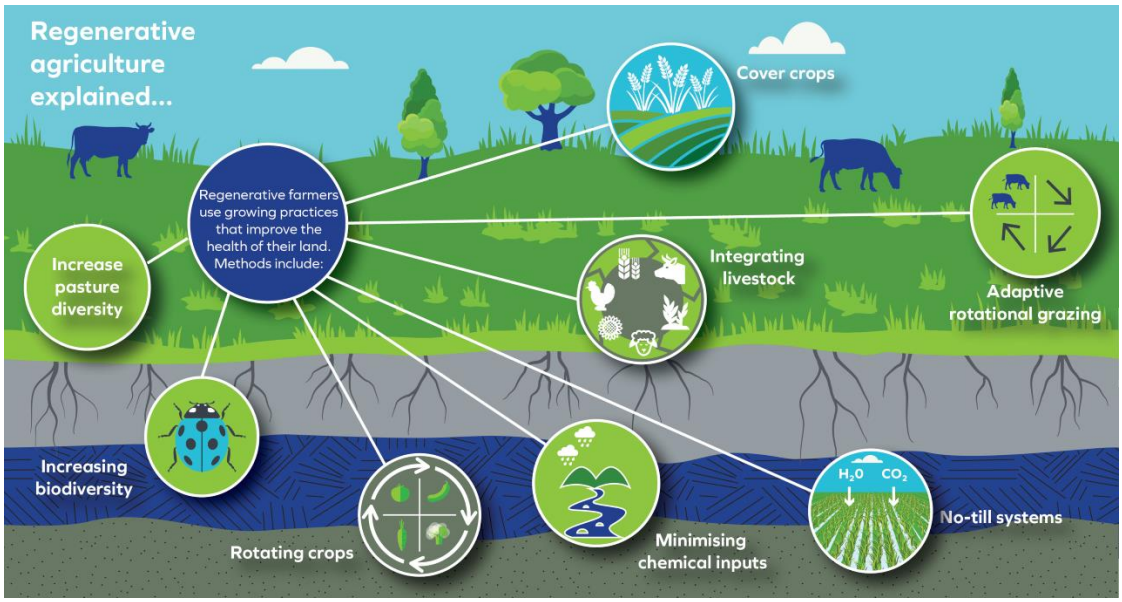


Figure 2.4 Suite of measures adopted in regenerative farming
(Based on image sourced from https://www.eitfood.eu/)

Interestingly, the 'Sustainable economic and ecological grazing systems - learning from innovative practitioners' (SEEGSLIP) project, finished in 2021 and led by Lancaster University and the Centre for Ecology and Hydrology (CEH); identified a similar grazing spectrum for 'mob' grazing (a highly regenerative type of grazing – see Figure Y) in the UK. Four main rotational grazing systems were identified as described in Wagner et al. (2023:1): "(1) conventional non-mob stocking by farmers still in the initial stages of discovering mob grazing; (2) mob stocking, involving reduced grazing duration at increased stocking densities, with pasture rest periods similar to those used in rotational non-mob stocking; (3) mob grazing, involving similar stocking densities as in mob stocking, but allowing for longer rest periods; and… (4) intensive mob grazing using very high stocking densities and frequent cattle movement, allowing for even longer rest periods".

2.3.4 Benefits of regenerative grazing

The SEEGSLIP project provides some of the first empirical evidence for the benefits of regenerative grazing. The data collection, interviews and observations are based on pasture-fed farms, those using purely pasture or forage to feed their livestock (no grain). Whilst the grazing system used in a pasture-fed system is not necessarily regenerative (as defined above), regenerative grazing is the approach used to optimise pasture growth for a grass-fed system (with no synthetic inputs). As such, the SEEGSLIP evidence does strongly suggest that the

financial benefits of pasture-fed grazing systems compare favourably to those of conventional farming averages from the Farm Business Survey (Figure 2.5) (SEEGSLIP, 2021).

Gross Margin (Output minus Variable Costs)	Pasture-fed Average (56 farms)	Farm Business Survey Average	How does it compare?
Breeding sheep flocks	£63/head (£16-106/head)	£21-59/head (up to £93/head)	
Suckler beef farms	£965/head (£464-1556/head)	£221-241/head (up to £470/head)	
Beef finishers	£404/head (£161-631/head)	£238/head (up to £441/head)	

Figure 2.5 Financial benefits of pasture-fed grazing systems compared to conventional farming averages Source: https://www.pastureforlife.org/news/pasture-for-life-makes-good-financial-sense/

2.4 Farming in Wales

90% of Wales' total land area supports 24,677 farms (Senedd Commission, 2022). This covers 1.8m ha, which is made up of permanent grassland (63%), new grassland (9%), rough grazing (13%), arable crops (6%) and other land i.e. woodland, buildings (9%) (June Agricultural and Horticultural Survey, 2023). The majority (55%) of Welsh farms are small (under 20 hectares) (Senedd Commission, 2022), and 27 percent is tenanted (Forest Research, 2023). Large landowners include Welsh Water (78,000 ha) and the National Trust (46,000 ha).

Farming in Wales is dominated by sheep and cattle grazing (by number of farms, and area of land farmed) in challenging mountainous and high rainfall conditions, defined as Less Favoured Areas (LFA) (covering 80% of agricultural land in Wales) (Senedd Commission, 2022). Within these LFAs, are also Severely Disadvantaged Areas (SDA) and Disadvantaged Areas (DA), which represent 'Hill' and 'Upland' farming areas respectively, which face even more challenging farming conditions. Lowland areas (20% of agricultural land in Wales, outside of LFAs) accommodate mostly dairy and crop farms (Welsh Government, 2024).

The Welsh Government splits farming into three main categories (although there are other types). These are LFA grazing, Lowland grazing and Dairy (Welsh Government, 2024). LFA grazing makes up the largest proportion of farms and land in Wales, accounting for two thirds (66%) of all farms and almost three quarters (73%) of the land in Wales. Lowland grazing livestock accounts for 7% of total land and 12% of all farms. Together, LFA and Lowland grazing contribute 45% of Welsh agricultural output (Welsh Government, 2024).

Dairy contributes the most in terms of Welsh farming output (47%), and generates higher income on average, despite only using 13% of farm land, and representing 15% of farms (Welsh Government, 2024).

LFA farms have seen a decrease in farm business income in 2022-23 compared to the previous year. SDA sheep farms have experienced the greatest decrease in income for 2022-23 by 45% to £28,700. DA sheep and beef farms continue to have the lowest average income of the LFA farm category, falling 33% in 2022-23 compared to the previous year to £18,600. SDA sheep and beef farm income has decreased by 23% in the same period to £24,100 (Welsh Government, 2024). On average, 67% of Welsh farm income comes from subsidies (57% from direct payments and 10% from agri-environment payments) (Senedd Commission, 2022).

Conversely, Dairy income in Wales increased by 87% over the same period, due to higher farm gate price of milk in Wales (milk production decreased over the same time by 4%) and despite an average increase in overall dairy farm costs of 27% in 2022-23. Of these costs, costs for purchased feed, fodder and fertiliser increased significantly.

The Basic Payment Scheme, other subsidies and diversified incomes contribute around 25% of the total income (outputs) and 153% of profits, on average, for the upland cattle and sheep farms in Wales. Many Welsh farms rely heavily on non-farming income and Welsh Government support payments (basic payment and agri-environment) (Aberystwyth University, 2024).

2.4.1 Regenerative grazing in Wales

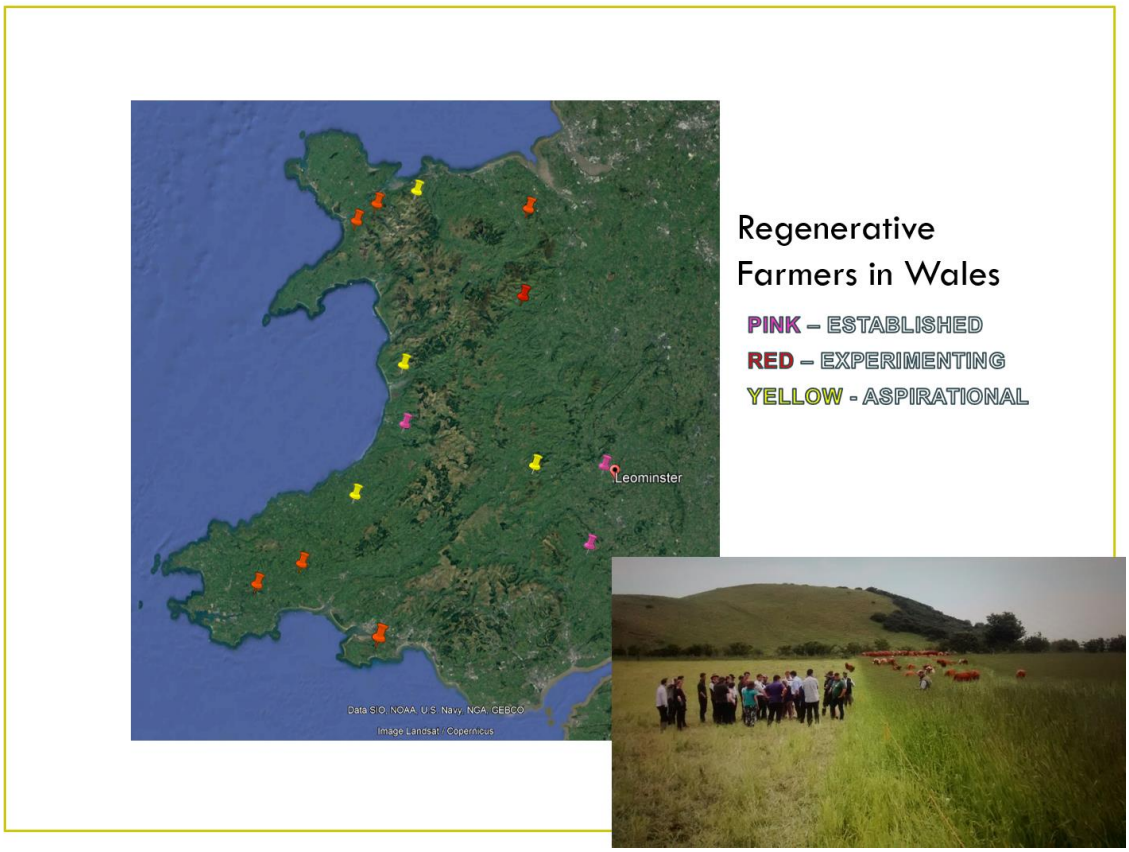
Farmers experimenting in specifically regenerative grazing in Wales are few in number. There are no databases nor known established networks of farmers experimenting in regenerative grazing practices in Wales. As such, farmers were identified in 2018 via correspondence with Farming Connect grazing specialists in Wales, via Google searches and social media platforms. Efforts were also made to identify regenerative farmers via various UK-wide farmer networks (LEAF, Regen-Ag, Pasture for Life, NFU, AHDB); only publicly available data was accessed. 15 'experimental' Welsh farms were identified (Table 2.1, Figure 2.6), with at least five using grazing practices that could be considered regenerative to a degree (as pe the spectrum in Section 2.3.3).

Table 2.1 Farms identified for potential participation in the research (identified in 2018)

Grazing practice	Farm Name	Notes
Welsh farms practicing regenerative grazing		
Cell (Rotational) TechnoCell	Osedd Fawr, Pencaenewydd, Pwllheli, LL53 6RD	TechnoCell System for yearling cattle, finishing cattle on pasture by 18 months. Organic. Farming Connect Project Site

Grazing practice	Farm Name	Notes
Cell (Rotational) TechnoCell	Penrhiw Farm near Llandysul, Ceredigion, SA44 4PG	Soil Association organic farm. Precision Grazing.
Cell (Rotational) TechnoCell	Pen-y-Gelli Farm Ffordd Bethel, Caernarfon, Gwynedd, LL55 1UH	
Mob-grazing	Mountain Hall Farm, Hermon, Pembrokeshire	
Mob-grazing	Llysun, Llanerfyl, Welshpool, SY21 0EL	Starting 'mob grazing' in 2018. Farming Connect Demonstration Site. Farmers' Weekly Beef Farmer of the Year.
Experimental Welsh farms (not necessarily regenerative grazing)		
Not known	J & P Price, Cwmnewynydd, Crai, Brecon, Powys, LD3 8YS Wales	Pasture for Life farm
Not known	Black Welsh Lamb, Pen y Wyrlod Farm, Llanvetherine, Abergavenny, Monmouthshire, NP7 8RG Wales	Pasture for Life farm
Not known	Gower Salt Marsh Lamb, Weobley Castle, Llanrhidian, Swansea, Glamorgan, SA3 1HB Wales	Pasture for Life farm
Beef and sheep	Aberbranddu, Cwrt y Cadno, Pumsaint, Llanwrda, SA19 8YE	Farming Connect Demonstration farm. Efficiency and productivity focus.
Beef, sheep, horticulture	Great Tre-rhew Farm, Llanvetherine, Abergavenny, NP7 8RA	Farming Connect Demonstration farm. To make the farms viable, producing quality food. To manage wildlife and to be sustainable.
Dairy	Moor Farm, Walwyns Castle, Haverfordwest, SA62 3EE	Farming Connect Demonstration farm. Improve profitability and business resilience, increase grass utilisation and productivity.
Beef and sheep	Newton Farm, Scethrog, Brecon LD3 7YG	Farming Connect Demonstration farm. Improved grassland management
Beef and sheep	Fferm Plas, Llandegfan, Anglesey, LL59 5SB	Farming Connect Demonstration farm. Increase grass utilisation and productivity
Sheep	Rhiwgriafol, Talywern, Machynlleth, SY20 8NY	Farming Connect Demonstration farm. Sustainability and farming financial viability.
Sheep	Tynyberth, Abbey-Cwm-Hir, Llandrindod Wells, LD1 6PU	Farming Connect Demonstration farm. Improve grassland management. Become as self-sufficient as possible.

Figure 2.6 Location of identified regenerative livestock farms in Wales in 2018



The Pasture for Life Association (network for livestock farms which aim to use 100% pasture feed) stated in 2018, that at that time (six years ago), of 93 UK wide certified Pasture for Life farms, only one was located in Wales. As at June 2024, this number has grown to seven as mapped in Figure 2.7. Whilst they do not necessarily use regenerative grazing practices, there will be some overlap. This suggests a gap in Wales compared to the rest of the UK suggesting low take-up in Wales.

Figure 2.7 Location of 'Pasture for Life' farms across England and Wales

Source:
https://www.pastureforlife.org/where-to-buy/
[accessed 26th June 2024]

2.5 Summary

In the last century, there has been a change in the policy context of farming in the UK. Eighty years ago, production was prioritised above all else to provide cheap and affordable food in a post WWII environment, spurred on by the Cold War threat and abundant cheap energy (fossil fuel based). Then, globalisation (financial deregulation and trade liberalisation) opened up new markets and vast amounts of agri-tech investment, propelling farming forward into the modernist era.

Since then, it has been realised that intensive farming costs society dearly, and indirectly, in other ways. Notably in the UK, this has manifested itself in terms of chronic flooding, biodiversity decline, soil loss, water pollution and decline in nutrient density in food. Despite decades of collaborative schemes to address these issues, the UK has failed to resolve these problems in any significant way. Arguably, these interventions, as valuable as they are, have just been skirting the edges of the challenges facing society.

Initial responses to this crisis sought to set land aside for nature's recovery, via the CAP in the 1980s. It is only now, more recently, that society has realised that more fundamental changes in the way we farm and manage land are required in order to address the multiple challenges of food security, biodiversity loss, flooding, water pollution and adaptation to climate change in combination – not separately.

Throughout this period of change, the geo-political context has played a pivotal role: recovery from the World Wars, the Cold War, globalisation, Brexit, the Russian invasion of Ukraine. It is now in the 21st century, that society is recognising the consequences of a market-based capitalist system, one which measures success by market traded goods and services only, ignoring any costs borne to the global commons and the declining value of its natural asset base. Framing farming practices within this broader context is as important to do now, as then, in light of current geo-political change and consequences for global markets.

Agroecology, and for the purpose of this research - specifically regenerative grazing - has emerged in response to these challenges. Regenerative grazing is based on the application of six core principles, working towards a 'holistic' mindset, which guides the choice of farming practices in a given context, working with natural processes to restore soil health. Regenerative grazing, in the context of Wales, consists of rotating livestock more frequently, reducing synthetic inputs, working to optimise pasture growth and diversity. Various grazing systems such as cell grazing, mob grazing, adaptive and planned grazing fall onto the regenerative grazing spectrum (developed as part of this research), each regenerative to

varying degrees. Regenerative grazing is a journey, or process which farmers can progress along to a lesser or greater degree depending on their individual contexts.

Farming in Wales is dominated by livestock grazing, mostly in challenging upland and hill areas, which is largely dependent on farming subsidies. Evidence suggests take-up of regenerative farming in Wales is low compared to the rest of the UK.

Whilst other types of ecologically sensitive farming (e.g. organic, conservation farming, permaculture) share similar principles and practices, regenerative farming differs in that it aims to be restorative, rather than solely a sustainable or conservation focus. There is emerging debate in the literature as to how its definition is shaping, varying from process-based, to outcome-based, to mindset-changes or a mix of all three. Regenerative grazing, as part of broader agro-ecological transformation, is seeking to relinquish control of natural processes and instead aims to adapt to uncertainties via close observation and response. Some in the literature suggest definition is needed to secure investor and policy interest, however, initial evidence gathering from pasture-fed farmers in the UK is that they may be able to farm independently of private and public sector payments, and thus defining what regenerative farming is, may perhaps not be needed. In this sense, regenerative farming may be as politically charged as the broader agro-ecological movement (as perhaps challenged by some in scientific literature).

Irrespective of social and political messaging, regenerative farming (and grazing specifically) provides a means for grazing in Wales to move away from higher input costs, fossil fuel dependence; towards ecological restoration and associated outcomes and higher resilience to external commodity markets, contributing to policy goals in Wales.

Chapter 3 Literature Review

3.1 Introduction

This section presents the principal findings of a two-stage systematic literature review. The first stage was undertaken in 2016/2017, prior to the formulation of the research questions for this thesis. The purpose of this stage was a general exploration of the peer-reviewed scientific literature, to aid an appreciation of what is, and what is not, covered; in order to shape the development of the research questions. The second stage was completed in 2020, with the specific purpose to understand what the literature says with regard to the research questions, and initial data collection findings. It has then been updated on an ad-hoc, rather than on a systematic basis, since then as more relevant papers were published. The research questions subsequently developed, have sought to contribute to the scientific literature, with regard to farmer transitions to regenerative farming in the UK. This is explained more below.

It is worth noting, that there was a sizeable increase in published scientific literature using the term 'regenerative agriculture' in the period between the two literature review stages undertaken for this research as show in Figure 3.1 below taken from Newton et al. (2020).

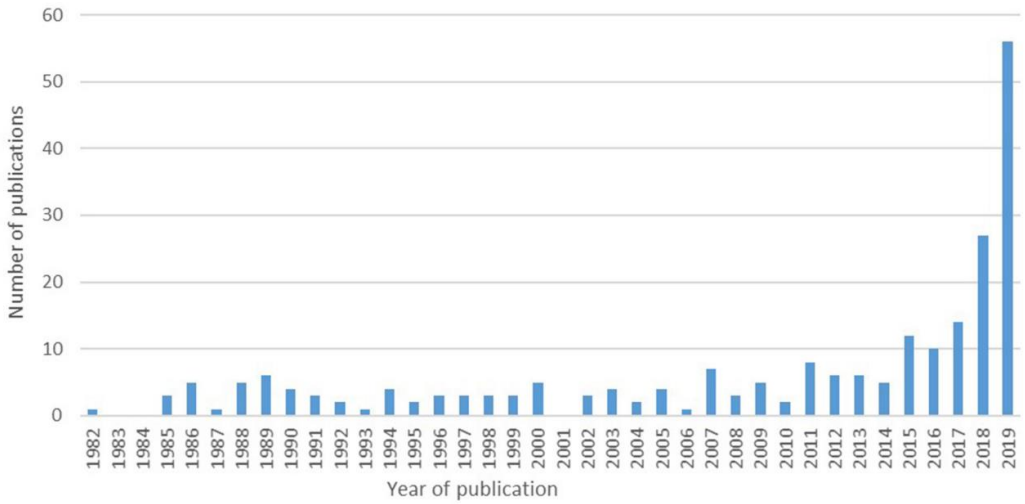


Figure 3.1 Published scientific literature using the term 'regenerative agriculture

3.2 Method

The systematic literature review followed the process set out in Figure 3.2 which followed guidance from Gough et al. (2013), Shamseer et al. (2015) and Siddaway et al. (2019). A copy of the searches, dates, databases, results and refinements (including any geographical exclusions) are given in Appendix 1.

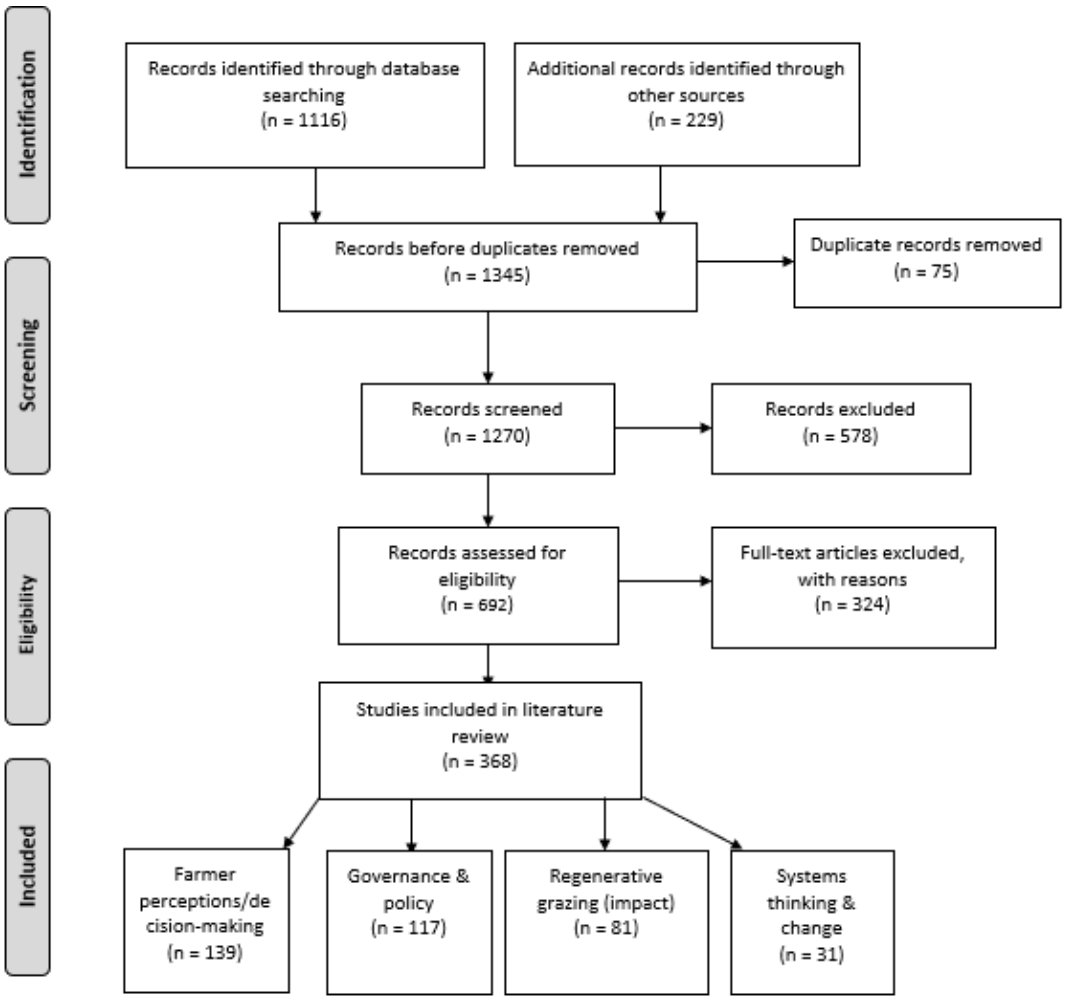


Figure 3.2 Breakdown of systematic literature review results (December 2020)

Initially, in Stage 1 (2016/17), the research was mainly interested in grazing practices in grassland systems in the UK, which were increasingly being linked to restoring ecosystems, natural catchment processes and multiple outcomes. At this time, such grazing practices were being referred to among farmers and practitioners in catchment management as 'holistic', 'planned' and 'adaptive' grazing regimes. As such, the initial literature searches in 2016 (see Table 3.1) orientated around such terms (as well as other related terms including rotational grazing, rational grazing, timing and division). The aim of these early literature searches were to look for evidence of the impact of these new grazing systems upon farm productivity and profit, as well as ecosystem outcomes. Terms such as systems thinking, systems approach and systems dynamics were also included in the search terms.

Table 3.1 Systematic literature review searches completed in Stage 1 (2016/17)

Search terms (in Summon*, Web of Science, Scopus, Science Direct and Google Scholar) – see Appendix 1 for search strings and specific dates.	**Month/Year**
Farming, holistic, income, profit, ecosystem services; Farming, agriculture, holistic, adaptive, planned, pasture division, grazing timing, rotational, rational, productivity, income, profit, hardier breeds;	October 2016 – October 2017

Farming, agriculture, UK, carbon, holistic mob, grazing, agroforestry; Catchments, management, ecosystem, water, systems approach, systems dynamics, systems thinking; Catchments, land, governance, policy, rights, property, regenerative farming, sustainable farming, agriculture, payments; Climate change, adaptation, resilience, farming, agriculture, systems, sustainable, experimentation; Soil, conservation measures, farmer decision making, innovation, perspectives, values, views.	

* *Summon is a University of Hull database which includes Science Direct, JSTOR and Academic Search Premier.*

Specifically, in 2016/17, the research was interested in the relationship between land rights (e.g. tenancy type, or landowner, or access to commons) and governance structures (e.g. networks, farming clusters, constituted groups) to farmer propensity to experiment in 'holistic', 'planned' and 'adaptive' grazing regimes; as well as the broader context of farmer incentivisation (e.g. payments, emerging credit markets) in farmer's propensity to move away from more intensive forms of agriculture. It was only later in the Stage 1 literature review that the term 'regenerative farming' started to become popular in farming media and discourse, and was thereon in included in the search terms. However, in later 2017, the research drew back from a focus on farmer take-up of specific grazing systems; to consider more broadly, the nested systems operating in and around farmer decision-making and transition (rather than taking a narrower focus upon one part of a given socio-ecological system).

Stage 2 of the systematic literature review took place in 2020 once research questions had been developed and tested with stakeholders (see Section 5.2), and data collection undertaken (i.e. farmer interviews). This sought to understand what the literature says with regard to the specific research questions, and in comparison to the emerging interview findings (as part of a Grounded Theory approach – see Section 6.6). The 2020 systematic literature review searches were based on the terms as set out in Table 3.2 .

Table 3.2 Systematic literature review searches completed in 2020

Search terms (in Summon, Scopus, Web of Science Core Collection) – see Appendix 1 for search strings and specific dates.	**Month/Year**
Soil health and conservation, farmer decision making, perspectives, values, views.	October 2020
Regenerative grazing, holistic, adaptive, mob, rotational, grazing, soil livestock impacts resilience.	October 2020
Farmer decision making, systems thinking, socio ecological resilience.	October 2020
Policy, sustainable agriculture, agri-environment, payments for outcomes.	October 2020

Search terms (in Summon, Scopus, Web of Science Core Collection) – see Appendix 1 for search strings and specific dates.	Month/Year
Climate change, adaptation, resilience, farming, agriculture, carbon, sustainable.	October 2020
Farming, regenerative, sustainable, carbon, transition, change, process.	October 2020

In total, 368 references of relevance for this research were identified from Stages 1 and 2 (of 1345 references initially idenfied). These comprise in the main, empirical evidence, conceptual frameworks and expert reviews. These references were divided into four relevant categories as follows:

A. Impact of regenerative grazing (81)
B. Farmer decision-making and perspectives (139)
C. Governance and policy (117)
D. Systems thinking (31).

The first two categories (A, B) are taken forward for more detailed exploration in this narrative literature review. Papers in the latter two categories (C, D) are referenced in this thesis where relevant and meaningful to do so.

3.3 A - Impact of regenerative grazing: review of evidence

3.3.1 Introduction

This section summarises the published evidence of the impacts of regenerative *grazing* practices (as defined in Section 2.3.3). These comprise practices such as frequent rotational grazing, longer pasture rest periods, and reduced inputs. The most regenerative grazing systems come with a more adaptive management style, responsive to grass growth and livestock needs, a focus on soil health, and the lower use of inorganic inputs. Such practices are referred to by different names in the literature and include intensive rotational grazing, adaptive multi-paddock grazing, holistic adaptive management, management intensive grazing, mob grazing and cell grazing (all fall onto the regenerative grazing spectrum, see Section 2.3.3); care was taken to ensure any findings linked to the impacts of these practices were included.

Whilst this evidence does not relate to the research focus (see Section 1.1) specifically (of farmer transitions to regenerative grazing), it is useful to provide a summary of the evidence for why a farmer may take-up regenerative farming (for the outcomes and benefits it offers) as a backbone to this research. Of note, there is little about profitability, neither impact on farm business and livelihoods in the scientific literature prior to 2020 (when this literature review was completed); since then, further UK based evidence has been published which has been added below.

3.3.2 Results

The literature search identified 81 references (either reviews (R, n=19), models (M, n=15) or empirical data (E, n=47)) that look at the impact of regenerative grazing to some degree. Some make only mention of regenerative grazing as part of a broader suite of considerations, where as some are specifically focused on regenerative grazing. Some references do not say 'regenerative grazing' per se and a judgment has had to be made as to whether the practices described fall onto the regenerative grazing spectrum (as per Section 2.3.3). The references date from the last twenty years.

40 of these references are overall favourable to regenerative grazing, reporting positive outcomes; 38 are inconclusive or report no change in outcomes; 3 report poorer (less favourable) outcomes for regenerative grazing.

Very little of the literature is from Europe (n=7 including 1 from the UK), most by far are from Australasia (n=25) and North America (n=24). Also, South America (n=5), Africa (n=5) and Asia (n=1) are represented. The rest (n=14) are global in coverage.

Only one is UK based (Blackwell et al., 2018). The John Nix Pocketbook 2023 (Redman, 2022) has introduced a new section for regenerative farming but this includes outputs and profit data for high performing regenerative arable farms only. Published output and profit data for pasture-fed grazing systems is available from Pasture for Life (2016) but this is not necessarily all regenerative grazing.

More up to date output and profit data for pasture-fed grazing systems has been more recently provided by the 'Sustainable economic and ecological grazing systems - learning from innovative practitioners' (SEEGSLIP) project, which was finished in 2021. SEEGSLIP conducted research with 56 farmers who are members of the Pasture for Life Association and was led by Lancaster University and the Centre for Ecology and Hydrology (CEH) (who were consulted in shaping the research questions for this thesis, see Section 5.2). The project sought to evidence the practices of pasture-based grazing systems in the UK, most of which (not all) may be considered regenerative practices. SEEGSLIP studied how and why mob grazing (a type of regenerative grazing, see Section 2.3.3) is being adopted by British pasture-fed beef farmers. 15 farms were part of this aspect of the research Wagner et al. (2023). Interviews explored farming context, farmer rationale and motivation for change. The findings of SEEGSLIP are included at Section 2.3.4 and touched on below. On the whole, SEEGSLIP found that farmers observed various benefits of pasture-fed grazing systems including to livestock production, soil and ecosystem health, and animal health. The scale of these benefits appears to be

proportional to the degree, and length of time, that such grazing systems had been established.

3.3.3 Evidence

In the empirical studies and models listed below (Table 3.3), many different types of regenerative grazing are being compared to 'non-regenerative' systems in order to draw conclusions. These are in terms of:

- Different types of livestock – sheep, cows, goats, horses.
- Different 'non-regenerative' grazing systems e.g. continuous extensive, continuous intensive
- Different farming systems – diary, beef, sheep; organic and non-organic – it is often unclear to what extent synthetic inputs have been used or not.
- Different environments, climates and soil types.
- Different extent to which 'regenerative' practices are undertaken and established.
- Some are in combination with a suite of capital measures e.g. riparian planting
- Different assessment methods, covering all or some of system impacts e.g. lifecycle analysis, soil analysis, productivity studies, biodiversity assessments, with few looking across a broader range of multiple impacts
- Different soil depths used for assessment.

This research has sought to manage these limitations which are expanded upon below.

In essence, the empirical evidence on the whole indicates that regenerative grazing, and forms there of, are on the whole beneficial for ecosystem health and associated outcomes. There are contexts in which it is likely to be less beneficial (e.g. in heavy clay, high rainfall regions). The greatest gains appear to be more beneficial when regenerative grazing is part of arable reversion to grassland. The evidence in the main, is positive for farm profitability, although a transition period of around five years is likely before profit levels stabilise. There is mixed evidence in terms of impact on productivity and animal performance. The picture is less clear in terms of outcomes for soil health and biodiversity, but this may be due to a lag period for beneficial outcomes to dissipate through the ecosystem (i.e. soil, flora and fauna impacts are likely to be more evidence on farms established in regenerative grazing for longer).

Table 3.3 – Papers evidencing positive, little or negative change of regenerative grazing practices (those highlighted in grey are non-peer reviewed grey literature).

Outcome	Positive	No / little change	Negative
Carbon: ■ Soil organic carbon or net carbon emissions	Oates and Jackson, 2014; Teague, 2018; Stanley et al., 2018; Mosier et al., 2021; Dowhower et al.,		

Outcome	Positive	No / little change	Negative
■ Soil surface emissions of CO_2 ■ Life *cycle analysis incl.* soil	2020; Ritchie, 2020; Alemu et al., 2019. Abagandura et al., 2019.	Grossi et al., 2020 (no change comparing rotational grazing to continuous grazing in an *organic* system)	
Greenhouse Gases: ■ Methane and nitrous oxide as well as carbon are referenced, usually assessed as part of a life-cycle analysis of a farming system, including soil fluxes	Stanley et al., 2018; Shrestha et al., 2020; Mazzeto et al., 2015; Byrnes et al., 2015; Guyader et al., 2016; Teague et al., 2016; Dowhower et al., 2020	Abagandura et al., 2019 (soil surface emissions of N_2O and CH_4).	
Farm profit	Teague et al., 2015; Pasture for Life, 2016; Sitienei et al., 2019; Schaub et al., 2020; Nix Handbook, 2023; Wagner et al. 2023		
Pasture characteristics: ■ *G*rass productivity and stocking capacity ■ Forage nutritive value of standing biomass ■ Herbage mass, quality and growth	Zhou et al., 2019; Ritchie, 2020; Alemu et al., 2019; Wagner et al. 2023 Steiner et al., 2019	Shakhane et al., 2013a; Hall et al., 2014; Steiner et al., 2019; Hawkins, 2017 (specifically HPG).	
Landscape function: ■ Ground cover, vegetation type and diversity, and ecosystem services	McDonald et al., 2018; McDonald et al., 2020; Badgery et al., 2017; di Virgilio et al., 2019; Wagner et al. 2023	Hall et al., 2014	
Pollination	Kovács-Hostyánszki et al., 2017; Wrage et al., 2011		

Outcome	Positive	No / little change	Negative
Livestock performance and health: ■ Liveweight, fleece cut and wool quality ■ Pasture quality and animal gain ■ Calf body weight	Odadi et al., 2018: Amaral et al., 2013; Mason et al., 2017; Badgery and Michalk, 2017, Wagner et al. 2023		Cox et al., 2017; Hall et al., 2016; di Virgilio et al., 2019. Shakhane et al., 2013b Alemu et al., 2019 Steiner et al., 2019.
Soil health: ■ Reduced bare ground, less erosion, nutrient cycling, less need for synthetic inputs ■ Soil nutrient content ■ Soil infiltration, soil carbon and bulk density ■ Soil moisture ■ Soil microbial communities	Kotze et al., 2013; Stavi, Lal and Owens, 2011; Galindo et al., 2020; Park, Ale and Teague, 2017; Dowhower et al., 2020; Alves et al., 2019; Wagner et al. 2023 Steiner et al., 2019.	Sato et al., 2019. McDonald et al., 2018; Carassai et al., 2011 – sheep grazing after crops). Mitchell et al., 2017. Oates et al., 2012	
Biodiversity: ■ Fauna diversity ■ Grasshopper densities or species composition ■ Grassland bird abundance	McDonald et al., 2019	Shakhane et al.2013c; Hall et al., 2014. Branson, 2020. Davis et al., 2020.	
Water quality: ■ In combination with riparian buffer strips ■ Eutrophication and acidification per hectare	Anderson et al., 2020 Tichenor et al., 2017; lower impacts from grass-fed beef with management-intensive grazing (GF) compared to confinement dairy beef (DB) production systems in the Northeastern U.S.		
Multiple outcomes	Teague, 2018; Teague et al., 2016;		

Outcome	Positive	No / little change	Negative
	Odadi et al., 2017; Peel and Stalmans, 2018; Li et al., 2020; Scott et al., 2013; Waters et al., 2017; Perotti et al., 2018; Mcdonald et al., 2019; Teague, 2014; Fisher et al., 2012; Teague and Barnes, 2017.		

3.3.4 Geography

The literature for the impacts of regenerative grazing comes from six continents. Here, the evidence gap for Europe is highlighted and various evidence from Australasia and North America is drawn on.

For **Europe**, only seven papers have been sourced (empirical, n=3; modelled, n=2; review, n=2). One paper takes a positive stance on the outcomes of regenerative *farming* (not just grazing), the others are less clear or unclear.

- A key paper is Grossi et al. (2020) which compares the modelled carbon foot print (life cycle analysis, which unusually also includes soil organic carbon) between a continuous grazing (Cg) system and rotational grazing (Rg) in an organic Mediterranean pasture-based system. Perhaps unsurprisingly, there is little difference between Cg or Rg in an organic, low input system. Most interestingly, is the approach – a life cycle analysis which includes soil organic carbon in the calculations.
- Another key paper is Perotti et al. (2018) who found that rotational grazing with animal stocking rate adjusted to match grassland carrying capacity, had a positive effect on biodiversity and soil fertility – although the findings are specific to sub-alpine and alpine pastures.
- The only paper from the UK (at the time of writing), Blackwell et al. (2018) does not offer much insight as it is focused on grassland grazing more generally, and is focused on making the case for long-term observations if any meaningful conclusions are to be made.

This highlights the lack of peer-reviewed empirical evidence for the impact of regenerative grazing systems in Wales. Faghihinia et al. (2020) and Staddon et al. (2022) support this view of research in Wales, with the latter stating “To date, research on the impact of grazing on productivity and sustainability of ecosystems has focused on comparing grazed with ungrazed … rather than aiming to identify an optimal grazing point allowing both livestock production and the maintenance of a healthy ecosystems” (Staddon et al., 2022:2). Their research, developed together with farmers in Wales, has sought to fill this gap by investigating optimal grazing management, developed to local conditions, is affecting soil biodiversity, soil

carbon content and grassland sustainability. Whilst the contribution to the knowledge gap is welcomed, particularly for Wales, the results are fairly inconclusive. Despite observing interesting patterns in soil health and soil carbon in fields under different grazing practices, the findings were inconclusive as past management, and length of time of how long said grazing practices had been established in each field, were not known (Staddon et al., 2022). The research has however, provided the foundation for future Wales-focused research.

Most of the empirical research for the impact of regenerative grazing practices upon ecosystem outcomes and farm financials, comes from Australasia and North America, where there is a much longer history of regenerative grazing. Key papers of most relevance to Welsh conditions and farming type are summarised (e.g. sheep and cattle grazing in higher rainfall, non-arid areas).

For **Australasia**, 25 papers have been sourced (empirical, n=19; modelled, n=4; review, n=2). Ten of the papers are positive about the outcomes of regenerative grazing, whereas 12 papers are less sure or unclear. Three report poorer outcomes.

- Scott et al. (2013) summarises the findings of the six-year long Cicerone project. It concludes that more profitable and sustainable outcomes are most likely to arise from grazing that is proactively managed towards optimal outcomes by employing flexible rotational grazing (i.e. regenerative grazing). Three other papers from 2013, by Shakhane et al. (2013a, 2013b, 2013c) also report findings from the Cicerone project but are less positive about regenerative grazing (noting a lower quality grazing, lower liveweight and wool quality compared to high input intensive grazing). Very little change was noted in biodiversity.
- Waters et al. (2017) studied the effects of rotational grazing and adjusted grazing intensity over eight years, upon soil organic carbon (SOC), soil nitrogen (TN), ground cover and biodiversity (flora and invertebrates). They found that grazing management affected red soils (more than grey soils), increasing SOC and TN. Rotational grazing resulted in more diverse vegetation but insect diversity seemed to be lower.
- Badgery's et al. (2017a, 2017b) study indicated that intensive rotational grazing could be as productive, with greater soil / pasture health benefits (as better ground cover) as more continuous systems.

For **North America**, 24 papers have been sourced (empirical, n=18 (one of which is qualitative); modelled, n=3; review, n=3). 13 of the papers are positive about the outcomes of regenerative grazing, whereas 9 papers are less sure or unclear. Two report no results, none report poorer outcomes. Key papers include:

- Guyader et al. (2016) took an early systems view with regard to regenerative grazing, connecting greenhouse gas emissions and sequestration, with other ecological benefits of regenerative grazing compared to conventional practices, such as conserving biodiversity, improving soil health, enhancing water quality, and providing wildlife habitat.

- Tichenor et al. (2017) compared a grass-fed beef system with management-intensive grazing (GF) to a confinement feed-lot dairy beef (DB) production system, on the whole finding that GF is not expected to have a lower carbon footprint than DB. They go on to say that holistic strategies have the potential to reduce regional GF and DB system footprints, by accounting for ecosystem services provided by pasture-based farming systems.
- Stanley et al. (2018) compare the impacts of finishing beef from an adaptive-multi-paddock grazing (AMP) to a feed-lot (FL) system. The analysis indicates that AMP has the potential to offset GHG emissions through soil C sequestration, and therefore the finishing phase could be a net C sink suggesting that AMP grazing can contribute to climate change mitigation.
- Guttery and Caudill (2019) reviewed over thirty investigations which looked at rotational grazing compared to continuous grazing. 89% of the studies found no change in pasture productivity where stocking rates were similar. Different stocking rates seemed to influence growth the most.
- Similarly, Steiner et al. (2019) compare a continuous system (CS) to a rotational system (RS) from 2009 to 2015. Findings indicate that plant biomass and animal productivity were similar in the two grazing systems. Forage nutrition was enhanced in RS compared to CS, yet animal performance was greater in CS.
- More recent empirical papers (Mosier et al., 2021; Shrestha et al., 2020; Dowhower et al., 2020) have reported positive soil organic carbon outcomes from regenerative grazing (or AMP as more readily know in North America) when compared to moderate or continuous grazing systems.
    - Mosier et al. (2021) report 13% more soil C, and 9% more soil nitrogen, on farms under AMP compared to conventional grazing (CG). They found that carbon shifted to more persistent organic matter, suggesting long-term C storage.
    - Shrestha et al. (2020:1781) found that “AMP grazing has the potential to mitigate the impact of a warmer soil on GHG emissions by consuming more CH4 compared to non-AMP grazing in northern temperate grasslands”.
    - Dowhower et al. (2020) provide evidence of soils under AMP emitting more CO_2, as they hold more carbon and greater soil microbial activity; N_2O and CH_4 emissions are lower meaning overall, AMP acts as a carbon sink compared to non-AMP.

14 papers conducting a **global assessment** of the impact of farming practices that are relevant to consider here (modelled scenarios, n=3; reviews, n=11). Eight of the papers are positive about the outcomes of regenerative grazing, whereas five papers are less sure or unclear, and one is very cautious (Garnett et al., 2017). Five key papers are summarised here.

- A leading review is Garnett et al., (2017) ‘Grazed and Confused’ report. The report focuses on understanding the relationship between grass-fed grazing systems with climate change; specifically in terms of carbon emissions, carbon sequestration, and importantly, also methane and nitrous oxide. The report concludes “that well-managed grazing systems can aid the process of soil carbon sequestration. Indeed, in some regions, quite high levels of sequestration are possible for a few years or decades – but the potential is highly context-specific. Critical variables include climate, terrain, soil quality, grass species composition, past land use and management and more, as well as the present management approach. Sequestration is not possible everywhere and gains in one season can also be reversed in

another" (Garnett et al., 2017:119). In summary, Garnett et al. (2017:58) conclude that "Regenerative grazing, applied well and by motivated farmers, could well benefit soils, build organic carbon matter and as such perhaps help sequester some carbon. However, the overall gains are likely to be modest, are not exclusive to rotational practices, and will be time limited – and the problem of the other greenhouse gases, methane and nitrous oxide – do not go away".

- McSherry and Ritchie (2013) conducted a meta-analysis of empirical studies looking at the impact of grazing on grassland soil carbon – not just regenerative grazing. They conclude that the effects of grazing management on SOC are very context-specific. Importantly, they found that the SOC may equally be a loss or gain depending on numerous agro-ecological conditions and that it is challenging to draw any generalisations (although they did note that gains with grasses in warmer climates are more likely).
- Teague's (2018:1521-1522) global review concludes "… Soil erosion and nutrient losses are generally considerably less under rotational and adaptive multi-paddock (AMP) grazing than from continuously grazed pastures (Sovell et al., 2000; Stout et al., 2000b; Webber et al., 2010; Teague et al., 2011; Weltz et al., 2011). … by decreasing bare ground, restoring productive plant communities, increasing water infiltration rates and soil water storage capacity, increasing fungal to bacterial ratios, and increasing soil carbon (Delgado et al., 2011; Teague et al., 2011, 2013). AMP grazing has been successfully applied in areas with annual rainfall ranging from 250 to 1,500 mm (Teague, 2018)".
- McDonald et al. (2019:2723-2731) conclude from their 'global met-analysis' that "Overall, total ground cover and animal production per hectare were significantly greater under strategic-rest grazing than continuous grazing management". They go on to say "but biomass, plant richness, plant diversity and animal weight gain did not differ between grazing treatments". They conclude that incorporating periods of rest into grazing regimes improves ground cover and animal production per hectare and that these benefits are more pronounced when the rest period is longer.
- Byrnes et al. (2018:758) conclude from their research that "The positive responses of SOC to rotational grazing could create climate change mitigation opportunities. Complete observations were notably limited or missing for many rotational grazing comparisons".

3.3.5 Limitations

It is very difficult in empirical papers, to be clear on what aspects of regenerative grazing are being compared to what – in order to draw conclusions of its impact. Take 'continuous grazing' for example – is that with or without inorganic inputs? Are the same stocking densities of farm unit being compared? Are the same soil depths being compared? Also, comparing regenerative grazing to, for example a continuous grazed 'extensive organic' system, is very different to comparing to a continuous 'input intensive' system. To demonstrate the variability: one paper for example, compares regenerative grazing to an un-grazed neighbouring nature reserve; in another paper, the comparison is between rotational cropping with and without rotational grazing (Galindo et al., 2020). Another paper is specifically about grazing in gum tree woodlands (Sato et al., 2019).

Other variables between empirical studies are highlighted as follows:

- *The depth of soil sampled* (McDonald et al., 2018)
- *Variable livestock densities between studies* (McDonald et al., 2018)
- *The definition of grazing intensity* (Garnett et al. 2017)
- *The legacy of previous farming practices and time passes since then* (McDonald et al., 2018)
- *The duration of empirical studies* (McDonald et al., 2018)
- *The soil type and seasonal differences between empirical studies* (McDonald et al., 2019)
- *Rainfall* (Hawkins, 2017).

McSherry and Ritchie (2013) found that six main variables (soil texture, precipitation, grass type, grazing intensity, study duration, and sampling depth) explained 85% of the (large) variance in the rate of carbon sequestration between grazing practices. It also found that generalisations cannot be made about the relationship between grazing intensity and any single factor such as rainfall or soil type. That said, McSherry and Ritchie (2013) suggest that a combination of warmer climate grasses and higher grazing intensity can lead to higher soil carbon gains – and that the reverse is true for colder climate grasslands.

3.3.6 Reflections

Despite most references being generally favourable towards regenerative grazing, the number of references being inconclusive, or reporting no change compared to conventional continuous grazing practices, provides enough doubt to question it and to remain cautious. However, it is perhaps more realistic to expect that results from studies of the real world, *should* lack definitiveness due to the inherent variability and complexity of different farming contexts.

It is challenging to draw conclusions from empirical studies when they differ so much as outlined above. Clear patterns reported are that benefits from regenerative grazing are far more likely on heavily degraded soils, and in warmer climates. But equally, this could be due to a lack of empirical evidence (whether favourable or not favourable) from other contexts (e.g. there are very few studies from the UK, specifically Wales).

However, perhaps what is more illuminating, is that there is little evidence that regenerative grazing has undesirable outcomes. These are reported with respect to animal performance (Cox et al., 2017, sheep, Australia), soil density and porosity (sheep grazing, Europe) (Carassai et al., 2011) and net GHG emissions (Garnett et al., 2017, a global review study from Europe). Two of these three references are from Europe. There is a risk that this is down to optimal bias: studies focused on looking for positive relationships.

The literature is very focused on reductionist, selective variables and impact pathways e.g. carbon. The trials in empirical studies are conducted over short timescales on very detailed, well-defined and contained variables. Only one paper took a systems perspective (Guyader et al., 2016), drawing out impact on multiple receptors (e.g. water, carbon, social) *then* thinking through how these receptors are themselves interlinked, and what the cascading outcomes may be. This suggests more insights could be added to the scientific literature through empirical studies using 'systems thinking' (Norton et al. 2024).

The current debate is clearly focused on the potential for regenerative grazing to sequester carbon. And it is very focused, understandably so, on this very singular outcome. However, in media, many farmers are reporting other outcomes beyond animal performance and productivity per head, as their primary goal. A focus on broader outcomes is prevalent including efficient use of water, increasing profitability per hectare, restoring soil health and overall building resilience to more extreme and unpredictable weather events.

This evidence review suggests there are risks in focusing solely on regenerative grazing in terms of its potential to sequester carbon and reduce emissions. The insights from empirical studies, that use reductionist science methods, appear to be very singular. There is a risk of overlooking the other possible outcomes of regenerative grazing, particularly in the UK context. Here, the main benefits are likely to be holding back water (reducing flood risk and exposure), cleaning water (reducing diffuse pollution and resulting treatment costs), the reduced carbon emissions linked to these, biodiversity improvements (promoting micro-biological and macro-invertebrate communities) and public health (more nutritious food).

The risks of regenerative grazing seem to be mainly around the possibility of lower productivity per head / live weight gain in livestock. However, this should be considered in light of other papers reporting increased profitability per hectare from reduced costs (Wagner et al, 2023).

The scientific literature is heavily dominated by evidence for ecological and biological outcomes of regenerative farming, principally in Australia and North America. The evidence clearly shows a lack of empirical data from Europe and specifically the UK and Wales, with regard to the impact of regenerative grazing practices upon natural processes and farm business systems. The empirical evidence does question the presumption that regenerative grazing practices are likely to be optimal in the colder, wetter, upland climate of Wales; as yet, this view is untested in the literature.

3.4 B - Farmer decision-making: review of the evidence

3.4.1 Introduction

This section draws from the extensive literature in rural sociology on farmer decision making and behaviours regarding farming transitions. This review has sought to focus on literature linked specifically to regenerative farming, however as these references are limited, the search was extended to consider broader sustainable farming practices and related topics.

Farmer transitions, experimentation, decision-making, behaviours, values and motivations; is studied in rural sociology, a discipline which arguably began in North America in the early 20th century (Constance, 2014). In the 1970s, Gasson (1973) suggested that farmers take into account other types of goals when making decisions, not just economic goals (Mill et al., 2017). Despite this, much of the subsequent research focused on incentivising farmers with payments, and barriers to uptake of agri-environment schemes and adoption of environmental practices (Mill et al., 2017). However, in the early 2000s, rural sociology took a 'cultural turn' (Mills et al., 2017), with a research focus upon the social and cultural factors affecting farmers behaviour (Burton, 2004; Burton and Wilson, 2006). However, much of this was fairly reductionist looking to single out specific variables that influence farmer behaviour but did consider multiple socio-economic aspects such as farm business, farmer demographics, education, values and attitudes (Prager and Posthumus, 2010).

In more recent years, rural sociology research has expanded to consider the 'full picture' of factors affecting farmer behaviour (financial, social, economic, environmental). For example, Mills et al. (2017) focus on understanding the reasons behind farmer motivations (as well as the motivations themselves); and to understand all of the influences upon farmer decision-making (not just focusing on some of them). This rationale for the research being that policy needs to look for ways to 'nudge' sustainable farming practices, as public funds for payments and incentives will not stretch far enough to deliver the scale of change needed. Arguably, rural sociology research that is looking at the 'full picture' around farmer decision making in the UK is still fairly new. Norton et al. (2024) say that very little research has focused on understanding livestock production within an integrated systemic approach which considers social, environmental, and economic aspects of production.

More papers in rural sociology and agro-ecological transitions are taking a 'systems thinking' perspective (Singh et al., 2016; Padel et al., 2017; Mann et al., 2019; Toffolini et al., 2019) and this is arguably an expanding area of research.

This review has steered away from literature pertaining to the take-up of incentivised schemes (Mills et al., 2017). This is because such schemes which involve paying farmers, tend to cloud any understanding of the underpinning factors and rationale for why farmers may adopt new practices. Essentially, when money is the incentive, this makes it more difficult to determine other factors which may promote take-up of such practices. As Prager and Posthumus (2010:6) state "It is therefore crucial to distinguish between studies that investigate adoption of soil conservation practices prescribed in an incentive scheme – which might create a bias towards factors relating to incentives – and studies that explore adoption of conservation practices without policy intervention (or at least make the different political-economic contexts explicit)". Papers covering payment schemes tend to focus on whether the payments are a sufficient incentive or not for the farmer to change their land management, use and practices; rather than seek to understand the conditions under which farmers may take-up such practices.

As such, the focus here is upon the voluntary take-up of regenerative farming practices (or similar), outside of payment schemes; in recognition of a) the current situation that public funds are limited and policy cannot depend on payments schemes to deliver such widespread and long-term necessary change in farming practices, and b) due to the long standing critique of payment schemes, which questions whether they can truly change long standing farmer behaviours, particularly once payment schemes end (Mills et al., 2017). Also, payment schemes often assume that farmers share the same perceptions of whatever agri-environment practices are being paid for, as those promoting the practice do, when this is often not the case (Meijer et al., 2015).

Having said that, it is challenging in the context of farmer transitions to more agro-ecological practices (specifically regenerative farming principles) to find studies, where this incentive is entirely removed as most if not all farmers, in the UK at least, operate within an incentivised payment system affecting their propensity to farm in an ecologically sensitive way or not (whether public subsidies or buyer conditions and delivery pressure by default encourages some practices over other). As such, realistically, it's not possible to disentangle farmer motives entirely away from financial incentives. Albeit, efforts have been made to pick out such nuances in the literature, to try and seek a more informed understanding.

3.4.2 Results

The systematic literature review identified 139 references of relevance to this research. Of these, by far most (83) are based on collected data (most of these are survey and/or interview

based), 15 are based on expert opinion/conceptual frameworks, 19 are quantitative models of existing data, and 22 are reviews of literature.

Most of the papers based on collected data (83) are based on study locations in Europe (29), Australasia (17), Africa (14) North America (10). Less data is collected from other parts of the world including Asia (7), Middle East (3), Central/South America (3).

Similarly, most of the Review papers (22) are from Europe (10), North America (8) with the remaining few from Africa (2) and Australasia (2). For papers modelling existing data (19), most are from North America (10), with few from Africa (6), Europe (1), Australasia (1) and South America (1). Most of the expert opinion/conceptual frameworks papers (15) are from Western Europe (8), the remainder split across Australasia, North America, Asia and Africa.

19 papers are of specific relevance to the UK (16 based on collected data, 3 are review papers). Only two relate to regenerative farming practices, but these either focus on very specific measures such as tillage (Ingram et al., 2010) or only arable practices (Boardman et al., 2017). This suggests that livestock regenerative farming is little covered in UK rural sociology literature (now with addition of SEEGSLIP publications in 2023/24).

There is related literature in the UK covering farmer decision-making with regard to broader topics, such as sustainable farming practices (Prager and Posthumus, 2010); environmental management (Mills et al., 2017); soil management and soil carbon (Ingram, 2008; Ingram et al., 2010; Ingram et al., 2016); water quality (Blackstock et al., 2010) and climate change (Hyland et al., 2016). Most of the papers from the UK and across Europe (in relation to farmer decision-making) cover the take-up of agri-environment schemes (e.g. Vanslembrouck et al., 2002; Lastra-Bravo et al., 2015; Morris and Potter, 1995; Riley, 2016; Posthumus and Morris, 2010; Taylor and Van Grieken, 2015).

Eight of the 19 UK papers sourced, come from The Countryside and Community Research Institute at the University of Gloucestershire. Their work includes understanding farmer values, decision-making, behaviours and learning in the context of soil management for water quality and soil carbon.

3.4.3 Evidence

The evidence gathered from the rural sociology literature is vast and as such, has been ordered as follows: farming contexts, farming transition, farmer experimentation, farmer agency, farmer categorisation, practices and their desirability, farmer values and beliefs, the decision-making process and farmer decision-making variables.

3.4.3.1 Farming contexts

Various research suggests that farmer adoption of new measures and practices is the result of a complex social process which involves a range of considerations (Meijer et al., 2014; Pannell et al., 2006; Lapeyre, Pirard and Leimonaet, 2015; Mills et al. 2020). Pannell et al. (2006:1407) state "adoption depends on a range of personal, social, cultural and economic factors, as well as on characteristics of the innovation [or measure] itself".

This understanding initially came about in the 1980/90s when the agri-industry was looking to increase the low take up of productivity improvement measures in marginal agricultural areas (Norman et al., 1995). This led to a wider examination of contextual factors – personal, socio-cultural, institutional, financial, practical and biophysical – in farmer decision-making (Norman et al., 1995; Darnhofer, Gibbon and Dedieu, 2012; Wauters et al., 2010, Prager and Posthumus, 2010; Boardman, Bateman and Seymour, 2017; Lahmar, 2010; CCRI, 2009; Wynne-Jones, 2013; Evans and Morris, 1997; Mills et al. 2020).

Socio-cultural factors such as self-perception, identity and cultural symbols were first focused on (Sherren, Fischer and Price, 2010; Riley, 2016) followed by the role of social networks and peers (Blackstock et al., 2010, Emery and Franks, 2012). This research steadily led over time to the realisation that farmers, as indeed for any person, do not make decisions solely as isolated, rational, objective thinkers (Wynne-Jones, 2014; Darnhofer, Gibbon and Dedieu, 2012). This has led to changes in agri-industry and policy engagement with farmers. One output of this change has been a plethora of research exploring the categorisation of farmers.

3.4.3.2 Farming transition towards agro-ecology

Padel et al. (2020) point out that the term 'transition' in itself is loaded and infers the assumption that trajectories and outcomes are more likely to be good than bad. It obscures the ups and downs in the process. Padel et al. (2020) prefer 'transition pathways' as this recognises the multiple trajectories farmers take, and not necessarily towards the same goal. Padel et al. (2020) makes the point that transition involves several incremental steps or improvements, as widely shown in the rural sociology literature offering guidelines to determine the best pathways towards agroecological transition: conceptual frameworks (Dendoncker et al., 2018; Gaba, Fried, Kazakou, Chauvel, & Navas, 2014; Therond, Duru, Roger-Estrade, & Richard, 2017; in Padel et al. 2020) and theories (Altieri, 1983; Gliessman, 2016; Tittonell, 2014; Wezel et al., 2009); (Gaba, 2020). The challenge remains of moving from top-down, global approaches to local and farmer-centred perspectives (Altieri, 2004; Loos et al., 2014; MacMillan & Benton, 2014).

Padel et al. (2020) refers to two prevalent models with regard to agroecological transition:

- The Efficiency – Substitution – Redesign (ESR) model (Hill, 1985)
- The Trigger, Active Assessment and Implementation (the 'trigger events') model (Sutherland et al. 2012).

The ' trigger events' model is not necessarily sequential, with the stages often overlapping. Missed by both models, is the cognitive shift farmer's experience.

3.4.3.2.1 ESR model

Originated by Hill (1985), the Efficiency – Substitution – Redesign (ESR) framework is commonly cited in the context of organic farming and agroecology (MacRae et al. 1990; Hill and MacRae 1996; Nicholls, Altieri and Vazquez 2016; Lampkin et al.2015).The stages are generally summarised as follows:

- Efficiency, a farm seeks to use inputs such as fertiliser or pesticides more optimally with minimal waste
- Substitution, environmentally harmful inputs are replaced by more benign ones.
- Redesign, the management approach is changed to reduce the need for inputs in the first place (Hill 1985).

Pretty (2016) argues that the redesign stage is the real 'game changer'. Redesign ultimately "aims to minimise problems and dependence on purchased inputs, increase resilience, and enable self-maintenance, self-regulation, sustainability, and ability to provide the needed ecosystem services and support for achieving the well-being of all" (Hill, 2014:402).

Padel et al. (2020) argue that the ESR model may actually in-grain existing conventional practices, making them more efficient (albeit less harmful) and may actually more the farm away for whole system redesign to more agro-ecological practices. Also, the ESR model implies that the first two stages are sequential, and that they precede any system redesign. Others have sought to reconceptualise the ESR model to tackle this inference, setting the 're-design' stage of Hill's (1985) model in its own distinct paradigms, to frame a farming transition, rather than as sequential stage (Altieri and Rosset 1996; Bellon. and Lamine, 2009; Lamine and Bellon 2009).

The ESR stages have also been recast as 'levels' which interact more dynamically and iteratively (Gliessman 2016, 2017). Gliessman (2017) goes onto say that the dynamic nature of these levels relate to the interaction of multiple farm factors; and that farmer experimentation and collaboration are key to promoting transition (Gliessman 2017) – see Section 4.5.3.

3.4.3.2.2 Trigger model

This model provides a more flexible concept for identifying various farming trajectories, their drivers and results. It is based on Rogers (1983) diffuse innovation model. The concept of 'trigger events' implies that path dependency is normally strong, so that only major events require triggers, which can include changes in access to markets, farmer health or flooding; these may be sudden or build up slowly over a few years. New market opportunities (rather than just adverse events), for example via nature finance markets, can also trigger system change.

Bredart and Stassart (2017) found that a 'trigger' always depends on farmers' reflexive learning. Farmers who are able to question their own expectations, are more likely to respond to triggers. This may include for example, learning to accept a temporary decline in profitability as a necessary phase towards longer term improvement; where as previously this may not have been acceptable to them. In this sense, changing the lens they consider a challenge through, leads to continual learning and readjustment. Bredart and Stassart (2017) therefore suggest that transition is the result of unexpected events, which encourages the farmer to question the status quo. That emphasis on farmer learning aligns well with Rogers' (1983) 'Diffusion of innovation' theory.

3.4.3.3 Farmer experimentation

Padel et al. (2020) note that 'experiments' are actions that are evaluated firstly against the baseline, and secondly, the results. Via trials or tests, farmers generate new knowledge and subsequently innovative management for their specific SES. Farmers may do this in small areas, before extending them (Padal, 2020). Interestingly, Darnhofer (2014) says that a farmer's capability to experiment stems from their ability to identify opportunities, implement options and to learn iteratively.

3.4.3.4 Farmer agency

In the UK, farmers are generally free to decide themselves, within reason, how and what they farm. Some farmers will have stipulations in some tenancy agreements and buyer contracts, and farming subsidies require farmers to meet basic conditions. However, these are all generally agreements that a farmer *chooses* to enter into, albeit through various degrees of choice. Perhaps the only situation in which some details of farming are specified, without farmer choice, are certain environmental regulations which stipulate limits on some practices (e.g. 2018's 'farming rules for water'). Other than that, farmers are in principle largely allowed to farm in whichever way they wish.

So, this being the case, why are not all farmers farming with nature in mind, if, from a rational perspective, this seems to be the best way to farm? Farmers, like any human, make decisions based on numerous factors – social, financial, economic, environmental. We all gain and define knowledge in different ways – whether based on direct experience, what the media said, what the scientists say, or what your peers say. Neither do humans have the best track record in doing what is best for us (ask any smoker). Hence, just because a farmer has freedom to practice farming in the way they wish, does not mean they will make the 'best' decision (depending on how 'best' is defined).

Farmers also work with an 'open living' system, which is dependent on external inputs outside their control (e.g. weather patterns, global commodity prices) and upon decisions made by many other people far away (e.g. public perceptions, consumer choices) (Darnhofer et al., 2010). They find themselves at the crux of many of the world's critical challenges. Hence, farmers are continually facing changes in agricultural policy and farming subsidies as different political parties win power and intervene to try to leave their mark. As the world shifts towards de-carbonisation, new green investment markets are also throwing open other risks and opportunities to farmers.

In essence, society's success in addressing its critical threats (i.e. climate change, biodiversity loss, disease outbreaks), will very much depend on farmer choice, farmer agency and their success in navigating the social, economic and environmental systems around them.

3.4.3.5 Farmer categorisation

Much research has sought to categorise farmers into various types, generally with the hope of identifying more effective ways to engage farmers through public schemes.

Many of these categorisations are trying to identify ways to make public funds spread further when paying farmers to incentivise change. For example, Morris and Potter (1995) categorise land owners by their likely level of participation in payment schemes for biodiversity conservation. They classify farmers as active participants, passive adopters, conditional non-adopters, and resistant non-adopters; and recommend that it would be fruitless to target 'resistant non-adopters' who do not participate in agri-environment schemes under any circumstances. Conversely, 'conditional non-adopters' are persuadable with financial incentive. Similarly, Ferraro (2008) categorises landholders into 'low-cost' and 'high-cost' landholders, referring to the cost required to keep landholders participating in public schemes (in Raymond and Brown, 2011). Also, for example, Knight et al. (2010) prioritise land managers for intervention, by their willingness to sell services, their conservation knowledge and their social connections.

Not all categorisations are payment related. For example, Rogers (1995) suggests five adopter categories: innovators, early adopters, early majority, late majority and laggards; as part of the 'diffusion of innovations' theory (see below). Davies and Hodge (2007) differentiate farmer types in the UK who are strongly financially motivated ('commodity conservations') with regard to taking up biodiversity measures, from those who have strong innate environmental convictions ('environmentalists').

Many of these categorisations do not consider how socio-demographic, economic, and farm variables influence farmer decision-making – coming back to the importance of 'context'. Some do, for example, Curtis et al. (2005, 2003) overlay socio-economic data with conservation opportunity in Australia, in order to produce a strategy of how to target farms (both financial and non-financial support) based on variables such as farm management (e.g. property size), socio-demographic characteristics (e.g. age, membership of schemes), economic factors (e.g. profit), environmental concern (e.g. water quality issues) and knowledge of natural resource management (e.g. value of woody debris in rivers or streams).

Furthermore, a number of studies have identified types of farmers based on perception frameworks, including farmer attitudes to change in agricultural policy (Gorton et al., 2008). Others have sought to categorise farmers by social factors within farming (Ilbery, 1983; Willock et al., 1999; Shucksmith and Herrmann, 2002) or by values placed on conservation (Fairweather and Keating, 1990; Brodt et al., 2006; Emtage et al., 2006; Davies and Hodge, 2007). Irrespective of categorisations of farmers or farming contexts, the take-up of new practices is often down to their attractiveness or desirability.

3.4.3.6 Desirability of new farming practices

The 'diffusion of innovations' theory has provided the back-bone for many studies examining the take-up of new farming practices, albeit mostly in the tropics (Meijer et al., 2014). Rogers' (1995) *'diffusion of innovations'* theory states that a practice (let us assume a new farming practice) must have the five traits of relative advantage, compatibility, complexity, trialability and observability; if it is to be taken up by a farmer. It also states that a farmer's decision follows five key stages: acquiring knowledge, being persuaded, making a decision, taking action and confirmation that it was a wise thing to do (Meijer et al., 2014). Interestingly, Rogers (1995) also states that farmer qualities, such as personality, social ability and innovation awareness, together shape the adoption of new practices.

Another theory frequently mentioned in the rural sociology literature is Bernoulli's '*expected utility theory'.* This is used as a framework for studying farmer decision-making in various contexts (Meijer et al., 2014; Oglethorpe, 1995; Babcock and Hennessy, 1996; Gomez-Limon et

al., 2004). The theory predicts that the decision-maker chooses between risky and uncertain prospects by comparing the expected utility values of their outcomes to maximize profit (Schoemaker, 1982). This in part seems to state the obvious, in that farmers (or any individuals) weigh up the pros and cons of an action prior to making a decision. As Pannell et al. (2006:1407) state "Innovations are more likely to be adopted when they have a high 'relative advantage' (perceived superiority to the idea or practice that it supersedes), and when they are readily trial-able (easy to test and learn about before adoption). Non-adoption or low adoption of a number of conservation practices is readily explained in terms of their failure to provide a relative advantage (particularly in economic terms) or a range of difficulties that landholders may have in trialling them".

3.4.3.7 Farmer and landowner values

The terms values, beliefs, attitudes, goals, perceptions and motivations are often used interchangeably. However, the rural sociology literature draws out their differences as follows.

3.4.3.7.1 Values, beliefs and attitudes

Values can be seen as beliefs that are meaningful to a person, whereas attitudes are a person's evaluation of a particular subject (Barnes et al., 2011). This suggests that perhaps attitudes are more changeable than their underlying beliefs.

Beliefs can comprise 'descriptive beliefs': when a link is based on direct observation; 'inferential belief': when a link between action and outcome is inferred; lastly, an 'informational belief' when the link is based on accepting external information (Fishbein and Ajzen, 1975). As such, beliefs are closely tied to obtainable knowledge, and how the farmer receives and deals with that knowledge (Meijer et al., 2014). It may be possible to give information to a farmer, but less scope to influence how they interpret that information, and what they take away from it.

3.4.3.7.2 Goals, perceptions and motivations

Goals vary widely between farmers depending on circumstances and personal preferences (Gasson, 1973). Pannell et al. (2006:1407) state "Adoption occurs when the landholder perceives that the innovation in question will enhance the achievement of their personal goals. A range of goals is identifiable among landholders, including economic, social and environmental goals". Goals may be long-term whereas perceptions are very subjective and unique to each farmer, depending on their own learning and social context. As such, it may be easier to work with a farmer to discuss and re-focus their goals (e.g. profit within a holistic focus, versus unsustainable profit) but less scope to influence a farmer's perception as to when they have achieved said goal.

Farmer motivations differ to goals. Whilst goals may be sought for years on end, as a means to an end, motivations are the desired end outcome (Farmar-Bowers and Lane, 2009). For example, Farmar-Bowers and Lane (2009) found that farmers rarely specified 'money' or 'wealth' as motivations as they were considered more to be the tools by which desired outcomes may be achieved. Farmar-Bowers and Lane (2009) found that motivations link to the five standard farming 'stories' as follows:

- 'Succession of family responsibility' refers to a farmer's desire "to be true to their own values, develop their own talents, behave as responsible citizens, and to bring up their children" (Farmar-Bowers and Lane, 2009, p.1137) as responsible people.
- 'Enjoying farming', for example, to ensure they have the opportunity to develop new areas of farming if desirable.
- 'Overcoming isolation' in seeking social networks and meeting with other farmers.
- 'Educating children' is very important but various approaches to this are adopted.
- 'Learning about farming', obtaining the skills and knowledge to be competent farmers is considered important.

In summary, the distinction between values, beliefs, attitudes, goals, perceptions and motivations sheds some light on the degree to which farmers may be influenced (e.g. goals versus values), and that decisions are very much rooted in an individual's 'core values' which are very difficult to change. This goes some way to explain how different farmers, all looking at exactly the same farm system, will see it in subtly different ways and take away subtly different insights.

3.4.3.8 Farmer decision-making

The rural sociology literature on variables affecting farmer decision-making in relation to conservation of natural resources, whether in relation to agri-environment schemes or conservation practices, is dominated by papers from Australia (Moon and Cocklin, 2011; Raymond and Brown, 2011; Moon et al., 2012; Pannell et al., 2006; Farmar-Bowers and Lane, 2009), North America (Knowler and Bradshaw, 2007; Yiridoe et al., 2010) and Western Europe (Morris and Potter, 1995; Prager and Posthumus, 2010; Celio et al., 2014; Lastra-Bravo et al., 2015). Clearly there is a gap in exploration of factors affecting farmer decision-making with respect to regenerative farming practices, particularly in pastoral systems, in the UK. Several of relevance to the UK are also reviewed here (Arnott et al., 2019; Ingram et al., 2009; McKenzie et al., 2013; Wynne-Jones, 2013).

Most reviews from the UK and across Europe (of those investigating factors affecting farmer decision-making) are focused on the take-up of agri-environment schemes (Lastra-Bravo et al.,

2015; Morris and Potter, 1995; Riley, 2016; Rocchi et al., 2017) i.e. when there is a financial incentive involved.. The Countryside and Community Research Institute at the University of Gloucestershire has published considerable research regarding farmer values, decision-making, behaviours and learning in the UK context, with regard to environmental management (specifically soil, water, carbon) (Ingram, 2008; Ingram et al., 2010, 2016; Blackstock et al., 2010; Sutherland et al., 2012; Mills et al., 2017). Key to note, is Padel et al. (2017) report for the Landuse Policy Group looking specifically at 'Transitions to Agroecological Systems: Farmers' Experience'. A further two papers investigate farmer decision-making with respect to adjusting farming practices however, these are focused on soil conservation in arable systems (Boardman et al., 2017; Prager and Posthumus, 2010).

This review has placed more emphasis upon studies that examine the take-up of farming practices outside of payment-based schemes. This is because schemes which pay farmers, tend to cloud any understanding of the underpinning factors and rationale for why farmers may adopt new measures and practices. Essentially, when money is the incentive, this makes it more difficult to determine other factors which may promote take-up of such measures.

Research covering payment schemes tend to focus on whether the payments are a sufficient incentive or not for the farmer to change their practices; rather than seek to understand the conditions under which farmers may take-up such practices. Research in the UK (Arnott et al., 2019; Ingram et al., 2009; McKenzie et al., 2013; Wynne-Jones, 2013) suggests that the successful uptake of 'agri-environmental schemes' requires more emphasis upon cultural sensitivities and a clearer, shared understanding of the wider benefits such schemes will deliver; rather than solely a focus on just financial motivations. Uptake of agri-environmental schemes are strongly linked to: the business opportunity it presents, perceived social benefits of taking part, how much it appeals to a farmer's personal values, and the scheme's flexibility (prescriptions must apply to individuals, taking into account farm capacity, lifecycle and location) (Ingram et al., 2009).

Therefore, this section focuses on trying to identify the variables which are likely to affect farmer decision-making, outside of payment schemes; in recognition of a) the current situation that public funds are limited and policy cannot depend on payments schemes to deliver such widespread and long-term necessary change in farming practices, and b) due to the long standing critique of payment schemes, which questions whether they can truly change long standing farmer behaviours, particularly once payment schemes end.

Also, payment schemes often assume that farmers share the same perceptions, as those prescribing the measures, when this is often not the case (Meijer et al., 2014). For example,

Douthwaite et al. (2002) found that researchers felt that farmers take up measures to improve soil fertility; whereas, farmers said it was their weed-controlling ability above all else.

3.4.3.8.1 Decision-making variables

69 papers have been sourced from across the world, which provide empirical evidence of farm system variables, farmer motivations and decision-making processes. These are either survey or interview based studies which summarise variables under several headings, including farmer values, farm characteristics, household characteristics, and other contextual factors (e.g. Moon et al., 2012; Fujisaka, 1994; Farmar-Bowers and Lane, 2009; Singh et al., 2016; Celio et al., 2014; Kassie et al., 2015).

The rural sociology literature identifies a mix of variables, some internal and some external to the farm system. The literature in general, poorly differentiates between variables affecting take-up of capital conservation measures (such as set-aside or fencing) and farming practices (such as zero tillage or alternative grazing practices). As such, an attempt has been made here to draw out some of this distinction.

In summary, in the region of 170 variables influencing farmer decision-making is evidenced in the rural sociology literature (Knowler and Bradshaw, 2007) that can be grouped, broadly speaking, under the eight headings as follows:

- Farmer characteristics (e.g. gender, education, age, experience, etc.)
- Farmer values (e.g. beliefs, attitudes, leadership, gregariousness, lifestyle)
- Farm biophysical characteristics (e.g. soil type, drainage, yield)
- Farm characteristics (e.g. location, farm size, ownership type, business set-up)
- Farm finances (e.g. income, assets, debt, liquidity)
- Farm management (e.g. tenure type, labour needs, input use, land practices)
- External factors (e.g. market prices, market size, subsidies, information access, transition costs, policy reforms)
- Cultural and societal variables (e.g. social status, public views, social networks).

Appendix 1 summarises the variables affecting farmer decision-making from the rural sociology literature. It also differentiates whether the observation was made for arable or pastoral farming. The rural sociology literature tends to reveal where studies indicate a correlation between variables (e.g. income and take-up of regenerative farming) but does not necessarily indicate which one came first i.e. whether income improved following regenerative farming, or if income was already good prior to regenerative farming.

In summary, Knowler and Bradshaw (2007:25) argue that there are “few if any universal variables that regularly explain” why farmers change their practices. They state that the most certain, positive variables appear to be a farmer’s awareness of environmental threats and farm income.

3.4.3.8.2 The decision-making process

Adoption, or arguably innovation, is a learning process comprising two key parts: the collection and evaluation of new information about the innovation; and improvements in farmer skills to apply the innovation to their farm (Pannell et al., 2006).

Firstly, new information helps to lower initial high levels of uncertainty about an innovation (Marra et al., 2003) and to increase the chances of an innovation’s outcomes meeting a farmer’s expectations. In farming, initial information gathering usually comprises knowledge of a new practice or technology, how to apply it, and what the outcomes are in terms of products, yield, potential environmental benefits, risks and costs (Meijer et al., 2014). In this light, this process is never complete and uncertainty is never entirely removed (Pannell et al., 2006).

Secondly, farmers are likely to need to adapt an innovation to their own context which may require certain skills (Ghadim and Pannell, 1999; Tsur, Sternberg and Hochman, 1990). Most farming innovations pre-require a certain level of skill for them to be applied in practice (e.g. in timing, sequencing, intensity, scale). Again, this is a continual process as farmers continue to learn about the innovation they have adopted and its suitability for their farm (Pannell et al., 2006).

This process is very closely linked to farmer propensity to become aware of an innovation. Pannell et al. (2006) reports that ‘awareness’ can mean a farmer is aware of an innovation; but then also it can be some time before a farmer is then aware of its potential relevance to their farm. This can vary greatly in duration depending on the farmer.

This time may be extended further depending on the time needed for the farmer to gather information to decide whether it would be worthwhile to trial an innovation or not (which could require considerable investment in time, energy and resource) (Pannell et al., 2006). Innovations may be modified to adapt them to changing circumstances (Pannell et al., 2006). Indeed, this is how many regenerative farming practices (e.g. holistic or mob grazing) work, via continuous review and adaptation to grass growth and weather. Pannell et al. (2006) also point out the imperfect nature of decision-making, in that no matter how much time and effort is spent researching a decision, uncertainty and risk cannot be removed entirely.

3.5 Summary

So far, this research has ascertained that:

- Regenerative farming (in particularly in grassland systems) is little covered in farming policy in the UK, neither in the details of the forthcoming ELMS or SFS known so far. This is despite: increased farmer and public interest in the UK, increased coverage in mainstream media, increased uptake in place-based projects, and greater global corporate interest in regenerative farming.
- The evidence of the impact of regenerative farming in the UK is sparse, particularly for regenerative farming in grassland systems in the UK.
- Regenerative farming, in the context of agro-ecological transition in the UK, lacks coverage in rural sociology literature, particularly with regard to grassland systems.
- Much of the rural sociology literature is fairly reductionist, forming lists of variables (specifically with regard to farmer decision-making and farmer categorisations). Very little takes a 'systems thinking' perspective suggesting there is opportunity to complement the current literature and potentially draw out new insights.

In the region of 170 variables (personal, social, environmental, financial, economic) have been found to influence farmer take up of new practices, whether voluntary or via payment schemes. Understanding which of these can be influenced and how, could aid in the scaling-up of agro-ecological transition.

In particular, the variables affecting farmer decision-making in the rural sociology literature, are poorly differentiated between different decision-making contexts: whether it is in regard to joining an agri-environment scheme with financial payments, whether with regard to voluntarily implementing one-off conservation measures such as set-aside, or whether with regard to whole-scale adjustment of the farming system for example. In essence, it is reasonable to expect that farmers will think differently with respect to taking one-off actions, versus making long-term adjustments in practices, and whether payments are involved or not. It is also difficult in the rural sociology literature to distinguish between farmer decision-making in different cultural and socio-economic contexts, e.g. developed versus developing countries.

Decision making in farming contexts is borne of complex interactions between personal, social, cultural, economic and environmental factors in any given setting. Farmers, as indeed for any person, do not make decisions solely as isolated, rational, objective thinkers.

A farmer's values, beliefs, attitudes, goals, perceptions and motivations are all subtly different and differ widely between individuals. Understanding which of these can be influenced, and how, may offer more effective and tailored support for farmers in agro-ecological transition.

Chapter 4 Key concepts

4.1 Introduction

Chapter 3 established key knowledge gaps in the scientific literature. This section explores approaches to obtaining valid knowledge to address these gaps. In so doing, it justifies the choice of systems thinking as an approach to inquiry. This chapter also introduces key concepts such as socio-ecological-systems and resilience concepts which are drawn on later in the analysis.

4.2 Philosophical positioning of this research

The measurement of goods and services from farming traditionally stems from positivism (primarily deductive reasoning rather than Baconian induction), in that a complex system is reduced to its constituent parts and measured (e.g. crops, head of livestock, water use). It focuses on the linear cause-and-effect relationship between parts of the system. However, it fails to recognise the social embeddedness of ontology and epistemology, and that the selected approach of any inquiry, is a product of scientists and the science community, shaped by social relations to the very core (Haines, Young & Petch, 1980).

As a researcher, I am ontologically and epistemologically pre-loaded with theories and assumptions, underpinning my personal rationale for the need for the research. As such it is impossible for theories to meaningfully emerge, without consideration of these underlying predispositions (the Duhem-Quine thesis). This indicates to me, as a researcher, that a positivist ontology offers little in seeking to understand farmer decision-making in transition to regenerative grazing. The importance of ontological and epistemological endeavour is therefore, clearly, to strip away theory-laden 'baggage' so that only 'valid' knowledge, and reflection on what makes it valid knowledge, is the research outcome (Haines, Young & Petch, 1980).

The ontology of idealism embraces the intersubjectivity of human agency in constructing meaning of the real world. Human agency is not rational and is not impersonal; and neither can humans be reduced to functions within a broader linear cause-and-effect process (Sen 1977). Subjectivity has a greater role in knowledge-making than positivism acknowledges, in that space is relative and not absolute (Unwin, 1992).

Idealism offers insight into, for example, how meaning in research interviews is constructed, and how it may be used (equally an ethical as well as an epistemological consideration). Various modernist to post-modernist perspectives capture assumptions around the effect of the researcher and interviewee on knowledge creation (e.g. whether conscious perspectives or

sub-conscious socially subjected positions), during and post interview; how the data is interpreted, framed and contextualised; and whether the findings are generalizable or not (Bastalich, 2009). This is not explored in full here (e.g. the multiple subject positions that researchers and interviewees covertly negotiate in interviews, influencing what is told and what is not told (Bastalich, 2009)), but of particular interest is the insight that specifically, interpretivism and social constructionism, as epistemological modes of inquiry, offer. Epistemological insights from these will help to understand the socially embedded context in which farmers make their decisions. These perspectives focus on "understanding how people enact and construct meaning in their daily lives" (Denzin, 2001:43; in Bastalich, 2009) whilst allowing extrapolation of themes that are "generalizable to similar social situations or subject positions" and not completely fragmentary (as per post-modern constructivist perspectives) (Bastalich, 2009:2.2).

Gadamer's hermeneutics or "historically effected consciousness" and focus on interrogating "contemporary being", rather than historical analysis, could help uncover deeply embedded historical social practices that produce every day meanings (Bastalich, 2009:2.6). However, I tend to agree with Foucault who reportedly refutes this view that it is even possible to become aware of one's own historical and linguistic discursive embeddedness (Bastalich, 2009). As such, I am attracted to some extent to the Frankfurt School's critical realism and hermeneutic ethnographic view which strongly criticizes social constructionism in going too far in producing only locally specific, 'snapshot' subjective knowledge that fail to "reflect on the deeper, more enduring social structures or relations that produce interpretation" (Bastalich, 2009:2.3). This leads me to reflect on structuralist (Marxism/feminism) theorisations and the insights these ontological frameworks may offer to my research.

From a Marxist perspective, farming as a land right is arguably a social construct devised as a means to control power over means of production in a capitalist system. As Harvey (1990:419) says "social formation, constructs objective conceptions of space and time sufficient unto its own needs and purposes of material and social reproduction, and organises its material practices in accordance with those conceptions". However, post-structuralists such as Giddens, gave more credence to human agency as active, rather than as largely passive subjects, under such broad all-encompassing power structures (Giddens, 1984).

Giddens' structuration theory theorises the relationship between humans (agency) and wider social systems and structures (a set of rules and resources) (Giddens, 1984). This theory is relevant to my research as it purports that hidden governing structures, and the dynamic between agency and structure, is both constraining and enabling (Giddens, 1984); thus

reflecting the context of farmer decision making within the prevailing socio-ecological-system. Giddens' believes it is a mistake to assume that it is solely structure that sets the parameters in which agency can act with independent discretion. He states that agency, and social practices, do have a role in re-shaping structures and power relations (principle of reflexivity), but that structures (and by inference the encompassing socio-ecological system or 'Regionalisation'), produce and re-produce the conditioned context for agency and social practice to exist within (Giddens, 1984). As such Giddens' is drawing on the ontological perspective of social constructionism. Critics argue that Giddens' theory underplays the influence of culture upon agency, and fails to consider the role of collective agency (e.g. farmer cooperatives, unions and associations).

Interpretivism, including social constructionism, therefore both give more opportunity (than pure structuralism as well as positivism) to reflect more meaningfully on the role of human agency (Cunliffe, 2008) and governing structures in farming: why farmers make the decisions they do, giving more credence to intersubjectivity and the situatedness of farmer sense-making. As such, this research is more inclined to align with Giddens' structuration theory, as this seems to align with interpretivism, specifically social constructionism but also acknowledges the role of wider power agendas and governance structures upon the emergence of knowledge.

Postmodern ontologies are less useful for this research as they purport fairly fragmentary idealist and relativist ontologies. They give little opportunity to progress science as it is impossible to step outside of the impact of situatedness upon knowledge. However, they are useful, as Sayer (1993) says, in that they highlight the role of discourse and language in research, and critically question "concepts of trust, falsification and empirical testing" (Sayer, 1993:320). As such, aspects of postmodern thinking are worthy of any researcher's critical reflection (Philo, 1992). In particular, Soja's 'third space' and trialectics of being (perceived, conceived, lived) provides a useful framework for my research which in part reflects my preference for a multiple ontological position (Merrifield, 1999).

4.3 Systems thinking

Systems thinking offers an alternative way of approaching complex problems, and provides insight into perhaps, less intuitive, ways to intervene in complex systems for desired goals. This contrasts to a focus on solely components of a system, which is more akin to reductionist philosophies. Jackson (2003) argues that the emergent properties of a system are indivisible to its constituent elements, and therefore by inference are unknowable via empiricist and positivist ontologies. My understanding of the ontology of systems thinking is that it can

support realist or idealist 'world views'. Arguably, systems thinkers particularly in organisational research, embrace interpretivism and social constructionism (e.g. Lakoff & Johnson's (1980) systematicity of metaphor). Some claim it is a paradigm itself which is starting to wholly replace the positivist paradigm of the 'Enlightenment' (Ackoff & Emery, 1972).

Whilst some 'hard' systems thinking fits largely within structuralism, with a focus on mechanisms or structures that govern the behaviour of the elements or subsystems, seeking archetypes of system behaviours (Jackson, 2003); other forms of 'soft' systems thinking (prevalent in organisational research) have moved away from cause and effect between constituent elements, to instead concentrate on the relationships between elements and the system (e.g. Checkland, 1981). This then sheds light on the system dependent properties of each element, whilst also illuminating the emergent properties of the system itself (Ackoff & Emery, 1972).

The research draws on Checklands' (1981) 'Soft Systems' ideas (not its methodology per se), in order to draw insights about connectivity, and relationships, between the variables affecting farmer transitions to regenerative grazing; but also farmer agency in influencing those variables. Thus, this highlights the tension in those relationships between agency and structure, drawing on Giddens (1984) 'structuration theory'. Giddens theorises the relationship between humans (agency) and wider social systems and structures (a set of rules and resources), purporting that hidden governing structures, and the dynamic between agency and structure, is both constraining and enabling (Giddens, 1984). Thus, this research draws on this thinking, to see if this offers any insights with regard to farmer transition to regenerative, within the prevailing socio-ecological-system in Wales.

Systems thinking is about the organising processes, relationships, interactions between things, and less about the things themselves (Jackson, 2003). The more you see and think in systems, the more you see systems with similar properties everywhere, trying to stretch and breath in response to knocks and bruises. It is a different way of looking at the same thing: a shift in perception from solely material objects and structures to the processes and patterns of organisation. It does not mean that material objects and structures are not important – they are. Both views are complementary and it is about expanding the way we consider a problem because clearly our current and prevalent mode of thinking is not working.

Systems thinking illuminates that in living systems, there is no such thing as a static state, nothing stays still. Systems thinking recognises, that something may appear to be static, but it is actually in a constant state of flux with its environment, being continually defined by the

processes around and within it. This idea underpins von Bertalanffy's (1968) 'General Systems Theory', who argued reductionism (categorising things into smaller units to try and understand things) was inadequate when dealing with open, living systems and that what we need, is a more 'holistic vision' when working to address problems in complex living systems. Interestingly, thinking holistically features in regenerative farming mindsets (Cusworth and Garnett, 2023) encouraging practitioners to understand the role of the farm system, within a greater whole, and nested systems above and below.

Systems thinking is about generating a much fuller picture of a problem, and not about replacing the current 'reductionist' philosophy per se – it helps to bring an expanded perspective to decision-making. Drawing on a systems perspective (more specifically a 'softs systems' approach) for this research is useful because:

- My research is looking at a complex socio-ecological-system, where problems are occurring arguably due to the narrow lens underpinning human choices in layered social and economic systems, and their relationship with natural systems.
- Much of the profiling of human (farmer) decision making is reductionist, listing for example 170 variables, with limited appreciation of how farmers or contexts may influence these relationships and in what conditions; thereby potentially missing insights from systems thinking.
- Also, the evidence of impact is very reductive, and focused on selective variables (e.g. carbon). Any wider, systemic, benefits of regenerative farming are overlooked and it is probably these that explain the 'groundswell' of interest in it in the UK. There is a lack of evidence (whether positive or negative), from both reductionist and systemic perspectives in the UK of regenerative grazing in the rural sociology literature.

Meaning, knowledge and interpretation depends on boundary judgments as to what 'facts' and 'norms' are considered relevant compared to those that are not (Ulrich, 1983). Specifically, systems thinking encourages critique of the existing complex problem boundary under inquiry e.g. the perspectives, boundaries and relationships, that characterise the complex issue of investigation (Ulrich, 1983). It illuminates whose perspectives are we considering, and whose should we be considering and why? It acknowledges that perspectives that are 'allowed in' and how, in itself this then controls the boundary of a systemic inquiry and determines how the problem is framed. For example, in exploring the transition of farming to agro-ecology in the UK, speaking with agronomists representing large agri-tech companies, to policy makers, to conventional farmers, to experimental farmers, will all highlight different perspectives on this complex issue. For this research, as it is so embryonic, the focus is just on understanding the farmer perspective to begin with. It would be very insightful to extend this out to a broader set of perspectives.

The focus of this research, is then to explore some of the interrelationships between components of the system and their properties (e.g. are they strong, weak, fast, slow, conflicted, collaborative, direct, indirect) as highlighted by the given farmer perspectives, within the boundaries of the complex problem they speak about (i.e the boundary is defined by what they choose to speak about, and what they do not, which in itself is illuminating). The importance of understanding the boundaries of the system, as spoken about by the farmers, and critiquing these is important (e.g. an agri-environment policy maker may not make the same one, and different farmers are likely to different self-imposed boundaries).

4.4 'Systems thinking' and farming

The 'farming systems' literature views farming as dynamic, that is emergent and in a constant state of interplay with its natural and socio-economic environment (Darnhofer et al., 2012; Norman and Lightfoot, 1992; Norman et al., 1982). It first emerged as an approach to engage with farmers, in order to encourage take-up of productivity enhancing practices in marginal farming areas, where take-up was low (Norman et al., 1995) i.e. the productivist approach was only successful in very specific, homogenous 'laboratory' conditions and less so in complex, heterogeneous farming environments; often leading to poor take up of agri-policy measures among farmers (Darnhofer, Gibbon and Dedieu 2012; Norman, 2002). In other words, farming systems literature arose in response to the perceived failings of the dominant productivist paradigm, which underpins the intensification of agriculture, and was orientated at maximising food production at all costs (Darnhofer, Gibbon and Dedieu, 2012).

Farm systems thinking views farming as the combined output of three parts: the farm (business and infrastructure), the natural environment and the farmer themselves (Darnhofer, Gibbon and Dedieu, 2012). Arguably, this boundary is too narrow and should include wider societal forces (market demand, legislation, policy etc). The general point is that the performance of a farm system will depend on how these four parts interact and how they are managed holistically, rather than how they act independently of each other (Darnhofer, Gibbon and Dedieu, 2012).

There therefore came a need to shift thinking of farm interventions towards an approach that accepts, and adapts to, uncertainty within a systems context; rather than trying to remove or control it. This fits with calls for transition to more resilient and adaptive regimes that "rather than maximising output over a narrow set of conditions, seek to guarantee output over a wide range of conditions" (Hodbod et al., 2016:5).

Within the farm systems perspective sits Van der Ploeg's 'farming styles' research. "Farming, as an 'organized flow of activities through time', can follow different patterns. Each pattern is based on particular driving forces, entails differently structured relations with markets and technology, and finally, evolves into a specific but coherent organization of the farm and a specific structuration of the labour process" (Van der Ploeg, 1992). This has similarities to farming 'modes' which arise when "similarities and repetition of patterns indicate that the large variety of farming systems may be reduced into a limited set of basic 'modes' that emerge according to the rules of the game (Cohen and Stewart 1994)" (in Schiere, Darnhofer and Duru, 2012:344).

In this context, transition to farming practices takes place within a 'feasibility space' set by the rules of the game, a space that is created by farmers as active agents of a system in continual tension with social, technical and institutional forces. This 'feasibility space' can be shaped by policy, institutional and governance structures as well as the agency of the farmer themselves (Schiere, Darnhofer and Duru, 2012:345). As such, there a role for policy to shape and stretch this feasibility space for farmers, rather than seeking to prescribe the activities that farmers should undertake.

Van der Ploeg's (2010) work on farming styles, offers the opportunity to explore the heterogeneity in farming systems, proposing that any classification of heterogeneity in farming should be based "on a careful analysis of the underlying patterns of farming, in terms of a strategically organized flow of activities through time" (Van der Ploeg, 1992:16). In so doing, he argues that this should help acknowledge the unpinning organization principles which farmers apply to construct their farm system. He suggests these are often consistent despite abrupt changes which leads to a variety of farming practices within one 'farm type'. Therefore, as this suggests, perhaps agri-environment policy needs to hone in on the agency of farmers and their underlying principles of organisation as agents of change, rather than the prevailing view that farmers are submissive to external drivers (Van der Ploeg, 2010).

This is supported by Darnhofer and others (Darnhofer et al., 2010; Darnhofer, Fairweather, et al., 2010; Darnhofer et al., 2016) who argue that resilience is thus "more likely to emerge when farmers hone the capacity to transform the farm, when farm production is attuned to the local ecological carrying capacity, and when learning and innovation are targeted outcomes" and "where change is the only constant (Rammel et al., 2007)" (Darnhofer, Fairweather, et al. 2010:186). Such an approach is compatible with calls for transdisciplinary approaches to farming and sustainability issues (Cousins et al., 2007; IAASTD, 2008; Aeberhard and Rist, 2009; Wiek and Walter, 2009; in Darnhofer et al., 2016).

Darnhofer et al. (2010) suggest that resilient farms with adaptive capacity, are more likely to be open to learning through experimenting, monitoring its outcomes, flexible farm organisation and diversification i.e. change. Such strategies give farmers more manoeuvrability or "feasibility space" in which multiple farm systems are available to transition to, depending on changing circumstances and external drivers (Schiere, Darnhofer and Duru, 2012). These options do not depend only on the farm itself, but also on the farmer's ability to mobilise external resources and to engage in collective action. Change is then no longer seen as a disturbance, but as a trigger for the re-organisation of resources, and for the continued renewal of the farm itself. This therefore suggests that perhaps the role of agri-environment policy is to stretch this feasibility space, rather than to prescribe what should fill this feasibility space.

As stated earlier, the literature in rural sociology and agro-ecological transition has started to embrace systems thinking more, with recent publications including Singh et al. (2016), Padel et al. (2017), Mann et al. (2019) and Toffolini et al. (2019). Padel et al. (2017:56) state that "The Farming Systems Research (FSR) tradition has argued that the social, cultural, ecological and economic context should be considered together when studying farms (Bawden, 1995; Gilbert et al., 1980). Bawden in particular referred to 'soft' systems thinking according to Checkland (1999), who describes the human activity as a central part of the system. This appears highly relevant to future studies of the agroecological transition".

It is in this context (agroecology, agri-environment and systems thinking) that Norton et al. (2024) draws on Abson et al. (2017), to discuss how and where society intervenes in farming systems to harness greater transformation. Abson et al. (2017) draws on Meadows (1999) to argue for an integrated systemic framework for tackling societal challenges and identify effective (strong) leverage points i.e., places where intervention is more likely to result in transformative change. This idea is drawn on later in the Discussion chapter.

4.5 Socio-ecological systems (SES)

Understanding how a human-environment system may behave, respond and adapt to internal or external stressors or interventions, is determined by system properties that emerge from the dynamic interplay between the social and ecological components (Walker et al., 2004; Turner et al., 2003), not necessarily from the individual components themselves. These properties exist over and above the components (they are more than the sum of the parts) and cannot be based on an appreciation of the component parts alone (they are non-decomposable) (Gallopin, 2006; Potschin, 2009).

This recognition is captured in the concept of socio-ecological-systems (SES) that is defined as a system that includes societal (human) and ecological (biophysical) subsystems in mutual interaction (Gallopin, 1991; Berkes and Folke 1998; Folke, 2006, 2007) that co-evolve together in close coupling (Potschin, 2009). The emergent properties will determine how a system will respond and behave towards a change (be it a stressor or planned intervention). As such, they are crucial to seek to understand. Any understanding of a SES is very unlikely to be definitive, therefore there is an intrinsic acceptance that governing SES is principally about embracing and managing inherent uncertainties (Folke et al., 2010).

Farming is a type of SES (Fischer et al., 2017) as it involves multiple, dynamic interactions between ever-changing human and natural components with feedbacks and operating across scales (Redman & Kinzig, 2003). No two farmers farm in exactly the same way, which results in management diversity that interacts differently with ecological processes, across time and space in our landscapes. Gaba (2020) highlights how ecological and social processes operate across different spatial scales, e.g. farming operates at field scale, whereas biological processes do not, and markets and regulations operate at a different scale again. These all interact to create complex mosaic of land-use at landscape scale that intercepts and affects environmental processes in aggregated ways e.g. water regulation.

Given the diversity of spatial scales, stakeholders and dynamic interactions within SES, farming is resulting in highly complex challenges, such as food quality, water quality or health (Gaba, 2020). Solving these requires a new approach in research, shifting from positivist, singular focus, approaches to more adaptive, participatory and transdisciplinary landscape-scale strategies (Angelstam et al., 2013). This requires moving from positivism, and reduction in scientific endeavour, one of control and removing uncertainty; to a novel approach that remains 'constantly in the fuzziness of the science in the making' (Barnaud & Antona, 2014:11). Exploring the self-organising capabilities of such complex SES is key (Ostrom, 2009). Such positioning may also help to unlock the barriers and to agroecological transition (Gaba, 2020).

4.5.1 Vulnerability, resilience and adaptive capacity

An overview of the key system properties of vulnerability, resilience and adaptive capacity is given here to help understand where and how intervention in a SES may be warranted, on what basis; and if so, the rationale for the intervention in the context of the multiple layers of the SES.

Gallopin (2006) sets out a conceptual framework for a SES, and summarises the literature discussion, around the key terms of vulnerability, resilience and adaptive capacity. His model is given in Figure 4.1. This has been adopted and re-worked by others in some instances (e.g. Gitz and Meybeck, 2012 in FAO (2013)).

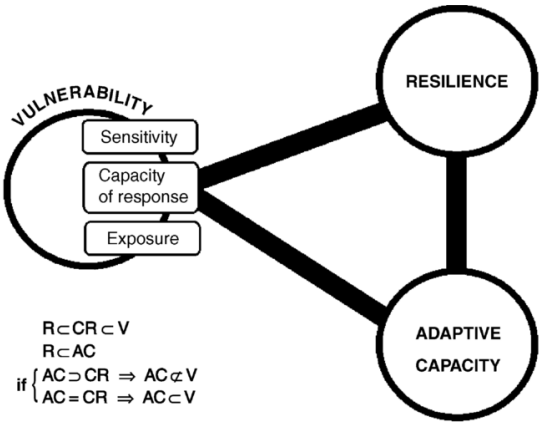


Figure 4.1 Gallopin's (2006) diagrammatic summary of the conceptual relations among vulnerability, resilience, and adaptive capacity in SES

4.5.1.1 Vulnerability

Vulnerability is generally defined as how a system is affected by a perturbation, rather than how it responds to the perturbation (Adger, 2006; FAO, 2013). Perturbations can either be slowly accumulating pressures or stressors that slowly build up over time (e.g. soil degradation) or a sudden, unexpected shock such as flooding (Turner et al., 2003). Perturbations can be either internal or external, positive or negative, multiple, multi-scale and interactive (Turner et al., 2003; Gallopin, 2006).

A system's vulnerability is determined by two properties: sensitivity to the impact and exposure to the impact (Adger, 2006; Gallopin, 2006). A system may be exposed to a perturbation but not sensitive to it, or vice versa; sensitivity exists prior to perturbation and is separate to exposure (Gallopin, 2006). Exposure defined as 'the degree, duration, and/or extent in which the system is in contact with, or subject to, the perturbation' (Adger, 2006). Gallopin (2006) retains sensitivity as part of vulnerability, to show that it is defined by the system's evolution and response to past perturbations (rather than being a pre-existing property of the system, irrespective of the environment it is in). Therefore, there is clearly a process of self-learning and a feedback loop between vulnerability, resilience and adaptive capacity (system responses to historical exposure to perturbations, not current exposure).

4.5.1.2 Resilience

Resilience is generally defined as the ability of a system to absorb disturbance and to not change as a consequence; "the ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973:14). This also seems to be a fairly binary concept, either a system is resilient or it is not. Walker et al. (2004:2) expands, saying that resilience is the system's capacity to "reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks". This

suggests a continuity to resilience, a process that is ever evolving and occurring (skin to Chiva's (2013) definition of 'complex adaptive systems'). Pimm (1984) (in Van Meerbeek et al. 2021) adds a time dimension saying resilience is the rate at which a system returns to the stable point or trajectory after perturbation.

Current populist interpretations of resilience in farming tend to narrowly focus on the need to keep producing food. This apparent simplistic notion of resilience is of particular concern, as not only does it ignore that farms are by their nature multi-faceted (e.g. productivity, profitability, stewardship, heritage, rural communities), they are also very heterogeneous in their practices, contexts, landscapes, styles, goals etc. (Van der Ploeg, 2010; Norman, 2002; Darnhofer et al., 2012). This suggests resilience may be defined depending on what it is seeking to be resilient to – lower food production or ecosystem degradation? As noted by Carpenter et al. (2001:765) "to assess a system's resilience, one must specify which system configuration and which disturbances are of interest".

Gallopin (2006) gives a sophisticated account of resilience in SES which expands on the general definitions above. Gallopin first describes system states and behaviour, which helps to form an understanding of the direction of travel of a given SES and its properties; prior to a detailed conceptualisation of resilience:

- A system has a state, defined as "any well defined condition that can be recognised if it occurs again" (Ashby 1956, in Gallopin, 2006) or "the set of values adopted by all the variables of a system at a given time" (Gallopin, 2006).
- A system adopts a succession of states through time along a 'trajectory' (Gallopin, 2006).
- The trajectory tends to move in time toward, or within, an attractor of the system. The behaviour of the system towards the attractor can take many forms in a predictable or un-predictable manner e.g. steady state, a limit cycle, an open-ended trajectory that never reaches its attractor (Gallopin, 2006).
- The attractor characterises the behaviour the system settles into. It can be a point, a trajectory itself, there can be multiple attractors (Gallopin, 2006).
- Each attractor has a domain of influence or basin of attraction, and these domains can overlap and intersect with other domains (Gallopin, 2006).
- Perturbations (shocks, stressors, changes etc.) seek to push the system away from the system's path, from one domain into another, but depending on the type of attractor, the system may never reach constancy anyway (e.g. single point attractor versus trajectory attractor) (Gallopin, 2006).
- Systems can have multiple attractors, therefore it may not be obvious when a system's characteristics start to change (e.g. if it starts to be pulled mainly towards one attractor over another) (Gallopin, 2006) – see Figure 4.2.
- Systems can have multiple basins of attractors (and of different types) which interplay to create a dynamic 'stability landscape' which represents all of the domain configurations and the boundaries separating them (Gallopin, 2006).

- The 'stability landscape' is part of the structure of the system, which depends on the parameters of the system. A change in a parameter could result in a 'bifurcation' or discontinuity in the stability landscape, where multiple attractors emerge from one or vice versa (Gallopin, 2006) – see Figure 4.3.

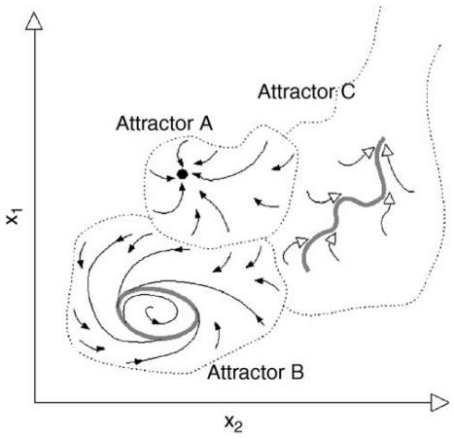


Figure 4.2 State space of a two-variable system with three attractors

Indicating the respective basis of attraction with dotted lines from Gallopin (2006)

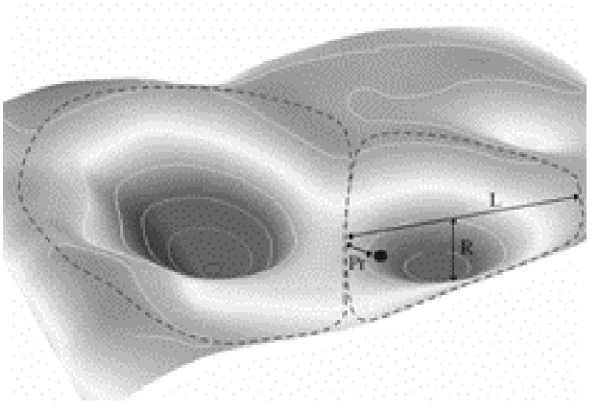


Figure 4.3 A 3D visual of a stability landscape from Walker et al. 2004

Showing three resilience measures of latitude (L), resistance (R) and precariousness (Pr)

Based on the above, Gallopin (2006:26) defines "resilience, in terms of the stability landscape, implies the ability of a multi-stable system to keep the values of its state variables within a given domain of attraction in the face of perturbations, and is not concerned with the stability of constancy or the state within the basin". Therefore, a system may be resilient but at the same time highly unstable and fluctuate widely within a domain's boundaries (Gallopin, 2006), even within the boundaries of multiple overlapping domains and attractors. Holling (1973) observed this in the ecological world, observing systems that are multi-stable, regularly flipping between two or more domains of attraction; across which the system seems to remain.

It is important not to forget that resilience can be considered in various dimensions (biophysical, economic and social) as well as at various scales (Gallopin, 2006). Arguably,

resilience has just been thought of for individual components at a time e.g. in food production, rather than resilience across multiple components, systems and services. The way the various dimensions and scales interact is crucial, precisely because of the importance of general resilience for coping with uncertainty (FAO, 2013). Therefore, even though such definition helps identify where and in what way we intervene in a SES, thus helping to maintain a SES in a desirable state (in theory); it also identifies that resilience exists in the governing structures and institutional organisations which intervene. Therefore, we not only need an understanding of resilience in the system of interest, but also that complementary resilience is needed in the nested, and parent systems surrounding (e.g. ecological, institutional, political). Only in understanding this dynamism between multiple layers of resilience around and within the bounded system of focus, can we effectively design SES interventions so as to reap the desired multiple outcomes (and not any unforeseen outcomes on other system properties) Cifdaloz et al., 2010). Indeed, there may be rationality in decreasing resilience at one level, in order to promote resilience at a higher over-arching level (Gallopin, 2006).

This sophisticated definition of resilience therefore implies that a system is not resilient if its variables move from one domain of attraction to a completely new domain of attraction – outside of normal variability. But then presumably, a system may become resilient, but with new variables/relationships, within its newly reformed stability landscape containing new domains of attraction. Therefore, it is hard to see how useful the concept and suggested measures of resilience actually are (see Box 1), if resilience exists equally in desirable and undesirable system states; irrespective of the 'living conditions' within the system state for people and the environment. Presumably, it is of use, as a means to understand how and in what way we intervene in order to maintain a desired state, and to stop it flipping to other less

BOX 1 - Four measures of resilience implying where and how interventions could help to improve resilience (Walker et al. 2004):

1. Latitude (L): the maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).

2. Resistance (R): the ease or difficulty of changing the system; how "resistant" it is to being changed.

3. Precariousness (Pr): how close the current state of the system is to a limit or "threshold."

4. Panarchy: because of cross-scale interactions, the resilience of a system at a particular focal scale will depend on the influences from states and dynamics at scales above and below. For example, external oppressive politics, invasions, market shifts, or global climate change can trigger local surprises and regime shifts" (Walker et al. 2004:2-3).

desirable states, in response to changing environmental perturbations. As such, this chapter now moves onto a discussion above adaptive capacity in SES and rationale for intervention.

4.5.1.3 Adaptive capacity

Walker et al (2004), in the context of SES, defines 'adaptability' as the collective capacity of human actors in the SES to manage resilience. As such, this implies some degree of human interaction. 'Adaptation' is slightly different and is a system's restructuring after its responses (Turner et al. 2003). This suggests there is always a structural element to adaptation, rather than just behavioural; indicating adaptation only really occurs when a system flips into another, new, domain of attraction and variables take on new values (i.e. when resilience is low). Adaptation tends to be considered to be of long-term duration rather than temporary and fleeting (Smit & Wandel, 2006).

In his model, Gallopin (2006) distinguishes 'capacity of response' from 'adaptive capacity', placing it in vulnerability, as a property of the system prior to perturbation. This highlights the role of human agency and institutional capacity in determining the vulnerability of a SES, and provides an opportunity to link Gallopin's model to the promotion of agency and institutional readiness, to prepare a system for anticipated shocks (rather than reactive agency). Gallopin himself, defines 'capacity of response' as a "system's ability to adjust to a disturbance, take advantage of opportunities, cope with consequences of transformations". This suggests that capacity of response can result in a system staying resilient (and therefore within its normal realms of variability) in the face of perturbations.

Resilience implies staying in the same stability landscape, whereas adaptive capacity suggests that a society could adapt to living conditions in a new SES in a different stability landscape; depending on whether it has the potential to do so. Depending on the regularity of perturbations, a new stability landscape may be unavoidable (if for example regularity and type of external perturbation changes permanently to become the 'norm' e.g. climate change).

In this sense, resilience is not necessarily a good thing, and is only a good thing if it presumably constrains the effect of perturbations on a system and keeps it from flipping into another, as yet unknown, stability landscape (not necessarily a resilience that seeks to control the perturbations). As such, adaptive capacity plays a critical role in reforming resilience (and the stability or 'known variability') in a new state system.

Interestingly, NRW (2016:8) state that "adaptability is part of the definition of resilience rather than an attribute that supports it" emphasising that it is "one of the most important features of resilience: dynamism and the ability to adapt to change" and that "This is especially relevant to

climate change where change is inevitable and we cannot expect to maintain the status quo". As such, this suggests that the need to adapt, is not necessarily to preserve the current state but that this could be a) somewhere along the current trajectory of the present system, within normal realms of behaviour (within the present stability landscape and range of attractors); or b) could be a new system, with new behaviours, within an entirely new stability landscape, which has different attractors, created after some major perturbations have exceeded present thresholds.

4.5.2 Complex adaptive systems

As stated earlier, a system is generally considered adaptable when it can adjust to changes in its environment without endangering its core organizational features (Chiva et al. 2013). Chiva et al. (2013) make the distinction between two types of system adaptation. Firstly, complex adaptive systems (CAS) adapt their behaviour to persistent conditions, learning from experience (Anderson, 1999; Houchin and MacLean, 2005). Whereas, complex generative systems (CGS) can change within themselves and their core characteristics (Jantsch, 1980 in Chiva et al. 2013), transcending into a new reality (or new stability landscape as referred to earlier).

From the discipline of organisational learning, Chiva et al. (2013:2) state: "the system evolves when any of the concepts reaches the edge of chaos... There are two main directions in which the system can evolve once the edge of chaos is attained: adaptability or transcendence. The former is fostered by concentration, discussion and an attitude of improvement within the organization….. which can be defined as the refinement of existing competences, technologies and paradigms, without necessarily examining or challenging underlying beliefs and assumptions…The latter is fostered by attention, dialogue and an attitude of inquiry within the organization, which brings about generative learning, radical innovation and global or high internationalization …which means changing their mental models, knowledge or organization".

The 'edge of chaos' can be thought of as the edge of the particular stability landscape, within which a present system sits along it current trajectory; beyond which the realm and structures of any new system is as yet unknown and unpredictable. Complex systems, both adaptive and generative, adapt and transcend respectively, when they find themselves at the 'edge of chaos' (Anderson, 1999).

4.6 Summary

Consideration of idealism versus positivist philosophical ontologies, has illuminated systems thinking as an approach to research inquiry which complements the rural sociology literature

and may provide meaningful insights into farmer decision-making and transition to regenerative grazing.

Epistemological approaches including interpretivism, social constructionism and Giddens' structuration theory, give more opportunity (than pure structuralism as well as positivism) to reflect more meaningfully on the role of human agency (Cunliffe, 2008) in farming: why farmers make the decisions they do, giving more credence to intersubjectivity and the situatedness of farmer sense-making.

Systems thinking offers an alternative way of approaching complex problems, and provides insight into perhaps, less intuitive, ways to intervene in complex systems for desired goals. This research has gravitated towards the SES literature (notions of vulnerability, resilience, adaptation and complex adaptive systems), 'soft systems' thinking (Checkland, 1981) and boundary critique (Ulrich, 1983); to draw insights about connectivity, and relationships, between the variables affecting farmer transitions to regenerative grazing; but also farmer agency in influencing those variables. Drawing on Giddens (1984) 'structuration theory' to highlight the tension between agency and structure; to see if this offers any insights with regard to farmer transition to regenerative, within the prevailing socio-ecological-system in Wales.

There is opportunity to draw on farm systems research from the rural sociology literature, in particular to draw on Schiere, Darnhofer and Duru's (2012) notion of farmer 'feasibility space'. Their work suggests that a farm system comprises of four core parts: the farm (business and infrastructure), the natural environment, wider society and the farmer themselves. Understanding how variables operate across and within these four parts sheds light on how farmers can be supported in agro-ecological transition. The approach prioritises the importance of learning from farmers and placing them at 'centre stage' of the decision-making.

The SES resilience literature (Folke, 2006, 2007; Folke et al., 2005; Gallopín, 2006; Walker et al., 2004) explores how human-environment systems behave, respond and adapt to internal or external stressors or interventions. In keeping with systems thinking, it focuses on properties that emerge from the relationships between social and ecological components (Walker et al., 2004; Gallopin, 2006), rather than from the individual components themselves. The SES literature argues that it is crucial to understand, or at least acknowledge, these emergent properties, because they determine how a system will respond and behave towards a change – their resilience. Gallopin's (2006) digestible exploration of system resilience suggests an approach for intervening in systems to aid resilience (see Chapter 9).

Chapter 5 Research questions

5.1 Introduction

This Section describes the development of the research questions, and how they were refined from the initial research focus as introduced in Chapter 1. This involved discussions with various stakeholders interested in agro-ecological transition in grassland farming systems in the UK (prior to this research's focus upon Wales). This is briefly covered below.

5.2 Developing with stakeholders

In 2016/17, 19 organisations and 31 individuals were consulted to help shape and refine the research questions. From a systems perspective, the aim of this exploration was to gain a broader understanding of a) which farmer decision-making factors, and their relationships, to focus on and why; b) the range of perspectives on the role of regenerative farming in restoring catchment processes, and what interests underpinned these perspectives; and c) what should the boundary of this research be? How far in the socio-ecological system enmeshing farming, should this research go and why? i.e. just talk to farmers, or their suppliers, their buyers, their advisors, policy-makers, lenders and end-consumers? Table 5.1 sets out the individuals and organisations spoken to help refine the research questions.

Table 5.1 Individuals and organisations spoken to help refine the research questions in 2016/17.

Organisation	Individual (s)
Centre for Ecology and Hydrology	David Fraser, Dr Lisa Norton
Defra	Alistair Rennie, Head of Evidence for Land Use team
Innovation for Agriculture	Stephen Briggs and Georgia Éclair-Heath
Yorkshire Water	Not recorded
Agricultural and Rural Livelihood Systems, Church Stretton, Shropshire	Professor David Gibbon
Soil Association	Tom MacMillan
Natural England	Louise Webb , Catchment Sensitive Farming; Dr Beth Brockett, Lead Land Management & Conservation Adviser
Phepson Farm / National trust Croome Court	Rob Havard, Regenerative Farmer
Wye and Usk Foundation	Stephen Marsh
Leeds University	Professor Julia Martin-Ortega

Organisation	Individual (s)
Natural Resources Wales	Russell Elliott, Integrated Natural Resource Management Programme
Regenerative Agriculture UK	Natasha Giddings
Lancaster University	Professor Claire Waterton, Sustainable economic and ecological grazing systems - learning from innovative practitioners (SEEGSLIP)
Welsh Government	Jo Amesbury – EU Exit Evidence Dave Ashford – Agriculture Sustainable Development Katherine Raymond – Strategic Evidence Dave Jones – Stats Stuart Neil – Stats David McNeil – Rural Development Mark Alexander - Agriculture Sustainable Development Karen Stothard – EU Exit evidence Ann Humble – EU Exit evidence (AH) Ken Stebbings – EU Exit evidence
Farming Connect	Red Meat Technical Officers x 2
Independent Grazing Advisor	Chris Duller
Aberystwyth University	Dr. William Stiles
Dwr Cymru / Welsh Water	Nigel Elgar
Pasture for Life Association	Russ Carrington

The consultations confirmed that understanding the experiences of farmers transitioning to regenerative farming in the UK, is of particular importance in light of the UK and Welsh Government's changing agri-environment policy; the upswing in investor interest in this area (Newton et al. 2020), and the transformation needed in the farming sector to deliver security in a broader suite of nature's goods and services as well as food production (i.e. clean water, clean air, nutritious food, carbon storage, disease regulation, biodiversity). Supporting farmers in navigating this change is fundamental to society's future welfare.

The consultations confirmed that first and foremost there is a need to look at this transition from the farmer's perspective, to get a solid understanding of this space; which could then be followed by the views of other catchment stakeholders, and wider farming supply chains. As

such, at this first stage, the boundary of the system under research is the socio-ecological-system from the farmer perspective (and not the perspectives of others in the same SES at this stage).

The consultations highlighted some key factors of interest, including any within the policy and market domains, but there was a general view to look at these across the SES, as they emerge and are identified by the farmer themselves (i.e. not to shape, or direct, the farmer's focus towards certain factors or system forces in any way). Interestingly, there was a view from some for the research to explore interconnections and feedback loops in the SES between different farmer decision making factors (e.g. in re-connecting missing system relationships, and in strengthening degraded relationships, and removing degrading relationships).

5.3 Research questions

The initial research interests set out in Chapter 1 were refined following the discussions with a broader range of catchment and farming system stakeholders in Wales, and the broader regenerative farming community in the UK as set out above. These research questions relate to livestock (grassland system) farmers in Wales specifically, and comprise:

- How and why are Welsh livestock farmers facilitating change around them, in terms of changing their farming system to a more regenerative one? What different approaches are farmers using?
- What do Welsh livestock farmers understand to be the factors enabling and constraining this change, and the relationships between these factors in an emergent system?
- What insights can be drawn from the above regarding support for farmers in transitioning to regenerative farming, for policy and for practitioners?

Specifically, this research is interested in how farmers perceive (their perspective) and navigate the mesh of decision-making factors (in the socio-ecological system around them); whether they think they can influence them and how. Also of interest, is whether there is a relationship between these different factors and the system they operate in

The rural sociology literature provides a lot of material to draw on, with respect to farmer decision making, agro-ecology transition models, farmer transition to new practices, farm systems research and political economy (agency versus structure). However, arguably little has looked at farming transition, specifically with regard to regenerative grazing in the Welsh context. This research will seek to explore the different decision-making factors, and transition models in the rural sociology literature, but explore in-depth the relationships between these factors, and properties of these relationships, between multiple factors from a systems

perspective in the Welsh context. Therefore, this may aid our understanding of where policy could effectively support the whole scale adjustment of farming in Wales to those which are more sympathetic to restoring natural processes.

Borrowing from Schiere, Darnhofer and Duru's (2012) notion of farmer 'feasibility space', this research hopes to learn which factors help to enhance this space and in what way. It is hoped that this will shed light on opportunity for system interventions to support farmer agency in facilitating change, rather than defining the limits of farmer agency. As such, this research seeks to explore the nature of the relationship between factors, the system and context they operate within, and to understand which factors farmers feel they can influence and how. As identified by Padel et al. (2017:8) "There is need for an improved understanding of the links between personal, farm specific and external drivers of change, considering farming as a human activity system. This should aim at further consolidating models for policy-making by considering available social evidence and by linking the different perspectives.".

5.4 Study area

The research is situated in Wales for various reasons including a) a desire to understand reasons for the apparent lack of take-up of regenerative grazing practices in Wales (compared to the rest of the UK), b) that farming in Wales is dominated by grassland grazing suggesting there is opportunity to implement regenerative grazing more widely, and c) that there appears to be little research regarding farming decision-making in Wales, specifically with respect to regenerative grazing. No known research has taken a system's view of this topic in Wales before. Also, the Welsh context is interesting as the policy context is quite different to that of England. As such, the study area, policy context and geo-political timing of the research, promise interesting and rewarding insights.

5.5 Summary

Understanding the experiences of farmers who are experimenting in regenerative farming in the UK, is of particular importance in light of changing agri-environment policy. Supporting farmers in navigating agro-ecological transition is likely fundamental to society's future welfare. Specifically, this research is interested in how farmers perceive and navigate the mesh of decision-making factors, whether they think they can influence them and how.

It is important to cover the topic of regenerative farming, in rural sociology literature, due to the upswing in interest in the topic in recent years (Newton et al. 2020). Currently there is a dearth of literature regarding agro-ecological transition in the UK from a 'systems thinking' and resilience perspective, specifically with regard to regenerative farming in grassland systems.

Chapter 6 Methodology

6.1 Introduction

This chapter sets out the research approach, as philosophically positioned within an idealism ontology, shaped by interpretivist and social constructionist epistemologies and drawing on systems thinking as a mode of inquiry (see Chapter 4). This chapter sets out and justifies the qualitative methodology and methods chosen for this research (Figure 6.1). It describes how systems thinking has been used ni this research, and appraises Grounded Theory as a methodology.

Figure 6.1 Philosophical positioning of this research

6.2 Background

This research aims to provide insight into the different approaches undertaken by farmers, and the actions they take, in transitioning to agro-ecological practices; specifically, in more regenerative forms of grazing in Wales. It aims to explore and generate theories for a) how and why farmers are facilitating this change around them; b) what factors do farmers understand to be enabling or constraining them in this change, with the aim to shed light on c) where farmers could be supported in this transition.

Based on preliminary reading and discussions with relevant consultees (Chapter 5), my research design is based on the following premises:

- My research is exploratory – it is trying to get a feel for what is going on in a novel situation, there are few pre-conceived theories that are directly applicable to this context (it is not seeking to confirm a previous explanation for a phenomenon);
- It will be based on gathering data from different livestock farming contexts in Wales, via in-depth data gathering, to complement survey-based approaches in Wales;

- Data analysis should allow previously un-defined themes to emerge from the data, thereby allowing relationships between different themes and associated variables to be identified with some degree of confidence (constraints and enablers). This is not necessarily a statistical confidence, nor even go so far as determining the direction of the relationship but just confidence that a relationship is present.

6.3 Applying systems thinking

This research has been shaped by systems thinking in its general theorisation (Jackson, 2003), and specifically the SES literature (especially notions of resilience and adaptation), and ideas from Checkland's (1981) 'soft systems thinking, and Midgley's (2000) and Ulrich (1983) for boundary critique (boundary, perspectives, interrelationships). Due to the exploratory nature of this research, following a specific systems thinking methodology was not deemed appropriate (but there are several that could be used as follow up to this research with broader catchment stakeholders e.g. Actor Network Theory).

Systems thinking theorisation has been part of this research from the start, thinking through framing of the problem, connections and inter-connections, existing and missing feedbacks in system resilience and adaptation. It was used to think through catchment challenges to identify grazing management as a critical part of catchment resilience and adaptation to climate change and biodiversity loss.

Boundary critique was used to think through what is the SES under inquiry and why, who to engage with and how, who is outside of this inquiry and how does that change knowledge creation. By asking who and what should count early in research, helps manage inclusivity, reduces the risk of marginalisation in order to help manage power relationships in subsequent research for policy design. It was decided early on, that farmer perspectives of this novel situation should be gathered primarily. As such, this research is bounded at farmer perspectives, and has not ventured further at this stage with other stakeholders in the catchment system. Follow on research could collaboratively explore this complex adaptive system with a broader set of perspectives (and a broader system boundary).

The SES literature (notions of vulnerability, resilience and adaptation) are drawn on in the discussion (Chapter 9), as a means to guide and critique potential system interventions to support transition to regenerative grazing in Wales.

6.4 Qualitative research

Qualitative research (including interviewing) is a relatively recent endeavour in research, emerging primarily in the twentieth century and passing through "successive waves of

epistemological theorizing … from positivist rigour, through interpretive reflexivity, to multiplicity and politicization." (Edwards and Holland, 2013:12; in Moore, 2017). The researcher's role as an 'instrument of data collection' begins before the process of data collection, rooted in the researcher's own philosophical approach to research (King and Horrocks, 2010; in Moore, 2017).

Qualitative research stretches across deductive and inductive reasoning as to what is knowledge, but primarily embraces the latter (Moore, 2017). Generally, structured questionnaires fit positivist theory-testing via deduction (Moore, 2017). Whereas, semi-structured and unstructured interviews tend to fit with more interpretivist, social constructionist and post-modernist 'world views', that recognise the socially embedded nature of complex sociological phenomena, looking to draw insights rather than verification of pre-formed theories (Gilbert and Stoneman, 2016; Edwards and Holland, 2013; in Moore, 2017). Arguably therefore, the research is in part informed by the researcher's 'world view' and their reasoning as to what constitutes knowledge (Moore, 2017).

This means that in all likelihood, researchers approach data collection from fundamentally different theoretical framings. For example, this could comprise open and exploratory approaches, versus pre-conceived hypotheses-testing studies; both influencing data collection methods and tools early on in the research process (often before research questions are formed). The researcher is therefore determining the means for producing knowledge and the validity of the data collected very early on. Critiques have argued that, because of this, it is difficult to standardise and generalise qualitative research into meaningful knowledge. (Moore, 2017).

As such, this infers that it is necessary to consider the underlying assumptions (the Duhem-Quine thesis) underpinning a researcher's research rationale. This highlights the importance of a researcher critically recognising and acknowledging their own positionality in their research, via reflexivity, before during and after the data collection process (Mason, 2002). This is particularly an issue if the interviewer is likely to hold very different views to the interviewee. This could lead to various effects on the data collection; for example, the interview being curtailed sooner that it would have been, a different depth of exploration than if the researcher had shared the views of the interviewee, and different questions being asked. (Moore, 2017).

6.5 Research design

To recap, this research aims to draw insights about farmer decision-making and how this is shaped by *in situ* social-ecological contexts. Much of the farmer decision-making research covered in the literature is based on quantitative methods such as large-scale surveys and questionnaires that are analysed using varying statistical methods and rooted in positivist ontologies (Knowler and Bradshaw, 2007). As such, such quantitative research focuses more on identifying the existence of variables and whether they are dependent or not on other variables (Knowler and Bradshaw, 2007). It also tends to break down, and reduce, complex systems into 'chunk' size understandable parts, focusing on linear short impact pathways. It does not provide a deep understanding of why or how different socio-ecological contexts shape farmer decision-making, nor how variables may link systemically, to other multiple variables in a complex lengthy pathway, that pass over and interact with other pathways, in non-linear and cyclical relationships.

This research seeks to complement these positivist (quantitative and qualitative) approaches by drawing more in-depth insights by talking with farmers and allowing the questioning to naturally 'deep-dive' into interesting topics that the farmer raises. This allows the farmer's experiences and perceptions to shape the questions, and the data that is forthcoming; rather than a questionnaire or survey, which by its fixed questions, or style of questions, can unintentionally lead the farmer to respond in particular ways (Sherren, et al. 2010). However, it is not just about what questions that are asked in a questionnaire, but what is *not* asked. In-depth non-structured interviews allow reasons behind reasons to emerge and to be explored, thus building a more systemic understanding of complex socio-ecological systems, than what is possible to derive from large-scale questionnaires. As such, large-scale questionnaires and surveys risk eliciting findings which do not explain, or are inconsistent with, social behaviour (Cary, 1993).

6.5.1 Overview of qualitative approaches

Table 6.1 gives a high-level overview of the advantages and disadvantages of various qualitative research approaches considered for the purpose of this research. Advantages of each approach focus with regard to its potential to align with the nature of this research as set out in the 'Introduction' to this chapter, is included in the table (i.e. exploratory, phenomenon based, few pre-conceived theories in context, in-depth data collection, theory emergence, relationships between themes and variables as yet un-defined in context). In summary, Glaser and Strauss' Grounded Theory Approach has been selected to take forward for this research and is examined in greater detail below.

Table 6.1 Overview of qualitative research methodologies

Qualitative Methodology	**Advantages**	**Disadvantages**
Case study approach (flexible design)	This focuses on phenomenon in context. Case studies can be based on around innovations and experimentation. A multiple case study approach could be used; first case study gives an idea of what is going on, then subsequent case studies test if this is the case or not. Provides scope for some generalisation (analytic or theoretical generalisation). Can be used to falsify any established theory via deduction.	It is the study of a particular instance in a given context. Therefore, perhaps in danger of being too context dependent or a particular instance (individual, organisation, setting etc.). Likely to be limited in terms of generating theory as so case specific (although some challenge on this). It is usually used as a verification process, to confirm a pre-conceived theory rather than allow theory emergence. Usually comprises different types of data collection. In multiple case study selection, there is a danger that case studies are selected to provide the verification required or over-simplification of what is really going on. Case studies are not selected in a random nor representative basis; they are selected because they are interesting in own right. For these reasons, this approach is disregarded for the purposes of this research.
Ethnography approach (flexible design)	This is based on field observation and interviewing. The emphasis is on depth, context and intensity. Seeing things from the perspective of those studied (Chicago School). Studying behaviour in natural settings. It allows open-endedness in the direction a study takes; adapting the research to what becomes interesting. It allows rules to be discerned, that govern relationships in the setting and allows identification of patterns in members' behaviours. The descriptive data aims to be free from imposed external constructs or ideas.	The researcher is immersed in a setting over a long period of time, often 'becoming a member' of a social group, and 'learning the language' of the setting in order to understand something. There is a risk of 'going native'. Risk of 'smash and grab' ethnography if not enough time is spent with the community of study. It risks confusion as to when and when not the researcher is collecting data. This usually comprises periods of time living with a community or full immersion; in order to understand meanings developed through patterns of behaviour (whether real or virtual communities). This approach can often be impractical for research depending on the circumstances of the researcher. For these reasons, this approach is disregarded for the purposes of this research.
Grounded theory approach (flexible design)	This approach focuses on generating a theory from a particular social situation; theory is not pre-conceived but derived from the data itself, particularly in terms of the *actions, interactions* and *processes* of the people involved. This approach is particularly useful	This approach is not considered to be an easy option, particularly in terms of the iterative nature of the research (data collection – coding – theory emergence dynamic) but also that, depending on whether the Glaser or Strauss approach is taken, there is a risk that the coding stages can become too prescriptive. This is not ideal if there are tight timescales in which to gather and interpret data. This

Qualitative Methodology	Advantages	Disadvantages
	when pre-existing theories are hard to come by.	approach is taken forward for consideration for this research.
Phenomenological approach	This seeks to reveal and convey deep insights and concealed meanings of phenomenon in everyday life.	This approach seems to focus on how humans view themselves. The researcher is inseparable from assumptions and pre-conceptions about the phenomenon. As such, continuous attempts are made to explain and integrate these into the research findings rather than treat them separately. Whilst this is important, there is perhaps a danger of this research approach being too reflexive and focused on the role of the researcher in 'meanings' more than the emergence of theory. For these reasons, this approach is disregarded for the purposes of this research.
Hermeneutics approach	This approach originates in analysis of texts and places emphasis on the importance of language, and terminology used, in understanding. This encourages a linguistic focus on the *process* of understanding; more so than just what is understood.	There is a danger that this approach could move away from addressing my original research aim and questions. For these reasons, this approach is disregarded for the purposes of this research.
Narrative approach	This approach focuses on the stories that people use to understand and describe aspects of their lives. This could be relevant here in that the narrative approach sometimes naturally emerges during research, if for example, the interviewees naturally start to talk about their life stories and key events that happens.	This approach is different to other forms of discourse in that it focuses on *sequence* and *consequence;* events are selected, organised, connected and evaluated by the narrator for a particular audience (Reissman, 2004). Whilst useful to the given research context (and to some degree is likely to overlap with grounded theory approach), I am reluctant to focus entirely on drawing insights purely from past events as such, whilst this approach is not disregarded entirely, it is not taken forward for further detailed investigation here.

Based on Robson, 2011; Gilbert and Stoneman, 2016.

The Grounded Theory approach is preferred for this research on the basis that it will generate a theory particular to the given social situation of study. It does not test existing pre-conceived theories, but generates new theory by examining the *actions, interactions* and *processes* of the people involved. It is attractive as it will discover concepts and generate novel theory (Robson, 2011). This approach is particularly useful when pre-existing theories are hard to come by. This seems to be very apt for exploring farmer decision making in the context of regenerative farming and natural resources management in Wales.

The approach is also attractive because the procedures are clearly defined and systematic yet flexible (Robson, 2011). However, Grounded Theory is a controversial methodology, partly due to the split between the two originators, Glaser and Strauss, and the development of subtly distinct ideographic procedures (Walker and Myrick, 2006). Strauss's version (Strauss and Corbin, 1998; Corbin and Strauss, 2008) is preferred for this research because it supports an interpretive stance (Duchscher and Morgan, 2004; Cutcliffe, 2000) and aspects of the analytical procedure, particularly the use of open, axial and selective coding, seem easier to use than Glaser's approach. I think Strauss and Corbin's main difference to Glaser is the separation of coding into prescribed procedures, with accompanying guidance: open, axial, selective.

6.5.2 Critical discussion of the Grounded Theory approach

6.5.2.1 What is Grounded Theory?

Grounded Theory (Glaser and Strauss, 1967) emerged in response to the dominance of the positivist deductive scientific method in the 1960s. This tradition focused on the testing and verification of pre-formed theories in social research. Glaser and Strauss (1967) set out an inductive approach, to allow the emergence and formation of new theories in situated social contexts. It is ontologically positioned more in relativism, recognising the social embeddedness of interactions with the real world; rather than the positivist paradigm that there is an entirely separate, immutable real world that can be observed outside of social condition. However, Glaser and Strauss (1967) sought to avoid the prevailing Chicago School's rich data and impressionistic social research stance at that time. As such, they developed an approach that is rigorously systematic in its approach yet creative and flexible.

Grounded Theory sets out a research strategy based on a particular set of procedures and techniques, for analysing data and generating theory (Robson, 2011). It encompasses the whole of the research process, and not just the data analysis stage. The data collection and data analysis stages are far more integrated, and the researcher is encouraged to follow an iterative dynamic between these two stages (known as 'constant comparative'). Data from initial interviews is analysed, to identify initial themes which are tested in subsequent interviews and gradually refined with each iteration of data analysis (following each stage of data collection). Systematic coding is undertaken following each round of data collection.

Grounded Theory is attractive for the purpose of this research as it is primarily inductive and allows themes and theories to emerge from an exploration of the data, free from pre-conceived theories (setting aside the researcher's embedded belief system which will be addressed via a reflexive research approach). In one sense it is systematic and rigorous; giving confidence to the researcher that they are 'covering all bases' and managing any risks of bias

in the data. On a practical level, the approach is well suited to analysis of interview data, particularly in applied research or novel areas of research; but equally it is compatible with some quantitative data collection. It provides a means to understand when data analysis is saturated, and therefore when there is little justification to continue with further data collection.

Conventional research approaches (particularly in more quantitative research) seek to pre-define who will be interviewed in advance in order to ensure and manage a representative sample. In Grounded Theory, sampling is *purposive* (known as theoretical sampling) in that, for example, interviews would be undertaken to gather additional information if it is felt that there is more scope to draw more insights (data is not yet saturated) to help the researcher formulate theory. A representative sample is not sought for its own sake and there is no notion of random sampling to achieve statistical generalisability.

6.5.2.2 What are the principal critiques of Grounded Theory?

Other than concerns surrounding sampling and saturation of data referred to above, there are four other principal challenges to Grounded Theory in the literature. These comprise the following and are discussed below.

6.5.2.2.1 Ontological challenges: induction or deduction?

A principal critique of Grounded Theory is that the early shift from exploration of emergent themes in collected data, to the deliberate investigation of these themes in subsequent data collection, risks a change from a purely inductive to more of a deductive ontological perspective (Heath and Cowley, 2004). However, proponents of Grounded Theory challenge this, stating that this process is about building and refining a theory; rather than seeking cases to fit a pre-determined theory (so arguably a compare and contrast process that looks for Popper falsification as much as Hume verification).

Hammersley (1989) asks a more elemental question: if understanding of the social world is extrapolated from the interaction and behaviour of actors in Grounded Theory, is there really a reality of external social processes to be investigated? (Heath and Cowley, 2004). Hammersley's critique is aimed more at Blumer's (1937) 'symbolic interactionism', a key influence on the development of Grounded Theory, which centres on gaining utility and significance from patterned relationships between concepts rather than quantifiable correlations (Heath and Cowley, 2004). In response, others argue that it is acceptable to draw on meaning from social agents, if we accept that there are multiple descriptive and explanatory claims about any phenomenon and that as such a phenomenon can be several things at once (Heath and Cowley, 2004).

Rennie and Fergus (2006) summarise this quandary succinctly in that they claim that Grounded Theory bridges realism and relativism: as 'social phenomena is external to the researcher and awaiting discovery' yet also infers that 'phenomena are to be formulated creatively'. With correct procedures, researchers can access social phenomena grounded in reality, but that understanding of the phenomena will vary depending on interests of the analyst.

6.5.2.2.2 Epistemological constraints: we cannot avoid constructivism

Grounded Theory encourages minimal reference to the literature early in the research process (Heath and Cowley, 2004) in order to minimise the risk of pre-defining theories and assumptions before data collection starts. But is it really possible to start research without pre-conceived ideas and assumptions? Can researchers really transcend their situatedness as Grounded Theory claims? (in a sense, mirroring positivist claims).

As Heath and Cowley (2004) say, citing Ashworth (1997), "Analysis will always be filtered through one's tradition and cultural position" (p. 143). Stanley and Wise (1990) state that 'All knowledge, necessarily, results from the conditions of its production'. Others argue that the introduction of systematic procedures merely shapes the ways in which the subjectivities of the researcher will manifest themselves; rather than seeking to avoid them or limit them as Grounded Theory purports.

Despite these challenges, many interpretivist constructivists (e.g. Charmaz, 1995:35) apply Grounded Theory's techniques and processes, claiming its usefulness in seeking a close fit between data and emerging interpretations, and protecting against arbitrary imposition of theory (therefore recognising that interpretation is subjective, but trying to manage this).

6.5.2.2.3 Risk of over prescription: at expense of creative theory?

In one sense, Grounded Theory is very systematic (in terms of data collection and data analysis), yet in others it is very flexible, emergent and non-systematic e.g. it is not encouraged to fully plan the research in advance. As such, there is tension between the flexible style (free-flowing, exploratory, inductive) and systematic approach of Grounded Theory.

One of Grounded Theory's most common criticisms is that it is overly prescriptive and that it places too much focus on data rigour and systemisation. Some claim that this constrains creativity and 'fertility is sacrificed for orderliness' (Thomas and James, 2006). Riessman (1993) feels that the selection of initial categories too early in the research process, may be wrong, risk over prescription and sacrifice data richness; which may mislead later interviews and subsequent theory formulation. Heath and Cowley (2004) expand on this and question whether this has the effect of closing down theoretical avenues, and moving it down irrelevant

paths, rather than opening up the analysis to its theoretical possibilities. Andreski (1972) is also concerned, arguing that focusing on minutiae may neglect consideration of the value or plausibility of an emerging theory; the risk of dismissing theory because it does not follow from a rigorous process.

6.5.2.2.4 Theoretical limitations: can't see the wood for the trees?

Others in the literature focus on Grounded Theory's possible lack of explanatory power; insisting that its focus on relating theory of a phenomenon to its detail (micro), prevents a broader understanding of a phenomenon from its wider context. As such, is Grounded Theory limited to developing small-scale theories that are fixed to context, rather than drawing out anything more useful for broader social life? In this sense, Layder (1993) says Grounded Theory is systematically biased against macro-structural explanations of phenomenon (e.g power and inequality) and is limited in the extent to which it can detect mechanisms underpinning phenomenon. As such, it is limited to 'substantive theory' rather than 'formal theory'. This challenge of Grounded Theory seems to come back to its epistemological roots in interactionist constructivism rather than structuralism.

6.5.3 Glaser vs. Strauss in Grounded Theory

The views of the two originators of Grounded Theory diverged in later years. Their main differences were principally around the following which are described in more detail below:

- *Prior reading:* Glaser encourages general, wider reading around the topic whereas Strauss encourages more detailed and focused reading;
- *Discovery:* a different emphasis on induction, deduction and verification in the formation of theory;
- *Coding:* the separation of coding into prescribed procedures (Walker and Myrick, 2006).

Glaser (1978, 1992) is generally viewed to have remained faithful to the original Grounded Theory whilst Strauss (Strauss and Corbin, 1990) revised their approach (Annells, 1996). Glaser (1992) subsequently claimed that Strauss' approach is so far removed from Grounded Theory, that it can no longer be considered as such; instead labelling it as 'full conceptual description'. Glaser (1978) did himself extend Grounded Theory beyond the original text (Glaser and Strauss, 1967) to explain in more detail concepts such as theoretical sampling, theoretical coding and use of theoretical memos. However, Strauss and Corbin (1990) diverged from the original concept the most, by focusing on developing the analytic techniques and providing guidance to novice researchers. Some feel (Keddy et al., 1996) that this has produced a rigidity never intended for Grounded Theory as outlined above.

Regardless, it is easy to focus on difference rather than commonality. Yet, it is important to remember that both approaches are centred on discovery of theory; one enters the field open to realising new meaning and the other, via cycles of data gathering and analysis, seeks to progressively build on a core theme around which other insights are integrated.

6.5.3.1 Prior reading

Glaser (1978) says that prior reading should be based on the general problem area in order to allow one's mind to expand to a wide range of possibilities; learning not to know is crucial to maintaining sensitivity to data. More focused reading early on is discouraged to try and limit the formation of pre-formed theories; this should only occur "when emergent theory is sufficiently developed to allow the literature to be used as additional data (Hickey, 1997)" (Heath and Cowley, 2004, p. 143).

Glaser (1998) discusses the risk whereby as a theory begins to emerge, literature of close relevance is subconsciously recognised and, whether intentionally or not, can bend the emerging theory from its true path. Glaser even goes so far to say that initial research questions should not even state what it is they want to know of the problem, rather, merely state that there is problem to explore; in order to perturb the risk of preconceptions shaping what is to be known (Heath and Cowley, 2004).

Conversely, Strauss (1987) acknowledges that the researcher's construction of self, for example cultural and geographic situatedness equally shape emerging research themes early on, as much as in-depth reading around a problem. Hence, he argues that both past experience and literature may be used to stimulate early theoretical sensitivity and generate hypotheses (Heath and Cowley, 2004). This then relates to processes of theoretical discovery and how this varies between Glaser and Strauss.

6.5.3.2 Discovery

For Glaser (1978, 1992), induction remains the key process, with the researcher moving from the data to empirical generalisation and on to theory (Bulmer, 1979 cited in Heath and Cowley, 2004). Through this process, theoretical memos are used to record ideas and potential insights. He discourages the temptation to fit preconceived or prematurely developed ideas, however creative they may appear (Heath and Cowley, 2004).

Whilst Strauss still focuses on discovery as much as Glaser, and 'the need to remain puzzled and warnings to escape from that which blocks new perspective', deduction and verification dominate this revised approach (Strauss and Corbin, 1990). This requires the asking of numerous questions and speculation throughout the 'constant comparative' about what might

be rather than what exists in the data. Some argue this could lead to sampling and selection of data to fit pre-conceived ideas (Heath and Cowley, 2004). However, is it that Strauss and Corbin's approach has been mis-read? Induction via ongoing data comparisons is clearer in the second edition (1998) of their book (Heath and Cowley, 2004) but are adamant that the role of induction should not be over-stressed. However, rather than emphasising deduction followed by verification, they talk of deduction followed by validation and elaboration from further data comparisons, in order to help ensure emergence (Heath and Cowley, 2004).

Glaser has heavily criticised Strauss and Corbin, stating that their insistence to construct theory around a predetermined framework is damaging. He believes that 'rather than demanding detail of theory, parsimony, scope and modifiability should be adopted; theoretical saturation can be achieved without complex details, indeed these can strangle workability' (Heath and Cowley, 2004).

6.5.3.3 Coding

Strauss and Corbin's (1990) finer, more systematic coding procedures split coding into three stages: open, axial, and selective. Proponents argue this is more conducive to a more interpretive and constructivist stance (Duchscher and Morgan, 2004; Cutcliffe, 2000 in Heath and Cowley, 2004). Glaser (1978) however refers to the first stage of coding as 'substantive coding'. Some, Kendall (1999), suggest theses initial coding stages differ only in the emphasis on emergence. But others (Heath and Cowley, 2004) feel that this difference is of profound importance for ensuring the theory's relevance. The intense questioning advocated by Strauss and Corbin (1990) generate hundreds of codes that necessitates considerable reduction (and the extra level of axial coding) which by inference, may lead to a stronger theory and clearer audit trail (Heath and Cowley 2004). However, whilst the specified coding framework produces a linear model of causes, intervening conditions and consequences that explain the phenomenon, context, actions and interactions; it risks positivistic linearity (Heath and Cowley, 2004).

Kendall (1999) also suggests that Strauss and Corbin's (1990) last coding procedure of selective coding is similar to Glaser's (1978) theoretical coding, but that they are used differently to generate different types of theory. It is the differences inherent in the terms 'selective' and 'theoretical' coding that are of key importance. In Strauss' framework, rules rather than interpretation take hold perhaps at the expense of insight. In their later work, Strauss and Corbin (1998) also modify their position in relation to coding and theory construction in that the stages and levels of analysis appear less contrived (Heath and Cowley, 2004). They claim a rigidly staged process was never intended.

In summary, the researcher should mix the two approaches with caution, aware that they may violate philosophical underpinnings of both; boundaries between the two should be maintained rather than a synthesis attempted (Heath and Cowley, 2004). For the purpose of this research, Glaser's approach is preferred for the reasons outline above: more inductive as opposed to deductive, avoids the risk of more positivist skews on the data due to the level of reduction and manipulation. However, in adhering to Glaser's approach, a stronger reflection on the social constructed nature of knowledge, and risk of pre-conceived ideas is required.

6.5.4 Summary

Grounded Theory seems to complement the more prevalent use of quantitative methods, and more quantitative forms of qualitative methods, in the farmer decision-making literature. It provides a primarily inductive means to draw insights from the social world from interpretativist and constructivist epistemologies in challenge to more positivist and reductionist approaches which have dominated natural resources management.

The existence of divergence in approach between its two originators, Glaser and Strauss, in my view is constructive in that it forces the researcher to delve deeper into what it means to draw truthful insights from interactions with others; both an appreciation of the limitations of this as well as how to make any emergent theories more useful.

Usefully, the literature has identified that in applying Grounded Theory I need to clearly align my thinking to either Glaser or Strauss, and as such:

- Be clear on my ontological stance (primarily inductive or deductive reasoning in knowing what knowledge is)
- Manage the epistemological constraints (where on the spectrum between positivism or interpretivism/constructivism, knowledge can therefore be known and how)
- Manage the risk of over prescription (tying in with ontological and epistemological stance above) which clearly links to the formulation of meaningful and robust theory
- Be aware of the theoretical limitations of using Grounded Theory (do I want to focus on drawing theory from the detail of the trees only (micro)? What about the broader context of the forest? (macro)).

All of the above have practical implications for my research. For example, allowing sufficient time between interviews to undertake prescriptive coding of data (as per Strauss). Or by leaving more detailed reading and formulation of conceptual framework to much later in research process to help avoid pre-conceived theories (as per Glaser); potentially incurring research programme risks further down the line.

6.6 Methods

This section touches on the various qualitative methods available to collect data for the purpose of this research. To recap, this research is positioned within systems thinking, drawing on idealist ontology, and interpretivist / social constructionism, via Grounded Theory as the means to acquire this knowledge. As such, this rules out more positivist and quantitative means of data collection such as surveys and questionnaires (whether postal or online). It does however leave interviews, focus groups and participant observation as methods to consider.

6.6.1 Qualitative methods

As set out in Table 6.2 , there are various pros and cons regarding each qualitative data collection method for this research. Interviews are selected as the data collection method for this research, as they tend to fit with more systems thinking as a 'world view', that recognise the context embedded nature of complex sociological phenomena, looking to draw insights rather than verification of pre-formed theories (Gilbert and Stoneman, 2016; Edwards and Holland, 2013).

Table 6.2 Overview of qualitative data collection methods

Method	**Benefit**	**Dis-benefit**
Participant observation	Emphasis is on depth, context and intensity and seeing things from the perspective of those studied (farmers). This would be very revealing and would provide valuable insights for this research.	More suited to ethnographic research methods. Requires intensive time and resource and willing hosts which are not possible within the constraints of this research.
Analysis of texts and linguistics	Emphasis on the importance of language, and terminology used, in understanding. This encourages a linguistic focus on the *process* of understanding; more so than just what is understood.	More suited to hermeneutics approach, unlikely to provide opportunity to answer research questions other than review of online material and videos.
Focus groups	This would be insightful and provide opportunity to co-create knowledge through group discussion and exploration of emerging themes, particularly if this followed interviews. This would fit various methodologies including grounded theory, narrative and case study approaches.	Would need careful management to ensure all voices heard, would not be possible to undertake on participants farm therefore risk of for-going in-depth knowledge. Basically a choice between co-created knowledge and in-depth knowledge. Due to research constraints, interviews chosen above focus groups.
Interviews	Provide opportunity to gather in-depth insights, particularly if in participants home. This would fit various methodologies including grounded theory, narrative and case study approaches.	Need to be carefully managed, and pitfalls in poor interviewing style avoided. Risk that misses out on co-created knowledge.

6.6.2 Interviews

Interviews have been selected as the qualitative data collection method to use in this research. Various approaches to interviewing have evolved over time, in part due the evolution of philosophical underpinnings and changes in broader society. As well as variance in style and structure, interviews can vary by type (e.g. ethnographic, narrative, psychoanalytic), in terms of the numbers of people present (e.g. online, couples, focus groups), where interviews take place, the weather conditions that day, and the tools used in the interview (e.g. photo elicitation, drawings). Such choices, as selected by the researcher (and by interviewees in some instances), influence the data collected from that particular interaction in time and space (Edwards and Holland, 2013). In this sense, the researcher and to some extent the interviewee, is an instrument of data collection.

Critics of the interview process argue that such variance results in inconsistency of data collection and the extent to which research findings can be generalised and transferred to other contexts (King and Horrocks, 2010). Arguably this can be the case, if qualitative research is poorly executed and lacks rigour. But equally, Edward and Holland (2013) argue that such a critique is redundant, as qualitative research seeks to explore subjectivity rather than notions of objectivity in social phenomenon. Others argue that extrapolation of themes that are "generalizable to similar social situations or subject positions" is reasonable and knowledge is not entirely context dependent (as per post-modern constructivist perspectives) (Bastalich, 2009, para. 2.2.). The researcher needs to be aware of the scope for inconsistency of style across these different factors particularly if adopting mixed methods. However, Mason (2002) argues that despite these variations, researchers share commonalities and seek in all interviews to 1) exchange dialogue in an interactional way, 2) start off with topics and themes they wish to cover and 3) recognize that knowledge is situated and that knowledge is co-created between interviewer and interviewee.

Forming a rapport with interviewees is critical in the interview process to allow interviewees to feel at ease so that they are willing to share information (Fink, 2000). This is enacted by the researcher's manner of speaking, their dress and body language for example (which is arguably within an individual's control) but also by other traits such as our gender, socio-economic background, ethnicity etc. (less within an individual's control). Rapport, although beneficial to the interview process, also brings with it a risk of interviewees leaning towards saying what they think the researcher may want to hear, or the researcher inadvertently loading their questions or affirmations with bias (Hammersely and Gomm, 2008). As such there is a risk,

which has been raised in particular in feminist literature, of exploitation where “rapport is used instrumentally to draw them out in order to get ‘good data’ (Cotterill, 1992; Duncombe and Jessop, 2007; Finch, 1984).” (Edward and Holland, 2013:80). Rigorous researchers will take care in allowing rapport not to pass into friendship and intimacy, and thus affecting the integrity of the researcher as an instrument of data collection.

6.6.3 Undertaking interviews

The behaviour and oration of the interviewer (researcher) may affect the responses given by interviewees (farmer). For example, and very simply, a non-Welsh speaker may be at an inherent disadvantage in gaining the trust of Welsh farmers who first language is Welsh. Various modernist to post-modernist perspectives capture assumptions around the effect of the researcher, and likewise the interviewee, on data collection and knowledge creation in the interview (e.g. whether conscious perspectives or sub-conscious socially subjected positions, and the multiple subject positions that researchers and interviewees covertly negotiate in interviews, influencing what is told and what is not told) (Bastalich, 2009). This can be in terms of how meaning in construed in the words used by both participants, how the research problem is initially framed, the researcher’s questioning style, their body language, and their use of words; basically the tools (via their body, words, aids) they use to obtain data from the interviewee.

Both researcher and researched bring with them concepts, ideas, theories, values, experiences and multiple intersecting identities, all of which can play a part in research interaction in the qualitative interview (Edward and Holland, 2013). The researcher must be reflexive and recognise themselves both as part of the research process and the power relations that permeate the research encounter of the qualitative interview (Hammersley, 2012). The researcher should acknowledge and reflect on the interviewer effect rather than deny its existence (Finch, 1984; Riessman, 1993; Tang, 2002).

Small subtle communicative signals, which may be thought of as ineffectual, are equally as important; for example, the space left between questions, the number of affirmations and prompts given. Effective interview styles seek to meld and adjust to the mannerisms of the interviewee; for example, some people may need more prompts than others, for some people it may be necessary to interject regularly. Regardless, the literature generally encourages researchers to avoid leading questions and negative questioning, and to seek clarification on responses that are not clear in order to avoid erroneous inferences. Researchers are encouraged to practice their interviews on others prior to starting in the field. It is through these subtle signals and interactions that the role of the interviewee, as well as the

interviewer, should be acknowledged in shaping the data collected from interviews (Edward and Holland, 2013).

6.6.4 Sampling approach

This research is based on purposive, or theoretical, sampling of research participants (Robson, 2011). This means that the research does not start with representative sampling of farmers across Wales based on pre-determined factors. Instead, further farmers are sought for interview if, following each interview, the researcher feels there are more insights to be gained (Hutchinson et al., 2010).

This sampling approach is common in qualitative research, whereby the researcher determines the number of interviews needed, stopping data collection when they feel that all possible insights that could be drawn, have been covered (King and Horrocks, 2010). This does however incur a risk that the researcher may undertake fewer interviews than required to realise a more complete understanding of the situation. Too few interviews could result in the researcher being dependent on drawing limited insights from a few data sources (Fink, 2000). Equally, there is a risk that a researcher could undertake too many interviews and as such, risk drowning in a swathe of un-manageable interview data. Different researchers could deem different numbers of interviews to be representative. More often than not, the number of interviews may be constrained by funding limitations, timescales and the personal circumstances of the researcher.

Accessing people to participate in the research may be easier or more challenging depending on the type of people and the sensitivity of the research. This research comprises interviewing farmers; it may be more difficult to make contact with large agri-business farms compared to say smaller, more environmentally concerned owner-occupied farms (or indeed the opposite depending on the farmer's circumstances). The effort that researcher's make in reaching such hard-to-reach participants is likely to influence data collection. Pitching the number of interviews just right will ultimately the robustness of any theory generated.

Edward and Holland (2013:5) feel that sampling in qualitative research depends on the context of the research "since whom you research and interview is totally dependent on the nature and design of your study". They even go on to say that the term 'sampling' is inappropriate, "given that the focus of data generation in qualitative research is on the process rather than an end point of numbers" (Edward and Holland, 2013:5). They argue that selection of participants should be made in light of the relevance of that participant to research aims and questions, and in enabling you "to develop the theoretical ideas that will be emerging in an iterative process between your theory and your data" (Edward and Holland, 2013:6). This suggests a

risk of omission in data sampling however. The researcher needs to manage this by iteratively and dynamically shifting between data recording, data interpretation and analysis in ensuring that they feel all insights are reasonably covered; but in a meaningful and manageable way. This draws on Glaser and Strauss' (1967) belief that data collection and analysis phases of research are not separate but are inextricably intertwined.

6.7 Data collection

6.7.1 Sampling of participants

There is no database nor established network of farmers practicing regenerative grazing practices in Wales. As such, farmers were identified via correspondence with Farming Connect, and via Google searches. Efforts were also made to identify suitable farms via various UK-wide farmer networks, social forums, media and websites (LEAF, Regen-Ag, Pasture for Life, NFU, AHDB, Agricology, Mob Grazing Scotland, Farmers Weekly) and talking to environmental organisations.

What was interesting from this search, is that a whole range of grazing practices exist in Wales, some of which (it is argued here) are partially regenerative because they adhere to some of the six principles of regenerative farming (see Figure 2.1). It became apparent that some of these farms are in a long, steady process of becoming more regenerative (i.e. working their way towards applying more of the principles), whereas some are fairly static, and happy to stay as they are (having only adopted one or two of the principles). At this stage of the research, it made sense to focus the sampling to these types of farms in Wales, those that have adopted some but not all of the regenerative farming principles. It was realised, that in talking to these types of farmers, a deeper fuller understanding of the 'transition' to regenerative farming would be obtained.

6.7.2 Interviews

As shown in Table 6.3 , nine in-depth interviews were undertaken for this research in 2019. The first five interviews took place in January to April at farms across Wales (see Figure 6.2 6.2). A break was then taken from interviews to focus on identifying early concepts for subsequent interviews. The remaining four interviews then took place in September to November 2019. Each interview lasted 2-3 hours and took place at the farm, often including a walk around the farm. Whilst the number of interviews were low, they were very in-depth in nature and generated significant data for analysis. As described in 2.4.1, the numbers of farmers established or trialling regenerative grazing were inherently low in 2016/17. The farms interviewed for this research are described in Table 6.3 .

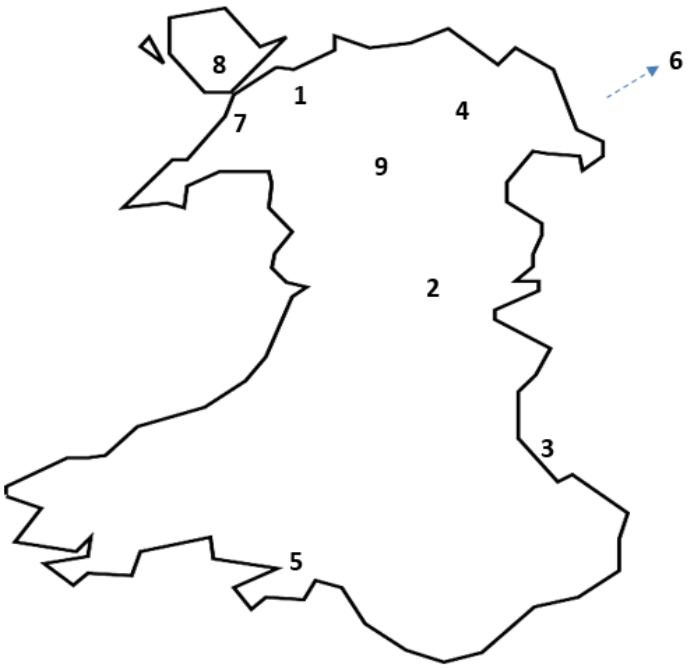


Figure 6.2 Location of interviewed farms in Wales (and Scotland and England)

Table 6.3 Summary of farms interviewed for this research

No.	Farm type	Farm owned land (ha)	Total grazing area (ha)	Current grazing practices	Previous grazing practices	2019 regenerative 'score'[1]
1	Sheep, upland	26 plus commons land and grazing contracts	Varies each year	Continuous	Continuous	3
2	Sheep, upland	566	606	Trialling rotational (on part of farm)	Continuous	7
3	Dairy, lowland	161	403	Mob, established since 2013	Continuous	8
4	Sheep, lowland/upland	81	81	Holistic, experimenting since 2018	Continuous/ Rotation	8
5	Beef, lowland	26	52	Holistic, experimenting since 2018	Continuous	7

[1] The 'regenerative score' (out of 9) is indicative and based on the degree (1-3) of i) rotational grazing, ii) chemical inputs, and iii) the diversity of the pasture's sward.

No.	Farm type	Farm owned land (ha)	Total grazing area (ha)	Current grazing practices	Previous grazing practices	2019 regenerative 'score'[1]
6	Mixed, lowland	1214	1214	Holistic, slow transition	Continuous	7
7	Beef, lowland	16	40	Holistic/mob	Continuous	7
8	Dairy, lowland	404	404	Rotational	Continuous	4
9	Dairy, lowland	2000	2000	Rotational	Continuous	4

As shown in Table 6.3 , the farms vary considerably in terms of grazing area, type of farming and current grazing practices. All are experimenting in a move away from higher input, continuous grazing systems. To give an indication of the extent the principles and practices of regenerative grazing has been taken up by each farmer, I have given each farm a 'regenerative score'. This is scored out of nine and is based on the degree of i) rotational grazing (score 1-3), ii) chemical inputs (score 1-3), and iii) the diversity of the pasture's sward (score 1-3). This shows that Farms 2-7 were fairly well progressed towards regenerative grazing, and Farms 1, 8 and 9 were less progressed along the regenerative scale.

Figure 6.3 sets out how the interview data was recorded and transcribed for subsequent coding.

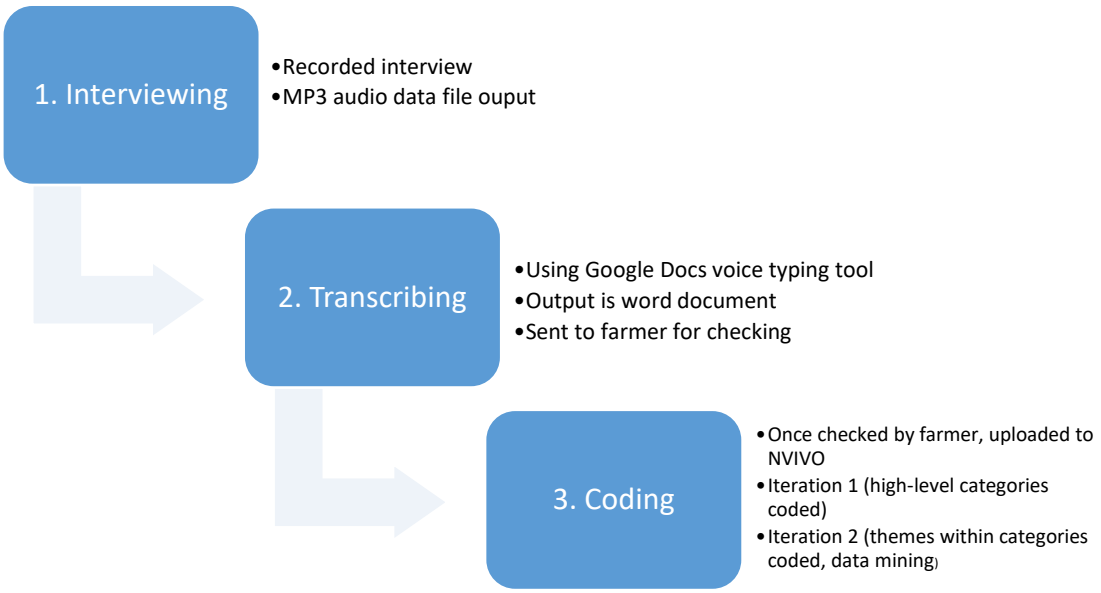


Figure 6.3 Process for data recording, transcribing and coding

6.7.3 Access, ethics and informed consent

As touched on earlier, the researcher's world view shapes the data collection process early on. As the 'world view' determines what is 'good' or 'bad' in terms of data collection, ethical research considerations are important in data collection as well as at each stage of research (van Deventer, 2009). For example, an insight from an interview may be ontologically and

epistemologically justified, but the interviewee may be unhappy with how representative the insight is, how they have been treated, or what argument it may be being used to support, and as such this raises concerns about ethical validity.

The researcher has a bearing on what data is collected in interviews and what is not via neutrality of questions, setting, timing etc. However, a researcher must also make other ethical decisions, which could influence data collection. For example, whether to allow interviewees to change their interview responses post interview or to pull data from research at any point. Clearly, researchers can be driven by personal interests, which if overtake the concern for data integrity and their duty to contribute meaningfully to society and science, can have a bearing on the data collected. In such instances, data collection may be at risk to fraudulent activity (fabrication or alteration of results) by researchers.

A robust ethical philosophical framework underpinning research is essential to ensure that researchers "actively do good" in society and that research participants are free from harm (van Deventer, 2009:46). Various codes of conduct guide good consideration of ethics in research (e.g. Singapore Statement, UKRIO) however, ethics must be rooted more deeply via adoption of ethical virtues as a researcher before, during and after research. This comprises actively pre-empting, accepting responsibility for, and managing the consequences of my research; and adopting continuous self-critical reflexive research by reflecting on assumptions, the risk of bias, use of language, power relations from the moment I start my research process.

van Deventer (2009) sets out how ethical research considerations are important at each stage of research. Before research begins, I need to reflect on what I mean by 'good', 'benefit' and for 'whom' (e.g. society or private, companies or communities), as well as the integrity of the core assumptions (conscious and unconscious) underpinning my research. On what basis am I assuming regenerative agriculture is a 'good' thing for society? My research seeks to maximise the societal 'net gain' from nature's 'goods and services' derived from 'good' practice regenerative agricultural practices. This assumes a rather instrumentalist or mechanistic view of the natural world, compared to other intrinsically organic or ecological conceptions (Livingstone, 1995); each incurs different moral stances to the natural world. It also raises social justice questions around equity between people, now and in the future.

Inevitably I am bringing my own pre-conceptions of what is good governance of natural resources to my research, which have considerable ethical ramifications upon the validity of my research during data collection, after data collection and in presenting my findings. For example, what do I mean by 'more effective' public intervention and how do I legitimise where this is needed and where it is not? Is it even ethical to assume that public intervention into

private property is warranted (depending on my ethical standing) and under what circumstances is it justified? If agri-environment payments are involved, there is a real risk this could lead to unethical and perverse incentives. There are a vast array of ethical considerations to make in my research at each stage, which will evolve as my own development as a researcher progresses. A preliminary attempt to pre-empt some of these ethical considerations is set out in Table 6.4 .

Table 6.4 Examples of ethical considerations at each stage of research

Research stage	**Examples of ethical considerations**
Before research begins	Expose embedded assumptions; process of identifying and selecting farmers to engage, ensure representative; timing of engagement; need for trusted relationship, ethics of using an existing trusted relationship; communicating clear understanding of how data will be used, potential implications for farmers of findings, seek consent.
During data gathering	Tensions between chosen ontology and epistemology and ethical implications? E.g. an insight from an interview may be ontologically and epistemologically justified, but if the interviewee is unhappy with how representative the insight is, or what argument it may be being used to support, raises ethical validity. Other considerations are potential to impact on what data is provided in interviews and what is not; careful design of data gathering e.g. neutrality of questions, setting, timing.
After data collection	Epistemological and ethical pros and cons of permitting interviewees to change their interview responses post interview; allowing opportunity to pull data from research at any point; interpretation of data e.g. a post-modern deconstruction of discourse and meaning to critique claims of trust vs. hermeneutic focus on deeply embedded historical social practices that produce every day meaning (but arguably non-generalisable), is social constructionism compatible with notions of universal social justice (Sayer and Storper, 1997)? Managing expectations of interviewees as to how their data will be used.
Presentation of findings	Accessibility of data to multiple, pluralist members of society and various audience expectations; managing commercial or personal sensitivities e.g. anonymised data; ensuring can validate that findings are transferable or generalizable to similar situations in other contexts; maintaining independence of research.

6.8 Approaches to data analysis

For reasons outlined above, a good researcher will feel a responsibility to accurately interpret and draw insights from the interview data (Fink, 2000). This is inevitably part of the interview process as the researcher interprets the responses of the interviewee during the interview, which in part aids the researcher in choosing their follow-on question. As such the two processes are inextricably inter-linked and hard to definitively separate (Glaser and Strauss, 1967).

The researcher arguably has responsibility during the transcribing and then coding of the data from the interview ("the process of assigning conceptual labels to different segments of data in order to identify themes, patterns, processes and relationships" (Gilbert and Stoneman, 2016:103)) which links to the style of interview e.g. thematic, narrative and questioning style. "As such the researcher is inextricably part of, and a key determinant of, what data is collected and how it is interpreted and the "building of theory from 'the ground up' (Charmaz, 1995:37)" (Gilbert and Stoneman, 2016:103). Unavoidably, 'translation' can involve inaccuracies, mistakes and interpretations (Kvale, 1996) and the researcher must traverse the challenges of deciphering the interviewee's intended meaning, the meaning received by the interviewer and how they internalise and make sense of this meaning.

6.8.1 Applying Grounded Theory

The Grounded Theory approach is based on *initially* generating numerous, detailed categories and associated labels. These are then combined into larger, more generalised categories. The emerging properties and relationships between codes provide the beginning of theory – building theory from the ground up (Charmaz, 1995). Systematic building helps to avoid 'theoretical flights of fancy' (Charmaz, 1995) and ideas are traceable back to data (for audit/end user confidence). This process is shown in Figure 6.4 .

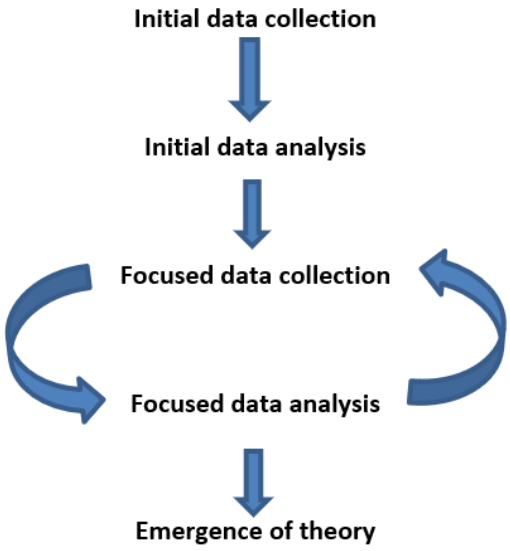


Figure 6.4 The Grounded Theory process

6.8.1.1 Research diary

A research diary, consisting of memos completed after each interview, was created in NVivo. This permitted salient points, emerging thoughts as well as critical reflections to be recorded. Hutchinson et al. (2010) suggest creating a 'memo structure' at this point in the application of Grounded Theory, to categorise all the types of memos being created (e.g. records of

meetings, post-event reflections, classification of nodes, emergent concepts and thoughts, reading activities). For the purpose of this research, this was collated together in an 'insights paper' which was prepared after the first five interviews (in July 2019).

The approach undertaken for this research may also have been improved in hindsight, by importing reading notes into NVivo as advocated by Hutchinson et al. (2010), in order to aid ongoing conceptual development. Likewise, there may have been benefits in importing relevant literature into NVivo to inform an appropriate purposive sampling strategy. Having it all within one place, NVivo, Hutchinson et al. (2010) argue, helps to ensure literature informs the ongoing analysis by identifying potentially important questions to explore in future (theoretical) sampling of interviewees.

6.8.1.2 Transcribing

Each semi-structured interview took place at the farm (except one undertaken by video conferencing) using open questioning and lasting approximately two hours. One interview was part conducted in the field (literally). The farmers were asked to read and sign an information sheet and consent form. Then, with their permission, the interview was audio recorded. Google voice typing was then used to transcribe each interview, which was checked and amended by myself. The transcript was then sent back to the farmer for comment (none received) and to check any unclear words. The final transcript was then uploaded into NVIVO as data files with relevant meta-data attributed (date of interview, location, time).

6.8.1.3 Coding

Robson (2011) sets out three stages of Grounded Theory coding, more akin to Strauss and Corbin's (1998) variation of Grounded Theory. These coding stages are not necessarily sequential and can overlap.

- *Open coding:* find categories in data (don't fix to pre-determined categories, although conceptual baggage of researcher will inhibit this somewhat). Within each category, look for several sub-categories (*properties)* and then for data to give dimensions (by which properties may vary and to seek extremes on these spectrum). Interpreting not summarising, drawing out theoretical possibilities of data. Units could have multiple labels.
- *Axial coding:* find relationships between categories. A *coding paradigm* (or logic diagram) is developed which identifies:
  - a *central category* (find concepts)
  - *causal conditions* (categories of conditions that influence phenomenon)
  - *strategies* (the actions/interactions that result from central phenomenon)
  - *context and conditions* (that influence the strategies)
  - *consequences* (the outcomes of the strategies for this phenomenon)

- *Selective coding:* conceptualise and account for these relationships via core categories.

Conditional propositions (or hypotheses), or theory, is built via continual interaction with the data; making comparisons and asking questions of the data. Generates a 'substantive-level theory' relevant to specific problem, group or issue.

6.8.1.3.1 Identifying early concepts (open coding)

A first round of coding followed, whereby upon reading the transcript, portions of text were assigned to codes as they emerged. If a code (or node) already existed for that concept, the text was stored there. The codes are structured into sub-categories as given in Table 6.5 to avoid long-lists of codes and to aid understanding.

Table 6.5 First level coding (open coding)

Code	**Sub-codes**	**Explanation**
Farm	Farm history Farm business and diversification Farm land holdings Ownerships, tenancies, land rights	Detail about the farm, its businesses, ownerships and land rights.
Farmer agency	Aspirations Motivations and values (triggers of change) Family Profitability Sense of pride Succession planning Management style Knowledge (of regenerative grazing) Perceived control and influence Perceived solutions	Detail of the farmer themselves, what they feel, what they believe, what they know.
Farmer observations	Benefits of grazing practice Biodiversity observations Farm resilience	Farmer observations of the real world, the outcomes and impact of grazing practices.
Farming context	State of farming Brexit and future agri-environment Land agreements	Comments made in relation to the socio-political context framing farming, not about this farm per se.
Farming practices	Grazing practices Diverse leys	Description of the farming practices, with particular focus on grazing – what they were and how they are changing.
Process of experimentation	Description of experimentation Farming interventions Factors affecting experimentation Environment	Commentary around the process of experimentation, how the farmer has approached it, and what they experienced

Code	Sub-codes	Explanation
	Farm Farmer Social Institutions and Law	(in particular factors relating to this change)

Due to the depth of data collected in the interviews around factors affecting transition to regenerative grazing, these codes were sub-divided further, as shown in Table 6.6 .

Table 6.6 Factors affecting experimentation

Code	Sub-codes
Environment	Weather
Farm	Assets Livestock breeds Surplus pasture Scale Size Type Finance Access to capital Debt Access to finance Access to grants Investment in infrastructure Management Labour Layout Control of resources Time Complexity Planning Unexpected events
Farmer	Family Health Legacy Mindset Succession Age Knowledge Personality Principles

Code	Sub-codes
	Reputation Return to farming
Social	Farming community Market demand Welsh language
Institutions and Law	Agri-environment Brexit Land rights, landowners

6.8.1.3.2 Finding relationships (axial coding)

Using the 'coding stripes' tool in NVivo allows codes to be examined to identify any potential early relationships between emergent concepts (from *open coding*). Hutchinson et al. (2010) recommend that this should involve examining relationships between concepts, and dimensions such as conditions, contexts, processes and outcomes that relate to the studied phenomenon.

For this research, the data was analysed to see if there are any relationships between 'factors of experimentation' and 'components of the system' (i.e. farmer, the farm, and farming context) i.e. what components of the system did the farmers note were enabling or constraining to transition to regenerative grazing and in what way? This aim of axial coding is to glean some understanding of the conditions and system properties that may give rise to farmer transition to regenerative grazing.

To aid understanding, the relationship is attributed as 'enabling' or 'constraining' in the data, appreciating that this is likely to be dependent on the conditions of the said relationship, and will vary in different farm systems.

This exercise revealed that most codes (Table 6.7, first level coding) were spoken about in terms of constraining farmer transition to regenerative grazing (see second level coding). The exception being 'Farmer' and 'Social' related variables, which are both spoken about as principally enabling. This suggests that overall, the farmers interviewed feel that they are trying to facilitate change within a system which is largely constraining, particularly with regard to 'Institutions and Laws', 'Farm' and 'Environment' variables. However, overall, the farmers spoke about mainly 'enabling' (75%) conditions for farmer experimentation, compared to those which are constraining (25%) change. This is due to the sheer number of references spoken about within the 'Farmer' category.

A summary of early relationships emerging from the data is given in Table 6.7 .

Table 6.7 Emerging early relationships in the data

Code, First Level (no. spoken references)	**Influence, Second Level (% of spoken references in code)**	**Summary of factors raised by farmers**
Environment (9)	Constraining (66%)	Poor weather Risk of drought
	Enabling (33%)	Flat, free draining Soil will carry cattle in wet weather
Farm (104)	Constraining (65%)	Unexpected events Lack of planning time Wrong goals / focus Mis-management, poor choices Lack of control over farm decisions Farm labour reluctant to change / narrow mindsets Lack of farm labour Farm layout not conducive Lack of fund to invest / debt to pay Needing new infrastructure Sunk assets Farm type Farm size Need more pasture to catalyse change Wrong livestock / need native breeds
	Enabling (35%)	Spare land and pasture to kick start change Suitable native breed of cattle Small farm, non-industrial mindset Easier with cattle Investment / time for new infrastructure (water, tracks, electric fencing, herbal leys) Supportive landowner Holistic management principles Focus on profit from land, not livestock Being allowed to fail
Farmer (297)	Constraining (9%)	Disillusioned, financial ignorance Personality (lack of drive, reluctance to change) Lost historical knowledge Lack of knowledge Lack of time to get knowledge Unsure where to access knowledge Narrow college curriculums

Code, First Level (no. spoken references)	Influence, Second Level (% of spoken references in code)	Summary of factors raised by farmers
		Health, age Family disagreements
	Enabling (91%)	Supportive family Younger farmer, more energy Knowledge, obtained via different social media and advisory services Knowledge of soil and land processes Learning from other farmers (peers / networks) Desire to learn Personality (13 traits noted) Returning to farming (fresh perspective)
Institutions and Laws (88)	Constraining (69%)	Cut public services / lack of farm advice and support Focus on production and livestock, rather than profit and land Subsidies focusing on narrow measure of efficiency Agri-environment too prescriptive, no flexibility Agri-environment ad hoc, not guaranteed Short tenancies, weak tenancy rights Mis-trust of third sector bodies Conflicting conversation management practices Lack of local abattoirs Uncertainty of Brexit
	Enabling (31%)	Removal of milk quotas Multiple land rights agreements, flexibility Agri-environment grants (fencing, hedges) Farming Connect funding for soil plans Brexit as a trigger of change / need resilience to it Informal longer tenancies / extra pasture
Social (49)	Constraining (22%)	Big Ag blocking, no profit in it for them to support lower inputs Farming industry / unions in denial, head in sand Low morale in farming, poor reputation Young farmers leaving industry / old farmers can't afford to retire Consumers not bulk buy direct from farmer
	Enabling (88%)	Relatively cheap inputs (but for how long?) Greater consumer awareness / choice (but for how long?) Farming movement ('groundswell') Key influencers / pioneers via social media Consumer demand, direct sell

Code, First Level (no. spoken references)	Influence, Second Level (% of spoken references in code)	Summary of factors raised by farmers
Overall coding (689)	Constraining (25%)	
	Enabling (75%)	

6.8.1.3.3 Developing a theory (selective coding)

At this point, core categories are defined based on the relationships that have emerged (via axial coding) to describe an emergent theory of the socially situated system under study. This is the descriptive process by which the data coding is drawn together (into 'sets') to outline a conceptual framework, or overarching theory. Corbin and Strauss (2008) liken this to the development of a storyline (Robson, 2011).

Coding queries can be used to select concepts (open coding) linked to either 'enabling' or 'constraining' relationships (axial coding). The data can be inverted (the 'flip-flop' technique) so that data not forming that relationship can also be examined, to understand why in some circumstances the same relationship is not holding true in that given context (Hutchinson et al., 2010). This technique may also offer further insights.

The coded data has also been mapped in an online tool called 'Wise Mapping' to show the connections between different system properties (or concepts) and the farmer experience of these (enabling or constraining) in their experience of experimenting in regenerative grazing. The wise maps will also allow relationships between different enabling and constraining factors of experimentation to be explored. Overlaying the 'wise maps' for each interview, and farming system, may indicate whether there are any outstanding emergent questions or theoretical possibilities that have not been explored.

It is hoped at this point, that a theory will begin to emerge, which will help explain the system properties (condition, processes, outcomes) which are more conducive to farmer transition to regenerative grazing in Wales. The end of a grounded theory study is marked by what is referred to as theoretical saturation.

6.8.1.4 Iterations

Good practice, in Strauss and Corbin's (1998) version of Grounded Theory, completes at least three or four subsequent rounds of coding and data analysis (Hutchinson et al., 2010), known as the 'constant comparative'. This research applies two iterations (or 'loops', see Figure 6.4). As per Glaser and Strauss (1967), data from the first five interviews was coded, to identify

initial themes which were explored in subsequent interviews (through *purposive* sampling), so that they could be refined in the next round of data analysis.

6.8.2 Critical reflection

It is fair to say that this research has been informed by Grounded Theory rather than adhered to it in exact terms. In an ideal world, this research would have continued, conducting more iterations and more farmer interviews. However, the ambition of this research has been constrained by numerous personal circumstances (young family, employment, elderly parents, hosting a refugee family) as well as other circumstances not in the researcher's control (e.g. global pandemic, jury service).

However, the approach adopted here is more in keeping with Glaser's original, more 'inductive', Grounded Theory approach (as opposed to Strauss' more 'deductive' revision to the approach in later years) which is preferred here for other reasons as stated above. Despite this limitation, the amount and in-depth nature of the interview data collected validates the use of this data for research purposes.

Inevitably, there is a risk that my research is tainted by my own pre-conceptions of what is 'good' farming, defining this as one that sustains and restores natural resources whilst producing plentiful, nutritious food. This may have had ethical ramifications upon the validity of my research during data collection, after data collection and in presenting my findings. Similarly, what makes a 'good' intervention can be interpreted differently. For example, it could be based on Bentham utilitarianism (in order to 'provide the greatest good for the greatest number'), the Pareto principle (focusing on proportionality and value for money, as per HMT's Green Book) or Kantian 'categorical imperatives' (because it's the right thing to do). Neither are such decisions made in political vacuums and clearly there are ethical tensions between different rationales for decisions, depending on who is making them (e.g. the fossil fuel supported agri-chemical industry and party lobbying).

6.9 Summary

This chapter has justified the use of in-depth interviews for this research, to address the research questions (Chapter 5) and to explore the transition to regenerative grazing in Wales (a specific SES). A challenge will be to draw out knowledge from the multiple ontological perspectives of the interviewees, any apriori knowledge and embedded assumptions, in the interview process so that multiple socially subject positions are explored (boundaries, perspectives, interrelationships) which could skew insights into the knowledge created (in order to understand how bias may be created).

This chapter has also:

- Reviewed qualitative methodologies, deciding upon the Grounded Theory approach for this research;
- Reviewed qualitative data collection methods, and settled upon face-to-face semi-structured in-depth interviews for this research; and
- Set out how data has been sampled, collected and analysed using Grounded Theory.

Chapter 7 Findings

7.1 Introduction

This chapter presents the findings of the nine farmer interviews. The data collected from the farmers is presented as broad 'buckets' prior to delving into them in more detail in the next chapter. This chapter aims to give you a 'feel' for the topics raised and discussed by each farmer – showing that each farmer, chose to focus on different topics – presumably those of most relevance to them, their circumstances, context and farming system. More detail is given for each farm in Appendix 2.

Generally, in the interviews, the farmers were asked to talk about their farm, their grazing practices, why they do these practices, compared to any historic practices, how they may be seeking to change things now and why. They were also asked to describe what may be enabling this change, what may be constraining these changes, and what they feel they can influence, and cannot influence. The information collected was coded in NVIVO and fell naturally into the following categories:

A. The farm (land holding, businesses, workforce, history, ownerships and tenancies)
B. Farming grazing practices (what they do, how and where)
C. The farmer (aspirations, motivations, management style, knowledge, perceptions)
D. The process of experimentation (enabling factors, constraining factors, how they've gone about it).
E. Farmer observations (of regenerative grazing practices primarily)
F. The farming context (Brexit, state of farming, agri-environment and policy).

An overview of each farmer interview is given in four main 'buckets' of information: A) a description of the farm, B) a description of the current, previous and aspirational grazing practices, C) an overview of farmer motivations and finally, D) an overview of the topics raised by each farmer in relation to the take up of regenerative grazing in the UK (see Fig 6.1); all as described by the farmer in the interview. Category E) is summarised in Appendix 3, and insights from both Categories E) and F) are picked up in the following chapters of this research when relevant to do so.

7.2 Farm 1

> "It would really turn around the UK environment, because you wouldn't have these islands of loveliness that the Wildlife Trust has, or Natural Resources Wales has, surrounded by green deserts. You'd have connectivity and things would be a lot more permeable".

7.2.1 1A – Farm description

7.2.1.1 Farm type, size and livestock

Small, upland, sheep farm. The farm has approximately 300 sheep (consisting of 170 Welsh Mountain ewes, 50 cross-bred ewes, 50 rare breeds) plus 25 cows and 20 ponies.

7.2.1.2 Land holdings

The farmer owns 64 acres (56 acres at farm, 8 acres nearby) with further rights to graze 220 ewes on a nearby commons. The farmer also manages a further 500 acres for wildlife benefit for various organisations under 'conservation grazing' arrangements.

7.2.1.3 Farm business

The farm sells most of its finished lambs at St Asaph or Preston. The farm also operates a contracting company which does works such as fencing, woodland management and invasive weed control. The farmer also has full-time job (has since decreased to 3 days a week) as a conservation advisor. The farm also directly sells 'salt marsh lamb' via meat boxes "so that's a bit of extra farm income I can gain £5-600 [total, per year]". The farm also has a holiday cottage it rents out.

7.2.2 1B – Grazing practices

7.2.2.1 Current grazing practices

At the farm, the sheep are grazed (set-stocked) mostly on the mountains in the summer and are brought down in late August / September. The ewes with single lambs are taken up to their 'cynefin' (the patch of land on the commons they are trained to stick to) in May. The ewes with twins stay down near the farm. They come down for shearing, then are back up until September. The sheep are kept outside for most of the year but can be brought inside the sheds for up to a month around lambing. Very little chemicals are applied to the land, and soil fertility is maintained via a farm based composting system. Some lime is added every few years to manage soil acidity.

The farm has sought to diversify its pasture species mix away from monoculture leys. "We're not doing very much reseeding now. I'd like to do more … seeding different species in … rather than just red grass and clover, so we tried to put a really reasonably good mix in and pollinators as well…we use chicory to try and help break up any soil pans that we've got and we've been doing that for years and then just, you know, having red fescue and timothy and different clovers and chicory and yarrow, things like that; just going in to give them a broader range of what there is to eat".

The farmer also does ‘conservation grazing’ on sites away from the farm, in agreement with various landowners. The practices vary depending on the needs of the species or habitats under protection.

7.2.2.2 Previous grazing practices

The farming practices have changed little from above in recent decades. Sheep numbers are down from approximately 525 sheep in the 1980s; a consequence of the removal of the headage payment. The farm has historically been accredited as organic for about 5 years. However, this stopped due to the cost of accredited status, and a lack of nearby organic accredited abattoirs. “So we were organic for 5 or 6 years but we never made a penny more out of being organic than we did being conventional because it used to cost us a million pounds to pay the Organic Farmers and Growers [association] like £800 a year and then … we used sell to somebody that was organic but we had to pay to get the lambs down to Pembrokeshire or somewhere crazy. And by the time we’d done that we didn't make any more money … I think Organic Farmers and Growers don't cost as much as that now … It's still hard for us to access an organic market. There's a limit to how many boxes I can do day today, to chop it up and everything, and now you need various accreditation and licenses and things to sell direct from the farm anyway”.

7.2.2.3 Aspirational grazing practices

The farmer is keen to introduce a type of regenerative grazing, which they refer to as holistic grazing. “I'm trying to get into more of a holistic grazing plan to have longer grass but I'm still failing at the moment on that. I've been trying to do it for about a year and a half”.

“So the plan of holistic grazing is that you fence with a back fence, and the front fence, and you move the animals pretty much every day, sometimes every 2 days. And they are on grass, which is about up to a foot long, and they just sort of eat what they like … You calculate how much they’re going to waste and how much they're going to eat and then you fence an area according to that calculation. And you can use a plate metre to measure what you’ve got in front of you so you can work out the size of your paddock”.

A year after interview, the farmer is now working 3 days a week in their day job and has since started holistically grazing some of the sheep as a trial. They report “I’ve been finishing the lambs much sooner because the grass is so much better which is great”.

7.2.3 1C – Farmer motivations

The farmer and spouse run the farm businesses. Both are middle aged, with grown-up children who have left home.

The farmer is motivated to change as they are keen to increase grass production, and thus profitability via cost savings: “And the advantage of that is that you get some 20% higher production because the way I am at the moment, set stock, my sheep eat all the yummy bits and then they go in another field and eat the yummy bits, and so you'll end up really favouring the rougher grass or the grasses that they like less; you’re going to get more of those and less of the sweeter grasses…and you get less production. So you can, in an ideal world, I would all sort of shut my farm up for a year and then start electric fencing and moving my stock round behind it”.

The farmer is also attracted by the broader, perceived, benefits of holistic grazing including enhancements to biodiversity, environmental resilience, and restoring the natural environment: “It would really turn around UK environment, because you wouldn't have these islands of loveliness that the wildlife trust has or Natural Resources Wales has, surrounded by green deserts. You’d have connectivity and things would be a lot more permeable”.

7.2.4 1D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of topics discussed by the farmer can be grouped under five broad headings: Farmer, Farm, Social, Institutions and Laws and Environment (see Figure 7.1).

Farmer 1 spoke mostly about matters which can be grouped under ‘Farmer’ (8% of narrative) including: farmer personality and attitude, leaving a legacy, the farmer’s past, tradition and practical matters such as time and planning. Less so, the farmer spoke about matters under the heading of ‘Institutions and Laws’ (6%) including land rights, college curriculums, land agreements, abattoir regulations and conservation NGOs. The farmer also spoke about issues that can be grouped under ‘Farm’ (5%), including access to investment, farm type and farm assets such as infrastructure, livestock and pasture. ‘Social’ factors were also mentioned (<1%) including: farmer to farmer learning, and public perception of farming. **Unique to this farmer, was discussion in relation to the importance of farm advisors and conservation land agreements.**

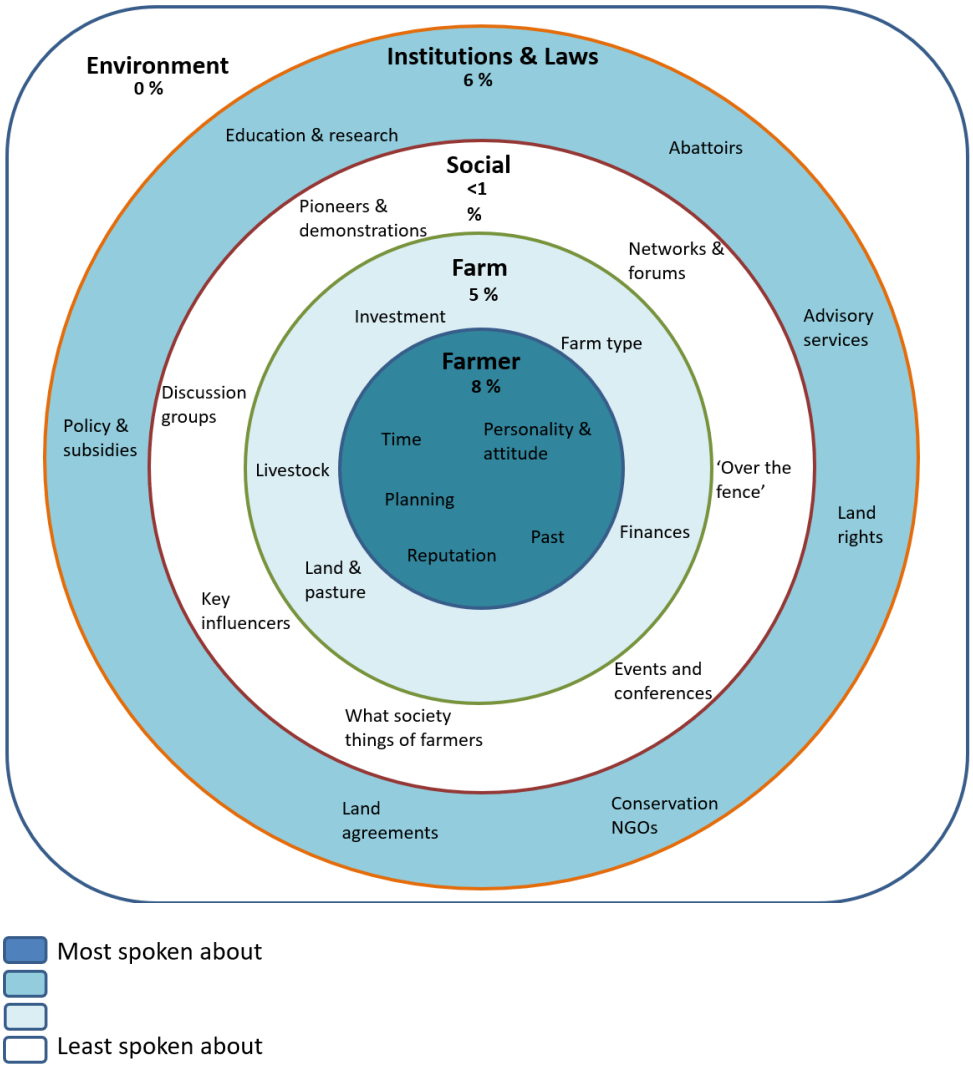


Figure 7.1 Topics related by Farm 1 to the take-up of regenerative grazing practices in UK

7.3 Farm 2

> "Yeah basically grow better quality grass, different varieties in it, putting more chicory, plantain, samfine, birdsfoot trefoil in… Just trying to be more clever with the grass, not just one variety like a lot of agronomists are pushing people to do, but total variation. Some people have pointed out 'oh you've got so many weeds in your field'. No actually they're not weeds, they are herbal plants and so on. So you know, farmers have got a lot to learn, to learn from what actually grows".

7.3.1 2A – Farm description

7.3.1.1 Farm type, size and livestock

The farm is a large, mostly upland, sheep farm with some suckler cattle. Up until Autumn 2018, the farm had just over 1000 ewes, 200 followers and 50 suckler cows. The farm is the process of adjusting to cater more for the UK market in light of Brexit, and is cutting down to 500 ewes, and 50 suckler cattle. "Basically the stock has been cut down because of Brexit and I'd rather make sure that I'm producing what the UK wants at the moment instead of concentrating on the Mediterranean lamb really".

7.3.1.2 Land holdings

The farmer owns a 1200 acre farm (1000 acres of upland, and 200 acres of grassland) and a further 200 acres nearby. The farmer also rents a further 100 acre mountain block.

7.3.1.3 Farm business

All of the finished lambs are processed in Wales, bought by wholesalers and distributed to buyers mainly in Europe including France and Portugal. The farmer uses Promotions Wales which has agents in different countries. Italy is their strongest market but "this is dwindling every year".

7.3.2 2B – Grazing practices

7.3.2.1 Current grazing practices

The farm is currently experimenting in rotational grazing (aiming to move them every 3 days, off 6 acres to the next 6 acre block), from set stocking, with 500 sheep and 680 lambs. "It worked quite well. The grass was recovering so much quicker from it as well, which is good".

The rotational grazing also "…worked really well with the store cattle last summer. We were splitting the field up. They were a bunch of 30 grazing an acre per day but in a strip of 3 acres, so 3 day moves front and back fence. They were grazing it down utilising closer to the 95% of the grass".

The farmer aims for a rest period of around 21 days following each 3 day block of grazing, depending on how the grass has recovered. The farmer would like every field to be about 6 acres … "but obviously not going to be able to do that so if it's a 12 acre field, well they're

there for 6 days". The farmer is reluctant to use electric fencing and would rather use boundaries such as hedges or fences… "I'm quite lazy in a way… so I can just open a gate, push them through and shut the gate"… "because that's helping wildlife, the environment and everything by having those hedgerows in there and shelter for the animals as well".

The farmer is still establishing rotational grazing on the grassland area… "because we haven't been doing it that long either, I'm not nailing it like I should and last summer [2018] because of the drought, knocked us from being able to do it but up until we ran out of grass it was working well".

The farmer is also doing a programme of reseeding pastures to introduce more diverse, flood and drought tolerant grasses; from a legacy of monoculture ryegrass pastures.

The farmer said "there's no exact routine of how I'm doing it but once they've gone off it, 21 days minimum [rest period] depends on how it's recovered"… "playing it by ear really. I'm not strict in that they've got to be off for 21 days and then go back in if it's growing well"… "yeah, learning as we going along".

7.3.2.2 Previous grazing practices

Previously, the farmer's parents practiced continuous grazing at the farm: "it was just put them across those 10 fields instead of maybe one field per 3 days".

The farmer's grandfather in the 1960s, was a dairy farmer using rotational grazing but on a uniform perennial ryegrass, rather than a variety of different grass species. They changed from rotational to continuous grazing in the 1980s, when the farm changed from being just a grassland farm to become a hill farm. The focus changed to producing sheep meat, pushing sheep up in the summer to the hill and bringing them down in heavy numbers in the winter. This system relied on getting winter grazing on other farms "so, you know, quite intensive for what this block of grassland had to do really".

7.3.2.3 Aspirational grazing practices

During 2019, the farmer plans to rear dairy heifers to utilise the grass better, to move the suckler cows up onto the hill to do the conservation grazing, and to develop larger sheep carcases for the UK market (instead of being 60% reliant on exports to Europe).

The farmer wants to utilise more of the grass resource: to grow a minimum of a third more grass every year. "We can control the cost of production … and work harder to grow better grass … so that we can sustain a cheaper price of selling lamb and beef. All the volatility of the

market on that side. So if we can have better grass on one side, we can sustain the hit on the other side".

A longer term aspiration is to introduce rotational grazing to the hill block, using electric fence across certain parts of it. "I think it's going to be an experiment to look into doing and see how well, and if it works we'll continue it. And if it doesn't, well, then we'll re-evaluate it and look at other options".

The farmer wants to rest the pastures over the winter, instead of grazing them, in order to have them ready for spring lambing. The farm has decided to stop sending the sheep away for winter grazing on other farms, and so will be investing in new buildings in 2019 so that the sheep can be kept on the home farm over winter. "I wouldn't mind housing them in here to rest the grassland. So that we can turn out to lamb when it's healthier and then they'll be going out to a nice grass ley so that we reduce the concentrate costs and so on".

The farmer wants to hold back water on the farm, for utilisation and to help avoid soil loss: "Drought wise I want to put more ponds in on the farm. So any hollow that we can dam up to store water, put troughs by them, is something I want to do. And again, it's holding water back from running off the farm quicker".

"I think the main thing is nailing and getting the rotational grazing on the grassland here done properly and then see what else we can achieve after that's proven to work, as well".

"We're getting there, it's not perfect… So you know, we're going to be constantly soil sampling to see the health and addressing issues as well, to help it happen instead of just buying that bag of fertiliser and putting it down. I'd rather use less of that and use more of the science to growing grass as well".

7.3.3 2C – Farmer motivations

The farmer and spouse live at the farm with their two young children. As soon as the farmer took over the farm in 2010, they wanted to focus on grass growth. Winter grazing pressure had heavily damaged the pastures; which the farmer says is a contributory factor to cutting the stock levels.

When the farmer took over the farm, a soil test indicated that the soil's health "was in a sorry state". To start the change, the farmer has started reseeding the pastures, focusing on the fields where "we could produce the most out of first". The farmer's strategy is to feel confident about the rotational grazing on the grassland, before "trying to attack another part of the farm at the same time as well".

The change on this farm has been gradual and steady, since 2010, when the farmer took over the farm. “As soon as we took over from my parents. I had an idea about how I wanted to grow the grass and everything”.

7.3.4 2D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.2).

Farmer 2 spoke mostly about matters which can be grouped under ‘Farmer’ (9% of narrative) including farmer knowledge, personality and attitude, age, family support and succession. This was followed by topics under ‘Institutions and Laws’ (7%) including: land agreements, land rights, advisory services, subsidies, agri-environment policy and conservation NGOs. Less so, the farmer spoke about matters under the heading of ‘Farm’ (4%). This comprised aspects such as the state of the inherited farm, infrastructure, availability and access to investment. The only ‘environmental’ aspects (1.5%) mentioned was changing weather patterns. ‘Social’ aspects (1%) were discussed the least extent and covered farming workshops and events. **Unique to this farmer, was discussion in relation to increasing farm resilience to market fluctuations as a result of Brexit.**

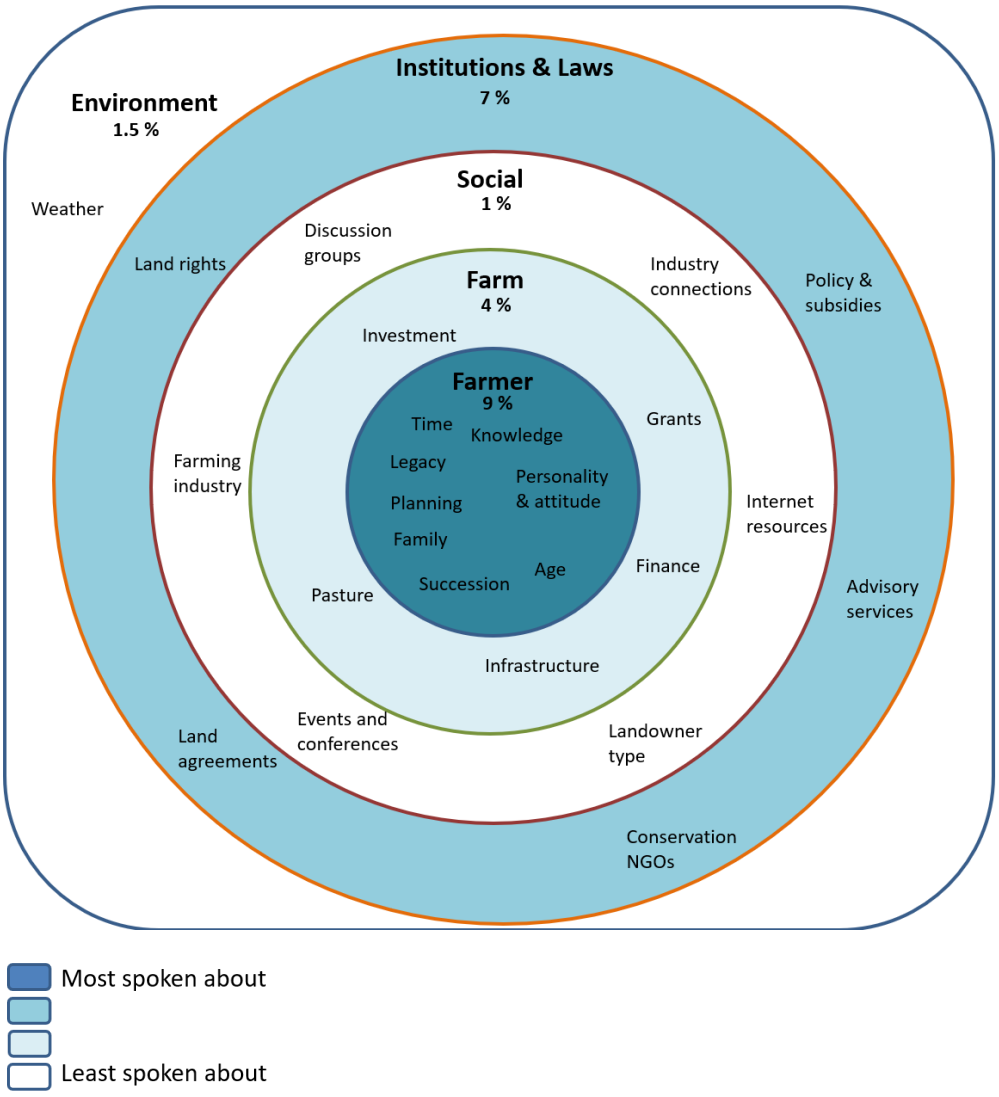


Figure 7.2 Topics related by Farm 2 to the take-up of regenerative grazing practices in UK

7.4 Farm 3

> "It's quite a thing to manage but once they get into the system, it worked brilliantly. Because the cows, you know, you're grazing them on the right amount of grass to produce the milk that you want".

7.4.1 3A – Farm description

7.4.1.1 Farm type, size and livestock

Large dairy farm, 500 dairy cows, 250 young follow-on stock, and a small Hereford herd (12 cows, their calves and previous year's calves).

7.4.1.2 Land holdings

The farmer owns 400 acres and another 600 acres is rented from surrounding farms. Some of the land is used to grow maize.

7.4.1.3 Farm business

The dairy business is a partnership between the farmer, spouse, their sons and their partners.

As well as the dairy unit, the farm has two other enterprises: a large 200,000 broiler chicken unit and an anaerobic digester. The 500kW anaerobic digester (AD) unit is run on waste from the cattle (60% of feedstock), chickens (15%), maize and silage (25%). The AD unit supplies the dairy and chicken enterprises with electricity and "quite a bit" is exported via an annual tendering process. Milk is sold to Morrisons via the Arla cooperative (there are various contract requirements including animal health, locomotion, minimum grazing days).

The chickens are sold to Avera which is Cargill Meats and it goes on to Nando's and other outlets. The only inorganic input into the farm at the current time is genetically modified (GM) soya concentrate feed for the chicken unit (because this is a much lower cost than organic non-GM feed), and so the AD digestate fertilizer for the fields is therefore non-organic.

The farm business also manages two other dairy units as well: one 500 cow unit on a nearby estate, and another one nearby which they are building up to a 350 cow organic unit.

7.4.2 3B – Grazing practices

7.4.2.1 Current grazing practices

The farm focuses on profit per head of cattle and finding the lowest cost way to produce milk. Previously, the focus was on maximising gross margins and yield. The farm's approach to this has been to cut input costs considerably by increasing grass production. The 750 cattle are moved twice a day to new pasture, in a highly rotational 'mob' system. This has enabled the farm to source a much greater amount of nutrients for the cows from the farm itself. Grass utilisation is high, and little to no residual is left. No synthetic chemical fertilisers or pesticides

are used. However, the farm is not accredited as organic due to the use of non-organic chicken concentrate feed which ends up as fertiliser on the pasture. The only other inputs to the farm system is slurry from surrounding farms for the AD unit, and some concentrate and feed for the cows at milking, and new born calves.

In the current system, the cows are only inside for approximately 2 months a year. Then they are grazed during the day, then on silage at night, from Jan to when the grass starts to grow in March/April. The only concentrate the cows get is 1-2 kilograms in their feed when they go in for milking. Whilst they are in milking, the paddock sizes are adjusted based on the dry matter measurements. Fresh calves receive more concentrate, around 4-5 kilograms.

The farm measures grass production to calculate the dry matter production in every field, every week. “they know when there's lots of grass in some fields and less in others. So they’ve got what they call a wedge and when the grass got to a certain level, they knew that they've got food in a field, or they can put a fence across, to give them a certain area, with a certain amount of dry matter in it, that would satisfy the herd of 500 cows going in there.” “But all the time the wedge would be growing. So the next day, they’d be in the next field because that one would have grown up to what they wanted. And if the fields weren’t the right size, they just put an electric fence across it to make it the right size”.

Surplus grass in the autumn (when calving) is left over winter, so that it is available in January. The rest period is much longer at this time of year, due to the slower grass growth rate. So it is 60 to 70 days before the cows can return to the same field. But once the grass starts to grow again, gradually the period between them coming around, gets shorter and shorter. Until in May, June time it might be only 30 days before they're back around to the same field.

7.4.2.2 Previous grazing practices

The present grazing system has been in place since 2013, when the broiler chicken unit and AD unit was introduced. Prior to that (2005 to 2013), the current grazing system was managed organically. Before that (1998 to 2005), the farm was still organic, but grazing was extensive, and grass utilisation was low, with a focus on yield and gross margin. Prior to 1998, the farm was intensively farmed in a conventional, set-stock system (significant use of inorganic fertilisers), with a focus on yield and gross margin.

Just before the farmer’s sons took over in 2005, the farmer was working 250 cows in an organic, extensive grazing, dairy system; also growing 120 acres of vegetables for supermarkets. The business focus then was on gross margin (rather than profit per head) focusing on maximising overall yield. The farm was working to quite high gross margins, so “I

was feeding more concentrates and grazing in nothing like a sophisticated way". The farm then, did not measure the grass, nor estimate the dry matter per hectare. The farm had no infrastructure in place (tracks, water system etc.) so a lot of the land was heavily poached at gateways. The farmer was housing the cows 180 days a year (6 months), "a very long time". Because of that, the farmer felt he was always up against it with the slurry system. He had to make a lot more silage than they do now.

Prior to going organic in 1998, the farm used conventional grazing systems (set stocking) for many years, in an intensive farming system, trying various different mixes ("strip grazing, paddock grazing, set stocking, mixtures, all of it really"). During this time, the farm used a lot of nitrate in an intensive farming system.

7.4.2.3 Aspirational grazing practices

The farmer spoke about no further aspirations. They are content with the current grazing practices.

7.4.3 3C – Farmer motivations

The dairy business is a partnership between the farmer, spouse, their sons and their partners.

The farmer was motivated to change to regenerative grazing practices, in order to be able to extend the farming business to be able to provide for two sons and their families. Both sons wanted to farm but felt that the farm system at that time, could not support two growing families. They felt the only option was to massively expand the business somehow, to allow both families to be supported. They had visited and worked on farms in New Zealand and felt that the grazing systems used there, had potential in the UK.

Also, environmental values played a part "By 1999, I was uncomfortable with all that [the conventional, intensive grazing system] because I've got a particular passion for wildlife I could see what was happening to the wildlife on the farm and I'm a fisherman as well so I'm in the river and I could see what was happening to the river. Well we were just catching less fish basically and I felt increasingly uncomfortable with the type of farming I was doing in spite of having 10 different ways I was managing the hedges. You can see the trees growing up all around the farm, we planted up corners. So I was doing an awful lot for a wildlife, nothing like enough".

7.4.4 3D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The

range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.3).

Farmer 3 spoke mostly about matters which can be grouped under 'Farmer' (14% of narrative). The emphasis was on family decision-making and succession planning, farmer values and knowledge, management principles. Next, the farmer spoke about factors under the heading of 'Institutions and Laws' (9%) including land rights, land agreements, policy and subsidies. Less so, the farmer spoke about issues under 'Farm' (4%) and 'Social' (4%) and topics included farm assets and characteristics, farmer to farmer learning, networks and discussion groups, and learning from other countries. Very little was raised in terms of 'Environment' (1%). **Unique to this farmer, was discussion in relation to the importance of family succession and business growth.**

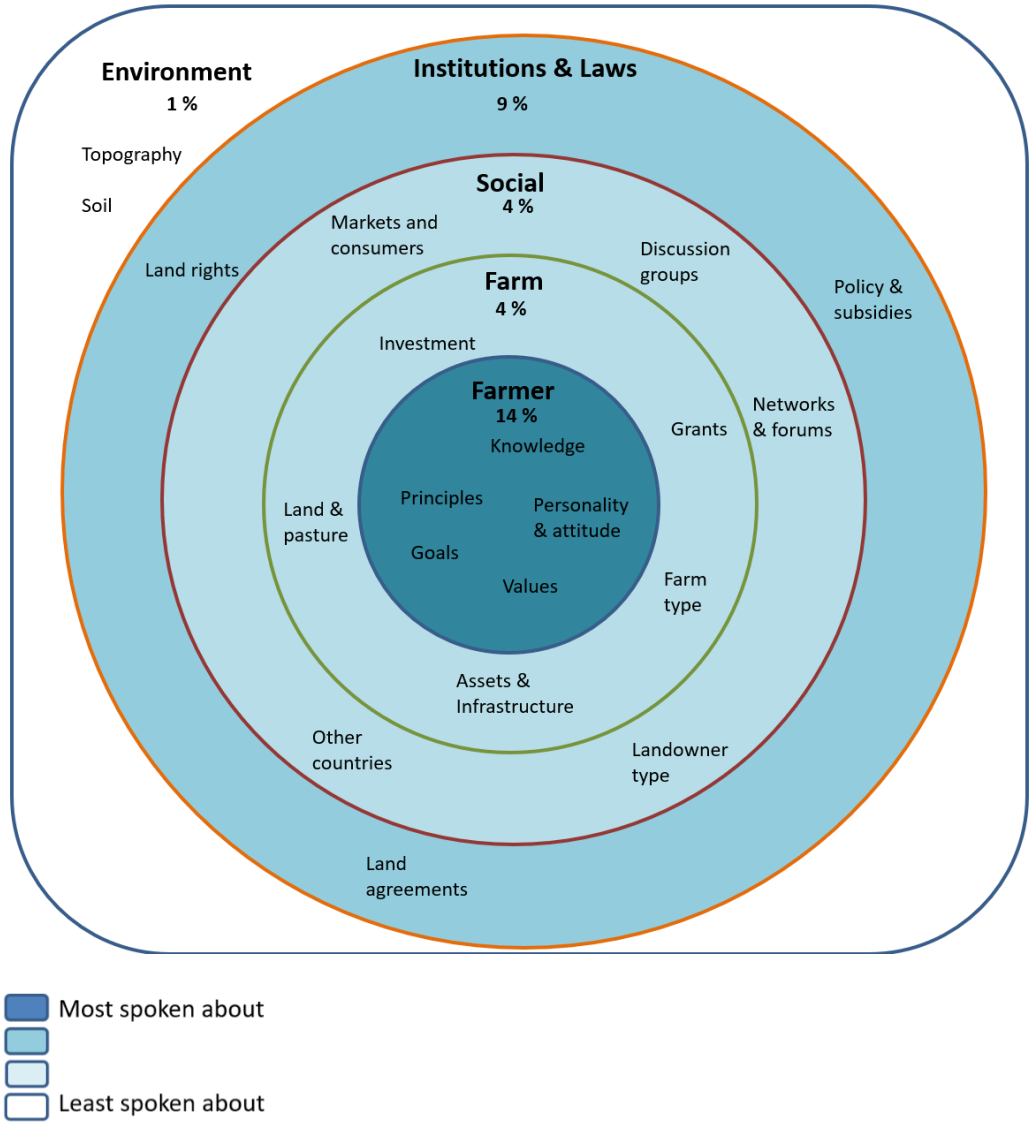


Figure 7.3 Topics related by Farm 3 to the take-up of regenerative grazing practices in UK

7.5 Farm 4

> "And most of the time I don't rush, I ponder and watch the sheep. I've become quite efficient at how I do things but then I waste the extra time, you know, just sitting down in the middle of the flock because it's fun, and it makes me feel good."

7.5.1 4A – Farm description

The farmer has been mob grazing 60 sheep and followers on 40 acres since May 2018, since returning to the family owned farm from a military career. The farmer is gradually taking over from their father, who is stepping back due to health problems. The farmer is motivated to make changes on the farm, firstly, to improve the profitability and resilience of the farm enterprise e.g. by cutting costs as much as possible by changing management practices. But also by more altruistic motivations including helping their father, helping to address environmental problems, and wanting to support a healthy, self-sufficient society in the UK. The farmer believes that restoration of the land will help the farm achieve its full potential; and that this is essential to achieving their desired goals.

7.5.1.1 Farm type, size and livestock

Small, lowland / upland sheep farm. The farm has 60 ewes, aiming for 75 lambs a year.

7.5.1.2 Land holdings

The farm owns 200 acres, comprised of 50% woodland and 50% fields. Most of the fields are designated as SSSI, leaving 40 acres of 'grazable' land.

7.5.1.3 Farm business

Farm income is generated from an informal, direct to consumer box sales scheme, which started about 20 years ago. Also, some irregular income is generated from forestry.

7.5.2 4B – Grazing practices

7.5.2.1 Current grazing practices

The farmer is currently 'mob' grazing 60 ewes plus lambs on 40 acres since May 2018 (see Figure 7.4). They are moving the sheep twice daily to fresh pasture, working to a 15-60 day pasture rest period depending on the time of year. Some bale grazing is undertaken in the winter. The pasture has not been re-seeded in recent years. And the farmer is awaiting the natural seedbank to recover sward diversity. Some supplementary feeds, such as a seaweed/molasses mix, is given just before and after lambing.

"So mob grazing and conservation grazing and regenerative grazing is all about growing grass, growing volumes of grass well" … "it's just that bunching them up for a very short period of time. Be it 10 minutes in some cases, to get impact and then move them on".

“Because I'm doing grass measuring. I’m working out and giving them a daily allowance, so I need to be pretty exact on what I'm giving them. But also I'm trying to make sure I’m leaving enough grass. Because again the longer the grass is, within reason, the faster the recovery period is. So the faster it greens up, the more time it can spend growing its roots, and/or doing all of that”.

“The idea behind the grazing is that you let grass grow to senescence, and you nip it off just before senescence. So senescence is seed head and it putting out its flowers or whatever. And if you nip it off just before that, which is about the 8in, then you are getting the most out of grass. And if you're not taking it back below 6 inches, so modern literature is saying 4cm for us, 4cm, 6in, there’s you know, there’s 3in of difference there”.

7.5.2.2 Previous grazing practices

The farmer’s father had previously always done rotational grazing, “somewhere between rotational grazing and set stocking”.

7.5.2.3 Aspirational grazing practices

The farmer is looking to integrate the woodland into the grazing management: “But I want to thin out the woodland enough and include more animals in there. So if I can get pigs in there that will help natural regeneration which again removes another action that needs, you know, I don't need to pay somebody to plant for me. The animals do it. … It also gives me again, if we got another drought, I can put sheep in there for that week and I can bale, put food in there for them and they get shade. So it's all these kind of big-picture factors that I can use the estate for”.

The farmer wants to plant hedgerows: “I've got to start thinking about things like shelter belts. Or things that I thought we don’t need shelter belts, we've got enough trees. I'm now looking very heavily at re-putting in some hedges in this parkland. One running along the bottom here. I'm breaking this up like it used to be”.

They have ambitions to up-scale production on the farm: “I could triple, if not quadruple, the number of sheep that I have, hopefully in three years. My time input won't go up. It will come down because I'll be doing less fences. You know. So I'll still be moving them every day but the only difference that I will be making is how much water I give them for how much grass”.

And to generate solar PV electricity: “The energizer units, the battery, so rather than going off mains which is something I’d love to do. It comes with a battery and I will make it solar at some point in the near future”.

The farmer wants to increase the farm's resilience to unexpected impacts, by taking on a further 28 acres under tenancy, so that they can have standing forage as a reserve if needed: "it's going to allow us to maybe re-seed or certainly long-term rest one or two fields, that we've just been hacking out, mainly our hay fields" … "One of the things I'm looking at is, 'cos we lamb outside, the sheep are out all year. Erm, and that's the way that it's always been. But I'm trying to look at, erm, sort of the other ways of doing things in terms of bale grazing. So maybe not actual bale grazing, but standing forage being left and shut up and left to grow. So I don't even need to bale. So if I need a reserve for drought or whatever, I've either got that as spare bits of ground or I can buy in fertility from someone else, who has to cut it, because you know they're putting a crop in next. There's gaps for stuff down the line".

The farmer has ideas to introduce other livestock into the grazing rotation: "He [Gabe Brown] has cows, followed by sheep, followed by geese, followed by ducks, followed by chickens and each one of those is an enterprise on his farm. And that's what I have to do here, because the sheep as much as I love them, won't give me an income".

The farmer wants to grow fruit and vegetables: "And add that to the other side of the finance, you know we don't grow our own food here. We should be able to, we've got a Victorian kitchen garden which is falling to bits. But we've not used it as a family for 10 years. There's now people making $100,000 off an acre for commercial sort of veg gardens. You can grow anything on anywhere because you can stack it. Now, people are making microgreens and making huge amounts of money off a back room and some UV lighting. So technology is allowing ventures that couldn't always been done".

The farmer is interested in promoting woodland education, and re-connecting people with nature: "Again, teaching, I think the more somewhere like this can be a test bed or an instructional place that people can come and visit and maybe take something away from; be it schools. You know, I'd love to get woodland schools because I think they're amazing. Anything that gets people back into nature rather than thinking nature's over there and we're over here".

Figure 7.4 Photos of mob grazing at Farm 4

7.5.3 4C – Farmer motivations

The farmer has returned to farming from a military career and is managing the farm on behalf of their father (farm is in father's and uncle's ownership). The farmer's father is gradually taking steps back due to health concerns.

The farmer is motivated to help the land and farm to deliver to its full potential: "So it's all these kind of big-picture factors that I can use the estate for … I'm also rebelling against that 'you've got to go off farm to make your money' and there's a big part of me that goes 'that's stupid' … I know we're not a big estate and I am not a big farm but we've got so much here that is not taken advantage of. And it annoys me a lot that the place is falling into disrepair because of financial troubles and family disagreements and succession problems; where there's scope for much more".

The farmer wants to achieve this, at as low a financial cost as possible, and thus create a profitable, successful enterprise: "So yeah it's, I'm coming in, and the fences aren't great, the land certainly that I've seen, you know the stock and the land, has kind of been nose-diving slightly because again, of no extra inputs have been put onto it. And finding a way that allows you to do it and make the animals work for it, so that you're not having to spend thousands on lime fertilizer or on all of the modern inputs". "So for me the grazing, I've given myself three years to see whether it works for us. Whether daily shifts are what I want to do… Goal wise, I've given myself three years for the sheep to try and build the flock up, and to get a handle on the woods. Because there's a reasonable amount of money in there… But at the end of the day, it's got to pay for itself".

The farmer wants to maximise profitability based on cutting costs: "If you can make profit, so for us its reducing inputs" … "and that's how I've got to look at this place: profit per acre, sorry per hectare, rather than I took £20,000 a year".

The farmer is focused on helping to address environmental problems: “And fixing water tables and wildlife and you know, all the tick boxes that are now becoming apparent and then add onto that your carbon sequestration; which as a forester is like ‘oh forests are fantastic, they’re the best’; actually grassland is better ‘cos it not carbon sequesters but you get a cow, or a crop of some variety off it as well”.

The farmer wants to support healthy, self-sufficient population in the UK: “And that's our, again, that's something that’s always bugged me that we in the UK can't feed ourselves, we have to import. And we saw during the war, that we can. It just means a lot more people from the countryside, sorry coming from the town to the countryside. And you look then at BREXIT and the common kind of thing of ‘we can't take any more people into this country, we're already too crowded’. Well, we’re over crowded in some places but not in the right places. You then go, well the people that are coming over and helping them, and working on the farms: the Poles and Romanians, they've got a work ethic that Brits don’t have. That is, you know, I'll go for my summer holiday and go hop picking. You know 50-60 years ago, when London de-camped to do all the hop picking, which was a seasonal job and it gave people a holiday. And if you take the Welsh Government's push on tourism at the moment, if you can combine those two things, a working holiday, low-skilled jobs, i.e. they’re fun, they’re outdoors, they will get you healthy”.

The farmer has returned to farming from another career and is motivated to do things differently: “So pretty much until I was what, 20, 30, pre-uni, I hated doing anything with the sheep, really hated it. But I knew at that time, that I always knew I wanted to be outside so I took myself off to join the army, which is what I did. Then I did my ankle in quite badly before I even really got in, but the flip side of that is that the whole holistic management side of things is based off the Sandhurst training manual”…”So I came back from that, took myself off to uni to do a forestry degree and I finished that just before, you know I gained that just before Christmas. So I've been marking time and I decided, well, I'm going to have to be doing more with sheep because Dad's ankle is a limiting factor sort of thing”.

The farmer was initially driven by a desire to find easier ways of working with sheep: “So we, traditionally, the sheep would just annoy the hell out of me because they wouldn’t ever do what you wanted them to do and we don’t have, we've never had a sheepdog. So it’s a plastic bucket or bag to rattle to get them to follow you, and if they don't want to follow you, they wouldn't. And again to do anything with them, it was always complicated. So I ended up looking online and I came across, erm, what's her name, Temple Grandin she's an American autistic stock lady like massively famous out there. It's all to do, she redesigned the American

slaughterhouses to do low stress for the animals. And I came across that, on a whim, one day and I was like 'I'll give that a go with the sheep' and it worked and I was like 'this is easy' and 'I wish we'd been doing that since I was that age' and it just rabbit holed from then on, and it was like 'what was that' and I started watching Richard Perkins, his YouTube videos, and realized that he was doing the holistic management. Wow, so it was coming from two different routes: from a permaculture style, slightly off-the-wall, hippie style and then the odd big farms in New Zealand, Australia, Africa and America".

7.5.4 4D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.5).

Farmer 4 spoke mostly about matters which can be grouped under 'Farmer' (15%), including their past, career history, family, succession and about acquiring knowledge. Reference was made to management principles, assets, infrastructure and resources under 'Farm' (7%). Less so, the farmer spoke about 'Social' (4%) including: farmer to farmer learning via social media, internet resources, and knowledge events. The importance of key influencers, pioneers and demonstration farms was also discussed. Under 'Institutions and Laws' (3%), the farmer spoke about land agreements with conservation NGOs, markets and consumer preferences. Little discussion was given to 'environmental' factors. **Unique to this farmer, was the depth of discussion in relation to the role and influence of social media.**

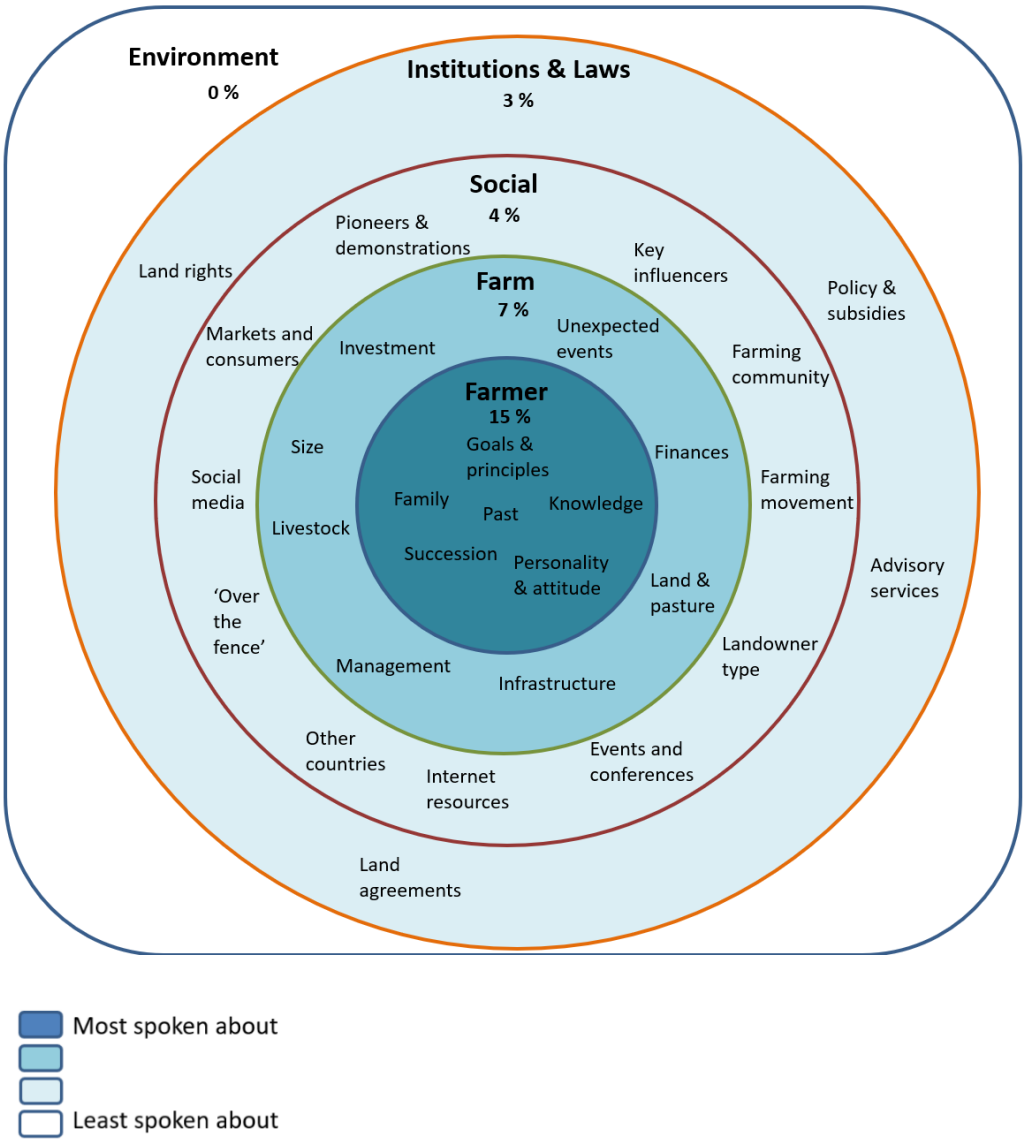


Figure 7.5 Topics related by Farm 4 to the take-up of regenerative grazing practices in UK

7.6 Farm 5

> "The thing is, if the worst came to the worst, all we would have had to do, is do exactly what we were doing before; which is not really a big deal is it. There really isn't, for us anyway, there isn't much of a downside to it.".

7.6.1 5A – Farm description

7.6.1.1 Farm type, size and livestock

Small, lowland, beef farm with 32 beef cattle (Welsh Black and Dexters) including their followers.

7.6.1.2 Land holdings

Total of 130 acres comprising of 65 acres owned by the farm; and a further 65 acres, rent free, under a conservation grazing contract on local nature reserves (some under a S16 agreement with NRW). Also, the farm has rights on nearby commons but this is not currently used.

7.6.1.3 Farm business

Income from selling branded '100% pasture fed' premium product direct to market.

7.6.2 5B – Grazing practices

7.6.2.1 Current grazing practices

The farm has been practicing 'holistic planned grazing' at the farm since November 2018, but in a fairly ad-hoc manner. Grass growth is gauged by eye, using 'beer bottle' measurements (when grass at beer bottle height the cows are moved in to graze, when it reaches stubby height, about 5cm, they are moved out and the pasture is allowed to recover for at least a month). They are moved roughly every few days, although "It depends on how much of an impact they are having on the sward. I play it by ear, you know". Some grass is cut for haylage. On the land under conservation grazing contracts, the young beef stock are continuously, set-stocked, grazed on nearby nature reserves.

Electric fencing is used to contain the cattle and move them up the field in 'strips' (not cells due to lack of water system to supply each cell at the moment). This is not 'strip grazing' per se as the cattle do not have access to the previously grazed areas. The fields are grazed after the hay cut. They have tried bale grazing for the first time this year. The cattle are out all year, except for calving time. No chemical inputs are applied to the pasture.

7.6.2.2 Previous grazing practices

Previously, cattle was continuously set-stocked grazed at the farm. However, cattle were still kept out all winter (not housed). Neither were chemical inputs applied to the pasture then.

7.6.2.3 Aspirational grazing practices

The farmer wants to install a water system so that cell grazing can be introduced (rather than in strips) within each paddock. The farmers is also working towards Pasture for Life certification. “My initial goal was just to see whether it would be possible to do it, practically and time wise and you know everything… Yes it does work and I’d like to just get it to a stage where we can learn from mistakes and manage to keep them out [the cattle] most of the year, perhaps with more careful management now we know where the pitfalls are, and try …we might get to a point where we can keep them out year-round without feeding them hay”.

7.6.3 5C – Farmer motivations

The farmer supports a full-time job, working with parents to run the farm. Aside from a focus on productivity and profitability, the farmer is focused on establishing a reputation based on a good quality, tasty, product. This means keeping the cattle until they are older, for more mature and tastier meat.

The farmer is motivated to restore nature, and to work with natural processes: “Well because it's the future isn't it. We spent so long destroying our soils and eating beef that is produced too quickly, on food that it's not supposed to eat. And it, we've been quite environmentally damaging in the process, losing our native breeds and you know, we've kind of lost our way. But we've kind of been forced to lose our way because of the market pressures that have been put on us. And I just wanted to try and bring it back in line with nature. So, [deleted to protect anonymity], as well as conservation grazing as part of that, our cattle are part of the natural ecosystem because they descended from the Aurochs; and they are supposed to be here, and they’re part of our grassland ecosystem, and to manage it more naturally is just err, has its benefits”.

7.6.4 5D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of topics discussed by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.6).

The farmer spoke mostly about matters which can be grouped under ‘Farmer’ (14% of narrative) covering family, farmer values, history, goals, principles, knowledge and learning. The farmer raised issues under ‘Social’ (7%) (including: pioneers and demonstration farms, discussion groups, internet resources, online forums, a farming movement) and ‘Farm’ (7%) equally (the latter covering aspects such as access to pasture and livestock breed). Less mention was made of aspects under ‘Institution and laws’ and ‘Environment’. **Unique to this farmer, was discussion in relation to the challenges of changing family mindsets.**

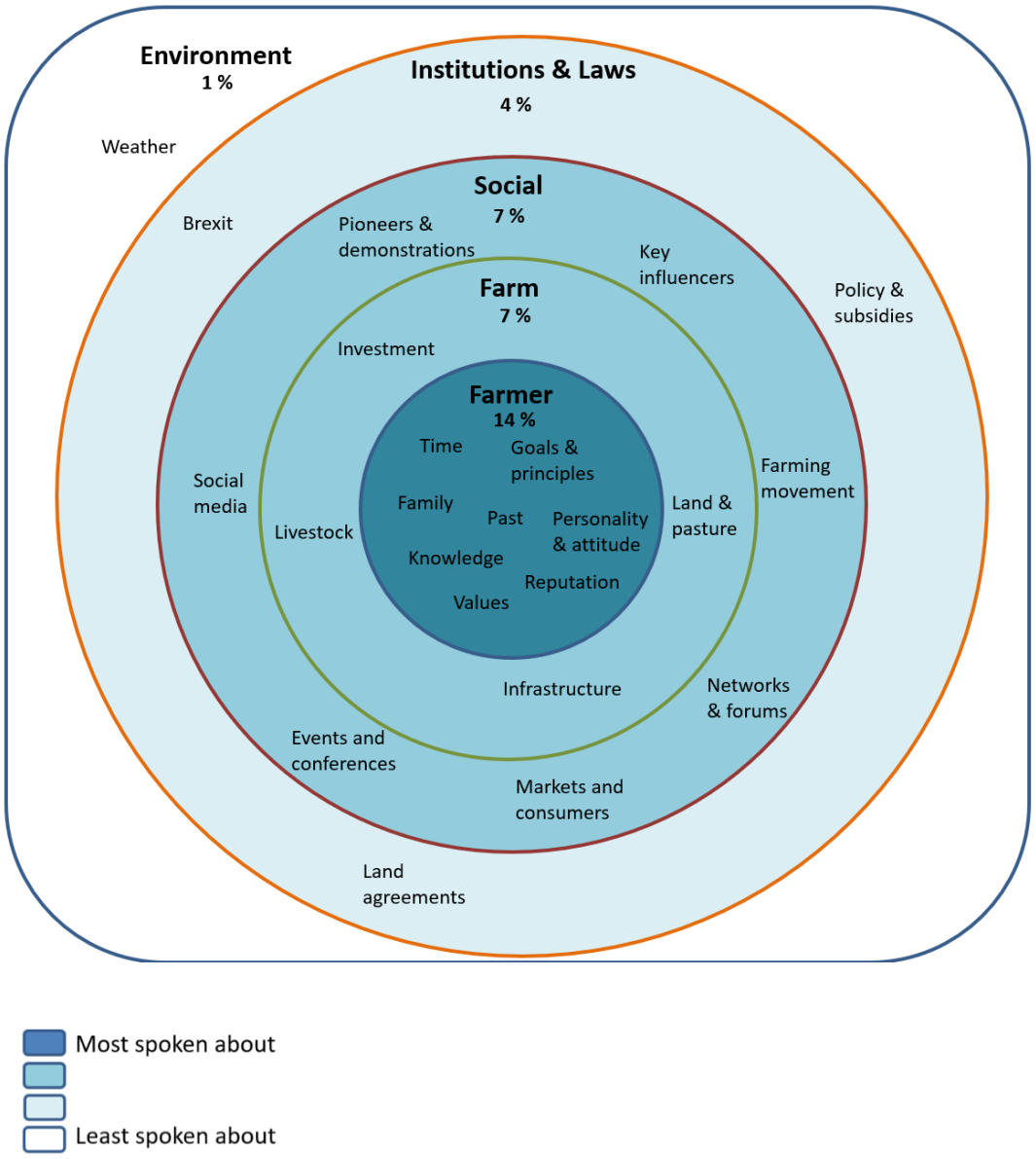


Figure 7.6 Topics related by Farm 5 to the take-up of regenerative grazing practices in UK

7.7 Farm 6

> "Because to my mind, a cow is a very simple being that has four legs and a mouth. So it seems a little bit silly to go into a field, harvest it, harvest the crop, store it somewhere, feed it back to the cow, have to bed the cow using some straw that you have harvested, and stored; and then shift all the muck out, store them up somewhere and then spread them up on the field. The cow does all of that for you… And you haven't got any of the expense in the middle".

7.7.1 6A – Farm description

7.7.1.1 Farm type, size and livestock

Large, mixed, lowland farm with 450-650 beef cattle. Also sheep and crops (wheat, barley, oats, potatoes, carrots, cabbages, cauliflower).

7.7.1.2 Land holdings

The farm owns 3000 acres.

7.7.1.3 Farm business

Income from arable, beef and sheep enterprises. Also some forestry and rental properties.

7.7.2 6B – Grazing practices

7.7.2.1 Current grazing practices

The farm is in a state of transition, introducing new regenerative practices gradually in different aspects of the farm. “Over the past, probably, 5 to 7 years I've been trying to push the process of change towards a better system… The changes that we're in the process of making now, are kind of across the board. We are trying to grow decent cover crops. We are re-integrating the cattle into the arable rotation. We are direct drilling. So all the things that you’ve found in arable farms around the place. And we are also trying to lengthen the rest period, shorten the grazing period, tighten up the grazing of the cattle”.

7.7.2.2 Previous grazing practices

The farm is evolving from a conventional, chemically intensive mixed farm. Up until 2005 it was a dairy farm. Previously the livestock was grazed separately to arable production, with no integration.

“When I took over we were basically a very, very, conventional mainstream farm in that we had … been finishing our cattle on a homegrown barley, mixed with whatever it is that they’re, with beet pulp or whatever else it is. And we have been, we are not organic in anyway. We have a full programme of chemicals to spray on and fertilizer and whatever. And [we made all] the appropriate noises to all of the schemes to say that we're doing integrated pest management and you know, that we’re taking care of the environment and what an absolute load of old hooey. I think it’s, if we really were taking care of the environment properly, we wouldn't have to tell anyone about it”.

“30 years ago, there used to be cattle as part of the arable rotation. So pretty much every field had gates and fences around it. But about 30 years ago, when it was fashionable to split up livestock and arable farms and ‘this is an arable field and this will grow crops’ and ‘this is a livestock field and it will grow grass’; what that meant was that every field that we had arable crops in, the fences just fell apart. Because there's no point in keeping them good. So now that we want to get animals back into the same arable fields, we're having to completely start from scratch and rebuild the fences, which is not cheap”.

7.7.2.3 Aspirational grazing practices

The farmer wants to work with nature to improve efficiency: “I don't want to be putting inputs on. I don't want to go out and buy a whole bunch of lime and then have to drive through the

field. I'd much rather put a fence and a mobile water trough and turn the field into 30 micro paddocks and go hard".

The farmer sees value in re-integrating grazing animals with the arable rotations: "We need to get better at growing better cover crops for specific times of year so that the cattle can, the cattle can be fertilizing fields that we want them to fertilise, when we want it to be fertilized".

"So the way that I want it to go is that in our grazing plan, we need to be keeping them on the grass for much longer into the autumn. We should easily have grass that is still good well into November. And if we don't have to move cattle off grass until, for instance, advent; that means that the requirements for some kind of, well it might be kale, … mixed with some legumes of some kind, and a bit of silage. If we can reduce that requirement from the current 4 months' worth, or 3 months' worth, down to only 2 [months' worth], that takes a lot of pressure off. Or it allows us to carry more stock".

The farmer aspires to plant hedgerows and create habitat: "And I also need to have wildlife corridors going from… currently there is three strips, that are currently quite isolated from each other, and from the wider forested land. And by building these hedges that I plan to do, I can link them up. So that there are wildlife corridors going through this patch of the estate that currently has nothing."… "And if I'm smart about where I put the hedges, I only need one side of fence in order to fence in what I want to fence in. So actually, I might be able to bring in, probably 250 acres worth of arable ground and put a fence around it".

7.7.3 6C – Farmer motivations

The farm is run by the farmer and their father. The farmer has a young family. The farmer returned to the family farm several years ago following a period away; and took over control of the farm 18 months ago (in 2018) following his father's retirement. Change has principally been triggered by the farmer's father's retirement and poor profitability from the beef business of the farm.

The farmer has holistic aims, essentially seeking long-term profit based upon restorative social, economic and environmental goals. "Well to me, the holistic aim is keeping my stool that I sit on, and it's got three legs that keep it up; being the social fabric, the environmental fabric and the finances, the economics. I have to make decisions that keep all of those legs standing".

The farmer is motivated for financial reasons, and the need to make and sustain profit: "We used to have a dairy up until 2005 but it wasn't working financially and we had to get out. To be honest the beef cattle today, or in the past few years, aren't really working financially

either; which is one of my main reasons for wanting to change to a more regenerative grazing model, is that I think we can save an awful lot of cost and actually increase the income in some way... So I think we would make much better margins from a better form of farming".

The farmer sees profit in greater grass growth and utilisation: "It's the difference in grass growth that I see on other places that makes it worth doing. I was, it was only today or yesterday, I was discussing what the animal days per hectare we were getting on some of our pastures, and even on a pasture that had, that did have fertilizer on it at the beginning of season; we were still only getting 280 animal days per hectare. Terrible, absolutely appalling. It means we need 1.3 hectares to keep a cow for a year which [inaudible] in an organic system. So we need to get better".

The farmer is motivated by a desire to try and restore the natural environment: "The reason I want to do it is that I want to have better biodiversity in everything and I need more diverse hedgerows. I need to be supporting more insects and birds in the hedgerows in order to give my crops the best chance of growing to their fullest potential".

The farmer is motivated by a desire to improve biodiversity: "Also the differences that I've seen visiting other farms that have much better biodiversity in their paddocks. That our pastures are perennial ryegrass, maybe a bit of clover if you're lucky, maybe a bit of Timothy, some Meadow grass and some dock leaves and that's about it. Plenty of people in their pastures could easily have two dozen different varieties of things; and they may well have a dock, and they may well have a thistle, but when they've got what two dozen other things, you don't notice the docks, it's fine. Yeah, biodiversity is a key thing that I want to see". "The biodiversity below ground is a multiple of biodiversity above ground. So if we can double the number of animals eating 20 times more plants, we can probably have, I don't know what the factor would be, of how many different things would be exchanging exudates and Mycorrhizae underneath the ground, it would be fabulous".

The farmer wants the farm to be more resilient to adverse conditions and events: "To me, the answer to any problem that you could throw at me, would be tighten the grazing up, maybe make the grazing period shorter, the rest periods longer and have a greater variety of animals. I would struggle to think of any externality that you can give me where the answer wouldn't be that. And that is going to, by doing that, we are going to be able to make ourselves more resilient in terms of climate; we are going to make ourselves more resilient in terms of currency; we're going to be able to make ourselves more resilient in terms of social changes. It's, we're going to be more resilient financially. It's just a win-win-win across the board".

7.7.4 6D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.7).

The farmer spoke mostly about matters which can be grouped under 'Farmer' (16% of narrative), including discussion around farmer education and knowledge, personality and attitude, but also management goals and principles. The farmer next spoke about topics under 'Farm' (11%) including: labour and staff, infrastructure and layout, and business model. Less spoken about were topics under 'Institutions and laws' (6%) including college curriculums, policy and subsidies. 'Social' factors (4.5%) were also discussed including: farmer to farmer learning, key influencers and pioneers, farming forums and networks, and the farming industry. **Unique to this farmer, was discussion in relation to the challenges of changing employee mindsets.**

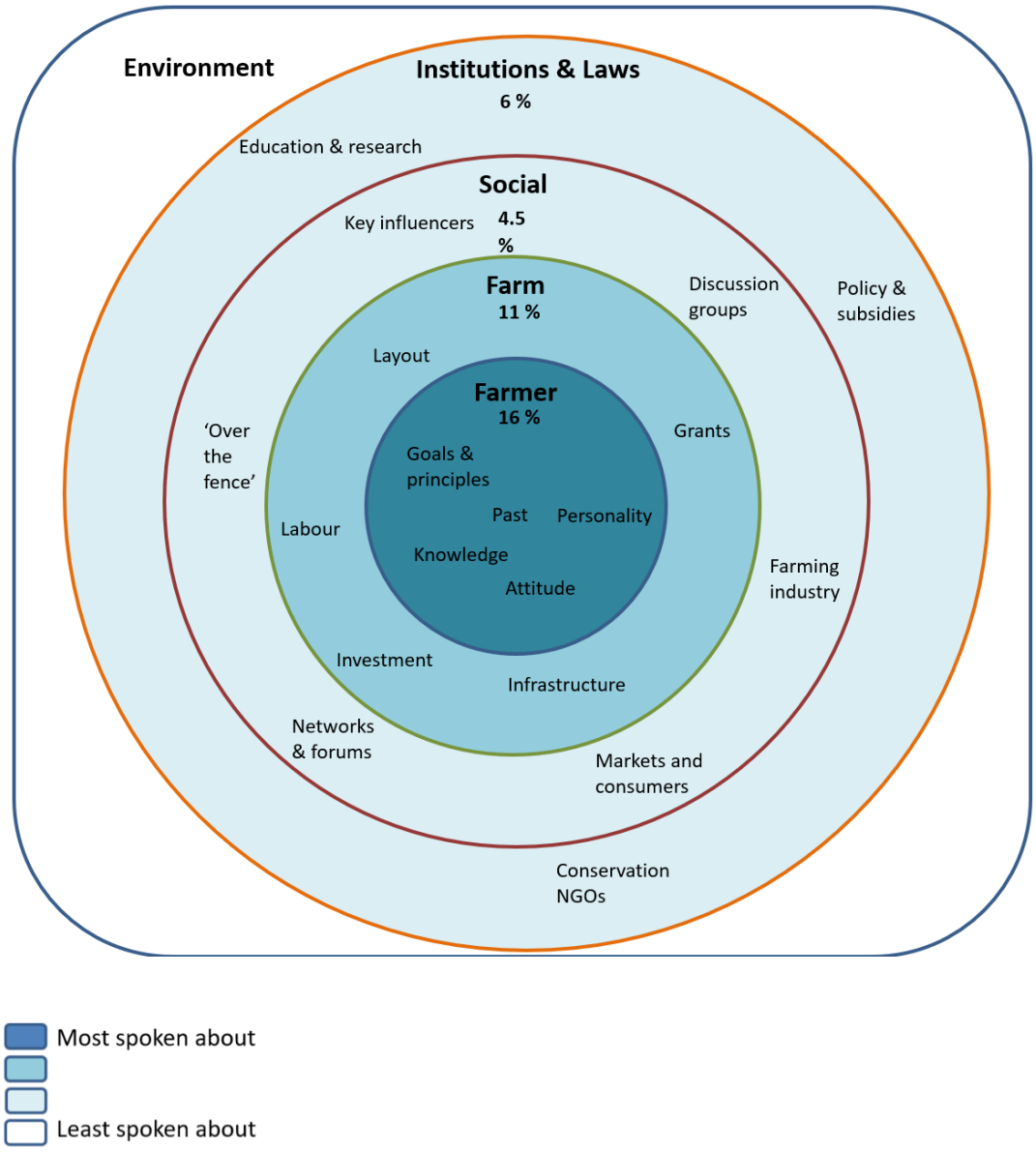


Figure 7.7 Topics related by Farm 6 to the take-up of regenerative grazing practices in UK

7.8 Farm 7

"To me, it all comes down to soil. Without the soil, you haven't got the grass, you haven't got the animals. You have to get healthy soil to have a healthy farm to be honest."

"It's like we had that big drought last year. If you look on Google Maps, mine's the little green farm in the middle of it all."

7.8.1 7A – Farm description

7.8.1.1 Farm type, size and livestock

Small, lowland, beef (20 cattle, heritage breed) and sheep farm. The farm also rotates chickens and goats after the cows in the grazing system, although this is not currently commercial (see Figure 7.8).

Figure 7.8 Photos of Farm 7

7.8.1.2 Land holdings

Owns 40 acres and has just taken on another 60 acres nearby as a tenant.

7.8.1.3 Farm business

The farm sells lamb direct to consumer in an informal box scheme. Income is also derived from a residential let. The farmer is aiming to sell beef boxes, again direct to consumer, starting 2020.

7.8.2 7B – Grazing practices

7.8.2.1 Current grazing practices

The farmer is currently rotationally grazing the cattle (not the sheep), moving them once a day "So it is then labour-intensive, very labour intensive". The cattle are out all year and not housed over winter. The farmer gauges grass growth by eye and experience, judging what grass is ready for grazing, how much and for how long. "It's still a learning process". Some of the grass is baled for winter silage. The pastures have not been re-seeded by the farmer.

"You know once you take your grass too low, it takes longer to recover. So it's finding that sweet spot of, if you take it too far, it will take 30 days to recover. If you just take the tops off it, it will recover within a week" .

"By holistic grazing, rotational grazing, the land should have a higher output of grass; not to support 50, 60 cows for 12 months of the year, but it should be able to support more than… open grazing is when every gate is open, cows and sheep will just graze continuously. If you let the grass recover and grow, it grows harder and stronger. And then you bring them back on it and they'll take a piece of it, and then you take them off it. So you're always moving your animals. It's trying to replicate nature".

A few sheep are kept to graze a hay / wild flower meadow (not under any land agreement) which is used for silage and which used to be part of the farm, but which the farmer now lets from a neighbouring property (which also used to be part of the farm).

“Because it’s management, you’re looking at the grass, you can't just say ‘it's going to be an acre every day’. In summer, there will be a lot of growth. So it might be small amounts, you know small fields, because there's enough growth there. By winter, you might have two months of non-growth, so then I’ll, I’ve bailed silage. So that supplements it”… “I've chosen a heritage breed, which is not a continental breed of cattle. Where continental breeds are European breeds are bred to be very big, very strong, a lot of meat but then they are very hungry as well. So they need a lot of feeding overwinter. With old English heritage breeds, which you know, they were bred four hundred years, two hundred years ago to deal with the land that they had”.

The farmer is currently trialling three types of chickens in the grazing rotation, to see which works best.

7.8.2.2 Previous grazing practices

Historically the farm was 100 acres. The land was previously let to a tenant farmer, when still in the farmer’s family ownership. The previous tenant continuously grazed the land (sheep winter grazing, cattle summer grazing) but applied very few inputs.

7.8.2.3 Aspirational grazing practices

The farmer aspires to create a profitable and resilient farm system with a strong, land restoration, focus. They aim to:

Improve the water system: “With water, as it was, they [the cattle] were in streams and rivers drinking from. And I know it’s, we're trying to get away from that, and I'd rather not be doing that either because they're breaking the banks. And when I'm doing my paddocks, not every paddock has got a stream next to it. So what I'm doing at the moment, is moving water with them. So I've got a trailer based watering system so that follows them. With the ultimate thought process of a little reservoir or little Jojo tank, or trying to get some sort of infrastructure going which would make it a heck of a lot easier for me”.

Promote a multi-sward pasture: “You go to a field, there's two types of grass and a bit of clover; you'd get bored of eating that salad with those three things. And then the Caer Doctor, or ‘doctor field’, there must be 20 species in it. It's something I'd love to do. There is now slowly a push towards multi-species ley. The research is out there where, if you have four types, you have this much growth, if you have five types you have this much growth [indicating

with hands]. If you have six species you have this much [indicating more]. You put more than 16 species and instantly the yield's [indicating much more with hands]".

Explore agro-forestry, as an income for the next generation: "Fungus talks to itself, helps itself, breaks everything down. You know, it decays and gives you your root's organic matter in the soil. I think in the old days, you used to have parklands; which is fields with a standing tree, and other standing tree. You know, big green, and as long as those roots were touching … you look at it and you think that's not agroforestry 'cos it's a big field with three trees in it. But the roots will go further than the tree is taller. So then there's always that communication. They say that the biggest living organism is in Oregan. It's a mushroom. It's a fungus. Because it covers… Oregan basically. They've gone in and tested its DNA over here and it's exactly the same over there… You know, the research is out there, it shows. And it's like they're talking as if the tree is sick here, or needs a mineral; the mushroom will go 'ok there you go'. And … all the chemical fertilizers that we put on just sterilises everything".

7.8.3 7C – Farmer motivations

The farmer is middle-aged with no family. The farmer left another long-standing career to return to the family farm: "So then, two years ago, I came out from my job and I decided I wanted to come back into farming. Which is quite strange, everybody wants to come out of it, but I chose to come back in. But it was a change of, a change of heart, a change of routine for me here. A change of farming practice" …

The farmer is motivated to do things differently … "So I come with a fresh face, fresh thoughts…not 'I've got two hundred head of cattle' and you carry on going with those two hundred head of cattle. I'm just starting fresh, starting small, and push, see what the land can deal with, see what it can handle". Because the farmer is concerned that most conventional beef farms are unprofitable: "I've got a PFLA handbook here… 'it can be done'. You know… they've taken their intensive details off ADHB, it gives you all the details, all farmers who were willing to put their figures into this system; erm you'll have best, worst, average. And all of them come in the zero marks or minus zero marks…beef. When they put it on here, it's not propaganda, it is what the figures are. And these are the farmers who are willing to put their numbers on. So if only 50% are willing to put their numbers on, and they all show a negative return… that's not a good way to be…And then that's purely, heavily reliant on nitrogen and oil-based system which, prices change, oil changes, grass is free".

The farmer wants to restore soils because "I've got fields here which were grazed hard for the majority, for the past 20 years; where soil erosion is horrendous. It's either all in the rivers or all at the bottom of the field".

The farmer wants to hold back water because “Historically now, it's always been ditches, ditches, Wales, ditches; get rid of the water, get rid of the water. But then you were washing all your nutrients away with it. You’re washing all your soil away with it. And I think there is now slowly close your ditches, there’s a little bit of you know, it’s not back the water, it's to get the soil to hold the water. … But then whatever is above the ground, is below the ground. So if you've got grass this big, you’ve got roots that big and that's all the water it can hold [hand action showing shallow depths]. If you’ve got grass this big [hand action showing tall grass] and it will hold all that water. I noticed… and also that much grass, uses a lot more water as well, you know it transpires, so it pulls it in and uses it. It's all about organic matter”.

The farmer wants to regenerate the land because… “I want to see a benefit to the land. You know, it’s… the more wildlife you see on that land, the healthier you know that land is. … For me, I'm a naturist at heart as well. So I enjoy seeing the land flourish”.

The farmer wants to generate local healthy food for local families because… “I'd love the people in the general house, husband and wife, to have good food on the table and to be able to buy locally. What's nice about the French, very militant in their way, but it's provenance; you know, it’s the way the whole, they would only buy local. Our village here would have its circumference and that's where their food comes from. You know what it is. You know how good it is. It hasn't travelled 7000 miles from New Zealand to sit in our, and be cheaper than the meat that's coming off our land”.

The farmer wants to support the local economy because… “It's food that's come from, it's not being patriotic or ‘it's come from our country’; it’s come from your area. If that pound stays in your area, your area flourishes”.

The farmer wants to provide healthy food for healthy children because… “There's so many ailments going on now, from when we were children. You know there's this friend of mine, part of the schooling system, report on the table and it was a silly amount, 66 or 70% of children under special measures due to problems, health or issues. And I was like my school, out of 7 classes, one class had four kids with naughty kids. I know that's generalising a hell of a lot. But there's a lot of, so many more people are sick, so many more people and children are ill… it can't be healthy where the chicken feed you buy is full of antibiotics”.

7.8.4 7D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The

range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.9).

The farmer spoke about topics under the heading of 'Farmer' (20% of narrative) the most including: farmer's skills, education, knowledge, family and reputation. This was followed by topics under 'Farm' (7.5%) covering infrastructure, investment, livestock breed and farm size. The farmer also spoke about topics under 'Social' (6.5%) including about the farming community, landowner type, internet resources, networks and forums, social media and consumer preferences. Less so, the farmer covered aspects under 'Institution and Laws' including abattoirs, agri-environment payments, and agricultural college curriculums. **Unique to this farmer, was discussion in relation to learning from South Africa.**

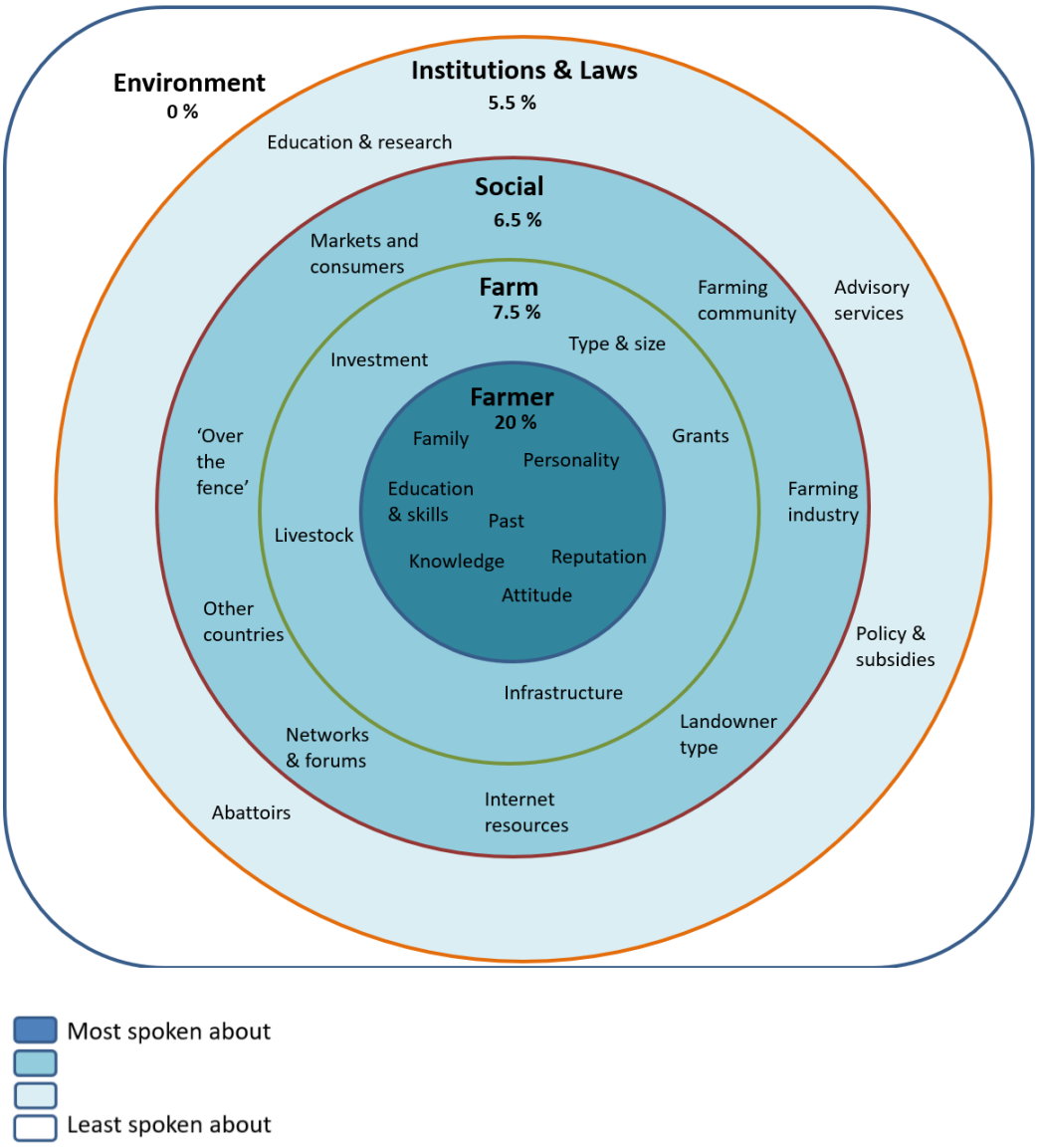


Figure 7.9 Topics related by Farm 7 to the take-up of regenerative grazing practices in UK

7.9 Farm 8

> "Rotational grazing was our way in I guess. It probably made me realise the potential of grass, had me thinking more about grass, and the utilisation of grass"… "We're probably more focused on maximizing grass than maximising the cow if that makes sense. So that actually growing more grass effectively and cost effectively and utilising it effectively; is the absolute driver of the whole business really".

7.9.1 8A – Farm description

7.9.1.1 Farm type, size and livestock

Large, lowland, dairy farm.

7.9.1.2 Land holdings

Manages three dairy units across 1000 acres.

7.9.1.3 Farm business

The farmer is a joint partner in three shared equity businesses, plus the original farm partnership (with their mother). The three shared equity businesses are three dairy units, one with 360 cows (started 2015), one with 260 cows (started 2017), and one with 300 cows (started 2020). "And they are farmed in partnership with lads that originally worked for me and have gone through into managing their own units. So they have equity shares within the cows, within those three businesses. So my role now is kind of overseeing those three businesses as well as running the original farm partnership".

The shared equity businesses all have separate partners; the farmer being the one common partner to all three businesses and the partnership. "Because the businesses all have separate partners, although I'm a common partner, So they're very simple clean businesses. They're just cows and infrastructure. There's no big capital expensive machinery. Each farm is basically equipped with a quad bike and a skid steer".

The original farm partnership, consists of a business which rears heifers, grows all the forage for those dairy units, and does all the contracting work (e.g. all the tractors are owned by the partnership and leased to the shared equity units). "We're doing a lot of invoicing backwards and forwards really but it does keep everything very transparent". The heifers or the young stock, are centrally reared by the partnership. "That's the only movement of stock within the businesses really".

The three dairy units sell milk to a dairy co-operative, a local cheese maker, and Yew Tree in Wigan, which exports dried processed milk products all over the world.

The farm also earns an income from a Combined Heat and Power (CHP) unit that produces and burns woodchip to sell electricity back into the grid, and creates heat for the houses and offices.

7.9.2 8B – Grazing practices

7.9.2.1 Current grazing practices

The farm started a New Zealand style rotational grazing dairy system in 2010. “Once the grass plant gets to a three leaf stage at 20 days, we're on a 20 day rotation and we’re taking away the three leaves; but only grazing for up to very short periods up to 36 hours. So the plant is able then to recover very quickly and motor away again. Basically it's optimising the efficiency of the grass plant and allowing the stock to eat forage which is at high energy levels as well”.

When the cows are brought out of the sheds in February, the grass is grazed on a 45-day rotation. As grass growth starts to speed up, the rest period is gradually shortened throughout Spring until the 1st May. Throughout the summer, grass rotation is speeded up to 20 days from the 1st of May to mid-September. From mid-September through to November, the rest period lengthens as grass growth starts to slow down. Over Winter, whilst the cows are in sheds, the grass gets approximately a 60 day rest period, to try and build a grass cover ready for grazing to start again in February. Between 2-4 acres are grazed at any one time. The grass is measured weekly by eye and plate metre.

7.9.2.2 Previous grazing practices

The change explored here is historical (ten years ago) when the farm changed from set-stocking to a rotational / grass focused dairy system. The farm previously had 2000 sheep and a suckler herd (80 cows). The ewes were set-stocked grazed and then kept indoors once lambed, intensively finishing the lamb on creep, to sell in May and June.

7.9.2.3 Aspirational grazing practices

The farmer does not currently wish to change practices further.

7.9.3 8C – Farmer motivations

The farmer is middle-aged with a growing family. The change explored here is historical (ten years ago) when the farm changed from set-stocking to a rotational / grass focused dairy system.

The business is based on profitability, and a blueprint of 300 cows on 200 acres. It is focused on profit per hectare rather than profit per animal; and utilising grass as much as possible, thus bringing down feed costs. Over the last ten years the business has evolved from one partnership, to the partnership plus three shared equity ventures.

7.9.4 8D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.10).

The farmer spoke mostly about matters across under 'Farmer' (12% of narrative) including farmer age, reputation, knowledge and skills. Less so, topics under 'Farm' (size and scale, business structure and labour) and 'Social' (discussion groups, industry connections, demonstration farms and key influencers) were covered. Mention was made of aspects under 'Environment' and 'Institutions and Laws'. **Unique to this farmer, was discussion in relation to business structure and scale.**

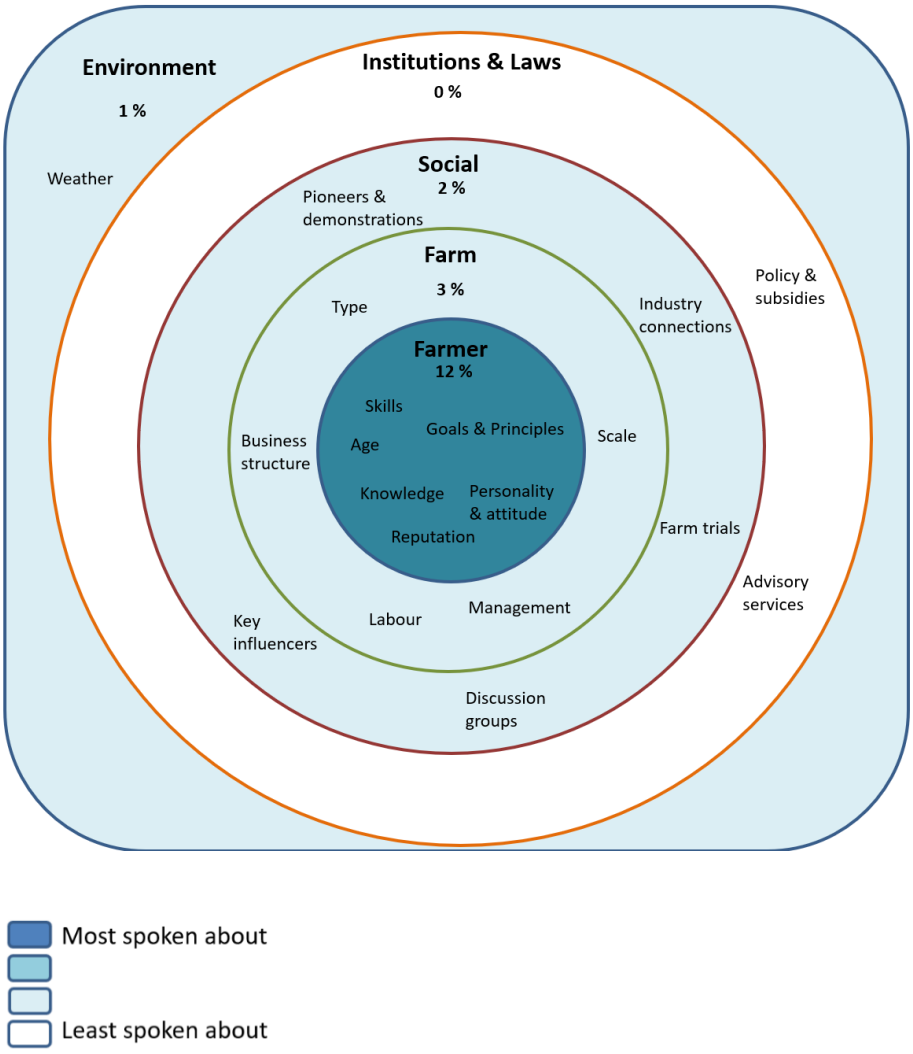


Figure 7.10 Topics related by Farm 8 to the take-up of regenerative grazing practices in UK

7.10 Farm 9

"At the moment, we're getting you know… farmers are the anti-Christ with climate change and veganism and that sort of thing. We're getting a bit of a

hammering. And I'm all ears… We use fertiliser, and you question how sustainable that is …Should we just be doing something completely different? Rather than using fertiliser in the first place?"

7.10.1 9A – Farm description

7.10.1.1 Farm type, size and livestock

Partner in numerous shared equity dairy units. Each dairy unit is approximately 250 cows to 250 acres.

7.10.1.2 Land holdings

8500ha of which farms 2000ha directly, across three different areas. The landowner has 63 tenants across the remaining 6500ha, who are mostly conventional beef and sheep farmers.

7.10.1.3 Farm business

The farmer has set up a system of shared equity dairy units, partnering with other farmers, who own a percentage of the cows that they manage. These are completely separate businesses to the tenancies. The landowner has very little control / input to the land under tenancy.

The farmer started farming in 2001, with a big beef and sheep business which was unprofitable. They shrunk that business down to one unit to see if it could be profitable, with the aspiration of operating independently of subsidies. Meanwhile, they let out the remaining land on short-term basis. The farmer realised that the only way to make a profitable enterprise was to convert the unit to a high grass utilisation dairy system. The farmer has subsequently, and slowly, expanded the business over the course of 20 years, as a number of share farming units.

7.10.2 9B – Grazing practices

7.10.2.1 Current grazing practices

The farmer moved to a New Zealand style, dairy, rotational grazing system in 2001, when they returned to farming from another long-standing career. The current system focuses on maximising grass growth and utilisation. "Roughly speaking, we measure things in kilos of dry matter per hectare. And roughly speaking a kilo of dry matter grazed grass costs 5p/kilo. A kilo of silage cost 10p/kilo. And a kilo of concentrate feed costs 25p/kilo. So we just focus on those. [So greater grass utilisation?]. Yes, exactly. Those 5p units of feed going into the animals". The farm is applying 250 kilos of nitrogen/ha.to achieve 15 tonnes of grass per hectare.

The farmer grazes to 'the three leaf stage'. When grass is growing from early April to September, grazing is rotated around the fields in 21 days (so the cows revisit the same patch of grass after 21 days, giving 21 days of uninterrupted re-growth). When grass growth starts to slow down, this lengthens to 30-40 days. Over the winter, there is a 100 day rest period, when the cows are in sheds. Grazing starts again on the 1st of February. Either every 12 hours or every 24 hours, the cows go onto a new patch of grass.

7.10.2.2 Previous grazing system

Prior to 2001, the farm was a beef and sheep enterprise which used a set stocking, continuous grazing system.

7.10.2.3 Aspirational grazing practices

The farmer aspires to use less inorganic inputs: "I think just less input. … I think dairy products is high quality nutrition yeah? I think it probably does depend how it's produced and what's its produced from. But I think the relationship between sunlight, energy, photosynthesis and plants, being converted into a form of energy that humans can consume by ruminants; is pretty cool, it's pretty sustainable. But at the moment, we are using inputs to do it with" … "I would like to be able to produce maybe not quite the same, but nearly the same with less. That's where I'm starting from. Rather than going, right, no inputs and produce way less, yeah? I don't want to, I'd rather come back a bit. So for instance, I can grow 15 tonnes [of grass] with fertilizer, and grow 7.5 [tonnes] without fertilizer; but if I can grow 12 tonnes with, without nitrogen say, but I could still use a little bit of phosphate, or a little bit of potash, or a little bit of sulphur or whatever, then that's a good compromise for me".

The farmer is interested in promoting more diverse swards: "And we grow perennials, but primarily ryegrass. And we use clover, but clover takes more careful management. And, we, you know, we, it's something that I've been sort of meaning to do. Because at the moment, we've got cows to feed and nitrogen fertilizer is financially cheap and effective, you know, a higher return on spreading nitrogen to guarantee you've got feed for the animals" … "Like I say, even in our current clover and ryegrass system, it's a massively oversimplified ecosystem underground. And for root exudates to really start interacting, you need about, I think he said 7 or 8 species, is what you really need to… so that soil life becomes self-sustaining I think, you know".

7.10.3 9C – Farmer motivations

The farmer is a large landowner and farmer, having returned to farming at the age of 30 from another long-standing career. The farmer is middle aged with a growing family.

The business focuses on profit per hectare, rather than profit per cow; and is focused on high grass utilisation in a low-cost, rotational grazing system. This allows it to produce milk at a very low cost. The farmer is content with the business model that is working today “But I don't know about the future. And I'm looking forward to learning about how we can do it differently, how we can do it better”.

In 2001, when the grazing system was changed from set-stocking to rotational, the trigger was a desire to be profitable, and to exist independently of subsidies. Now, the trigger is less direct but more a growing concern for the future well-being of the farming community and natural environment.

The farmer is motivated by a sense of duty, to keep the land in good condition: “I suppose it's because we own land and we aspire to continue to own it and look after it”.

The farmer is motivated by a concern about environmental damage, the sustainability of farming, and the reputation of the farming community: “At the moment, we’re getting you know… farmers are the anti-Christ with climate change and veganism and that sort of thing. We're getting a bit of a hammering. And I'm all ears. And then so environmentally, I've always been… We use fertiliser, and you question how sustainable that is. We could actually make nitrogen fertilizer using renewable energy but is that still the right thing to do? Should we just be doing something completely different? Rather than using fertiliser in the first place” …

7.10.4 9D – Experimentation topics

The farmer was asked to talk about topics which they feel relate to the take-up of regenerative practices in the UK; both on their farm and more generally in the farming community. The range of issues and concerns described by the farmer can be grouped under five broad headings: Farmer, Farm, Institutions and Laws, Social and Environment (see Figure 7.11).

The farmer spoke mostly about matters which can be grouped under ‘Social’ (9% of the narrative) including the public perception of farming, the farming industry’s mindset, Welsh culture, market pricing, farmer to farmer learning, key influencers, other countries, ‘over the fence’ experiences, farm-based trials, and knowledge events. Topics under ‘Farmer’ (8%) were also covered such as knowledge, goals and principles. Other topics covered included ‘Farm’ (4%) finances, scale, type and business focus; and policy, subsidies and advisory services under ‘Institutions and Laws’ (1%). Climate was discussed under ‘Environment’ (<1%). **Unique to this farmer, was discussion in relation to on-farm trials and Welsh culture.**

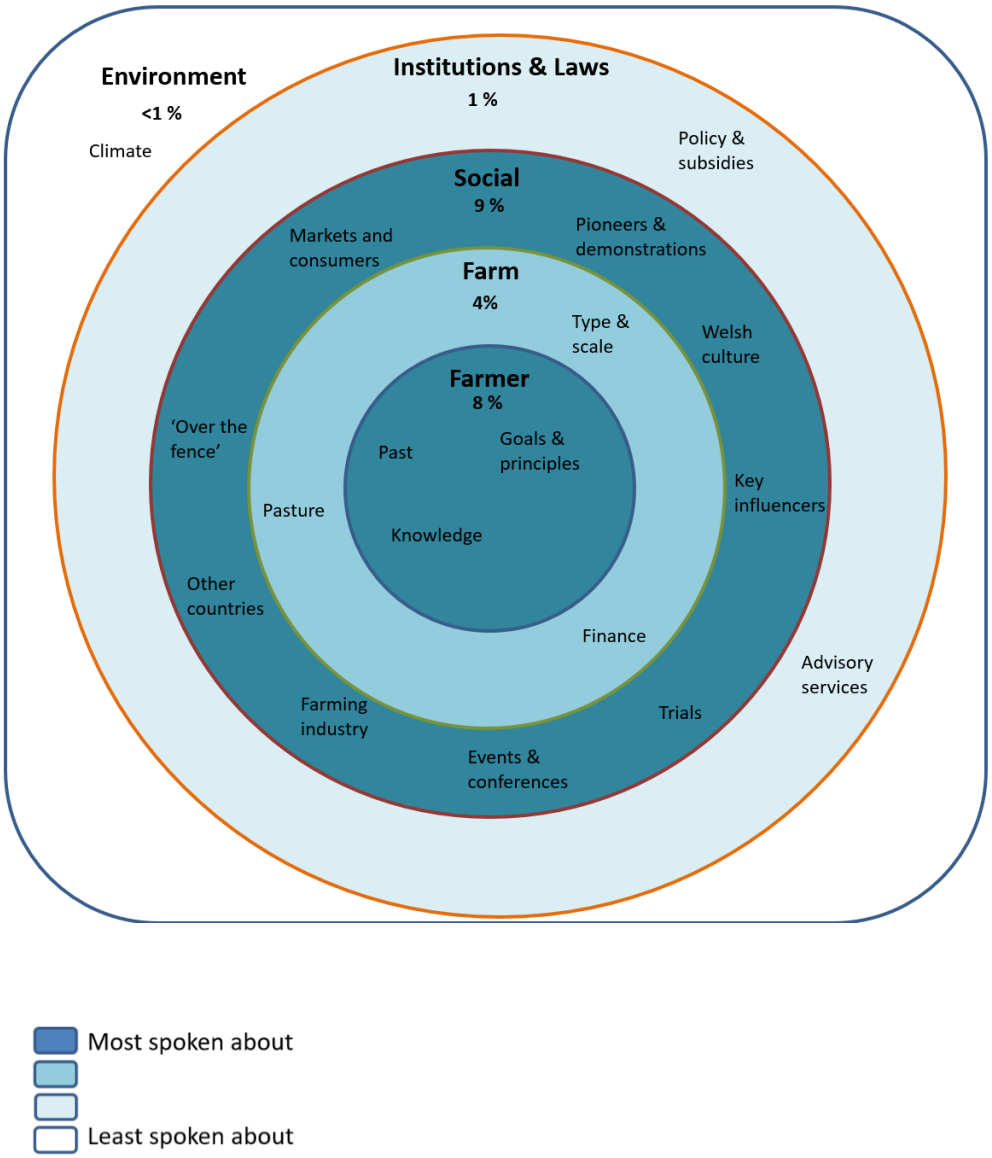


Figure 7.11 Topics related by Farm 9 to the take-up of regenerative grazing practices in UK

7.11 Summary

A diverse mix of farms have been interviewed for the purpose of this research, which vary by farm size, type, business structure, location and land rights. They also vary in terms of their progress towards more regenerative grazing practices: all are experimenting to some degree, some are more established in regenerative grazing than others. Several of the farms made changes 20 years ago, others have been experimenting since 2018. Some have made a degree of change (e.g. have started rotational grazing, but have not introduced diverse swards, nor cut chemical inputs) and are content with where they are. Whereas others, have made the same changes, but still aspire to do more.

What is perhaps surprising, is the breadth and depth of topics raised and covered by the farmers in relation to the take up of regenerative grazing practices on their farm. These can be

captured under five broad headings of Farmer, Farm, Social, Institutions and Laws, and Environment. Interestingly, the farmers spoke very little, if at all, about Government payments in making the change happen. Most spoke the most about constraints and enablers under 'Farmer'. All of the farmers spoke very little about topics under 'Environment' (these aspects were mostly covered under discussion of motivations and observed benefits).

Each farmer in turn highlighted a particular angle on the experience of taking up regenerative farming practices. These were:

- The role of farm advisors and conservation land agreements.
- Increasing farm resilience to market fluctuations.
- Family succession and business growth.
- The role and influence of social media.
- The challenge of changing family mindsets.
- The challenge of changing employee mindsets.
- The value of learning from abroad.
- The role of novel business structure and scale.
- In relation to on-farm trials and Welsh culture.

Aspects of these themes are explored in more detail in the following chapter.

Chapter 8 Analysis

8.1 Introduction

This chapter introduces and describes a conceptual system for farmer decision-making, which has emerged from the data, and explores this within the context of this research: transition to regenerative grazing in Wales. This conceptual system develops Schiere, Darnhofer and Duru's (2012) idea of a farmer's 'feasibility space' which they suggested can be shaped by policy, institutional and governance structures as well as the agency of the farmer themselves. This conceptual system, and the relationships between components of the system as evidenced by this research, is sketched out in more detail.

Specific areas of the system are then 'deep-dived', to explore interconnections and feedbacks as noted by the farmers; acknowledging that the system is too vast to be extensively explored in detail across its whole for this thesis. Efforts were made to diagrammatically show the links between different components of the system as described by the farmers. But this proved to be too complex a visual. As such, the narrative in the deep dives seeks to draw out these more systemic observations.

Whilst developing a theory from nine farmer interviews may be considered to be limited, there is still considerable insight to be drawn from the in-depth exploration of one farmer's experience. This thesis has not taken the approach of theory development based on how much one farmer's experience, is legitimised based on how many other farmers experience the same thing. The richness of the interview data (far more than was able to be covered in this thesis) illuminated the nuances between, and subjectivity of, farmer experiences of transitioning away from one set of practices to another. It highlighted that there is a lot to contribute to knowledge, policy and practice by exploring the differences between farmer experiences, as well as those that may be more generalisable. Also, by the nature of the topic explored, the number of farmers engaging in regenerative transition was found to be rather low based on online searches, as such nine farmers is likely to represent a reasonable percentage (see Section 2.4.1). The data collected is particularly rich as it reflects nine very different types of farming set-ups in Wales (ranging from large intensive shared equity dairy enterprises, to small sheep grazing with commons rights, covering landowners, to tenants, dairy, beef, sheep and mixed farming); as well as nine very different farmers (from skills, education, world views, reductionist to systems thinkers). The chapter concludes with insights drawn from the data for the system described.

8.2 The system

From the data emerges a largely conceptual system, but one that is rooted in the tangible real world (via the physical presence of the farmer, and the farm, and the natural environment). Naturally emerging from the data, are decision-making components which aggregate into shared categories (social, environment, for example) stretching outwards from, but originating in, the farmer's conceptual space. Making up each category are components, or receptors, which were spoken about by each of the farmers and captured in the data (Figure 8.1).

The farmers spoke about the relationships which exist between these components, indicating that they are tugging and pushing in tension – sometimes constantly, sometimes intermittently, sometimes as one-offs. These components and their relationships, can be thought of as constantly jostling for space, thus defining each other continually by their existence and morphology to the changing conditions around them. As illuminated by the farmers, these relationships can be enabling or constraining depending on system conditions. In the context of Gallopin's (2006) description of SES, this supports the notion of a continual process of self-learning and feedbacks as the system responds to changes around it. As explored in Section 4.5, the nature of this continual jostling, and response, defines a farm systems vulnerability, resilience and adaptive capacity to changes around them, and within the system as defined here. Hence, this is useful to explore with respect to crafting future policy.

Figure 8.1 shows each of the components, making up each of the five spheres (Farmer, Farm, Social, Institutions and Law, Environment - shown by coloured squares) which emerged from the first round of coding (open coding). Stemming from each component in the system, are factors, identified through the second round of coding (or axial coding, coloured green or orange). Included in Figure 8.1 are all the components and factors spoken by all the farmers interviewed for this research.

The factors are named 'factors' because they exert an influence on the farmer's propensity to experiment in regenerative grazing; they have a 'relationship' with other factors in the system which together determine whether the system on the whole, is conducive or restrictive for farmer transition to a particular context.

Take Farm 6 for example. The factors that are in a coloured box (green or orange) in Figure 8.1 , are those identified and spoken about by Farmer 6. If this box is green, the farmer spoke about these factors in an enabling way. If they are orange, the farmer spoke about them in a constraining way. If 'paler' orange or green, these are factors which the farmer spoke about affecting farmers in general, but not in relation to their farm specifically.

For Farm 6, Figure 8.1 shows that factors enabling transition to regenerative grazing, are mainly in the Farmer and Social spheres. Whereas constraining factors are mainly in the Farm and Institutions and Laws spheres. This suggests that intervention to aid farm resilience and adaptive capacity could in part be addressed by policy, markets and legislation.

In the Social sphere, the farmer spoke about the rising cost of chemical inputs, *"The other interesting thing about chemicals is that when we were born you could buy four tonnes of fertilizer for every tonne of grain. Today, you can buy two or three tonnes of grain for every tonne of fertilizer. So, inputs have gone up, in terms of cost, hugely"* (Farm 6). This may seem to be a negative factor, but actually it is urging the farmer on to make change, a 'move away' from something, and thus is an enabling factor for transition to regenerative grazing in the system. As such, factors can appear to be negative but are actually creating an enabling environment for experimentation – they can be termed a 'negative enabler' rather than a constraint. In the Social sphere, the farmer talks about other enabling factors, termed here has 'positive enablers', mainly around farmer-to-farmer learning.

Figure 8.1 clearly shows that the concentration of constraining factors in the system, for Farm 6, are mostly in the Farm sphere but also in the Institutions and Laws spheres (although in this sphere, they are mainly factors affecting farmers in general, not just Farm 6 per se). For Farm 6, physical aspects of the farm have needed restructuring in order to accommodate transition to regenerative grazing. This has included more fencing, water infrastructure, and planting hedgerows which together create a paddock system to accommodate the regular movement of livestock for grazing. Wagner et al. (2023) notes these aspects as constraints stated by the farmer in their transition to mob grazing (a type of regenerative grazing, Wagner et al. 2023). These are not necessarily constraints exactly, but are actions that the farmer has taken to facilitate 'change towards' a desired goal.

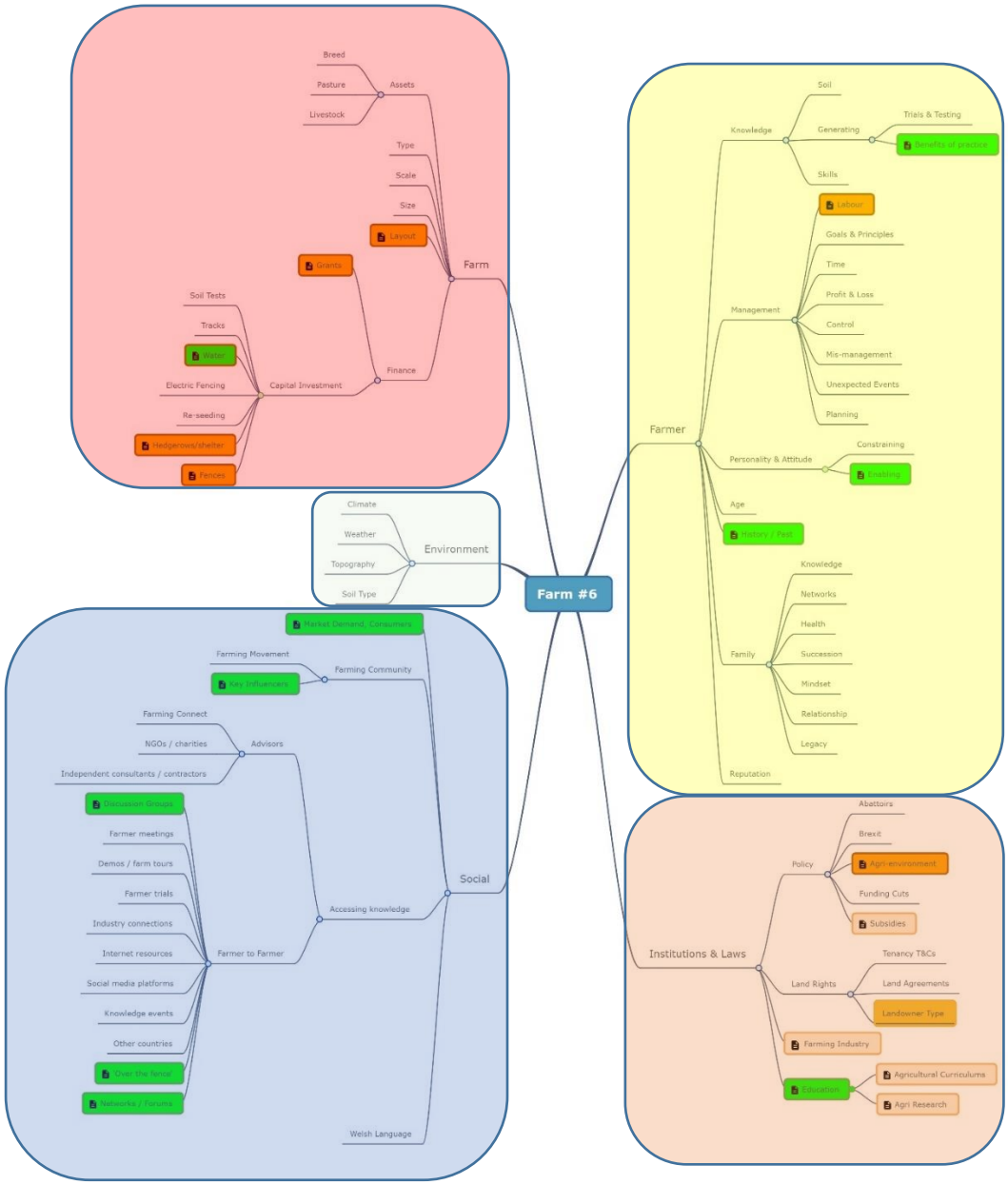


Figure 8.1 System spheres, components and factors for Farm 6

The farmer notes that these actions have been constrained by limited access to funds, grants and a historical legacy of big open fields *"So now that we want to get animals back into the same arable fields, we're having to completely start from scratch and rebuild the fences, which is not cheap"* (Farm 6). These are arguably true constraints in the system, not constraints that have actually spurred on a 'move away' from something (as per the example or rising costs earlier in this section). Farm layout is also an issue and is not always conducive to change: *"Unfortunately, where we do the calving is not where we have all the grass, which is a legacy of the former business going back 40 years… Because … from that shed, we need to take them seven miles to get them to where the grass might be; which causes a bit of a logistical headache"* (Farm 6); another example of a true constraint.

Now contrast this system to that for another farm (Figure 8.2 , Farm 5). For Farm 5, enabling factors are spread across all five spheres except for Environment. Fewer constraining factors were spoken about compared to Farm 6. Farm 5 specifically spoke about 1) being unable to influence family mindsets, 2) finding enough time to plan and manage, 3) accessing funds to plant hedgerows for shelter belts, and one factor completely out of their control, 4) a drought the preceding summer. This illustrates that farmers are experiencing different enabling (positive and negative) and constraining factors in the systems unique to them, and their farming context; and that these are spread across the different spheres in different ways.

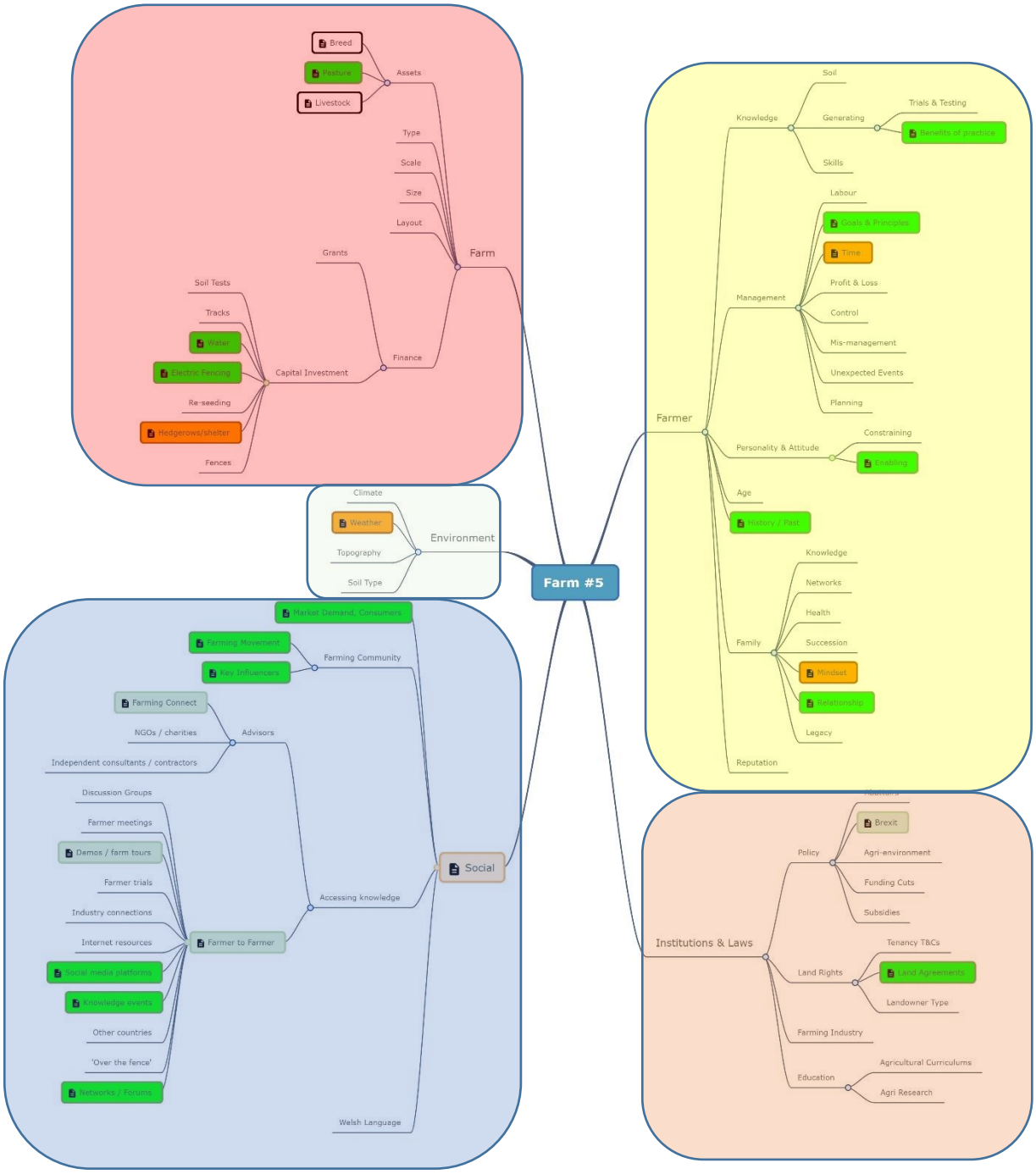


Figure 8.2 System spheres, components and factors for Farm 5

8.3 Context dependency

On the whole, the farmers seem to be experiencing the different factors in similar ways, e.g. access to grants is a positive enabler, a supportive family is a positive enabler, poor farm layout is a constraint. However, clearly, the data shows that different farmers, in different farming contexts, are exposed to different factors. For example, for some of the farmers, family mindset has been an issue, for others it has not.

For some of the factors, farmers are clearly experiencing them in different ways; for some they are enabling transition to regenerative grazing, for other farmers the same factor may be constraining experimentation. Take land rights for example, specifically farming tenancies. Farmer 3 talks about the flexibility afforded the farm system, by having multiple types of different tenancies:

“I think we're in every type of tenancy you can possibly think of...Over many years we had three little fields, and it used to cost me a couple of bottles of gin every month [laughter]... As long as I had a few cattle in the field that he could look at out of the window, and the fences were up together, and it was fairly tidy and that’s all he wanted really. Then we've got FBTs, we’ve got contract farming agreements, we’ve got share farming…The other estate, where we’ve got the other unit, is contract farming agreement and that runs for ten years with 5-year renewal. So you know, at least 5 years ahead what's happening …It's been rolling onto some while now… The share farming is the next farm. We don't make a lot of profit there but he's quite content to have it farmed. He’s asked us, even though we’re not organic any more, he’s asked us to run the farm on organic principles which we’re quite happy to do." (Farm 3).

Whereas Farmer 2 has experienced how limited land rights constrains experimentation, specifically, investment on the farm:

"Well basically if, as myself as a tenant farmer, unless you're lucky enough to still be on a three generation tenancy, most people aren't anymore, … maximum you get is a 15 year Farm Business Tenancy, a lot of people get 5 to 10 so you know it's not enough to be able to invest into something… Because a lot of tenancies, on the short-term, the payments are linked to the landowner and the tenant has to make money out of what he can produce from it. So there's no incentive for that tenant then, to care for the environment or anything then because he just needs to pay his bills, put food on the table. So it needs much more of a fairer system going forward" (Farm 2).

Clearly there are nuances in each farmer’s experience of land rights (and this is just one factor in one sphere). Farmer 3 is benefitting from the flexibility of multiple tenancies to allow the

farm to expand and contract when needed, in response to different system conditions. Whereas, Farmer 2 is talking about the limitations of one tenancy, specifically in terms of duration, five years as opposed to a desired twenty years. This shows that one element of the system may be constraining for one farmer, but for another farmer it may be enabling and that this can be down to variables, or characteristics, of each factor themselves and their interaction within a given farming context. This is explored in more detail, together with 'land agreements' later on in the 'deep dive' section.

Identifying what might be a factor (whether constraining or enabling) rather than just happenstance is a consideration. For example, Farmer 5 spoke about their education (degree in ecology), as a factor for their interest and motivation for regenerative grazing. However, their upbringing, personal interests and personality traits may equally be a factor, which could have motivated the farmer to seek a degree in ecology in the first place. As such, it is challenging to understand whether one factor generated the other, whether they support one another, or whether they exist independently of each other**.**

It is also difficult to follow the relationships in the system back more than one or two preceding factors, to the root cause (if there is a string of causality), as a) either the interviews were not long enough to permit this opportunity, or b) the farmer did not speak about this (either because they were not asked to talk about it, or do not / would not know, or have not thought about it before for example). For example, Farmer 6 talks about the 'enabling' influence of a network of farmers in the same position, all experimenting to some degree in regenerative farming. The network was set up by the Soil Association, therefore its existence may be assumed to be dependent upon the Soil Association to obtain funding to support a facilitator role. This 'enabling' factor also depends on the participation of other farmers, all with time and motivation to take part and learn from one another. **Each of these factors in turn will be dependent on a myriad of other system factors, in their farm systems, allowing this to happen.**

To support this point, another example is provided by Farmer 4. Farmer 4 spoke about feeling constrained by a lack of control over finances, and a legacy of mis-management on the farm. Delving deeper, it emerged that this was due to the ownership of the farm being in the ownership of both the father and uncle. Family disputes had hindered any investment in the farm, leading to deterioration in farm assets and planning. This had been compounded in recent years by the father's poor health. At first glance, a lack of investment would be taken as the main reason for constraining transition to regenerative farming. It is only down to further questioning and reflection from the farmer, that land rights, split inheritance, family dispute

and poor health were also contributing factors. The lack of a feeling of control over finances was a consequence of this context.

Despite these constraints (or negative enablers), the *concatenation of factors* is shifting the farmer's propensity for experimentation and is clearly motivating Farmer 4 to change things significantly. In this case, it is insufficient to seek explanation of farmer propensity to experiment through single factors and more insight is drawn from seeking to understand the relationships between single factors in the given context.

8.4 Farmer agency

This section takes some 'deep-dives' into parts of the system described above, to explore how farmers are taking action to influence components of the system (their 'agency'), in order to try and make the entire system more conducive to regenerative grazing. This explores some of the relationships between different factors in the system along 'pathways of change'.

8.4.1 Deep-dive 1: Land agreements

There is a relationship between land agreements, in place for conservation purposes, and farmer transition to regenerative grazing. Three of the farmers spoke about this relationship, in both constraining and enabling ways. All three farmers were seeking to access additional areas of pasture to incorporate into their regenerative grazing system. Two of them were trying to facilitate change with regard to land agreements on their farm, in order to adjust the system towards one that is conducive for regenerative grazing. The literature review in Chapter 4 did not highlight land agreements as a key variable. This is explored below.

Farmer 2 spoke in relation to accessing commons land, i.e. hill land where farmers have shared rights to graze the land but they do not own it. Farmer 2 wanted to send livestock up to graze as part of their rotational grazing plan but this was made difficult by both seasonal and stocking density restrictions in place, which had the effect of hindering a rotational grazing system for the entire farm: *"…at the moment I'll be breaking the rules sending them up. On the three mountain blocks that we have, there is only one that we are allowed to graze 12 months of the year but that's on such a reduced stocking rate, it's frustrating … they want the stock off, there's nothing written down why they want them off, they just, goes back to the CROW act, destocking and so on. That's what they're still following. Frustrating really" (Farm 2).* The farmer was linking this to the Countryside and Rights of Way (CRoW) Act, allowing the public the right to access open country (mountain, moor, heath and downland) and 'registered common land' on foot. However, the reasons for this was not expanded on but it suggests that

the restrictions in place on commons land are primarily to allow for public access, and perhaps less so other considerations such as farming and ecology.

Farmer 2 also linked these restrictions to environmental advisors from statutory bodies and environmental NGOs, and was working on an opportunity to speak with them, to try and change the restrictions: *"I just basically… want to sit down with the relevant people to discuss it from, well the RSPB would be one group of people to talk to, because of the ground-nesting birds" (Farm 2).* Farmer 2 communicated that there is a lack of information and communication to the farmer as to why these restrictions are in place, inferring feelings of powerlessness and not feeling well-informed. They also felt discouraged by fellow farming peers to engage with the environmental NGOs stating *"the amount of older farmers that will come up to me, 'Oh I liked hearing you talking about the Lapwings and so on but don't mention anything, we've still got them on the farm, we refused access to certain people to come onto the farm, because we know they've been in other places and they interfered and they lost them straight away'."..."They happily talk about producing food but it's the interference of third sector bodies coming in and telling you this is how you should be doing it." (Farm 2).*

Farmer 5, conversely, spoke about the land agreements linked to designated areas in a positive, enabling sense: *"the other land, the conservation grazing is all rent free … so there's a piece of land under a section 16 agreement in the national nature reserve"..."We can carry more stock than we could. The way it works is that it allows us to take a hay cut" (Farm 5).* Farmer 5 inferred how access to additional pasture was helping to create flexibility in their new rotational grazing system, for example, if grass growth was poor one season, the additional hay cut would tide things over until grass growth improved. It meant there was somewhere to graze the livestock whilst grass grew at the farm. This flexibility in the system seems to be enabling the farmer to slowly adjust and adapt to a new system.

An overview of the enabling and constraining factors surrounding land agreements spoken about by the farmers in relation to experimenting in regenerative farming is given in Figure

8.3.

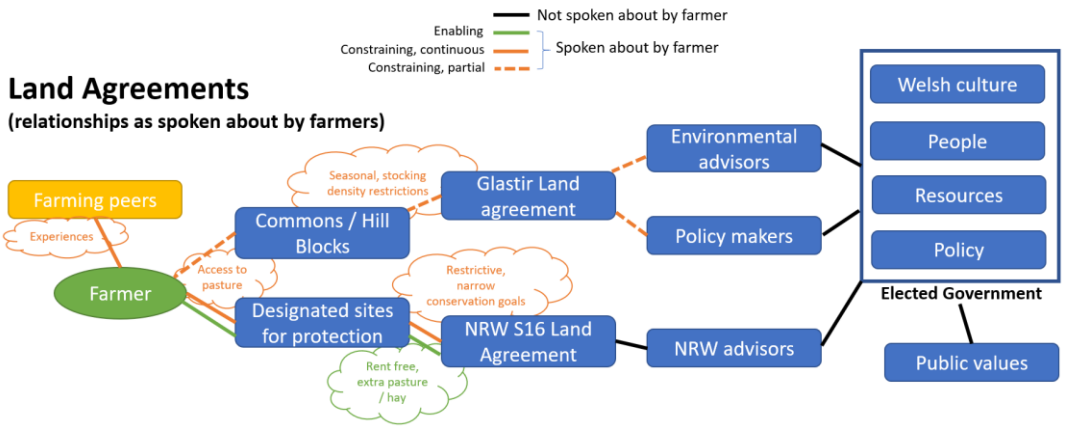


Figure 8.3 'Deep dive' into land agreements enabling and constraining factors

The relationships are complicated further when a farmer has multiple land agreements in place, and trying to navigate their varying conditions, to incorporate the pasture into an adaptive flexible rotational grazing regime. Farmer 4: *"I'm SSSI, I'm PAWS, I'm Ancient Woodland; so I've got all of the limiting sort of government regulations around all those things"..."So the area at the top of our thing, it's an iron age hill fort …. Conservation wise it's down for butterflies, so Grizzled Skipper, Pearl Bordered Fritillary, another one that I can never remember. But they want us to manage the bracken to make it more of a limestone grassland but Pearl Bordered Fritillary, they only breed on bracken. So you've got some of these conflicting conservation, preservation concepts that have been around for 20 odd years".* (Farm 4). Again, the messaging is not clear, and the farmer infers a feeling of confusion and dismay because of the narrow conservation goals, that hinder a regenerative grazing system which they believe will ultimately enhance natural processes and promote biodiversity. The farmer feels that many designated area prescriptions are missing the 'bigger', more holistic, picture.

Farmer 4 linked these designated area land agreements and restrictions again to the people behind them, the environmental advisors. The farmer spoke about trying to gain access to the pasture, by talking with the environmental NGO involved: *"So the constraints that I'm going to have to deal with on that area, on the SSSI, such as getting pig's back into the woodlands; the conversations that I know I'm going to have to have, but I'm going to be proactive in it. So I'm going to say this is what I'm doing, and this is how I'm doing it and this is why it will work. Rather than I can't do it because the rules say I can't. Well I've got a friend who lives just down the vale. She's an RSPB nature officer. For years it's been we don't want that on our land because they'll write and it'll get on a list somewhere, and we won't able to do x, y and z. The people that are now in those jobs they are looking for reasons why not to. If you can say, look I can sequester x amount of carbon on this, I can floodplain this"* (Farm 4).

Overall, this deep dive has explored the component, Land Agreements, in the 'Institutions and Laws' sphere, in more detail; a critical part of the system under investigation in this research. It has described how two of the farmers are using their own agency, to change land agreements in order to modify their farm system towards one that is conducive for regenerative grazing. It has shown that multiple factors are at play here, ranging from legalities in land agreements, the policy driving the laws, and the people making and enforcing the laws. It highlights that this factor is nuanced, in some instances land agreements for conservation purposes are enabling farmer transition to regenerative grazing, in other instances it is hindering but perhaps providing opportunity to challenge the status quo. It does suggest that perhaps land agreements could show the same site-specific consideration for farming practices as they do for site specific conservation needs, to greater recognise the interplay and dependence between viable farming systems and broader biodiversity health for any area, rather than prescription treatments for singular species or habitats in an area. There is a risk of too much reductionist in conservation management. Perhaps greater flexibility and adaptability in conservation land agreements could deliver greater outcomes overall.

8.4.2 Deep-dive 2: Land rights

As introduced earlier, land rights are an example of one element of the system that may be constraining for one farmer, but for another farmer it may be enabling and that this can be down to variables, or characteristics, of each factor themselves and their interactions within a given farming context. Interestingly, the literature review in Chapter 4 did not highlight land rights as a key deciding factor. This is explored in more detail here.

In farming contexts, land rights seem to be enabling towards farmer transition to regenerative farming when this allows pasture area to expand and contract as needed (due to drought for example, or changing livestock carrying capacity on the land). This may be provided for when the farmer has:

- Multiple tenancies in place, of different types (both formal and informal);
- Long term tenancies in place, of at least 15 years.

This may also be achieved via:

- Land agreements to graze sites designated for conservation purposes (e.g. S60 agreements), or access to commons land;
- Contract farming, when a farmer pays another farmer to graze an area of land as and when required (for ten years with 5-year renewal).

Farm 3 specifically states that transition to regenerative farming was made possible by *"…taking on more land, which we were luckily able to do by taking on the neighbours' farm."..."I think we're in every type of tenancy you can possibly think of...Over many years we had three little fields, and it used to cost me a couple of bottles of gin every month …Then we've got FBTs [Farm Business Tenancies], we've got contract farming agreements, we've got share farming".* This farmer actively decided (their 'agency') to take on more tenancies, of different types, in order to help transition the farm to more regenerative grazing practices. As Farm 3 notes, they were 'lucky' and this in part is down to happenstance – not all farmers would have this opportunity. Ideally, new tenancies need to be land neighbouring the farm, for ease of movement of livestock. However, some of the other farmers (Farm 5) were making use of grazing rights further away (via land agreements) to facilitate their change to regenerative grazing.

Figure 8.4 shows the relationships around land rights in the farming system, captured from the data in the 'deep-dive'.

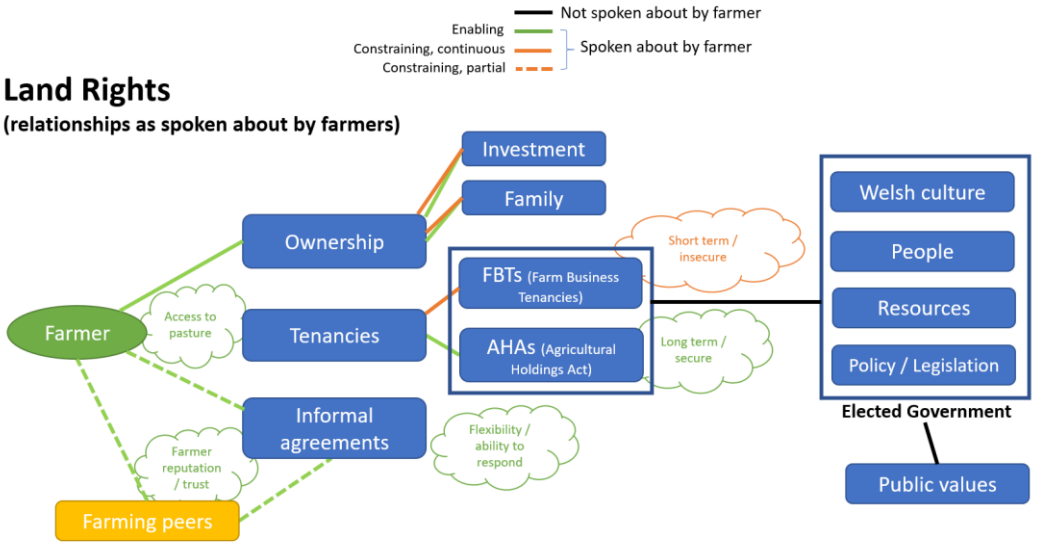


Figure 8.4 'Deep dive' into land rights enabling and constraining factors

The introduction of Farm Business Tenancies (FBTs) in 1995, replacing Agricultural Holding Act (AHA) tenancies, has had the overall effect of increasing uncertainty in farming tenancies, reducing terms of lease to 5-10 years. As Farm 1 notes *"Well if you're a tenant you're not going to want to spend [on infrastructure on the farm], depends what sort of tenant you are and how much you're prepared to spend on sorting out your water and investing in the, well it's not a massive investment for the fencing, it's probably easier if you're a landowner because whatever you do is what you've done and you've chosen to do it is your land".* This however highlights that farmer personality, motivation and ambition are related issues to 'agency' and willingness

to take action; and also that it depends on the type of infrastructure required on the farm for regenerative farming e.g. new fencing may be affordable to the farmer, but not new water infrastructure.

Prior to 1995, AHAs allowed for up to three generations of a family to run and manage a farm. This is likely to have encouraged greater farmer agency, more investment, and long-term management of farms for long-term gain i.e. farmers are likely to have ranked the importance of good soil (an outcome of regenerative farming) much higher than if subject to short-term, insecure tenancies. As Farm 2 says *"Well basically if, as myself as a tenant farmer, unless you're lucky enough to still be on a three generation tenancy, most people aren't anymore, and say maximum you get is a 15 year Farm Business Tenancy, a lot of people get 5 to 10. So you know it's not enough to be able to invest into something. There's a lot of money that the tenant has to invest into things so I'd rather see, it doesn't have to be like a generational tenancy, but something towards 20 year tenancies so that you can invest into it, as if it is your own farm. And then the tenant, the landlord, everybody wins".*

Farm 2 went on to say *"You get stories of farmers taking farms for say a 5 year tenancy, the farm might be in a very poor state, the tenants invest a lot of money in, and after 5 years they get notice, the landlord wants it back and someone else has fixed his inability to farm in simple words. Obviously, there are other things why people let land out, but I'd say the majority of it is people that'd rather have an easy life and get money for doing nothing. Because a lot of tenancies, on the short-term, the payments are linked to the landowner and the tenant has to make money out of what he can produce from it. So there's no incentive for that tenant then, to care for the environment or anything then because he just needs to pay his bills, put food on the table. So, it needs much more of a fairer system going forward".* Shorter term, more insecure tenancies clearly have the effect of reducing farmer agency and arguably deter tenant farmer investment, especially when it comes to changing farm systems. However, this sheds light on the relationship between farming subsidies and land rights and their combined effect on farmer propensity to experiment in regenerative farming. On one hand, a short term tenancy might be conducive to changing to regenerative farming, if the landlord wants this, but the tenant does not. Conversely, a shorter term, more insecure tenancy might not be conducive to changing to regenerative farming if the tenant wants this, but the landlord does not.

This suggests that on one hand, farmers need flexibility in land rights (access to pasture) to allow for expansion and contraction on demand, depending on grazing conditions. But to justify investment, and initial conversion to regeneration farming, long-term and secure access

to pasture is required. This suggests that greater scrutiny and understanding of the relationship of land rights (including land agreements) with propensity to experiment in regenerative farming is required. It may be that initial take-up and capital investment requires long-term security, but then on-going day to day management requires greater flexibility in land rights (with multiple agreements in place, both formal and informal in nature). This mirrors the plans of investors e.g. environmental bond developers, to 'buy up' farms, convert them to regenerative farming, then lease them out as 'low operating cost regenerative farms'. One of the farmers interviewed (Farm 8), a very large landowner with multiple tenants across Wales, sums it up well *"I've just been offered a farm … on the Llyn Peninsula…. They're not all good opportunities and some of the people aren't… you need a mix of the right landholding and the right personality to do it."*

8.4.3 Deep-dive 3: Challenging mind-sets

Two of the farmers spoke about the challenge of persuading other people in the farm system (whether family, or farm workers) that experimenting in regenerative farming is a good idea. The farmers spoke about the strategies they were taking (their 'agency') to try and bring these people around to their way of thinking. In some instances, this took three years of gentle persuasion; in others, farm estate workers were put through training with limited results. This is explored in more detail here, and provides new data which was not highlighted in the literature review (Chapter 4).

Farm 5, with reference to bringing their Dad around to the idea, said *"So, the last few years, I've been trying to convince him that it's a good idea".* They noted their Dad was not obstructive per se, but neither was he wholly bought into the idea. But they want onto say, that *"…although my Dad was quite averse to the idea initially, he's actually come around to quite a few ideas which has helped our relationship to an extent".* The link to 'their relationship' suggests that the farmer's desire to take a risk, and experiment in regenerative farming, actually caused tension in the family which was only improved over time with gentle demonstration that small changes were gradually taking effect (in this instance, rotation of grazing, changing to a hardier stock and keeping the cattle out all winter). In this case, the older generation needed evidence that little changes were working, and so the farmer took slow steps in transitioning towards regenerative farming on their small farm (50ha). The next example sets out a different approach.

Farm 6 took a different strategy and, fairly abruptly, went about wholescale farm system change (across a large mixed 3000ha farm). The farm employs six people, and the farmer was surprised at the negative reaction from long-standing farm workers to the prospect of change.

The farmer said *" …often the reasons I'm given for not doing something is weather related. And I think farmers are too quick to blame the weather for any of their bad management decisions"*. They went on to say *"I have to try very hard not to blame the staff for that because to me, it's a mental problem, and nothing to do with the weather"*. Insightfully, the farmer links staff resistance to change to their mental framing of the real world, specifically reductionist versus holistic mindsets. The farmer's solution was to challenge the workers way of thinking: *"So I got them in to do the introduction to holistic management for all of the staff, not only the farm staff but also the gamekeeper and the guys doing property and you know everybody. To really look at, and to try and define the whole. That training, I kind of prepared myself for it not going down very well, but it really didn't go down very well at all. All the reductionist scientific thinking has permeated much further than we might imagine. Even people who are, have almost certainly never read a scientific journal in their life; and in fact, of the staff I have, only one of them has a degree. Plenty of them left school when they were 15 but they, they still think very linearly and still think, [pause] they can't see more than a couple of steps ahead. So trying to persuade them to do the grazing has been particularly difficult because there's always a reason why not to".* The farmer really saw it as their goal, in order to be able to transition the farm to regenerative farming, to change their workers' way of thinking, of how they construct knowledge from the real world: from a linear one, to essentially a more systems thinking framework. And the farmer's approach to doing this was through training. The farmer almost seemed baffled, as to why people with no higher education, were so bought into a linear, reductionist way of thinking; as they assumed this was something only that those going through higher education would be trained in.

The farmer may have been over-thinking it, and perhaps the challenge was to break long-standing habitats rather than a way of thinking. Seeing that the re-training approach did not work, the farmer went onto talk about their next tactic: stripping it back to raw financials: *"I'm quite open with our financials and I showed them all a PandL from last year, spit out between arable, livestock and everything else. And the livestock had a big red number at the bottom and I said if this isn't black, you can't keep doing what you're doing. You either change and if it's still red and you've made the change, I'm happy half the way because at least you've made the change. If you don't change and it's still red, I'm getting rid of the whole lot. So there was a bit of a threat there really. However, I'm not entirely sure they still believe that the numbers that I've shown them are right which is weird because I'm the one who's a qualified accountant".* This flags another issue that the farmer was really struggling to communicate with the farm workers, that the farm was making no profit from livestock grazing; almost as if the farm workers were in a state of denial or disinterest.

Interestingly, the farmer's own conversion to regenerative farming took seven years of research, so perhaps on reflection it was unreasonable of them to expect a sudden change in their own staff's mindset… *"I've been researching this for 7 years, whatever it is, 5 years. And it's taken this long to get to where we've got to now. But we could have easily got to where we got to know in a year".* They went on to say, that despite some progress, they still feel like they are "*wading through thick sludge"* in bringing their staff around to the idea. *"As we say here, the 'it's always been that way' attitude is pretty prevalent in terms of everything … It's great having land but when you've got to bring people along with you, it creates an added layer of problems. I sometimes just want to go buy myself 50 random acres which I don't have to pay any wages on, and just do it".*

Insightfully, this really highlights the challenge that farms – whether large or small – may face, in changing to regenerative farming practices; when other people, their behaviours, their mindsets need to change also – and not just the farm practices themselves. Particularly, when this is fundamentally challenging the way people construct knowledge and experience of the real world around them (their world view). It does suggest that perhaps support for farmers in changing to regenerative farming, is not just about advice as to what measures to do and where, what payments to access and how, but also how to challenge reductionist world views and encourage systemic thinking. Despite the farmer's own agency in trying to enact change in mindsets as part of their adjustment towards regenerative grazing, in some instances this is harder to do, than others.

8.4.4 Deep-dive 4: Accessing knowledge – old and new ways

The farmers spoke about ways in which they are accessing knowledge to transition to regenerative farming. All of these ways (Figure 8.5), focus on harnessing knowledge via farmer to farmer learning rather than another external source; and many of these ways are facilitated by IT as well as traditional in-person approaches. This deep-dive focuses on drawing out useful insights, with regard to farmer agency; rather than giving a description of these farmer-to-farmer ways of accessing knowledge. This builds on some insights from the literature review (e.g. Kallas et al., 2009) which finds that the greater the farmer's use of IT, the higher the likelihood of conversion to organic farming (this is not specifically linked to the take up of regenerative farming).

Ways in which the farmers access knowledge

- Discussion groups
- Farmers from other countries
- Demonstration farms
- Farmer trials
- Industry connections
- Internet resources
- Social media
- Knowledge events
- Over the fence
- Networks and forums

Figure 8.5 Ways in which the farmers access knowledge

The farmers spoke about their need to 'access knowledge' in terms of:

- Acquiring new knowledge (soil health, different types of grasses)
- The importance of learning
- Filling a lack of knowledge
- Piecing together fragmented knowledge
- Remembering forgotten knowledge.

All of this represents 'agency' on the part of the farmer, taking action to acquire knowledge to be able to influence their farm system, and to take steps towards regenerative farming. Interestingly, some of the farmers spoke about what they then do with that knowledge; and that time is needed to understand and know what to do with the knowledge. This highlights that 'having knowledge' does not necessarily provide the solution to the challenge at hand; 'applying' that knowledge and testing how it works in a single farm system, in different conditions, over time; was the natural progression to acquiring knowledge. *"Even now with all the research that I've done, some of those specifics, you know you've got to have been doing them for 10 years to even know what they are"* (Farm 4) and *"I think just farmers tend to be practical people obviously, so having demonstrations, visits and talks, that sort of thing is essential. I think that's changed across Wales*" (Farm 5). This reflects the different ways that farmers are accessing knowledge as set out in Fig. 7.5; much of the knowledge is is from other farmers who have done it, who are trialling it, and who are trying it out. As such, farmer agency is accessing knowledge, is very much dependent on the agency of other farmers to provide this knowledge.

Other ways of accessing knowledge (as per Fig. 7.5) are dependent on Government agency to provide funding and to facilitate access to farming trials, demonstration farms, farming networks and discussion groups. In Wales, Farming Connect, a subsidiary of Welsh

Government and publicly funded, provides many resources to assist with farmer-to-farmer learning. Farm 1 "*It's run by Farming Connect but it's, you can start up a group of farmers and you have an Agriscop group and you have 10 or 11 meetings and they're all paid for and you can talk about anything you want, …. And an Agriscop group or the Agriscop coordinator will get experts in to talk to you and you can all work together to do things and I think groups that work like that can make more changes"..."you have discussions around stuff, these leaders get new people in, they take them out for trips and then you see other things instead of just keeping your head down and feeding the sheep. It's a lot easier isn't it".* Farmer 3 noted that the role of facilitator is key, to allow open free discussion in a trusted environment: Farm 3 *"And the discussion group met once a month and had a facilitator and they were absolutely brilliant because they could all float their ideas and criticize each other, and they all go round each other's farms and pulled them apart".*

Four of the farmers spoke about learning from farmers in other countries including Sweden, USA, Canada, New Zealand, Australia and South Africa. This suggests that farmer agency in this instance, depends on access to technology and social media platforms. This is supported in the literature by, for example, Mills et al. (2019) in farmer's use of Twitter for sharing knowledge around sustainable soil management, and Skaalsveen et al. (2020) in farmer's use of social media to share knowledge of no-till management. For Farm 7, learning was sourced online via family and business connections in Africa. They said *"Family in Zimbabwe… as soon as I started talking about holistic management two years ago, they were like 'we've been doing this, this is all we do, we have been doing this forever"…"Friends in Africa farming. It's amazing how they are, they are not oil based, and industrial based. So they do work more with the land, rather than just force the land with machinery".*

The strongest sense of farmer agency in accessing knowledge, comes from Farmer 9 who, having been disappointed in the lack of evidence of regenerative grazing in dairy systems in the UK, has decided to set up their own trials. Farm 9 *"[I need] to be able to prove to myself that I can grow 12 tonnes, it's a compromise, 12 tonnes of dry matter, without…well… getting to zero artificial nitrogen. Maybe with some phosphate and potash …I've been looking for somebody who's achieving it and I haven't found… I've heard that there are some, but I haven't seen anyone yet. So we're going to start doing our trials…we'll dedicate a couple of paddocks, particularly on one farm; and we'll give different treatments. Experience, experience, I suppose that's what's limiting".* Here the farmer places on emphasis on 'being able to prove to myself' that the change is possible. Their focus is on direct experience and evidence, rather than relying on what others have said from other farm systems; it seems that the farmer rates the

importance of learning in context, and that the confidence that can be drawn from learning in other farm systems is limited, as no two farm systems are quite the same.

Conversely, Farmer 4 places a greater emphasis on learning from other farmers in other contexts: *"I watch far too much YouTube, farming, regenerative agriculture stuff because the Internet is just the most amazing resource for everything nowadays. Certainly, for anyone wanting to learn, or pick up, or just share ideas; it's phenomenal. I range from watching a guy who does welding videos … to a market gardener in Sweden, who's doing holistic management style things but he's doing it from a completely different viewpoint and he's got all of his challenges. And then I'm speaking to people in New Zealand and Canada who are doing the same sort of thing. And it's just this, "I did this, ooo try that", not "that will never work" and there's a lot of that around".* The farmer here recognises the contextual differences, the 'completely different viewpoints' but sees that as an opportunity to glean even more insight in terms of what might work in their own farm system context.

These findings are supported by Wagner et al. (2023:7) who state "Our data reveal that the move towards mob grazing involves a marked learning process, with highly active self-learning, reading articles, watching Youtube videos, and taking part in discussions on Twitter and Facebook. A main inspiration of the burgeoning mob grazing movement in UK livestock farming are influential pioneers of mob grazing and related grazing approaches primarily in North America. Those mentioned by farmers in our interview included the originator of Holistic Management Allan savoury (Zimbabwe and USA), Gabe Brown from North Dakota, Greg Judy from Missouri, Joel Salatin from Virginia, Allen Williams from Mississippi (all USA), and Neil Dennis from Saskatchewan (Canada). There is also an active exchange amongst UK mob graziers of ideas and farming experiences. Farmers create discussion groups, visit each other, share discoveries on the PFLA Google group, and hold demonstration days on their farms. Many farmers in this study felt that they were on the bottom rung of a ladder of learning that they imagined would carry on further into the future".

Farmer 4 goes on to point the reciprocal nature of online social media, that despite all its fakeness *"the plasticity or the hero-worship"*, the support from other farmers going through the same changes really promotes farmer agency, *"the gentle pressure of 'well done', 'oh I like what you're doing' or, you know, validation I guess. Which even if it's fake is enough to keep you getting up in the morning and enjoying what you are doing"* (Farm 4). Not only that, Farmer 4 speaks about social media by default providing a way to record and monitor actions and outcomes over time, *"So Instagram has been my, again, record-keeping because it allows me to share the pictures much easier when I'm talking to people on the internet".*

Akin to social media, access to farmer networks (e.g. Pasture for Life Association, Soil Association, Nature Friendly Farming Network and facebook groups) and knowledge events seems to boost confidence in farmer agency, via sense of shared experience and comradery. As Farmer 1 notes *"we all went to the Oxford Real Farming Conference last week …it's really bizarre because everyone you talk to, agrees with you, …So I think there's a much bigger undercurrent of farmers who are interested in nature"*. Farmer 4 linked this to hearing from pioneering farmers, key influencers, who again boost confidence, winning hearts and minds: Farm 4 *"… 'let's get these people over from the states, these incredible grazers, scientists, whatever, and we'll have a conference here'. … and I came back and I was just like 'yep, I'm sold, done".*

Two of the farmers also spoke about learning from neighbouring farms, who are already going through the process. Farm 6 said *"Just down the road who are going through a very similar thing to us….they are moving all of their herd over to a mob grazing system for next season; and they're also going to be, they've already applied to be pasture-fed certified. We're not quite there yet and speaking to them is very helpful".* This suggests, farmers with the personality and motivation to go and speak with neighbouring farms, are likely to find it easier to access knowledge. But it is not necessarily talking with neighbouring farmers, but looking and observing what they are doing. As Farmer 1 says *"There's a big effect of the over the fence affects; if I start so doing something and next door has look and they think that looks to be working, show me how you did it. So that works. We found that on Anglesey. We changed something on one farm then we'd get a cluster of farms around it who are prepared to change".* Here, the role of public agency in facilitating change via neighbouring farmers – whether intentional or not – had an effect in facilitating and empowering farmer agency. As summed up by Farmer 7, *"I think a lot of things with farmers is, don't want to know, don't want to know. But then they see results by looking over the wall, so they won't entertain it until they see it, until they look over and go 'that does work, now I will do it'".*

8.5 Framing the system

The system as described above (a high-level abstraction) and accompanying deep-dives into different parts of this system, is likely to have existed in a similar way across time and space, but the characteristics of the components of the system change and evolve. The components of this system would look very different for a farmer in the 1920s in the UK, compared to one in current times; yet the spheres as described here were probably fairly similar. Likewise, the components for this system would likely look very different for a Nigerian farmer, than for a UK farmer; but again the five spheres as described here were probably not too dissimilar.

It may also be, that over time, new components arise and join onto the conceptual system – factors which previously were not a consideration to farmers and their propensity to experiment, but now are. For example, this could be buyers (corporates) seeking regenerative produce in order to in-set emission reductions within their supply chains, as a result of mandatory carbon emissions reporting; thirty years ago, the same factor would not have existed.

Neither does the system end with the farmer's conceptual space; the farmer's decisions have impacts and effects on receptors which are part of other systems, for example a changing grazing regime will affect soil, affecting water processes, potentially affecting downstream flood risk, people's livelihoods and health etc. The conceptual system set out here (or abstraction of a system) is a zoomed in part of a much greater whole. Another 'zoomed in' part, would not have the farmer as the central component, but may be a peripheral part for example. The point being, that exploration of a system, should always be simultaneous to an appreciation of the broader and adjacent systems (even sub-systems) in which it is a part.

However, it is not so useful nor manageable to work with a system that extends in perpetuity across time and space. There needs to be some statement of what is within the system being considered, and what it outside of it; but in a way that appreciates what is outside of it, rather than ignoring it, and recognising that what takes place within this system, affects what is outside of it and within it. A systems perspective therefore acknowledges the existence of 'nested' systems, sub-systems and systems within systems and so forth. As such, the data presents the opportunity to tentatively set some limits on the farmer-decision making system as outlined here.

Grounded theory advocates 'saturation' i.e. that repeated data gathering should start to indicate that there are no other avenues to explore, that all relevant areas for an emerging theory feel that they have been explored. This also helps to define the boundaries of the system at hand: does it feel like the system described above captures all relevant components and factors as spoken by the farmers? In this research, it became apparent from around the fifth or sixth interview (of a total of nine) that the farmers were talking about factors *within the same spheres.* However, they each interview added different components to these spheres to build a detailed, rich picture of what is going on inside each sphere. As described above, each farmer provided detail on different components, shedding light on their different experiences of different factors.

Talking to more farmers, in different contexts, in Wales and outside of Wales, would add to the richness of detail regarding components within each sphere, and relationships between these

components, within and across spheres. It may add new spheres, but this feels less likely. This research did not seek to confidently capture a system applicable to all farmers in Wales transitioning to regenerative grazing, but rather to explore in-depth the richness of the farm decision making system of individual farmers (depth as opposed to breadth); perspectives that are all valid in their own right.

As such, it is proposed here that the system of study here is defined as the farmer sphere, nested within the farm sphere, and all outside of that is defined as the environment of the system (so the Social, Institutions and Laws, and Natural Environment spheres) (Figure 8.6); altogether comprised of the components and variables that the farmers themselves chose to talk about, that exist within their conceptual frame of thinking. This is based on the assumption that they spoke about everything they thought about, when this might not be the case. This also presumes that the farmers thought about everything affecting them within their system, which is neither likely to be the case (the unknown unknowns). Defining the system in this way, allows exploration of the system (the farmer and farm spheres) as it continually adjusts itself in response to changes in its environment within which it operates (structural coupling).

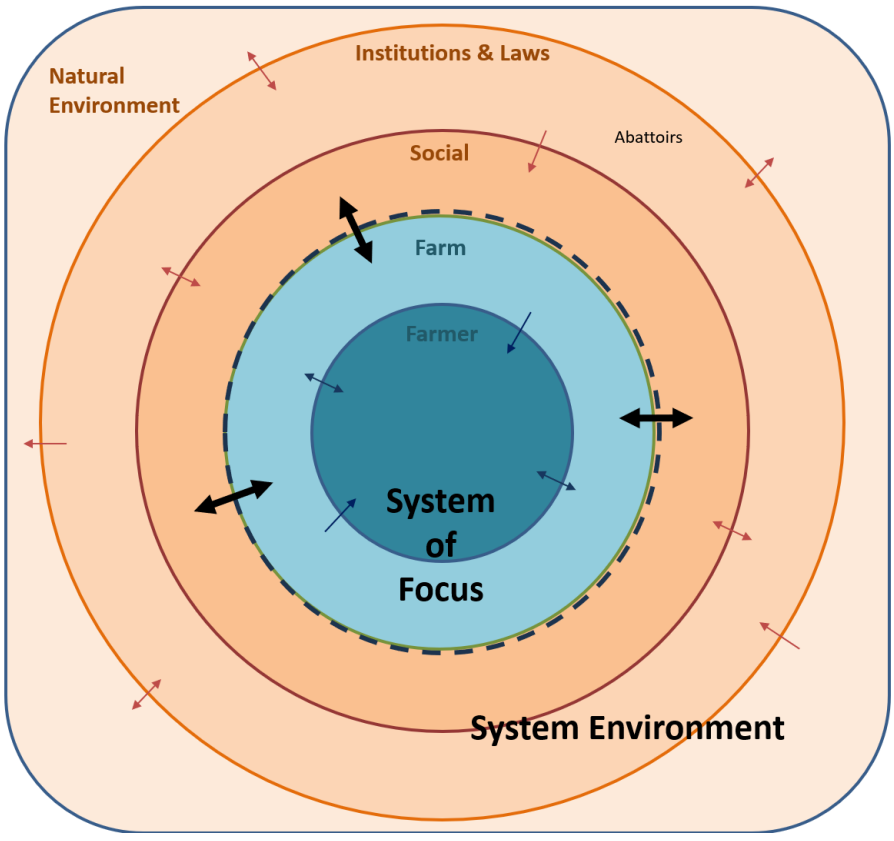


Figure 8.6 Illustration of the boundaries of the system

The arrows represent the forces operating between and across spheres such as changes to agri-environment payments, or energy prices, or weather patterns (this is expanded on in Section 8.6); that they are tugging and pushing in tension – sometimes constantly, sometimes intermittently, sometimes as one-offs. These components and their relationships, can be thought of as constantly jostling for space, thus defining each other continually by their existence and morphology to the changing conditions around them.

This abstraction of the farmer decision-making system is loosely defined here, as it is acknowledged that for some farmers, these spheres stretch broader and further than for others. What is contained within each sphere, changes between different farmers also, and the depth of experience of different components and factors. But as the farmers interviewed for this research began to show, towards the last of those interviewed, they spoke about system components that comfortably mapped onto those already highlighted by earlier interviews. As such, the boundaries set out here, feel to be a good capture of the system targeted for the purpose of this research.

8.6 Conceptualising farmer 'feasibility space'

From the research and system as described above, has emerged a theory, which sets out a way to understand and conceptualise a farmers' 'feasibility space' (Schiere, Darnhofer and Duru, 2012). The properties of each farmer's feasibility space, as captured by this theory (Figure 8.7), can be used as a means to understand a farmer's propensity to transition to regenerative grazing (or other type of agro-ecology). The characteristics of the components of this theory will be unique to each farmer.

The theory comprises five key spheres (or 'domains'). Together these domains intertwine to create a unique context for any given farm. The system of study for this research is defined as a farmer and farm spheres, with the other spheres making up the environment of the system. These could be split down further into sub-domains but for the purpose of setting out a theory which is not cumbersome, these are defined as follows:

Farmer domain: This recognises the situated embeddedness and subjectivity of farmer knowledge and experience. It recognises that different farmers will have a unique view of a farm system, which will be different to any farmer viewing the same farm system (this can be thought of as different views through different windows onto the same scene).

Farm domain: This recognises that all farm systems are unique in terms of their practices, their management and their resources. No two farm systems can be exactly the same. As such, contextual variations will play a part in terms of what happens at the farm.

Social domain: Again, this recognises that each farmer is making decisions within a societal context that will vary in terms of access to markets, peer networks, consumer and community choices for example. This is part of the environment around the farming system.

Institutions and Laws domain: Again, this recognises that each farmer is making decisions within a regulatory and political context that will vary in terms of laws, regulations and policy. For example, how this varies between Wales, England and Scotland (see Appendix 4 for an overview of the relevant policy context in Wales). This is part of the environment around the farming system.

Environmental domain: Similar to above, this recognises that each farm is unique in its setting. So that place-specific interactions between soil type, climate, ecology, water run-off for example will vary. This is part of the environment around the farming system.

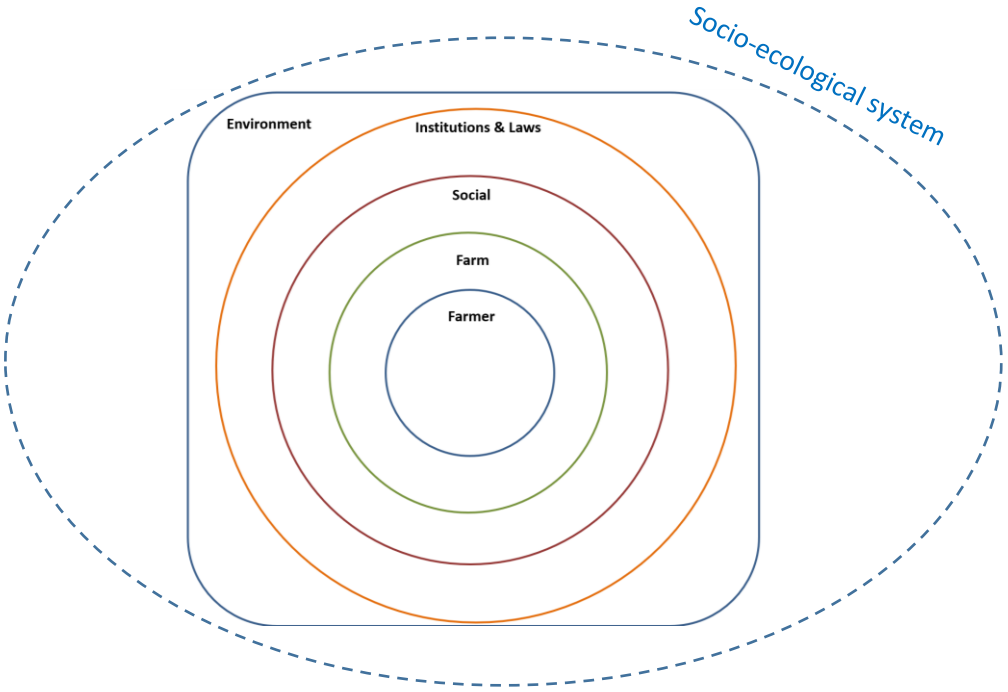


Figure 8.7 Five domains of the conceptual theory

All five domains are contained within **a socio-ecological system:** which can be thought of as the coupling and dynamic interplay of all ecological, social, institutional, cultural, etc. processes and feedbacks (Gaba, 2020; Gallopin, 2006).

Numerous variables exist within this system which affect, or indeed determine, the characteristics of the system. Some originate from the farmer themselves (e.g. values, attitudes, family, education), others are attributable to the farm (e.g. management, labour, proximity to markets, access to finance, assets and resources), whilst others are part of the

farm's natural environment (e.g. rainfall, seasonality, soil type). Depending on the variable, they may exert an influence in one direction (e.g. farmer's motivations upon farming practices) or in multiple directions (e.g. farm access to finance based on good financial management but also influenced by bank's willingness to loan and wider market activity). These variables are shown as blue arrows in Figure 8.8. These variables may also operate within a domain, or across more than one domain.

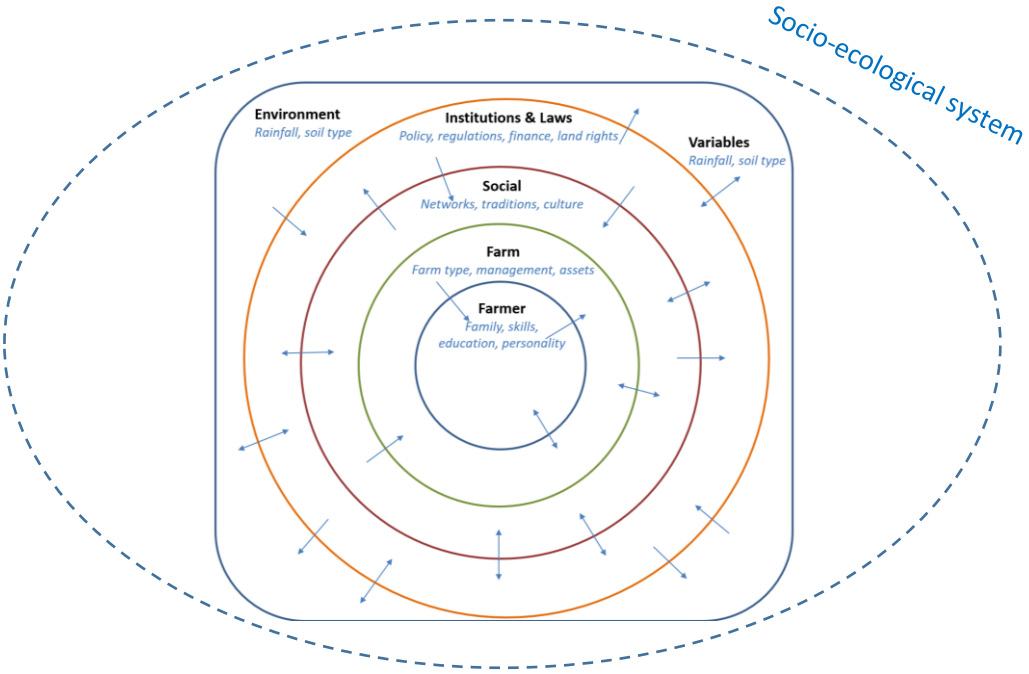


Figure 8.8 Variables operating within and across the five domains of the conceptual theory

There are then broader structural forces at play from the wider socio-ecological system of which the five domains are a part. These may be considered to be perturbations (either sudden shocks e.g. market price crashes; slowly encroaching stressors e.g. climate change; or part of day-to-day dynamism between farmer and farm system e.g. delayed deliveries). Some perturbations may be temporarily fairly fixed (e.g. laws and land rights), others may be very changeable (e.g. markets) and others very unpredictable or unknown (e.g. biophysical responses to climate change). Each therefore brings with it varying degrees of uncertainty, and are generally out of the farmer's control. They interact in a highly complex web to generate greater uncertainty. These perturbations are shown as orange arrows in Figure 8.9.

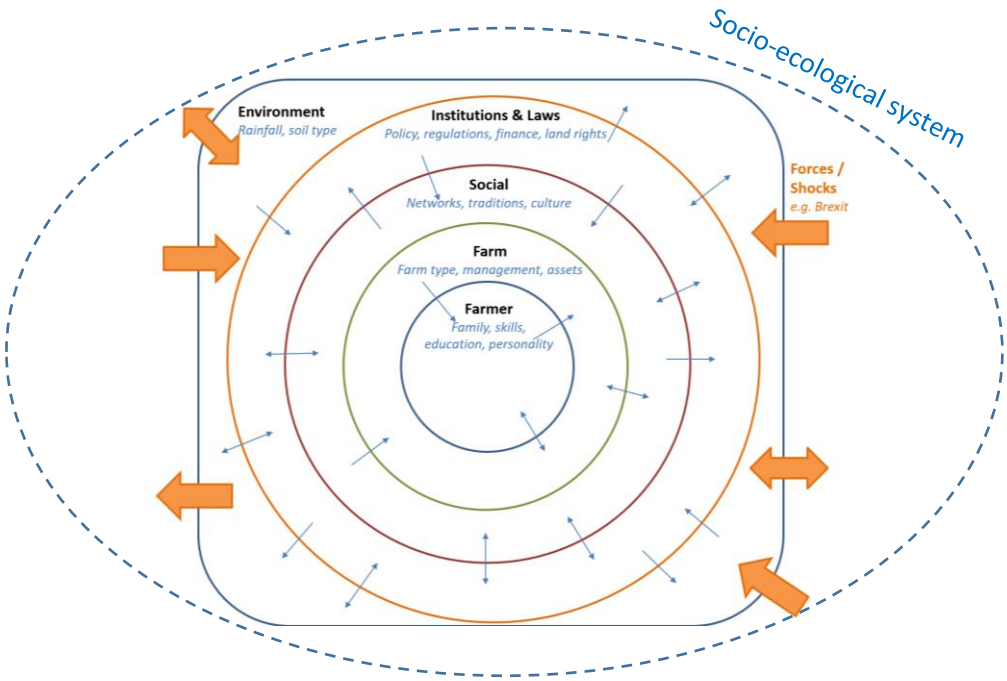


Figure 8.9 Perturbations upon the socio-ecological system in the conceptual theory

So why is this relevant to understand? It is useful to know how and why farmers decide to do things differently in such a system. How do they manage this complexity and uncertainty? Very simply, we can think of this in terms of firstly, '**what farmers believe they can do'** (farmer domain), within the confines of **'what they are able to do'** (farm domain) and then within the broader system of **'what they are permitted to do'** (institutions and law domain) and **'what they are supported to do'** (social domain) (Figure 8.10). Drawing on Chiva et al. (2013), this all has a bearing on whether and how a farmer can adapt (via refining existing competences, without challenging underlying beliefs and assumptions), or transcend (via inquisitiveness and generative learning, fundamentally challenging one's world view) in order to become more resilient; in this context how a farmer may seek to become more resilient via transition to regenerative grazing – what actions do they take to do this and how. It could be that 'what farmers believe they can do' is more aligned with Chiva's (2013) notion of transcendence, where as 'what a farmer is able/permitted/supported to do' is more aligned with Chiva's (2013) notion of adaptation.

Others (Walker et al., 2004, Turner et al., 2003, Gallopin, 2006) suggest adaptation is a reaction to system perturbations (an internal 're-jigging' as it were), and that the less resilient a system becomes to external conditions (after it's done as much re-jigging as it can), it must then transcend, structurally reform around a fundamentally new belief system at its core in order to become more resilient. This seems to reflect the movement of farms along the regenerative grazing spectrum (section 2.3.3) as initially the make a few tweaks (put some

fencing in, water infrastructure, rotate the livestock more) to ultimately a change in thinking as to how the farm is managed (e.g. the livestock are the tools to achieve the outcome, not the product or outcome themselves).

But of course these conceptual spaces are not fixed; farmers beliefs can change, farm resources and access to finance can change and aspects of the broader socio-ecological system can change (e.g. society's perceptions of the role of farms, laws and policies, access to markets). Although arguably the environmental domain is fairly fixed in terms of humanity timescales, depending on local climate change responses. The fluidity and ever changing nature of these conceptual spaces may be thought of in combination, as the farmer's 'feasibility space' (their freedom within which to make decisions and to act).

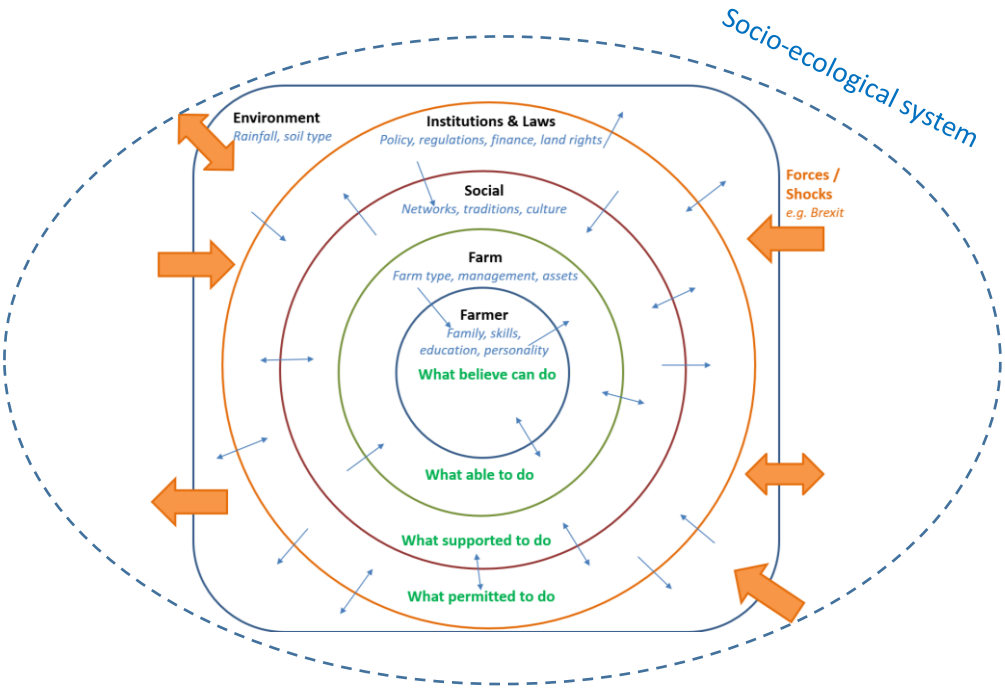


Figure 8.10 Farmer agency in the socio-ecological system in the conceptual theory

These conceptual spaces or systems, determine the process of doing things differently; whether and how the farmer takes on knowledge (e.g. direct observation, inferential, external information), the strategies they adopt to navigate the system they are in, and subsequently their behavioural intention and actions they take. In other words, **'what they can do'.** It could be thought of as the farmer's approach to stretching and testing their feasibility space, within the confines of the broader socio-ecological system (or degree to which they may influence the broader socio-ecological system). The system will have temporal properties too in that there will be a delay between farmer awareness of a desired change and then subsequent action (which to is likely to depend on various system variables).

8.7 Farmer strategies

This research has also shed light on strategies that farmers have adopted to navigate the system they are in; the steps they have taken to stretch their 'feasibility space'. To emphasise, the components and properties of the system will be unique to each farmer, thus a navigation used by one farmer, will not necessarily work for another farmer. Despite this journey being different for each farmer, it is worth exploring as it may highlight where and how intervention could make this journey easier.

The first point of note, is that each of the farmer's journeys have taken place over different timescales. Some have made gradual step by step changes over time, others have made abrupt changes to the farm system. Some of the farmers were trialling changes on parts of the farm first, prior to rolling out to the whole farm.

This finding is supported by Wagner et al. (2023:7) who state "farmers are actively applying what they are learning. As part of what we call the 'mob grazing journey', they are experimenting and tinkering – with paddock sizes, with fencing and water supply infrastructure, with rest periods and with stocking densities. Our analysis suggests that farmers … may well increasingly adopt elements of mob grazing as they figure out how to get around the initial constraints that initially face them on this journey".

Figure 8.11 shows how this has varied between 2 to 20 years. It also shows how each farmer is starting from a different baseline. I have judged where on the regenerative scale, each farm sits; based on each farmer's description of current grazing practices, and historic grazing practices. The 'regenerative score' (out of 9) is based on i) the degree of rotational grazing, ii) the degree of chemical inputs, and iii) the diversity of the pasture's sward. It is based on information provided by each farmer, using a scale I (the author) developed as a proxy measure of how regenerative a farm is. These scores are provided in Table 6.3 .

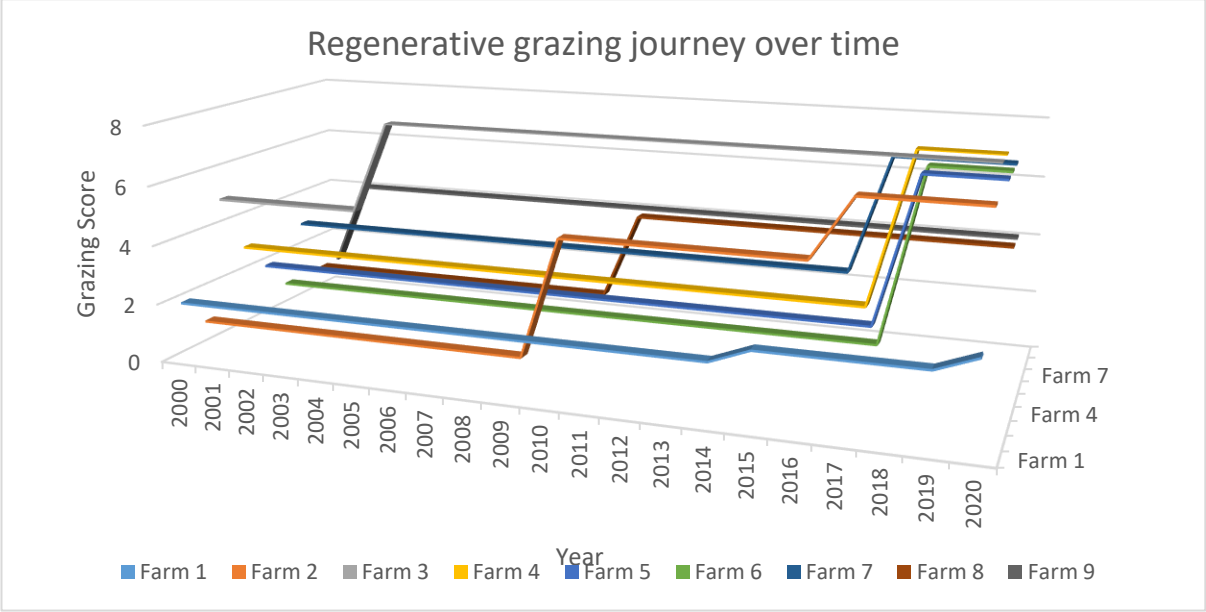


Figure 8.11 Timescales for farming transition to regenerative farming

The graph does not show farmer aspirations, and the changes they still want to make, which they currently aspire to. Some of the farmers still want to make changes, whereas others are happy with the progress they have already made; despite the potential to make more changes. What is not captured on the graph, is the 'un-tapped' potential of each farm to be regenerative, irrespective of farmer aspirations.

Appendix A describes the progress of each farm along a scale: where they were, where they are now, where they want to be. Their potential could be added to this. However, what we are specifically interested in here, is where farmer agency has helped progress up this scale, the action and strategy they have adopted. This is also described in Appendix A but in summary:

- Seven of the nine farms (1, 3, 4, 5, 6, 7, 9) have demonstrated agency, in trying to change the system conditions in which they are operating in terms of *'what they believe they can do'.*
- Four of the nine farms (3, 6, 7, 8) have demonstrated agency, in trying to change the system conditions in which they are operating in terms of *'what they are able to do'.*
- Three of the nine farms (2, 3, 4) have demonstrated agency, in trying to change the system conditions in which they are operating in terms of *'what they are permitted to do'.*
- One of the nine farms (5) has demonstrated agency, in trying to change the system conditions in which they are operating in terms of *'what they are supported to do'.*

Three of the farms (1, 4, 8) arguably began from mostly 'constraining' conditions, which is still hampering progress now. Six of the farms (2, 3 ,5, 6, 7, 9) started from more 'enabling (positive and negative)' conditions which has arguably helped them to make the change quicker.

To expand on this, most of the farmers therefore have demonstrated agency in 'what they believe they can do'. This is via accessing knowledge, learning about regenerative grazing and whether they think it will work in their given context, in order to build confidence to make changes. The farmers have used different methods to do this (e.g. social media, qualifications, conferences, visiting other countries) but essentially by demonstrating agency in seeking knowledge, asking questions and being open to new ideas, they have enacted change.

Four farmers have demonstrated agency in terms of 'what they are able to do'. This is demonstrated by those who have the on-farm resources to enact change (e.g. money to invest, a quarry to build tracks, conducive paddock sizes and pattern). These are farmers who looked around them, and saw the opportunity to start regenerative grazing, using simply what they already had on the farm. Farm 4, despite showing agency in other areas (e.g. what they believe they can do, what they are permitted to do) found themselves rather stuck in terms of what they are able to do on the farm, as they are limited by farm management, ownership and finances constraints.

Three of the farmers showed clear, proactive agency in seeking to challenge 'what they are permitted to do', via land agreements and land rights (see deep-dives in Chapter 7). Finally, just one farm demonstrated agency in terms of 'what they are supported to do': by setting up a direct sell of locally branded, pasture-fed meat, to consumers in the local community.

Of interest to note, is that some of the farmers made multiple changes in different spheres of agency; some made this abruptly over fairly short periods of time, others gradually over longer periods of time.

8.8 Summary

This chapter has explored farmer agency, and key areas where there is evidence of farmers enacting change in the farm system, to change it towards one that is more conducive for regenerative grazing (the deep-dives: land agreements, land rights, challenging mindsets and accessing knowledge) and set this out in a framed, conception of this socio-ecological system. The farmers are experiencing different enabling (positive and negative) and constraining factors in the systems unique to them, and their farming context; and these are spread across the socio-ecological system in different ways.

The analysis has found that one element of the system may be constraining for one farmer, but for another farmer it may be enabling and that this can be down to variables, or characteristics, of each factor themselves and their interaction within a given farming context.

The analysis has highlighted where there are relationships between different factors in a system. It is also shown that it is difficult to follow these relationships back more than one or two preceding factors, to the root cause (and indeed, even if there is a string of causality). Each of these factors in turn will be dependent on a myriad of other system factors, in their farm systems, allowing this to happen.

Despite these constraints, the *concatenation of factors* is shifting the farmer's propensity for experimentation and is clearly motivating some of the farmers to change things significantly. In this case, it is insufficient to seek explanation of farmer propensity to experiment through single factors and more insight is drawn from seeking to understand the relationships between individual factors.

Interestingly, this chapter has illuminated where farmers are choosing different paths to enact change: most of the farmers interviewed are doing this with in terms of 'what they believe they can do'; some in terms of 'what they are able to do' and 'what they are permitted to do'. But only one in terms of 'what they feel supported to do'. How each farmer is choosing to flex the 'feasibility space' in which they are operating, is having a bearing on their transition to regenerative grazing.

Drawing from the SES literature, the data suggests that the less regenerative farmers (to the left of the grazing spectrum in 2.3.3) are seeking to adapt their practices within the confines of what they are 'able' and 'permitted' to do; still *being exerted upon*, and responding to, the resilience properties (see Walker et al. 2004) of the environment to their SES in which they sit. Arguably, those farmers towards the right of the regenerative grazing system, are starting *to influence* the resilience of the SES' environment within which they sit, via a fundamental re-working of values, beliefs and re-structure and in Chiva et al (2013)'s terminology, transcendence of the resilience of the given SES e.g. working with natural processes and adapting to unknowns rather than seeking to control natural processes and remove unknowns.

Chapter 9 Discussion

9.1 Introduction

This chapter reflects on the findings of the previous chapter, asking what implication this has for policy and practitioners in facilitating change towards more regenerative farming practices. The research has established that some farmers are following 'pathways' of change' and are indeed facilitating these pathways as they go. Most of the farmers interviewed are doing this with in terms of 'what they believe they can do'; some in terms of 'what they are able to do' and 'what they are permitted to do'. But only one in terms of 'what they feel supported to do'. These pathways are having systemic effects and understanding where and how other forms of agency (e.g. policy, practitioners, the public) can also help to catalyse and support these 'pathways of change' in the system is key. This chapter makes some specific recommendations as to how intervention may leverage system change to support the take-up of regenerative farming in Wales, and across the UK.

An overarching finding of this research, is that intervention should **promote 'enabling' conditions for all farmers. In this way, farmers are more likely to make their own changes towards more regenerative farming**; in a manner which is more suiting to context, rather than enacting blanket 'prescribed' measures. This approach will also encourage farm systems which are independent of state subsidies and more resilient to perturbations, as they are adaptive and sensitive to farm setting.

Creating enabling conditions for change, should in theory be about enhancing a farmers' 'feasibility space'. Therefore, this research has helped to identify where constraints exist (so that intervention can help to remove these); and where enablers exist (so that intervention can promote these and spread these to all farm contexts where appropriate); taking care not to misconstrue negative enablers as constraints (e.g. a hike in prices for imported goods may be negative in one sense, but may provide the necessary encouragement for farmers to reduce farm dependency on imported inputs).

However, the counter argument is that just because a farmer has the optimum enhanced 'feasibility space', does not mean they are going to act on it, and make changes. This would come down to what a farmer 'believes they can do'. This has been covered less in this research, as it has focused on farmers already experimenting in regenerative farming, rather than those who do not know about it, or do not have the inclination to make changes; this could be the focus of further research.

This research is particularly pertinent, as evidence has highlighted the potential mis-fit of well-intentioned policy to experience on the ground (Bunce et al., 2010; Way, 2017; Hart and Wilson, 1998; Franks, 2016; Darnhofer, Gibbon and Dedieu, 2012). Policy mis-fit may in part also be due to blanket prescriptions across heterogeneous farming 'styles', contexts and set-ups, each with varying 'feasibility space' (Van de Ploeg, 1992). Such prescriptive top-down policy risks unintended consequences, and potentially constrains emergent adaptation.

The farming community has long awaited the revised agri-environment policy, based on payments for outcomes; however, such payments risk overlooking some of the prevailing system constraints (e.g. access to knowledge, land rights) which exist irrespective of whether a farm receives payments or not. Indeed, there were more mentions from the interview data, of Government intervention hampering farmer transition to regenerative farming (i.e. land agreements, land rights) than enabling it. **As such the finding is not so much about how the Government can do more via policy, legislation and funding; but more about perhaps where the Government can stop doing less.**

9.2 Intervention strategy

As Norton et al. (2024) note, identifying what needs to change in pasture systems and providing valuable research on key leverage points could be very significant for the UK environment, and also in terms of social and economic sustainability. This research has sought to understand in which parts of the system, intervention would be most effective in catalysing regenerative grazing; particularly, where it can help enhance farmer 'feasibility space' to encourage farmers to enact change themselves. The data indicates various opportunities to intervene, from training, support and advice; to regulations around land rights and land agreements which are explored in more detail below. However, it is important to question these from a systems and resilience perspective.

Exploration of the SES and complex adaptive systems literature, illuminated that there are multiple re-configurations of resilience in different SES, irrespective of the desirability of 'living conditions' in said SES (i.e. a SES may be resilient yet undesirable to humanity). Hence, this research finds that it is more meaningful to appraise interventions on their merits to a) reduce vulnerability (specifically sensitivity) to 'out of the ordinary' perturbations (recognising that perturbations are continuous not discrete events) and to b) maximise the potential for adaptive capacity (ecologically, socially, institutionally) in SES in readiness for such significant perturbations. This aligns with the Welsh Government and NRW's approach of focusing on promoting the diversity, extent, condition and connectivity of Wales' underlying natural resources in seeking to improve ecological resilience.

Norton et al. (2024) set out an approach to identify critical system 'leverage points', based on Abson et al. (2017) which draws on Meadows (1999). These leverage points are: 1) 'Re-connect': reconnecting people to nature, shortening feedbacks to choices, and improving wellbeing; 2). 'Re-think': considering how knowledge is created and used, shared and validated and 3). 'Re-structure': re-organising institutions and considering how institutional dynamics can create an enabling environment" (Norton et al. 2024:2). Whilst Norton et al. (2024) work is applied to livestock systems in the UK, this approach (which is underpinned by Meadows (1999)), is used here to guide the approach taken to identifying interventions for this research. As Norton et al. (2024:3) note: "The leverage points framework presented here uses Meadows's (1999) 'Places to intervene in a system' to illustrate that shallow leverage points are concerned with changing materials and processes in a system whereas the deeper leverage points aim to change design and intent [see Abson et al., 2017]. Shallow interventions can be implemented rapidly, e.g., through policy change. Deep interventions include changing underpinning values and goals to profoundly change systems indefinitely". These shallow and deeper leverage points are shown in Figure 9.1.

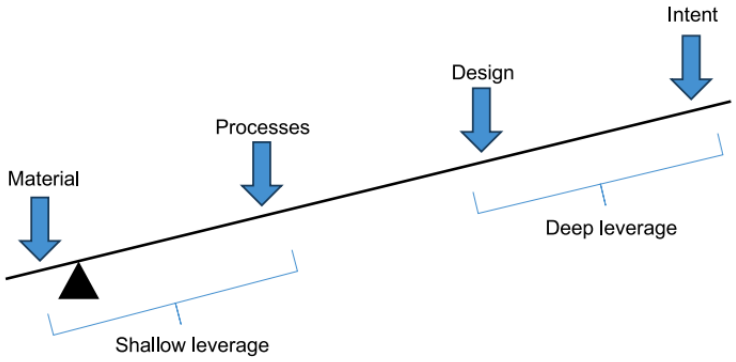


Figure 9.1 Shallow and deep leverage points in a system to instigate transformation (Abson et al. 2017)

9.2.1 Interventions

The deep-dives in Chapter 8 illuminated four key areas spoken about by the farmers, each suggesting areas where external agency (whether it is policy, payments, practitioners or the public for example) could intervene to affect lasting change. These are set out below, along with other areas of action for intervention highlighted by the research. They represent a mix of shallow and deep leverage points. The data suggests that most of the missing links are in social, policy, and market systems which if re-instated, will help restore nature's natural feedbacks thereby boosting the resilience of all social, economic and institutional systems contained therein.

9.2.2 Land agreements

Land agreements could show the same site-specific consideration for farming practices as they do for site specific conservation needs, to greater recognise the interplay and dependence between resilient, regenerative farming systems and broader biodiversity health for any area, rather than prescription treatments for singular species or habitats in an area. The government could facilitate greater flexibility and adaptability in conservation land agreements, that could deliver greater outcomes overall. **For example, all conservation land agreements could stipulate that, where reasonably possible, a land owner is expected to enact the principles and practices of regenerative farming.** This would include any land agreements and permissions linked to farming activities within, and ideally in proximity to, designated sites such as SSSIs (see Example below) which would benefit from reduced agri-chemical inputs (only 20% of Wales' 1000 SSSIs are currently in 'favourable' condition (NRW, 2020)).

What relationship does it have with components of the system? Land agreements state what grazing practices are allowed or not, within or in proximity to a site designated for species and habitat protection e.g. a SSSI. The land agreement stipulates whether grazing is permissible, the duration of grazing permitted, the grazing intensity and type of livestock. These are usual defined based on specific risks to the habitats and species under protection. The constraint is that most land agreements do not consider the merits of regenerative grazing (timescales, duration, intensity etc.) and assume that without the land agreement in place, grazing would be intensive, high impact and continuous. It is accepted that some low intensity, extensive, low input grazing, termed 'conservation grazing' is necessary for some species and habitat preservation (e.g. coastal grasslands, to keep bracken at bay for example). However, there is potential to consider the merits regenerative grazing for conservation of habitats and species as part of land agreement for designated sites in Wales. This is endorsed by Wagner et al. 2022, who provide evidence of one-off mob grazing creating very diverse species rich grassland. Land agreements then help influence what the farmer can do and where on a farm.

Does this change by context? How does information flow along this relationship? Not all farmers have land agreements in place. Some will only cover part of a farm. Others may be for reasons other than protection of sites designated for habitats and species. Some farmers will have multiple land agreements in place, with differing public agencies. Some attract a payment (to cover income foregone for example), others do not. Increasingly now, with emerging nature markets (e.g. BNG, Regenerate Outcomes), farmers are entering land agreements privately. As such, the relationship between land agreement and farmer can be highly variable, with differing incentives, risk and weight in terms of what a farmer decides to do and where (e.g. many of the SSSIs in poor condition in Wales are due to farmers

disregarding the grazing restrictions, either because they are not aware, or due to lack or monitoring and enforcement).

Will the intervention repair, replace or even weaken a feedback mechanism in the system? How and in what way, for the better? Encouraging land agreements for designated sites to be flexible towards the merits of differing grazing regimes, as well as with regard to the needs of protecting said habitats and species, could repair numerous feedback links. It could allow a rotational, responsive grazing system to be implementing, thus allowing reduction in chemical inputs on neighbouring land, which would reinstate soil health and biodiversity, thus helping protected species and habitats (see example below). This would also boost the farming system, permitting the implementation of regenerative farming principles (and the benefits therein).

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Removing the designations (e.g. SSSIs) may be counter intuitive but should be considered, if only to rule out. The question is worth asking when the land agreements of only 20% of SSSIs in Wales are working (and this may not be due to the land agreement). Advocates would argue this is because they are not being effectively monitored, and rules are not being enforced. This could be a symptom of 'reductionist' philosophy in conservation. **Trialling of greater flexibility in land agreements for protected species and habitats, with regard to more regenerative grazing regimes, would be worthwhile to understand if this would generate greater systems outcomes for both biodiversity, and farming resilience.**

9.2.3 Land rights

Farmers need flexibility in land rights (access to pasture) to allow for expansion and contraction on demand, depending on grazing conditions. But to justify investment, and initial conversion to regenerative grazing, long-term and secure access to pasture is likely to be required. This suggests that greater scrutiny and understanding of the relationship of land rights (including land agreements) with propensity to experiment in regenerative farming is required. This would cover:

- Review the relationship between land rights and regenerative farming: including, short-term farming tenancies, and commons land restrictions, with ability to implement the principles of regenerative farming. This research suggests, that the Government should be promoting long-term, flexible tenancies to help free up farmer propensity to experiment in more regenerative farming practices.
- Trial flexibility in land rights on a case by case basis i.e. for several different farms, review what land rights should be trialled such as re-introduction of an inter-generational tenancy,

or temporary exclusive access to commons land, or a landowner stipulating the principles and practices of regenerative farming in a tenancy agreement. The data suggests that the change to short-term Farm Business Tenancies has eroded tenant and landowner long term investment in land as a sustainable asset.

- Set-up of 'pasture loans', to help farmers make the initial step in conversion to regenerative grazing. For example, this could be by facilitating one-off or short-term agreements between neighbouring farmers, with commons land, publicly owned land or protected sites (that would benefit from grazing and manure input). This is already in place to some degree for some farmers for designated sites, but could be trialled at a greater scale.

What relationship does it have with components of the system? Land rights determine what land type, size of area and infrastructure a farmer has access to, for how long and with what certainty. Thus it will relate to levels of investment and implementation of practices on the farm. Which in turn, will impact various farm business, social and environmental aspects.

Does this change by context? How does information flow along this relationship? As explored in Chapter 7's deep-dive (and so not repeated here), this will vary by landowner and tenancy agreement. This varies greatly across the farmers interviewed for this research, many with multiple rights in place to navigate across different parcels of land.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? How and in what way, for the better? Whilst in some instances, multiple land rights increased the complexity and frustration of implementing regenerative grazing; in others it allowed greater flexibility to expand and contract grazing as required in response to system changes. This really is about re-instating farmer access and control of pasture – a missing element in some farm systems, which limits how adaptive and responsive the farmer can be to natural system changes. Arguably, there should be flexibility in land rights so that they are responsive to the needs of the given context; they should be available as a set of tools to aid optimal system resilience for a given place, both farm business, social and natural systems. So, a tenant farmer, on a short term Farm Business Tenancy, should have the choice of opting into a longer term, inter-generational tenancy, if it gives them the certainty and security required to implement a regenerative farming system. A farmer should be able to negotiate different access to commons land on a short-term basis if it means they are then able to kick-start a rotational grazing system. A landowner should be able to stipulate regenerative principles as part of tenancy agreements (this may already be permitted). This research shows that there is a relationship between land rights and regenerative grazing, which requires further investigation.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Land rights are needed to stipulate rules of engagement with natural

resources, by whom, for what length and duration. As such, they are needed. Problems occur when they are in place to protect the interests of one ruling elite, rather than more egalitarian, distributional systems based on shared wealth (economic, social and natural). Ostrom (2015) has written extensively on this, and further research could explore this further. Again, similar to the 'land agreements' section above, the issue is the merits of prescription versus flexibility, and ability to respond and adapt to system changes. There is no 'one size fits all' and the data suggests we really need to be better in being flexible, understanding situations and setting up responsive systems. One of the farmers interviewed, was being very innovative and responsive in 'land rights'. A large landowner themselves, rather than trying to farm everything themselves, they had set up multiple tenancies (on different agreements to suit the given context and tenant farmer); and they had also set up farm businesses with tenant farmers based on 'shared equity' giving the tenant farmer access to capital investment and equipment as required, in return for shared profits. **This clearly highlights that there are innovative land rights models worth exploring, in terms of how they enhance farmer feasibility space and transition to regenerative grazing.**

9.2.4 Transition payments

With regard to initial conversion to a regenerative farming system, and roll-out of the core principles and practices of regenerative farming; the farmer is likely to need to invest in capital infrastructure, specifically electric fencing (ideally solar PV powered), herbal leys, fencing, hedgerows, water infrastructure and tracks. **Grants or loans for this initial period will help reduce the risk of farming transition (indicative five years).** Loans could be recouped over time via savings in avoided costs (chemical inputs, bedding, housing and vet costs). These could be one-off up front grants or payments over an initial five year period.

Transition payments should really be available to all, or made on a needs assessment; some types of farmers such as large landowners should not automatically excluded on the assumption that they will have the funds – they may not. The data suggests this transition payment is fairly low, and probably lower than what might be pre-conceived. Many farmers have reduced investment cost by using materials they have around the farm, learning 'cheaper' ways from fellow farmers, or by making slow changes and low investments over many years.

What relationship does it have with components of the system? A transition payment would help to remove financial risk. As such it is critical to starting on a regenerative grazing journey. Implementing the capital infrastructure is necessary for applying the principles and starting

the practices of regenerative grazing. A transition payment is likely to speed up the adoption of regenerative grazing, as fewer farmers would be seeking to spread risk over more years.

Does this change by context? How does information flow along this relationship? These upfront costs are not required by all farmers as some will have some of these in place already; and not all farms will require all of these to trial regenerative grazing. Some farmers will have the capital to invest, others will not; very much depending on the farmer's unique circumstances irrespective of farm size or whether they are the landowner or not. This does closely relate to land rights as described above, as without the security or certainty in place to reap the rewards of capital investment, a farmer is unlikely to invest.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? How and in what way, for the better? It will weaken the dis-incentive to make changes towards regenerative grazing and provides the necessarily financial mechanism to remove the risk of negative feedback of implementing the principles.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Other types of financial mechanisms may be just as effective, for example, annual payments over a longer period (e.g. whether for regenerative principles, outputs, measures or outcomes – depending on who from), or equipment loans, tax relief, premium payments or low interest loans. For example, the Arla dairy cooperative has started paying a premium price for regeneratively produced milk. **Further research could explore the cost-effectiveness and cost-efficiency of different approaches. But again, these are likely to be context specific and farmers may have preference for the type of financial incentive they access.**

9.2.5 Training, support and advice

The data has highlighted that changing mindsets is as much a part of transitioning to regenerative farming, as is changing farming practices. Particularly, when this is fundamentally challenging the way people construct knowledge and experience of the real world around them (their world view). Support for farmers in changing to regenerative farming, is not just about advice as to what measures to do and where, what payments to access and how, but also how to challenge reductionist world views and encourage systemic thinking (e.g. Farm 6). **The Government could coordinate a training, support and advice programme, using existing farming advice organisations, to deliver targeted advice (principles, practices, funding and mindsets) depending on what is required.** This could cover a whole suite of different ways to share knowledge and change mind-sets. Another opportunity would be **a pilot scheme, to pair young aspiring farmers (with no access to land but knowledge of, and passion for,**

regenerative farming) with older, struggling farmers (looking for knowledge and technical support) via a placement scheme.

What relationship does it have with components of the system? Accessing knowledge and changing mind-sets is fundamental to arguably all components of the system, and the organising processes between them. Making changes to regenerative principles and practices, and acting on new knowledge, requires the impetus in terms of 'what a farmer believes they can do' which then rolls out to agency in terms of 'what they are able / permitted / supported to do'. Catchment intervention programmes based on payments alone are more likely to fail in generating farmer take-up than those which include training, support and advice.

Does this change by context? How does information flow along this relationship? Yes, again, this intervention is very context dependent; farmers, like all people, have different ways of viewing the world. It's not just the farmer this needs to reach, but farm workers also. Two of the farmers interviewed for this research, stated changing employee and family mind-sets was one of their greatest challenges in starting regenerative grazing. This intervention will be of particular importance in scaling up regenerative grazing, in accessing those farmers for whom regenerative farming is not even on their radar. Most of the farmers interviewed for this research were of a holistic mind-set, or on their way. Some had more ready access to knowledge being more tech savvy or better connected, compared to others. They were each following different ways to access new knowledge (e.g. via peers, farming networks, conferences or social media), some more patchy than others in accessing the information they needed. It is also important to remember, that not all farmers need the same level of information to enact change, depending on how risk averse, or risk loving, they are.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? How and in what way, for the better? Much of regenerative grazing principles and practices is borne of historic ways of farming. As such, arguably, this is about re-instating long forgotten knowledge (pre-war). For example, one farmer spoke about the historic practice of using wooden hurdles to create smaller paddocks in fields for adaptive, rotational grazing. Regenerative grazing is basically doing the same thing with electric fencing (in a less labour intensive way). This suggests that the post-war industrialisation of farming in the UK, eroded farmer knowledge of these historic, more regenerative, practices over the last two or three generations. Providing training, support and advice will help bring this back. In turn, this will arguably weaken the messaging from large agri-tech which consistently argues for high input chemical feeds and treatments.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Farmers are finding their own knowledge via accessing knowledge themselves, or creating knowledge themselves via trials and sharing this with peers. This intervention in some way could therefore be considered redundant. However, its purpose is to speed things up, and support farmers in getting to where they need to be (in terms of knowledge and mindset) sooner, in order to enact change. **There will be different ways to do this (campaigns, via networks, advisors, conferences) and the effectiveness of these could be explored. However, they are all likely to be needed as different farmers prefer different ways of accessing knowledge.**

9.2.6 Government campaign

As stated above, the research has highlighted how regenerative farming is much about reinstating historical farming principles but via practices using complementary modern technology (e.g. electric fencing rather than wooden hurdles). This could be the focus of **Government led campaign, one that ties in with reinvigorating culture identity and historical practices (and the Welsh language in Wales) as one farmer mentioned, with contemporary market and policy needs (around net zero, BNG, flood protection and water quality).** This campaign would be focused on messaging via farmer-to-farmer networks, community engagement, workshops and social media; as well as support via a farm advisory service (by investing in existing services and expertise as above, and ensuring advisory services are fit for purpose (Ingram & Mills, 2019; Ingram et al., 2022). This campaign could also raise consumer awareness of the nutritional benefits of regeneratively farmed meat and dairy products (e.g. the GREAT project), facilitating market demand for such products and farm business confidence in transition. This could potentially be funded by corporate investment with an interest in scaling up regenerative farming, match funded by the public purse. I was involved in a NRW and Welsh Government funded project, Our Living Trails, which clearly demonstrated the potential to tie in historic landscape features, such as 'clawdd' (raised earth embankments with hedges on top) with the scaling up of regenerative grazing, as they provide shelter for livestock, a haven for biodiversity and break up large fields into smaller paddocks for rotational grazing.

What relationship does it have with components of the system? Similar to above, a Government campaign would help provide the impetus in terms of 'what a farmer believes they can do' which then rolls out to agency in terms of 'what they are able / permitted / supported to do'. However different to above, such a campaign would not target farmers alone, but all decision-makers in the surrounding and supporting systems; in markets (wholesale, retail, consumers, suppliers), landowners and land agents, public agencies and

environmental charities. This awareness would help generate support in all of the surrounding system components, particularly for those where change may be needed most (e.g. land rights, land agreements) and help make some conversations easier for the farmer.

Does this change by context? How does information flow along this relationship? The campaign can probably be enacted from a central point, rolled out via networks to regional and local delivery partners. However, the way it is received will most likely vary by different partners in different localities. As such, flexibility in the campaign will most likely be required to ensure specific areas of need (say public agency advisors) can be targeted with information and messaging as required.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? How and in what way, for the better? A Government campaign is most likely about instilling some sense of shared purpose, across the various components of the shared and nested systems (social, economic, institutional in Wales). In this sense, it is helping to strengthen, repair and re-instate multiple feedbacks, whilst weakening some.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Without a Government led campaign, change is likely to be slow, harder and more patchy in take-up. Many large corporate bodies and public agencies understand and see the potential benefits of scaling up regenerative grazing in Wales, and across the UK; and so working in partnership will make a campaign more achievable.

9.2.7 Public procurement

The private sector is instigating investment in scaling up regenerative farming in the UK via procurement routes, such as retailer supply chains (e.g. MacDonalds, General Mills), and direct purchasing (e.g. Ethical Butcher, Wyld Burger). The Arla dairy cooperative for example, has invested in a trial of regenerative practices in dairy farming and now pays a premium price for regeneratively produced dairy products.

The public sector could also support the scaling up of regenerative farming, by facilitating market demand via public procurement (e.g. currently being explored by the GREAT project). **Government could phase in the purchase of regeneratively farmed produce for all health and education services**, to help ensure that the most vulnerable in society have access to healthy, nutrient dense food; whilst helping to clean the air, clean our water, store water, sequester more carbon and promote biodiversity; **thereby reducing Government, consumer and business costs** from addressing health costs, lost employee days, flood damages and water

treatment in the long term. Thinking systemically, and tackling problems at root cause, will save costs all round and help to future proof public services.

What relationship does it have with components of the system? Within the economic system, facilitating market demand for regeneratively farmed produce, will help boost farm business confidence in making the change, re-orientate consumer choices to produce which delivers multiple wider benefits thus addressing market externalities (which in large part has created the catchment problems we have in the first place). **Public agencies could link their carbon and BNG obligations to this (i.e. developer purchase of BNG units could be used to support regenerative farming systems).**

Does this change by context? How does information flow along this relationship? The ability of public education services and health boards to do this would vary by region, and this would initially be constrained by supply. Trial areas could be introduced to test the approach. But in time, as more farmers make the change, premiums would likely decrease as regenerative produce becomes the new norm.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? The aim would be to strengthen an existing mechanism, market demand for regenerative produce; and weaken the existing demand for carbon intensive, synthetic chemically dependent produce. Ultimately, the basis for all efforts to scale-up regenerative grazing, is reinstatement of feedback mechanisms within the soil (the trade of carbon for micro-nutrients between plants and micro-biological communities) which underpins all the societal benefits spoken about here; which sadly is broken by synthetic chemical inputs.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? As described, the private sector has started procuring regenerative produce via various means, but arguably this is not yet mainstream. This could be left to happen of its own accord, but this may take some time, and public procurement will help speed this up. There is also the ethics of feeding school children and healthcare patients food that is low in nutrient density. Also, there is the argument that public agencies should be procuring regenerative produce anyway, as to do otherwise is in direct challenge to many public policy and other public investment goals.

9.2.8 Payments for outcomes

Interestingly, none of the interviews with farmers touched on payments for outcomes for regenerative farming. It maybe because the farmers experimenting in regenerative farming, are seeking to operate independently of external payments, or that the situation in 2019 was

so uncertain (with respect to Brexit and changing agri-environment support) that it was not deemed worthy of mention.

However, there are many private-led initiatives emerging for paying farmers for the outcomes of regenerative farming in the UK: environmental bonds specifically investing in the carbon and biodiversity benefits of regenerative farming (e.g. Regenerate TEAM), water companies setting up multi-catchment targeted programmes (e.g. Northumbrian Water Group), both facilitated by public innovation funding to kick start the process (i.e. Defra's Natural Environment Innovation Resilience Fund, and OfWAT's water programme innovation funding). These more or less seek to compete (or arguably in time replace) agri-environment payments and are strongly related to the global corporate shift of pension fund portfolios and institutional investors towards 'green' investment. This has recently all the more been reinforced by the growing area of Environment and Social Governance (ESG) reporting, Taskforce for Carbon-related Financial Disclosure (TCFD) commitments and now COP 15's recently announced Global Biodiversity Framework (Target 15) and emerging Taskforce for Nature-related Financial Disclosure (TNFD). Payments for outcomes to farmers for changing to regenerative farming is only going to grow.

However, arguably, there is still a place for public agri-environment schemes in recovering some of the mistakes of its past. The recently published outline proposals for the new SFS (the new agri-environment scheme in Wales) suggests there is potential to line up with the outcomes of regenerative farming. The principles, objectives and outcomes upon which the SFS is based (see Section 2.1.2), are all aligned with the principles of regenerative farming. **As the SFS develops to roll-out in 2025, Welsh Government should review the measures and payments against the *financial* needs of farmers looking to change to regenerative farming (e.g. transitional grants, low interest loans for first five years) to confirm that payments directly to farmers are the best course of action (as stated above, payment via public procurement may be more worthwhile). This should include a review of emerging private-led schemes across the UK which are offering payments to farmers for switching to regenerative principles.**

What relationship does it have with components of the system? Within the economic system, payments for regeneratively farmed outcomes, will help boost farm business confidence in making the change. The payment would help to remove financial risk and reward farmers for all the benefits they provide society. Marrying payments for outcomes with adoption of regenerative grazing, will help to speed up the adoption of regenerative grazing at scale.

Does this change by context? How does information flow along this relationship? The approach is challenging as despite a farmer adopting the principles and practices of regenerative farming, little impact in terms of outcomes may occur in their given context due to other factors. As such, providing that these outcomes are additional and would have happened somewhere else, and so the farmer will be paid, draws in many ethical and evidential challenges. Also, one farmer doing exactly the same thing, somewhere else, may result in far greater outcomes, because the baseline level was lower to begin with.

Will the intervention repair, replace or even weaken a feedback mechanism in the system? Payments for outcomes creates a new feedback mechanism, where there has been none before. Many believe a great failing of our current economic system is failure to assign a monetary value in markets for the services provided by nature's capital (like we do for manufactured or intellectual capital); for example in cleaning our air, cleaning our water and storing carbon. This failure is resulting in the steady erosion of natural capital assets (habitats, biodiversity and natural processes) as this is not taken into account by investment decision and consumer choices that may directly or indirectly damage these services. Introducing this change was endorsed in the HMT commissioned 2021 Dasgupta Review. This called for changes in how we think, act and measure economic wealth in order to protect our natural world.

What influence will this intervention really have? Are there more effective ways to have the same desired impact? Payments for outcomes is likely to induce systemic change and provide the impetus for considerable scaling up of regenerative farming and agro-ecological transition in Wales and the UK. There are however, risks of payments for outcomes, such as perverse incentivisation and outcomes not being delivered as expected; which suggest maybe there are better ways to trial first (such as via procurement in line with commitment to standards for financial disclosure). Farmers interviewed for this research suggested that payments for outcomes are perhaps not necessary, and that transitional payments alone would be suffice. However, this may not be the case for other types of farmers, not already started on the journey towards regenerative grazing, not interviewed for the purpose of this research. **It may be worthwhile researching other similar incentives, such as payments for regenerative outputs, principles adopted or practices implemented; and also to explore whether transitional payments or loans may be sufficient.**

9.2.9 Policy

The research has highlighted how societal resilience (i.e. policy, markets, institutions, consumers) should seek to mirror ecological resilience, in terms of how 'we' (regulatory

authorities, policy makers, land owners, the public etc.) appropriately govern the use of our natural resources. This has implications for the resilience of broader socio-ecological systems; looking at one aspect of this (e.g. ecological resilience alone) seems to be only one part of the picture. Knickel et al. (2017:27) start to think through the drivers and limitations of systemic change in four thematic areas including the resilience of farms and rural areas and; the governance of agriculture and rural areas. It concludes that "practitioners, grassroots initiatives and pilot programmes are already generating a wealth of experiences and knowledge that could be fruitfully used to inform higher-level policy development. The paper concludes that systemic change requires more critical reflection of conventional wisdom and approaches, and openness to ideas and practices that are outside the mainstream".
Wales has a strong legislative and policy context underpinned by three key acts (Well-being of Future Generations Act 2015; Environment (Wales) Act 2016; Planning (Wales) Act 2015) which are designed to work together, with references between them, with the aim of providing a more efficient means to regulate, enforce and encourage the sustainable management of natural resources. There is a clear understanding that these three acts point together towards delivery of seven 'well-being goals' which stretch across, and bring together, the social, environmental and economic domains. Resonating through the legislation and supporting policies, is a clear 'systems thinking' steer. Whilst perhaps not overtly 'systems thinking', a more systemic approach is clearly encouraged in that it promotes a) an emphasis on pro-active intervention, b) attention on connectivity and relationships rather than the components themselves, c) and a focus on creating adaptive, responsive systems to stressors and shocks.

Whilst Wales has arguably set out a progressive, enabling policy environment, that other parts of the UK are looking up to; it is perhaps lacking traction on the ground (as per the example given above in 'Land rights') and the challenge now is to ensure different legislation are all working towards the seven 'well-being goals' in a conducive manner, and one that does not see some legislation undermining others. Also, agri-environment policy should facilitate change across all spheres of the farming system, **to promote 'enabling' conditions for all farmers; and remove constraints affecting farmer agency towards regenerative grazing (as per the Conceptual Theory set out in Chapter 7) across for example, land rights, land agreements, advice, support and training – and all the other system interventions set out above.** Paying farmers alone will not enhance farmer propensity to make changes, within the existing system constraints in which many farmers operate. Only in this way, can Welsh Government (and UK Government) truly facilitate change at scale. The legislative and policy context is described in more detail at Appendix 4.

With the many emerging ways that private markets are offering payments to farmers for outcomes in the UK (e.g. woodland planting, regenerative farming), Government has a role to help farmers navigate these choices in a manner which protects farm businesses, land rights (especially those of tenant farmers), as well as ensuring the benefits are provided where they are needed most. For example in England, local authorities are beginning to broker land agreements and payments via 'habitat banks', based on Government guidance, as part of BNG and NN; both clear legal mechanisms, with fairly clear governance, that are channelling money towards catchment restoration, in some instances as part of regenerative farming transition. In other instances, the transfer of private investment to regenerative farming is based on internationally verified standards (e.g. Verra, Gold) which skip the Government level. Many agreements, are seeking to stack payment mechanisms (BNG, with Verra for carbon) with different liabilities, terms, outcomes, monitoring requirements and timescales. **Welsh Government could enact the legislative framework to allow similar market mechanisms in Wales** (i.e. BNG and NN) as well as environmental bonds for example. **Government is needed to provide clear navigation of these opportunities, and governance of the risks associated with these different payment mechanisms** (which could all be managed and passed through a quasi-public agri-environment subsidy scheme).

What relationship does it have with components of the system? The policy and legislative underpinnings of the conceptual theory set out in Chapter 7 is very important, as it sets the parameters and 'rules for engagement' across the farm, social and market systems. It is a critical part in defining society's direction of travel, and in terms of defining what is allowed and what is not allowed.

Does this change by context? How does information flow along this relationship? Whilst this in theory should be consistent across Wales, practitioner adherence to the progressive policy goals will vary (as in time, people come up to speed with what it means and how they apply it in practice). One of the farms interviewed has their address in England, but most of their land in Wales. There are clear contrasts between the two policy environments; whilst there is ample opportunity for England to learn from Wales in terms of ambition and a systems perspective, there is also opportunity for Wales to consider the market mechanisms in place in England to channel investment towards nature's recovery (and regenerative grazing).

Will the intervention repair, replace or even weaken a feedback mechanism in the system? Policy should aim to weaken some feedback mechanisms and to strengthen others. Its purpose is to steer market outcomes towards goals which are societally desirable, especially where

market forces risk going unchecked resulting in costs to others e.g. pollution of our water ways from sewer overflows in storm events, or from agricultural land. These interventions would build on the existing good work of policy in Wales and provide the financial incentive to really start to move private green investment towards nature's recovery (including weaning farmland off costly synthetic chemical inputs).

What influence will this intervention really have? Are there more effective ways to have the same desired impact? These mechanisms in England, BNG and NN, leverage investment for nature recovery using the planning system; consent is only granted for development if specified impacts are off-set. Whilst these are questionable (e.g. in terms of additionality, and whether house buyers should ultimately bear this cost) and such mechanisms are not necessarily the best way to do this (it is beyond the scope of this research to assess this); these feedback mechanisms are successfully channelling investment to nature restoration and are being used to enable regenerative grazing. These mechanisms can only happen with the required legislative and policy background in place. The new COP15 Global Biodiversity Framework may in time remove the need for countries to set such mechanisms up individually, but for now, the onus is on national policy environments to enable this.

9.3 Summary

This chapter has set out eight areas of action which the data suggests, if enacted would help promote the take-up of regenerative farming at scale in Wales and across the UK (Table 9.1). These system interventions range from changes to land agreements and land rights; to training, support and advice and a Government led campaign; to transition payments, and payments for outcomes; from public procurement through to policy. These interventions have been tested against a systems thinking and resilience lens. Whilst the focus here has been on Wales, the findings may be applied to the rest of the UK. Similarly, these findings may be useful for other catchment stakeholders such as environmental NGOs, water companies, investment vehicles and retailers.

Table 9.1 Summary of system interventions to enable regenerative grazing

Area of system intervention	**Proposed intervention activity**
Land agreements	Land agreements could show the same site-specific consideration for farming practices as they do for site specific conservation needs. For example, all conservation land agreements could stipulate that, where reasonably possible, a land owner is expected to enact the principles and practices of regenerative farming. Trial greater flexibility in land agreements for protected species and habitats, with regard to grazing practices, to understand if this would generate greater systems outcomes for both biodiversity, and farming resilience.

Area of system intervention	Proposed intervention activity
Land rights	Review the relationship between land rights and regenerative farming including, short-term farming tenancies, and commons land restrictions, with ability to implement the principles of regenerative farming. This research suggests, that the Government should be promoting long-term, flexible tenancies to help enhance farmer propensity to experiment in more regenerative practices. Trial flexibility in land rights on a case by case basis i.e. for several different farms, assess what land rights enhance farmer propensity to experiment in regenerative grazing over others. A trial could re-introduce an inter-generational tenancy, or allow temporary exclusive access to commons land, or a landowner stipulating the principles and practices of regenerative farming in a tenancy agreement. The data suggests that the change to short-term Farm Business Tenancies has eroded tenant and landowner long term investment in land as a sustainable asset. Set-up of 'pasture loans', to help farmers make the initial step in conversion to regenerative grazing. For example, this could be by facilitating one-off or short-term agreements between neighbouring farmers, with commons land, publicly owned land or protected sites (that would benefit from grazing and manure input). This is already in place to some degree for some farmers for designated sites but could be trialled at a greater scale.
Transition payments	Grants or loans for an initial period (say five years) to help reduce the financial risk of farming transition. Further research could explore the cost-effectiveness and cost-efficiency of different approaches (e.g. annual payments equipment loans, tax relief, premium payments or low interest loans). But again, these are likely to be context specific and farmers may have preference for the type of financial incentive they access.
Training, support and advice	The Government could coordinate a training, support and advice programme using existing, trusted farming advice organisations, to deliver targeted advice (principles, practices, funding and mindsets) depending on what is required. This could cover a whole suite of different ways to share knowledge and change mind-sets. There will be different ways to do this (workshops, online training via networks, advisors, conferences) and the effectiveness of these could be explored. However, they are all likely to be needed as different farmers prefer different ways of accessing knowledge. Another opportunity would be a pilot scheme, to pair young aspiring farmers (with no access to land but knowledge of, and passion for, regenerative farming) with older, struggling farmers (looking for knowledge and technical support) via a placement scheme.
Government campaign	Government led campaign, one that ties in with reinvigorating culture identity and historical practices (and the Welsh language in Wales), with contemporary market and policy needs (around net zero, BNG, flood protection and water quality). The campaign would target all decision-makers in the surrounding and supporting systems; in markets (wholesale, retail, consumers, suppliers), landowners and land agents, public agencies and environmental charities in addition to farmers (who would be supported via the training and advice programme above).
Public procurement	Trial public sector procurement of regenerative farmed produce which would facilitate market demand and help scale up regenerative farming. Public procurement for all health and education services would help ensure that the most vulnerable in society have access to healthy, nutrient dense food; whilst helping to clean the air, clean our water, store water, sequester more carbon and promote biodiversity; thereby reducing Government, consumer and business costs from addressing health costs, lost employee days, flood

Area of system intervention	Proposed intervention activity
	damages and water treatment in the long term. Thinking systemically, and tackling problems at root cause, will save costs all round and help to future proof public services.
Payments for outcomes	A review of the SFS proposed measures and payments against the *financial* needs of farmers looking to change to regenerative farming (e.g. transitional grants, low interest loans for first five years) to confirm that payments directly to farmers are the best course of action (as stated above, payment via public procurement may be more worthwhile). A review of emerging private-led schemes across the UK which are offering payments to farmers for switching to regenerative principles; could these be applicable in Wales, and also to explore whether transitional payments or loans may be sufficient.
Policy	Whilst Wales has set out a progressive, enabling policy environment; it is perhaps lacking traction on the ground (as per the example given above in 'Land rights'). Approaches could be developed to roll out more holistic, systems thinking, on the ground with public agency practitioners in Wales. Welsh Government could enact the legislative framework to allow market mechanisms in Wales for public goods (i.e. BNG and NN, environmental bonds for regenerative farming). Government is needed to provide clear navigation of these opportunities, and governance of the risks associated with these different payment mechanisms (which could all be managed and passed through a quasi-public agri-environment subsidy scheme).

Chapter 10 Contribution

This chapter sets out how this research has contributed to knowledge, policy makers and practitioners; in terms of the data gathered, insights captured and theory developed.

10.1 Contribution to knowledge

The data collected via this research provides a valuable contribution to the rural sociology literature. As described in Chapter 4, there is a lack of empirical data from Europe and specifically the UK, with regard to understanding farmer decision-making in relation to the take-up of regenerative farming, particularly within grassland systems. The variables affecting farmer decision-making in the literature, are poorly differentiated between different contexts. As such, very little of the 'deep-dives' in Chapter 7 could draw on any existing published research from the literature in any depth. Related published literature does not appear to be as detailed nor be entirely transferable to the given context.

Admittedly, the literature review was focused on the take-up of regenerative farming outside of payment schemes (in order to understand the decision-making factors in voluntary take-up, rather than in an incentivised take-up) which may have restricted the data captured. However, decision-making variables in relation to broader agro-ecological practices were covered in the literature review, such as organic farming, suggesting that not much was missed by the literature review thus the view above holds true.

This research has highlighted the difference in coverage and depth of insight from data gathered from surveys (in the literature) compared to data gathered from in-depth interviews regarding farmer decision-making. Whilst a small number of farmers were interviewed for this research, compared to the numbers of farmers surveyed in some of the literature, the richness of the data appears to be far greater from the interviews. In-depth conversations really allowed relationships within contexts and other variables to be explored, to a level not possible in surveys.

As such, **the data collected by this research adds depth and coverage to the rural sociology literature,** specifically around factors of land agreements, land rights, changing mind-sets and accessing knowledge (the 'deep dives'); and how these relate to take-up of regenerative farming in the UK and specifically Wales. The data could be explored further, in more 'deep-dives', as a follow up to this research.

This research has also contributed to the rural sociology literature, in that the conceptual theory presented here, which emerged from the data, **builds on and develops further,**

Schiere, Darnhofer and Duru's (2012) idea of a farmer's 'feasibility space'. It has explored and expanded this notion of 'feasibility space', seeking to understand how the farmer and farm context shapes it; how broader policy, institutional and social structures help to stretch and contain it, and where farmers are flexing it through agency to try and change what they are able to do. It is a theory developed specifically for farmer decision-making with regard to take-up of regenerative farming in Wales, as such the components and relationships between them, are nuanced to this particular context. However, learning can be applied to the rest of the UK for regenerative grazing, and the general constructs of the theory applied to decision-making in all aspects of life.

The conceptual theory as set out, **sketches out the relationships between components of the system** being explored and allowed targeted areas of the system to be 'deep-dived' for further investigation. Importantly, rather than looking at decision-making in a reductionist manner (i.e. factors examined separately from each other, and isolated from the context by which they are defined), this theory permits an interpretation of the real world that is rooted in systems thinking; that things are constantly shaped by their context, they have relationships with variables around them that create feedback mechanisms, they are kept in check by governing structures and perturbations happening around them around them all the time, which stretch and flex boundaries. This very much draws on social constructionism but also literature on socio-ecological systems (Folke 2006, 2007; Folke et al., 2005) and resilience and adaptive capacity in systems (Gallopin, 2006; Walker et al., 2004).

This research adds to the literature on socio-ecological systems, by exploring how farmers in Wales (a specific human-environment system) are behaving, responding and adapting to internal and external perturbations. Specifically, it has contributed to the need "… for an improved understanding of the links between personal, farm specific and external drivers of change, considering farming as a human activity system. This should aim at further consolidating models for policy-making by considering available social evidence and by linking the different perspectives." (Padel et al., 2017:8).

Further analysis of this research, and follow up data collection, could focus on exploring system properties that emerge from the relationships between the social and ecological components set out here (Walker et al., 2004; Turner et al., 2003; in Gallopin, 2006). Understanding how these emergent properties (of a regenerative farming system) increase farm resilience and adaptability to external forces, drawing on Gallopin (2006) would be insightful for scaling up regenerative farming in the UK, to help address the ecological, economic and climate crises facing society. Clearly the rate of take-up and interest in

regenerative farming in the UK, surely evidences the existence of these emergent system properties which reductionist science so far has been unable to pin down.

10.2 Contribution to policy makers

Agri-environment policy tends to focus on 'what more can be done' with a prevailing focus on *paying* farmer and landowners to make changes; whether for actions or outcomes. This research has shown that perhaps we should question this focus.

The data suggests that paying farmers alone will not free up farmer propensity to make change towards regenerative farming, within the existing system constraints in which many farmers operate. As such the finding is not so much about how the Government can do more, but more about where the Government can stop doing less (by introducing flexibility into restrictive and prescriptive land agreements for example). Only in this way, can Government, as well as all catchment stakeholders, truly facilitate change to regenerative farming at scale.

The overwhelming finding of this research has been that system interventions (whether policy, practitioners or the public) should pro-actively promote 'enabling' conditions for farmers to make changes themselves. This will enhance farmer 'feasibility space' and in this way, farmers will be more likely to make their own changes towards regenerative farming. This means in practice, removing constraints affecting farmer decision making across land rights, land agreements; as well as promoting enabling conditions, via for example advice, support and training.

This is not to say payments will not help – they will; the farmers spoke about up-front costs for electric fencing, herbal leys, fencing, hedgerows, water and track infrastructure. Aligning the forthcoming SFS in Wales with the needs of aspiring regenerative farmers will certainly help. Transition payments for the first five years, until soil biology recovers, would also help to manage business risk. However, progress towards regenerative grazing will be limited in any farm system, irrespective of financial support, until other farm constraints are eased.

Whilst Wales has arguably set out a progressive, enabling policy environment, that other parts of the UK are looking up to; it is perhaps lacking traction on the ground (as per the example given above in '2. Land rights') and the challenge perhaps is to ensure that different legislation are all aligned to the co-delivery of the seven 'well-being goals'. As stated by Knickel et al. (2017:1), "Systemic change requires more critical reflection of conventional wisdom and approaches, and openness to ideas and practices that are outside the mainstream".

10.3 Contribution to practitioners

The system interventions in Chapter 8 are relevant to any catchment stakeholder looking to work with landowners and farmers to facilitate change to regenerative farming practices. As summarised in Chapter 8, there are many different organisations entering this space, from environmental NGOs such as wildlife trusts, to water companies, wholesale cooperatives, retailers and supply chains, investors and financers. Many are mimicking similar programmes, others are trying new approaches, but each with the same goal in mind: to pay farmers to change their farming practices. The data has illuminated that payments are not necessarily the 'fix all' solution; all catchment stakeholders need to work towards enhancing farmer 'feasibility space', to remove constraints around farmer agency, and to help empower farmers in order to enact real change at scale. Paying farmers alone will not free up farmer propensity to make the changes required, at the scale and speed required.

This research has illuminated that critically testing catchment interventions from a resilience and systems thinking perspective, is necessary for making effective, optimal, decisions about how to intervene and where. Rather than, arguably, interventions for 'interventions sake' (e.g. paying farmers to make changes, whether for measures or outcomes), systems thinking purports that understanding those interactions, between and within systems, that maintain the semblance of a system as a static object, is key. As such, this research has set out an intervention strategy, by which the following questions are asked of systems interventions, to critically appraise them in terms of boosting system resilience in any given application or context:

- What relationship does the intervention have with components of the system?
- Does this change by context? How does information flow along this relationship?
- Will the intervention repair, replace or even weaken a feedback mechanism in the system?
- What influence will this intervention really have? Are there more effective ways to have the same desired impact?

Systems thinking suggests that these interactions and relationships, share properties, irrespective of scale and system type; there are always trade-offs and synergies between different system relationships, but resilience requires the feedback mechanisms in place in order to keep these in check. Great strides would be achieved towards upscaling regenerative grazing if practitioners could appraise their choices and actions via a systems thinking lens (and in so doing, expand their own 'feasibility space').

10.4 Conclusion

This research adds depth and coverage to the rural sociology literature, specifically regarding land agreements, land rights, changing mind-sets and accessing knowledge (the 'deep dives'); and how these relate to take-up of regenerative farming in the UK and specifically Wales. The data could be explored further, in more 'deep-dives', as a follow up to this research.

This research contributes to the rural sociology literature, in that the conceptual theory presented here builds on, and develops further, Schiere, Darnhofer and Duru's (2012) idea of a farmer's 'feasibility space'. It has explored and expanded this notion of 'feasibility space', seeking to understand how the farmer and farm context shapes it; how broader policy, institutional and social structures help to stretch and contain it, and where farmers are flexing it through agency to try and change what they are able to do.

This research also contributes to policy learning, findings that farming system interventions should pro-actively promote 'enabling' conditions for farmers to make changes themselves. This will enhance farmer 'feasibility space' and in this way, farmers will be more likely to make their own changes towards regenerative farming. The research questions an agri-environment policy focus which is based primarily on payments to farmers. The findings indicate that paying farmers alone will not free up farmer propensity to make change towards regenerative farming, within the existing system constraints in which many farmers operate.

Finally, this research has illuminated that critically testing catchment interventions from a resilience and systems thinking perspective, is necessary for making effective, optimal, decisions about how to intervene and where. It calls on catchment practitioners to work towards enhancing farmer 'feasibility space', to remove constraints around farmer agency, and to help empower farmers in order to enact real change at scale. Paying farmers is not the 'fix all' solution and alone, will not free up farmer propensity to make the changes required, and at the scale and speed required.

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Appendix 1. Systematic Literature Review searches

2016/17 Systematic Literature Review

Database, date, comment:	Search string:	Results:
SEARCH A	General terms: farm, holistic, income, profit, ecosystem services	
Hull Uni Summon	Farm*, agri*, holistic, adaptive, planned, pasture division, grazing timing, rotational, rational, product*, income, profit*, hard* breeds	0
21/10/2016	Farm*, agri*, holistic, pasture, product*, income, profit*	0
Notes on search: a lot of hard work (half a day) to find very little. Identified 17 papers in all of broad relevance but nothing specific.	Farm*	356292
	Farm*, holistic, income, profit*	0
	Farm* AND holistic AND income AND profit*	0
	Terms (in full text):	
	Farm* AND holistic AND income AND profit* and ecosystem services	3097
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science	773
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT mangrove NOT asia	633
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind	357
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT fish NOT seafood	277
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT fish NOT seafood NOT indigenous rights	225
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT fish NOT seafood NOT indigenous rights NOT afforestation	220
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT fish NOT seafood NOT indigenous rights NOT afforestation NOT trophy NOT nursing	203
	As above, ticked 'add results beyond your library's collection'	448
	As above, removed magazine articles, newspaper articles, transcripts, book reviews, book/ebooks	308
	Farm* AND holistic AND income AND profit* and ecosystem services NOT plant science NOT wind NOT fish NOT seafood NOT indigenous rights NOT afforestation NOT trophy NOT nursing NOT software NOT android	244
	As above, removed following from subject terms: africa, banking industry, cities, commercial banking, marketing	221
	As above, time period changed to 2000 to present only	183
	Manual check	33
	Manual check of abstracts and exported	17
Web of Science	Farm*, agri*, holistic, adaptive, planned, pasture division, grazing timing, rotational, rational, product*, income, profit*, hard* breeds	0

Database, date, comment:	Search string:	Results:
21/10/2016	Farm*, agri*, holistic, pasture, product*, income, profit*	0
	TI=(Farm* "OR" agri*) AND (holistic "OR" adaptive "OR" planned "OR" pasture "OR" grazing "OR" rotational "OR" rational "OR" product*) "AND" (income "OR" profit* "OR" hard* breeds)	0
	TS=(farm* AND holistic*)	989
	AGRICULTURE OR ENVIRONMENTAL SCIENCES ECOLOGY OR BUSINESS ECONOMICS OR BIODIVERSITY CONSERVATION OR WATER RESOURCES OR FORESTRY	857
	Since 2000 only	658
	REVIEW OR EDITORIAL OR CLINICAL TRIAL OR BOOK OR NEWS OR ABSTRACT	538
	TS=(farm* AND holistic* AND pasture)	33
	Manual check of abstracts and exported	16
Web of Science	silvopasture carbon	
16/11/2016		29
	Manual check of abstracts and exported	29
Google scholar	Farm * agri * UK carbon, holistic mob OR grazing OR agroforestry	12200
27/10/2016	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american, -africa	1860
Notes on search: Not really relevant to specific initial search but still PhD relevant.	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions	750
	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions	620
	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions -portugal -spain -mediterranean 2000-2016 only	424
	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions -portugal -spain -mediterranean -romania -plants 2000-2016 only	142
	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions -switzerland -denmark -portugal -spain -mediterranean -romania -plants	114
	Farm * agri * UK carbon holistic mob OR grazing OR agroforestry -american -africa -footprint -emissions -sri -lanka -ethiopia -switzerland -denmark -portugal -spain -mediterranean -romania -plants	101
	Manual check of abstracts and exported	12
Web of Science	TI=(water* AND quality AND retention AND soil OR sward AND height AND grazing AND grass)	22
27/10/2016		

Database, date, comment:	Search string:	Results:
SEARCH B	systems approach catchment management ecosystem services	
Mendeley Library	Manual check of abstracts and exported	32
29/11/2016		11
SEARCH B	catchments, management, ecosystem, water, systems, approach, dynamics, thinking	
Science Direct	(catchment management ecosystem water) and (systems approach dynamics thinking)	1471
29/11/2016	AND LIMIT-TO(topics, "water,soil,model,river,lake,earth,climate change,geology,ecosystem,land,forest,ecosystem service,europe,australia,climate,environmental,sediment").	702
	AND LIMIT-TO(topics, "water,soil,model,river,lake,earth,climate change,geology,ecosystem,land,forest,ecosystem service,europe,australia,environmental,sediment,china").	698
	Manual check of abstracts and exported	
Scopus	(catchment management ecosystem water) and (systems approach dynamics thinking)	609
21/12/2016	AND (LIMIT-TO (EXACTKEYWORD , "Climate Change") OR LIMIT-TO (EXACTKEYWORD , "Water Management") OR LIMIT-TO (EXACTKEYWORD , "Decision Making") OR LIMIT-TO (EXACTKEYWORD , "Adaptive Management") OR LIMIT-TO (EXACTKEYWORD , "Ecosystems") OR LIMIT-TO (EXACTKEYWORD , "Water Resources") OR LIMIT-TO (EXACTKEYWORD , "Biodiversity") OR LIMIT-TO (EXACTKEYWORD , "Stakeholder") OR LIMIT-TO (EXACTKEYWORD , "Rivers") OR LIMIT-TO (EXACTKEYWORD , "Catchments") OR LIMIT-TO (EXACTKEYWORD , "Catchment") OR LIMIT-TO (EXACTKEYWORD , "Water Resource") OR LIMIT-TO (EXACTKEYWORD , "Water Quality") OR LIMIT-TO (EXACTKEYWORD , "Water Supply") OR LIMIT-TO (EXACTKEYWORD , "Ecosystem Services") OR LIMIT-TO (EXACTKEYWORD , "Governance Approach") OR LIMIT-TO (EXACTKEYWORD , "Integrated Approach") OR LIMIT-TO (EXACTKEYWORD , "Land Use") OR LIMIT-TO (EXACTKEYWORD , "Ecosystem Service") OR LIMIT-TO (EXACTKEYWORD , "Resilience") OR LIMIT-TO (EXACTKEYWORD , "Participatory Approach") OR LIMIT-TO (EXACTKEYWORD , "Uncertainty Analysis") OR LIMIT-TO (EXACTKEYWORD , "Conceptual Framework") OR LIMIT-TO (EXACTKEYWORD , "Agriculture") OR LIMIT-TO (EXACTKEYWORD , "Conservation Of Natural Resources") OR LIMIT-TO (EXACTKEYWORD , "Groundwater") OR LIMIT-TO (EXACTKEYWORD , "Land Use Change"))	297
	AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "AGRI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "ARTS") OR LIMIT-TO (SUBJAREA , "MATH") OR LIMIT-TO (SUBJAREA , "MULT"))	286
	Manual check of abstracts and exported	
SEARCH C	catchments, land, governance, policy, rights, property, regenerative, sustainable, agriculture, payments	
Scopus	ALL (catchments AND land AND governance OR policy AND rights OR property OR regenerative OR sustainable AND agriculture OR payments)	8849
16/05/2017	…. AND NOT renewable AND NOT energy	6001

Database, date, comment:	Search string:	Results:
	...AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "AGRI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "BUSI"))	5420
	… AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Agriculture")) AND (EXCLUDE (SUBJAREA , "EART") OR EXCLUDE (SUBJAREA , "MEDI") OR EXCLUDE (SUBJAREA , "COMP") OR EXCLUDE (SUBJAREA , "ENGI") OR EXCLUDE (SUBJAREA , "BIOC") OR EXCLUDE (SUBJAREA , "ENER") OR EXCLUDE (SUBJAREA , "PHAR") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "CHEM") OR EXCLUDE (SUBJAREA , "MATH") OR EXCLUDE (SUBJAREA , "ARTS") OR EXCLUDE (SUBJAREA , "VETE") OR EXCLUDE (SUBJAREA , "PHYS"))	629
	… AND NOT phosphorus AND NOT nitrogen AND NOT macroinvertebrate	252
	Manual check of abstracts and exported	252
Science Direct	ALL (catchments AND land AND governance OR policy AND rights OR property OR regenerative OR sustainable AND agriculture OR payments AND NOT renewable AND NOT energy) AND NOT phosphorus AND NOT nitrogen AND NOT macroinvertebrate	3751
19/05/2017	AND LIMIT-TO(cids, "271800,271740,272592,271239,271991,271238,271853,271139","Science of The Total Environment,Land Use Policy,Journal of Environmental Management,Agriculture, Ecosystems & Environment,Environmental Science & Policy,Agricultural Water Management,Landscape and Urban Planning,Agricultural Systems")	1008
	AND LIMIT-TO(cids, "271740","Land Use Policy"	175
	Manual check of abstracts and exported	175
SEARCH D	climate AND change AND adaptation AND resilience AND farming AND agriculture AND systems AND sustainable AND experimentation	
Scopus	climate AND change AND adaptation AND resilience AND farming AND agriculture AND systems AND sustainable AND experimentation	0
02/07/2017	adaptation AND resilience AND farming AND agriculture AND systems AND sustainable AND experimentation	0
Science Direct	climate AND change AND adaptation AND resilience AND farming AND agriculture AND systems AND sustainable AND experimentation	221
02/07/2017	Journals only	174
SEARCH E	climate AND change AND adaptation AND resilience AND farming AND agriculture AND systems AND sustainable AND experimentation	
Scopus	ALL (soil AND conservation AND measures AND farmer AND decision AND making AND innovation AND perspectives AND values AND views)	238
25/10/2017	ALL (soil AND conservation AND measures AND farmer AND decision AND making AND innovation AND perspectives AND values AND views) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch"))	77
Science Direct	ALL (soil AND conservation AND measures AND farmer AND decision AND making AND innovation AND perspectives AND values AND views)	1506
25/10/2017	ALL (soil AND conservation AND measures AND farmer AND decision AND making AND innovation AND perspectives AND values AND views)) and not (riparian OR payments OR set-aside OR expert OR chemical).	150

2020 Systematic Literature Review

Database:	Search code:	Results:	Notes:
Summon 07/10/2020	policy sustainable agriculture payments outcomes	22,997	Last ten years, all fields, journal articles and reports only
	policy sustainable agriculture payments outcomes	11,521	-amazon -poverty
	policy sustainable agriculture payments outcomes UK	2,300	-china
	policy sustainable agriculture payments outcomes UK	1,922	-ecolabels -olive -"community farms"-genetic -vietnam
	policy sustainable agriculture payments outcomes UK	970	-certification -horse -trinidad -burundi -dutch -italy -czech -romania
	policy sustainable agriculture payments outcomes UK	760	Disciplines excluded
	policy sustainable agriculture payments outcomes UK	385	-australia -tourism -irrigation
	policy sustainable agriculture payments outcomes UK	289	-organic -denmark -lewes -"environmental impact assessment"
	policy sustainable agriculture payments outcomes UK	156	-biomass -africa -"developing countries" -gender -feminist
	policy sustainable agriculture payments outcomes UK	50	Excluded government documents, -latvia, -"new zealand"
Summon Search 1-A	**Exported to RefWorks**	**50**	
Summon 08/10/2020	climate change adaptation resilience farming agriculture systems sustainable carbon	6,089	All fields
	climate change adaptation resilience farming agriculture systems sustainable carbon	3,191	All fields, journal articles and reports only
	climate change adaptation resilience farming agriculture systems sustainable carbon	1,156	-prawn -Bangladesh -aquaculture -"prawn-fish-rice" -Vietnam -Africa
	climate change adaptation resilience farming agriculture systems sustainable carbon	562	-cocoa -olives -cereals -realignment; 26 disciplines removed
	climate change adaptation resilience farming agriculture systems sustainable carbon	70	-rice -forest -organic -corn, last ten years only
Summon Search 1-B	**Exported to RefWorks**	**70**	

Database:	Search code:	Results:	Notes:
Summon 08/10/2020	soil health conservation farmer decision making perspectives values views	3,124	All fields, journal articles and reports only, last ten years only, disciplines excluded
	soil health conservation farmer decision making perspectives values views	410	-biosecurity -seed -china -urban
	soil health conservation farmer decision making perspectives values views	258	-citrus -randomised -pond -kenya -africa
	soil health conservation farmer decision making perspectives values views	150	-councils -ecotourism
	soil health conservation farmer decision making perspectives values views	72	-cinnamon -solidarity -index -econometric -ferrets -wine -maori -cocoa
	soil health conservation farmer decision making perspectives values views	41	-school -leopold
Summon Search 1-C	**Exported to RefWorks**	**41**	
Summon 08/10/2020	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	6,639	
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	5,291	Last ten years only
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	4,519	13 contents types removed
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	3,303	32 disciplines removed
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	1,419	-forecasts -mongolia -nomad -baltic -nesting -jatropha -buffel -old-growth -china
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	900	-"coral reef" -rewilding -mexico -grain
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	682	-germination -littoral -maasai -ecotourism -egypt -brazil -"rich and poor" -"comparative functional" -wildebeest

Database:	Search code:	Results:	Notes:
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	552	More disciplines and content types excluded
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	319	-urban
	(regenerative OR holistic OR adaptive OR mob OR rotational) grazing benefits resilience impact	99	-tunisia -fishing -himalayan -ocean -"baker field" -thermoregulation -carnivores -reindeer -elk -palaeo -atriplex -"national forest system" -"parental efficacy" -"climate migration" -indigenous -ovine -subsistence -"labor management" -"root imaging" -trout -oneself
Summon Search 1-D	**Exported to RefWorks**	**99**	
Summon 08/10/2020	farmer decision making systems thinking socio ecological resilience	1,640	Last ten years only, disciplines and content types excluded
	farmer decision making systems thinking socio ecological resilience	710	-mining -"plant breeding" -forestry -"oil palm" -tourism
	farmer decision making systems thinking socio ecological resilience	348	UK
	farmer decision making systems thinking socio ecological resilience	118	-tourism -urban -"tropical disease"
	farmer decision making systems thinking socio ecological resilience	36	-feminist -household -kenya -organic
Summon Search 1-E	**Exported to RefWorks**	**36**	
Scopus 08/10/2020	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	1,647	All fields
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	1,637	AND NOT (africa philippines ethiopia equation conflict)
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	1,477	Last ten years

Database:	Search code:	Results:	Notes:
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	1,318	Subjects limited
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	317	Limited by document type, and to UK region
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	181	AND NOT (bangladesh OR malaysia OR urbanisation OR peatland OR colombian OR ghana OR gender)
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	157	OR bonus OR cambodia OR nepal
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	108	Irrelevant journals excluded
	(ALL (policy AND sustainable AND agriculture) OR (agri-environment)) AND (payments AND outcomes AND uk)	79	OR zambia OR cyprus OR tropical
Scopus Search 2-A	**Exported to RefWorks**	**79**	
Scopus 08/10/2020	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	5,125	
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	4,786	Last ten years
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	824	Limited by document type, and to UK region
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	769	Limited by subject
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	254	AND NOT (wheat OR islam OR africa)
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	88	OR aquaculture OR kelp OR madeira OR urban OR sitka OR fir OR vietnam
	(ALL (climate change adaptation resilience) AND (farming OR agriculture)) AND ((carbon)) AND (sustainable)	77	OR "supply chains" OR genotypes OR "green jobs"

Database:	Search code:	Results:	Notes:
Scopus Search 2-B	**Exported to RefWorks**	**77**	
Scopus 09/10/2020	ALL (soil AND health AND conservation AND farmer AND decision AND making)	3,097	All fields
	ALL (soil AND health AND conservation AND farmer AND decision AND making)	2,533	Last ten years
	ALL (soil AND health AND conservation AND farmer AND decision AND making)	2,369	perspectives OR values OR views
	ALL (soil AND health AND conservation AND farmer AND decision AND making)	304	Limited by subject area, limited by document types, and UK
	ALL (soil AND health AND conservation AND farmer AND decision AND making)	124	AND NOT (africa OR cyanobacterial)
	ALL (soil AND health AND conservation AND farmer AND decision AND making)	52	OR india OR pakistan OR emergy OR mexico OR marine OR china OR amazon
Scopus Search 2-C	**Exported to RefWorks**	**52**	
Scopus 09/10/2020	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	71,289	
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	41,601	Last ten years
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	30,135	AND (soil OR livestock OR impacts OR resilience)
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	17,024	"United States" "Australia" "Germany" "United Kingdom" "France" "Canada"
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	15,213	Limited by subject
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	8,909	NOT (fisheries OR "heat shocks" OR savanna OR biochar OR sudan OR africa OR gum OR wheatgrass)

Database:	Search code:	Results:	Notes:
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	8,711	Limited by document types
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	7,637	Limited by source type
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	3,723	OR wetlands OR halide OR genetic OR coastal OR autogenic OR isopod
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	1,844	OR tortoise OR grain OR salt OR "dust storm" OR polymer OR urban OR arid OR anthelmintics
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	1,733	Limited by source again
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	1,020	OR danica OR oceanic OR marine OR genotype OR diatoms OR biofilm OR cowpea OR crossflow OR plasmid OR genes
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	434	OR mountain OR hygiene OR heat OR ornithology OR birds OR deer OR corncrake OR veterinary
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	391	Limited by source again
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	318	OR membrane OR daphnid OR dgvm OR topmodel OR silicon OR bermudagrass OR atomic
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	244	OR mexico OR n-3 OR isotope OR goats OR tillage
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	155	OR infrared OR geometry OR cultivar OR lichen OR srtm OR wheat OR beech OR sorption OR uranium OR exoplanetary OR bushfire
	grazing AND (regenerative OR holistic OR adaptive OR mob OR rotational OR cell)	122	OR organic
Scopus Search 2-D	**Exported to RefWorks**	**122**	
Scopus 09/10/2020	farmer AND decision AND making AND systems AND thinking AND socio AND ecological AND resilience	746	

Database:	Search code:	Results:	Notes:
	farmer AND decision AND making AND systems AND thinking AND socio AND ecological AND resilience	676	Last ten years
	farmer AND decision AND making AND systems AND thinking AND socio AND ecological AND resilience	136	UK, limited to document types
	ALL (farmer AND decision AND making AND resilience) OR (farmer AND systems AND thinking AND socio AND ecological AND resilience)	79	AND NOT (marine OR health OR broadband OR india OR oyster OR microfinance OR child OR violence OR africa OR urban OR criminology
	ALL (farmer AND decision AND making AND resilience) OR (farmer AND systems AND thinking AND socio AND ecological AND resilience)	441	Removed UK affiliation, OR schizophrenia OR households OR analytics OR iraqi OR "credit flows"
	ALL (farmer AND decision AND making AND resilience) OR (farmer AND systems AND thinking AND socio AND ecological AND resilience)	256	OR schizophrenia OR households OR analytics OR iraqi OR "credit flows" OR tropical OR seed OR greece OR transmission OR "policy scenarios" OR injury OR dea OR thailand OR "south america" OR tourism
	ALL (farmer AND decision AND making AND resilience) OR (farmer AND systems AND thinking AND socio AND ecological AND resilience)	45	OR university OR credit OR "market making" OR automotive OR sumatra OR china OR citizenship
Scopus Search 2-E	**Exported to RefWorks**	**45**	
Scopus 16/10/2020	ALL (farming AND regenerative OR sustainable OR carbon)	149,517	
	ALL (farming AND regenerative OR sustainable OR carbon)	120,688	AND (transition OR change OR process)
	ALL (farming AND regenerative OR sustainable OR carbon)	93,114	Last ten years
	ALL (farming AND regenerative OR sustainable OR carbon)	87,488	Limited by document type
	ALL (farming AND regenerative OR sustainable OR carbon)	50,644	Keywords excluded

Database:	Search code:	Results:	Notes:
	ALL (farming AND regenerative OR sustainable OR carbon)	37,787	Subject areas excluded
	ALL (farming AND regenerative OR sustainable OR carbon)	32,532	Limited by source type
	ALL (farming AND regenerative OR sustainable OR carbon)	15,179	Limited by country
	ALL (farming AND regenerative OR sustainable OR carbon)	14,129	Limited by source type
	ALL (farming AND regenerative OR sustainable OR carbon)	10,089	AND NOT (TITLE-ABS(cocoa OR ethiopia OR acid OR sudanese OR dietary OR transects OR amino OR carrot OR nino OR indonesia OR composite OR bangladesh OR crop)
	ALL (farming AND regenerative OR sustainable OR carbon)	8,267	architecture OR africa OR pakistan OR fungicide OR urban OR nigeria OR student OR resident OR reservoir OR sturgeon
	ALL (farming AND regenerative OR sustainable OR carbon)	7,739	OR sunflower OR palm OR ghana OR sweden OR tanzania OR neoliberalism OR amazonia OR lipid OR mining OR tribal OR gender OR rubber
	ALL (farming AND regenerative OR sustainable OR carbon)	5,160	AND (england OR uk OR scotland OR wales
	ALL (farming AND regenerative OR sustainable OR carbon)	1,666	UK affiliation only
	ALL (farming AND regenerative OR sustainable OR carbon)	984	Last five years
	ALL (farming AND regenerative OR sustainable OR carbon)	195	Farmer AND transition
	ALL (farming AND regenerative OR sustainable OR carbon)	172	OR oman OR lao OR peatland OR african OR neolithic OR jamaica OR basque OR malawi OR DNA
	ALL (farming AND regenerative OR sustainable OR carbon)	158	OR podzol OR mekong OR fishing OR medieval OR wind OR slovakia OR ukraine OR holocene

Database:	Search code:	Results:	Notes:
	ALL (farming AND regenerative OR sustainable OR carbon)	144	OR home-grown OR bronze OR rice OR oil OR uruguay OR italy OR tropical OR mortuary
Scopus Search 2-F	**Exported to RefWorks**	**144**	
Web of Science Core Collection 16/10/2020	policy sustainable agriculture payments outcomes	31	
WoS Search 3-A	**Exported to RefWorks**	**31**	
Web of Science Core Collection 16/10/2020	climate change adaptation resilience farming agriculture systems sustainable carbon	21	
WoS Search 3-B	**Exported to RefWorks**	**21**	
Web of Science Core Collection 16/10/2020	soil health farmer decision perspective	19	
WoS Search 3-C	**Exported to RefWorks**	**19**	
Web of Science Core	grazing (regenerative OR holistic OR adaptive OR mob OR rotational) AND soil AND livestock	226	
	grazing (regenerative OR holistic OR adaptive OR mob OR rotational) AND soil AND livestock	172	Last ten years, articles and reviews

Database:	Search code:	Results:	Notes:
Collection 16/10/2020	grazing (regenerative OR holistic OR adaptive OR mob OR rotational) AND soil AND livestock	157	Topics excluded
WoS Search 3-D	**Exported to RefWorks**	**157**	
Web of Science Core Collection 16/10/2020	farmer decision making systems resilience	111	
	farmer decision making systems resilience	79	Last five years
WoS Search 3-E	**Exported to RefWorks**	**79**	
Web of Science Core Collection 16/10/2020	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	6250	
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	3209	Last five years
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	4801	NOT (fish OR aquaculture OR marine OR shrub OR africa OR china OR bacteria
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	3699	OR sugarcane OR electricity OR hemp, article or review only
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	1326	Countries limited
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	267	farmer

Database:	Search code:	Results:	Notes:
	(farming (regenerative OR sustainable OR carbon) AND (transition OR process) NOT (fish OR aquaculture or marine))	57	England Scotland Wales
WoS Search 3-F	**Exported to RefWorks**	**57**	

Appendix 2. Variables affecting farmer decision making

Variable	Comment	Differentiation	Source
Environmental characteristics			
Availability and quality of water/rainfall	Some studies have observed a positive correlation with rainfall (e.g. Gould et al., 1989; Uri, 1997), others have revealed insignificant (e.g. Rahm and Huffman, 1984; Clay et al., 1998) and even negative correlations (e.g. Fuglie, 1999).	All in relation to arable farming only.	Knowler and Bradshaw, 2007
Soil quality (including drainage)/risk of erosion	Some studies have found that the presence of soil erosion and other soil problems on a farm correlates positively with conservation tillage adoption (Fuglie, 1999; Soule et al., 2000; Uri, 1997). Farmer awareness of soil problems is more likely to be the critical factor.	All in relation to arable farming only.	Knowler and Bradshaw, 2007
Climate (incl. temperature, length of growing season)	Kallas et al., (2009) reports that farms in colder climates are more likely to convert to organic farming.	All farming	Kallas et al., 2009
Gradient/slope and drainage	Farm operations on steep slopes and erodible soils have a greater tendency to adopt soil conservation practices (e.g. Uri, 1997; Soule et al., 2000; Pautsch, 2001). Kallas et al. (2009) reports that steeper farms are more likely to convert to organic farming.	All in relation to arable farming only.	Knowler and Bradshaw, 2007; Kallas et al., 2009
Proximity of farm (to farmhouse, roads, markets, other farms etc.)	Kallas et al. (2009) state that the further the distance between farm and home, the lower the likelihood of conversion to organic farming. They state that the nearer a farm is to other farms adopting organic farming, the higher the likelihood of conversion to organic farming.	All farming	Kallas et al., 2009

Variable	Comment	Differentiation	Source
Financial characteristics			
Financial independence (incl. debt, income diversity, access to finance)	Cross et al. (2011) show that a lack of financial independence diminishes motivation to participate in conservation programs, but that it is a subjective experience, related to farm income and land characteristics. Kallas et al. (2009) links higher debt, and poor access to loans; to lower likelihood of conversion to organic farming.	Farming type not specified. Study from developed country.	Celio et al., 2014 (survey based); Pannell et al., 2006; Kallas et al., 2009
Farm characteristics			
Farm size (incl. area planted, field size, ratio of arable to pastoral areas, areas in fallow).	Many studies have found that farm size correlates positively with adoption (Westra and Olson, 1997). Larger farms who manage a variety of crops, and who generate high gross sales are more likely to implement new soil and water conservation practices than small-scale crop farmers with lower farm revenues (Serman and Filson, 1999). Other studies report a positive relationship between both crop and non-crop acreage managed and conservation behaviour (Norris and Batie, 1987; Gould et al., 1989). Larger crop farms were more likely to use conservation practices (Smit and Smithers, 1992; Fuglie, 1999). However, some have found a negative relationship (e.g. Shortle and Miranowski, 1986; Clay et al., 1998) and insignificant correlations (e.g. Nowak, 1987); Kallas et al. (2009) report that smaller farms are more likely to convert to organic farming.	Larger farms tend to be more likely to adopt biodiversity measures. Not clear from literature if payment related. Some papers question this.	Yiridoe, 2010; Knowler and Bradshaw, 2007; Kallas et al., 2009
Land tenure	Owned land tends to be better maintained than leased land (Clay et al., 1998; Neill and Lee, 1999), although this is refuted (Smit and Smithers, 1992; Fuglie, 1999), and others have found no significant link (Nowak, 1987; De Herrera and Sain, 1999).	Mostly for arable farming although not clear for some.	Knowler and Bradshaw, 2007

Variable	Comment	Differentiation	Source
Labour (family versus hired)	No significant correlation with take up of biodiversity measures (Saltiel et al., 1994; Uri, 1997). Although Kallas et al. (2009) report that more family labour, increases likelihood of conversion to organic farming.	From studies of arable farming in developed countries only.	Knowler and Bradshaw, 2007; Kallas et al., 2009
Labour (total hours)	Kallas et al. (2009) report that higher the labour on the farm, the increased likelihood of conversion to organic farming.	No comment	Kallas et al., 2009
Income and profitability	Studies investigating the impact of income, gross income and farm profitability on adoption revealed a positive correlation with take-up of biodiversity measures (e.g. Gould et al., 1989; Saltiel et al., 1994; Smit and Smithers, 1992; Okoye, 1998). Some question this conclusion (e.g. (Warriner and Moul, 1992; Clay et al., 1998).	Mostly from studies of arable farming	Knowler and Bradshaw, 2007; Yiridoe, 2010
Yield per hectare	No further information provided.	No comment	Knowler and Bradshaw, 2007
Off-farm activities and diversified incomes (incl. part-time farmers)	No clear relationship between off-farm income and take-up of conservation measures but suggests more likely to be positively correlated in developed countries (e.g. Camboni and Napier, 1993; Fuglie, 1999; Kallas et al., 2009).	Not clear if from arable or pastoral farm studies.	Knowler and Bradshaw, 2007
Farm business ownership	Yiridoe (2010) reports that incorporated crop farms and those with partnership arrangements tended to invest more in conservation practices. However, the reported differences across farm ownership status were generally small. Saltiel et al., 1994 found that type of farm enterprise played a larger role in adoption of low-input practices than management intensive ones.	Mix of farming types. Study is looking at take-up of agri-environment scheme so likely to include some financial incentives (not clear).	Yiridoe, 2010
Access to required machinery, infrastructure and equipment	No further information provided.	No comment	Knowler and Bradshaw, 2007

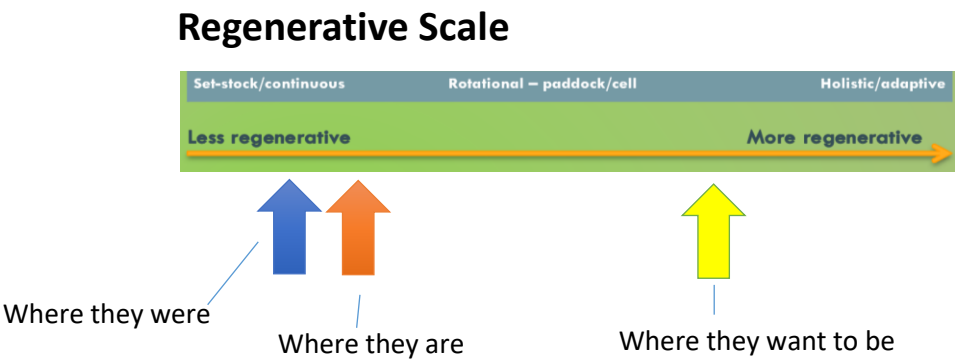
Variable	Comment	Differentiation	Source
Proportion of costs on fertilisers, pesticides (other chemical inputs) and fuel	No further information provided.	No comment	Knowler and Bradshaw, 2007
Current farming practices (land-use intensity, rotation system, seeding rate, proportion of land irrigated)	No further information provided.	No comment	Knowler and Bradshaw, 2007
Farmer characteristics			
Gender	Female, formally educated, hobby farmers on small farms, with high off-farm incomes are more likely to adopt biodiversity measures. Supported by Kallas et al. (2009) who state female farmers are more likely to adopt organic farming.	No comment	Raymond and Brown, 2011; Kallas et al., 2009
Experience and skills	Some studies show farmer age is positively correlated to take up of biodiversity measures (e.g. (Warriner and Moul, 1992; Okoye, 1998; Rahm and Huffman, 1984; Clay et al., 1998); some negative (e.g. Gould et al., 1989; Clay et al., 1998); and others insignificantly (Neill and Lee, 1999; Shortle and Miranowski, 1986; Traore et al., 1998). Kallas et al. (2009) find that the greater the use of the internet and emails, the higher the likelihood of conversion to organic farming.	Mix of developed and developing countries – difficult to draw distinction. Mix of arable and not specified.	Yiridoe, 2010; Knowler and Bradshaw, 2007; Kallas et al., 2009
Age	Mixed findings: Some studies say older farmers more likely to implement soil conservation practices than younger farmers in part because they are more likely to recognise a soil erosion problem (Gould et al., 1989). Conversely, Traore et al. (1998) say that experienced farmers were more likely to rely on traditional practices than less experienced counterparts, lack awareness of environmental problems or perceive environmental degradation as normal (Kallas et al., 2009). Some find that younger	Generally, from arable farms in developed countries. Difficult to determine if age is treated synonymously with experience.	Wauters et al., 2010; Yiridoe et al., 2010; Knowler and Bradshaw, 2007; Kallas et al., 2009

Variable	Comment	Differentiation	Source
	farmers may be slower at identifying a problem, but then are more likely to address the problem once recognized.		
Education and qualifications	Some studies report a positive association between education and adoption of biodiversity measures (Kallas et al., 2009; D'Souza et al., 1993; Rogers, 1995; Kilpatrick, 2000; Serman and Filson, 1999; Rahm and Huffman 1984; Shortle and Miranowski, 1986; Warriner and Moul, 1992).	Mix of developed and developing countries – difficult to draw distinction. Mix of arable and not specified.	Yiridoe, 2010; Knowler and Bradshaw, 2007; Kallas et al., 2009
Family health	Kallas et al. (2009) state that the higher the farmer's concern about family health, the higher the likelihood of conversion to organic farming.	No comment	Kallas et al., 2009
Farmer values			
Farmer goals (e.g. to pass farm onto family member)	No further information provided.	No comment	Pannell et al., 2006; Knowler and Bradshaw, 2007; Hatton MacDonald et al., 2013.
Farmer awareness of soil erosion	Clear relationship: farmers working land that is "inherently more susceptible to erosion problems are thought to have a greater propensity to adopt conservation practices (Smit and Smithers, 1992; Nowak, 1987; Kallas et al., 2009; Gould et al., 1989; Traore et al., 1998)." (Knowler and Bradshaw 2007:35).	Generally, from farms in developed countries. Mix of arable and pastoral not specified.	Boardman et al., 2017; Knowler and Bradshaw, 2007
Farmer attitudes to, and awareness of, conservation issues	More generally, the presence of conservation attitudes among farmers has been assessed in relation to conservation agriculture adoption, and studies have revealed both positive (Warriner and Moul, 1992) and insignificant correlations (Saltiel et al., 1994; Okoye, 1998).	Mix of developed and developing – difficult to draw distinction. Mix of arable and not specified.	Knowler and Bradshaw, 2007; Wauters et al., 2010; Celio et al., 2014
Willingness to learn (literature, attend	No further information provided.	No comment	Knowler and Bradshaw, 2007

Variable	Comment	Differentiation	Source
courses, network events, memberships etc.)			
Cultural and societal variables			
Social status, approval and acceptance, cultural values, shared values	Rogers (1995) reported that farmers with higher social class tend to adopt innovations more readily than their counterparts with lower social status. Local opinion leaders also tend to adopt new measures more readily because such farmers tend to be better educated, have a good understanding of farm resource conservation problems, and manage large farms.		Yiridoe, 2010; Knowler and Bradshaw, 2007; Hatton MacDonald et al., 2013
Social networking	Kinship and 'connectedness to others' have been shown to positively influence the adoption of biodiversity measures (Warriner and Moul, 1992). Similarly, membership in producer organizations is a positive influence (Smit and Smithers, 1992; Kallas et al., 2009). Traore et al. (1998) found that farmer participation in local social organizations and government farm programs was associated with increased availability of timely and accurate information on conservation, and increased access to technical personnel.		Knowler and Bradshaw, 2007; Kollmuss and Agyeman, 2002; Celio et al., 2014; Yiridoe, 2010
External factors			
Information about biodiversity measures (sources, ease of access, type e.g. demos, trials; trust)	Studies of innovation, adoption and diffusion have long recognized information as a key variable, and its availability has been found to correlate with adoption (e.g. Traore et al., 1998; De Herrera and Sain, 1999; Kallas et al., 2009; Nowak, 1987).		Knowler and Bradshaw, 2007
Market prices (for inputs, outputs) and volatility	No further information provided.		Knowler and Bradshaw, 2007
Interest rates	No further information provided.		Knowler and Bradshaw, 2007

Appendix 3 Farm descriptions

Farm 1



Farm 1 is a small, owner-occupied, 26 ha, upland sheep farm with access to commons grazing. At the farm, the sheep are grazed (set-stocking) mostly on the mountains in the summer and are brought down for the winter. As the farm set-stock grazes it's sheep, in this sense, it is less regenerative (blue arrow). However, the farmer in recent years has re-seeded pastures with diverse swards (red grass, chicory, red fescue, timothy, different clovers, yarrow) and applies very little chemical inputs (orange arrow). The sheep are housed for a month over lambing and the farm generates compost from the muck which is spread on the fields. Lime is applied every few years to keep acidity levels reasonable. The farmer aspires to try rotational, holistic grazing with sheep at the farm (yellow arrow).

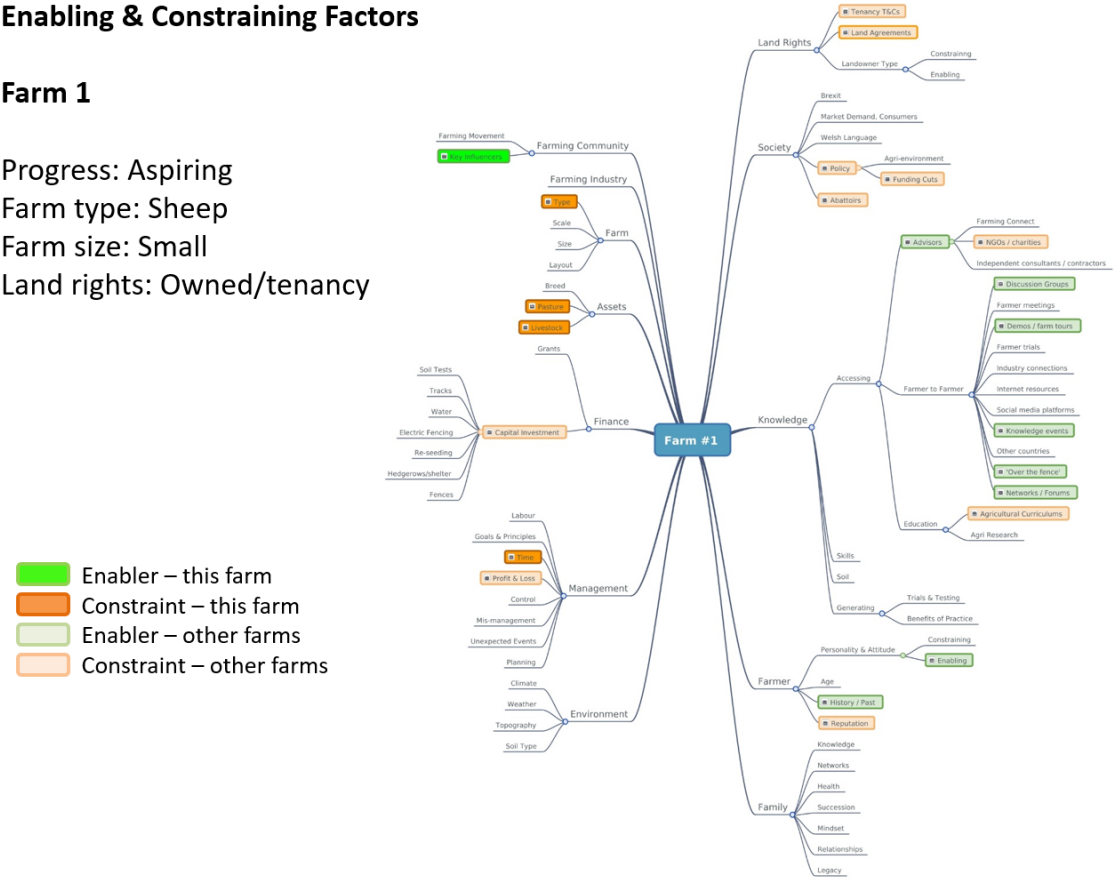
Farm 1 finds itself in a more constraining environment (shown by a greater number of red and orange boxes in Figure 28) indicating that it is finding it far more difficult than, for example Farm 4, to change grazing practices. The farm has faced a number of knock backs in recent decades, reducing from 525 sheep to 300 sheep when the headage payment was removed; and have had to stop using their grazing rights on local commons due to management issues and health risks to their stock. The farmer also supports a part-time job.

The farmer has strong environmental values and wants to do holistic/adaptive grazing (very regenerative) but is primarily held back by a lack of time (as needs to do the other job) and available funds to invest in electric fencing. They feel they have their head down all the time, with no time to learn about new practices, and no room to fail. The farmer thinks that more regenerative grazing practices have the potential to be complementary with the conservation objectives of designated sites and that NGOs should be exploring this.

Enabling & Constraining Factors

Farm 1

Progress: Aspiring
Farm type: Sheep
Farm size: Small
Land rights: Owned/tenancy

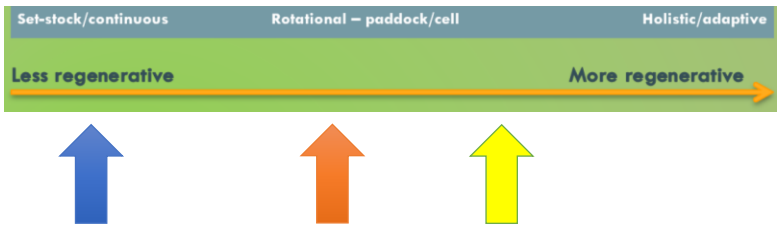


Enabler – this farm
Constraint – this farm
Enabler – other farms
Constraint – other farms

Figure 28 – Enabling and constraining factors described by Farm 1

Farm 2

Regenerative Scale



Farm 2 is a large, owner-occupied, 566 ha, sheep/cattle upland hill farm with a further rented 40 ha. It is currently experimenting in rotational grazing on part of the farm, aiming to move the livestock every 3 days (orange arrow) and resting the pasture for around 21 days, depending on how well it has recovered. The farm still applies some chemical inputs but has started soil testing. Although the rotations are still fairly non-responsive to grass growth (i.e. on a more calendar basis), the farmer showed signs of learning about soil health, and adapting practices to soil and pasture health on a more responsive basis. The farmer is also doing a

programme of reseeding pastures to introduce more diverse, flood and drought tolerant grasses; from a legacy of monoculture ryegrass pastures. Historically, the livestock was continuously, set-stocked, grazed at the farm by the farmer's parents and grandparents, without any rest periods (blue arrow). In the 1960s, the farmer's grandfather was dairy farming using rotational grazing but on a uniform perennial ryegrass, rather than a variety of different species. They changed from rotational to continuous grazing in the 1980s, when the farm changed to become a hill farm. A longer term aspiration is to introduce rotational grazing to the hill block, using electric fencing across certain parts of it (yellow arrow). In the meantime, the farmer is focusing on doing the rotational grazing on the grassland properly.

Farm 2 finds itself part-way on the journey to more regenerative grazing practices, having already changed from set-stock to rotational grazing systems on part of the farm. They are now motivated to do even more regenerative grazing (mob) on a part of the farm to improve the condition of their lambs. Due to Brexit, Farm 2 has cut down its ewe numbers by 50%, keeping 50 suckler cows and bringing in contract rearing dairy heifers.

The farm is compelled to do more regenerative grazing, having experienced a big reduction in costs, improved sheep health, and drought resilience since introducing rotational grazing. Their main constraints are grazing restrictions on upland area by Glastir land agreements, which is limiting experimentation. They feel constrained by other land agreements also, and so the farmer is going to proactively approach RSPB advisors to explore possibility of regenerative grazing alongside bird habitats; which the farmer feels is compatible. The farm is also constrained by a lack of funds to invest in electric fencing and a water system. Interestingly, the farmer has made the link between regenerative grazing and introducing NFM measures on the farm, feeling that the two will support each other e.g. swales and ponds to reduce sediment loss and run-off, important in flood prone catchment; that will also provide a water resource for adaptive grazing.

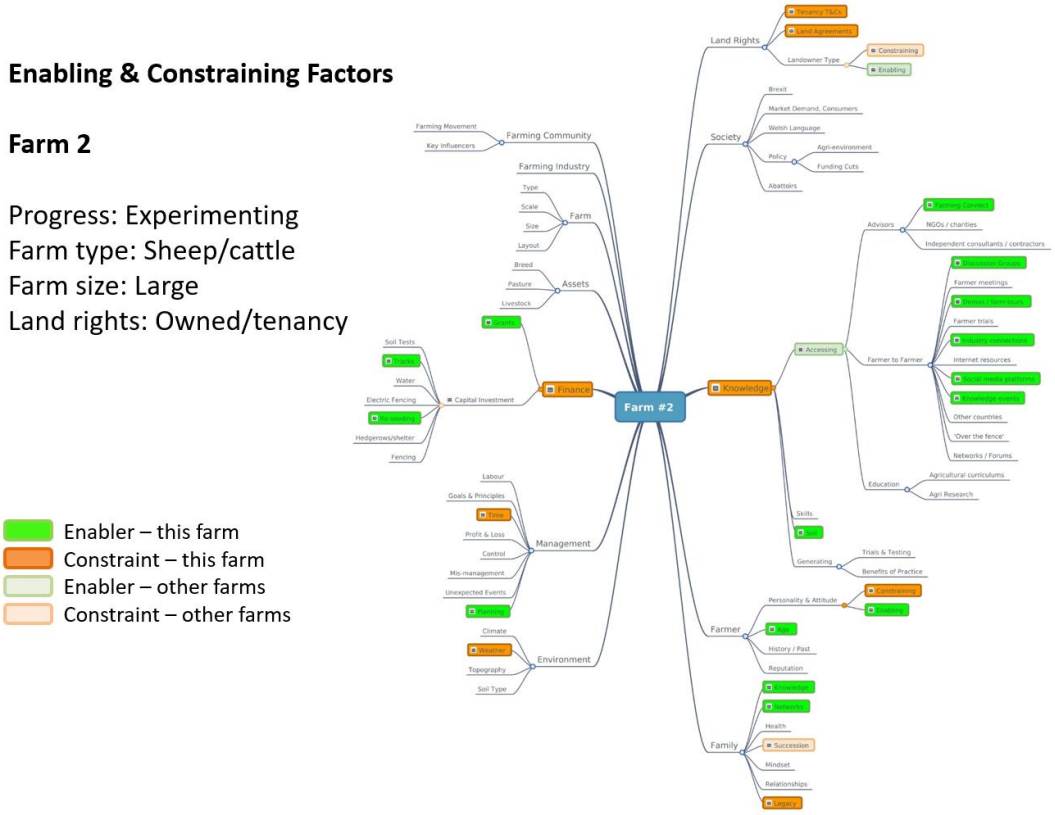
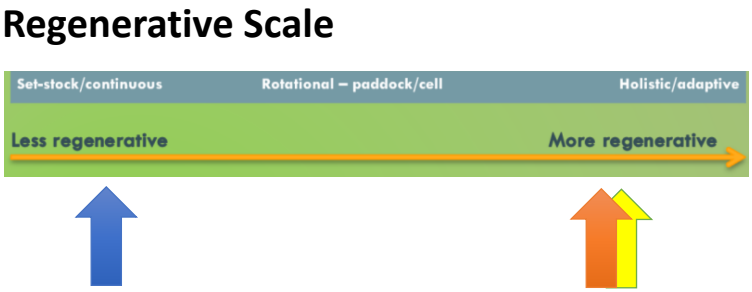


Figure 29 – Enabling and constraining factors described by Farm 2

Farm 3



Farm 3 is an owner-occupied 161 ha lowland, dairy farm which rents a further 242 ha (403 ha total). It 'mob' grazes 750 cattle, moving them twice a day to new pasture, in a highly rotational 'New Zealand' style system with no chemical input (orange arrow). This has been practiced since 2005, although with organic status up until 2013. The farm depends on fertiliser produced as a by-product from its anaerobic digestor which utilises slurry and chicken waste (the chickens are fed on inorganic soya grain hence the farm could not maintain its organic accreditation when this was introduced to the farm system in 2013). Prior to 2005 (since 1998), the farm practiced a continuous, yet extensive, organic grazing system. Before

that (prior to 1998), the farm was an intensive, dairy farm using significant amounts of chemical inputs in a continuous, set-stocking, grazing system (blue arrow). The farm has no further aspirations to change (yellow arrow). There is potential to introduce more diverse swards, hence the farm is not judged fully regenerative here.

Farm 3 (dairy, large size, part owned/ part tenancy) is well established in mob grazing (very regenerative) on over 1000 acres (40% own land). Its income comes from dairy (750 cows), a broiler chicken unit and an anaerobic digestor. It is located in England but in a Welsh river catchment. Looking at the diagram, the farm clearly found itself in an 'enabling' environment at the time it transitioned from conventional to more regenerative forms of grazing. It experienced few constraints, and change was principally driven by enabling factors.

Family succession was the trigger for change. With two sons both wanting to farm, regenerative grazing provided a way to do this; with a focus on significantly cutting costs and farm inputs, prioritising grass growth and responsive/adaptive grazing, and sourcing mostly on-farm nutrients, thus increasing profitability. The family made several trips to New Zealand to learn the practice.

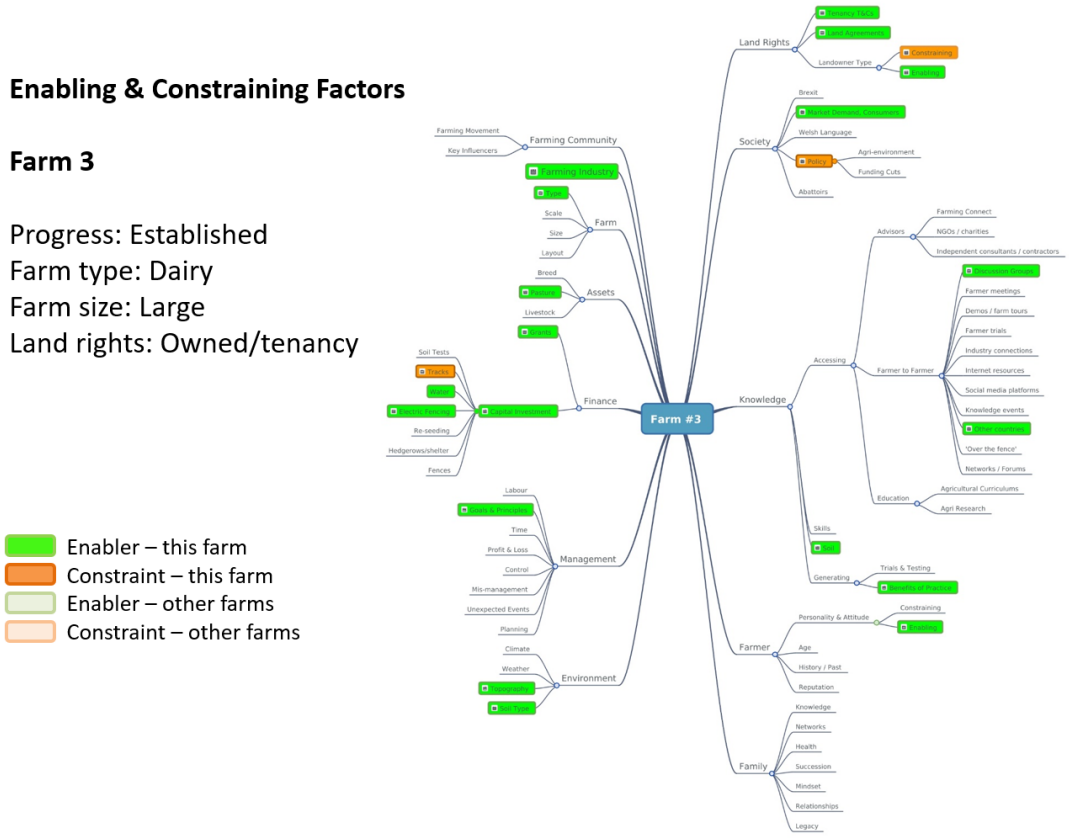
The family already held environmentally conscious values, and had the attitude to 'think outside of the box'. The farm is located on very flat ground with free draining sandy soil which, the farmer feels, made things easier. The dairy industry and dairy cooperatives were supportive.

In terms of enabling factors, the farm had the initial up front capital to invest in electric fencing and a water system. Being a large farm, it needed to build tracks to move large numbers of cattle between paddocks. This would have been expensive had it not been for the on-farm quarry. In addition to its own 400 acres, the farm has been able to expand and retract pasture areas as required, through a number of flexible, informal tenancy contracts on a further 6-700 acres

Enabling & Constraining Factors

Farm 3

Progress: Established
Farm type: Dairy
Farm size: Large
Land rights: Owned/tenancy

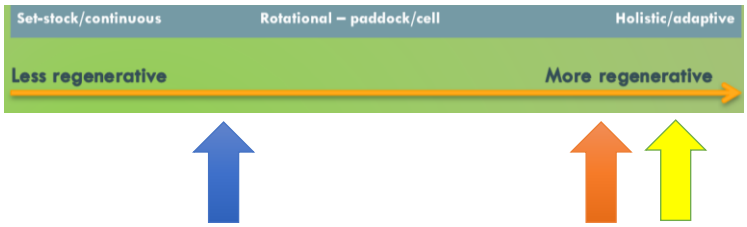


Enabler – this farm
Constraint – this farm
Enabler – other farms
Constraint – other farms

Figure 30 – Enabling and constraining factors described by Farm 3

Farm 4

Regenerative Scale



Farm 4 is a small, owner-occupied, lowland, 81 ha, sheep farm. It started 'mob' grazing sheep in May 2018, moving them twice daily to fresh pasture with a 15-60 day rest period depending on the time of year (orange arrow). No chemical inputs are applied. The farmer is waiting for the natural, diverse, pasture swards to recover. Historically, the farm had used a less frequent, also low input, rotational grazing system; in the farmer's own words which was 'nearer to set-stocking' (blue arrow). The farmer is still experimenting and is very keen to make the 'mob' grazing system work. The farmer has broader aspirations to integrate the grazing with the

farm's woodland, and to introduce more species of livestock into the grazing rotation (yellow arrow).

Farm 4 is solely experimenting in holistic and adaptive grazing (very regenerative) of 60 sheep on 40 acres. It is a small, owner-occupied, farm. The farmer has recently come back to farming from a military career. They derive income from direct box sales of lamb, and timber from forestry. The farmer again finds themselves in a very enabling environment and feels that very little is holding them back. The main enabling factors have been learning from other farmers from other parts of the world on social media; and freedom to experiment on the farm (few financial commitments). A main constraint has been trying to make sense of lots of disparate, loose information on social media; and through trial and error, trying to understand how it applies to his own context. Other constraining factors include getting access to water in each paddock, and flexibility in NGO land agreements on farm. The farmer is currently proactively addressing these issues. The farm receives no subsidies.

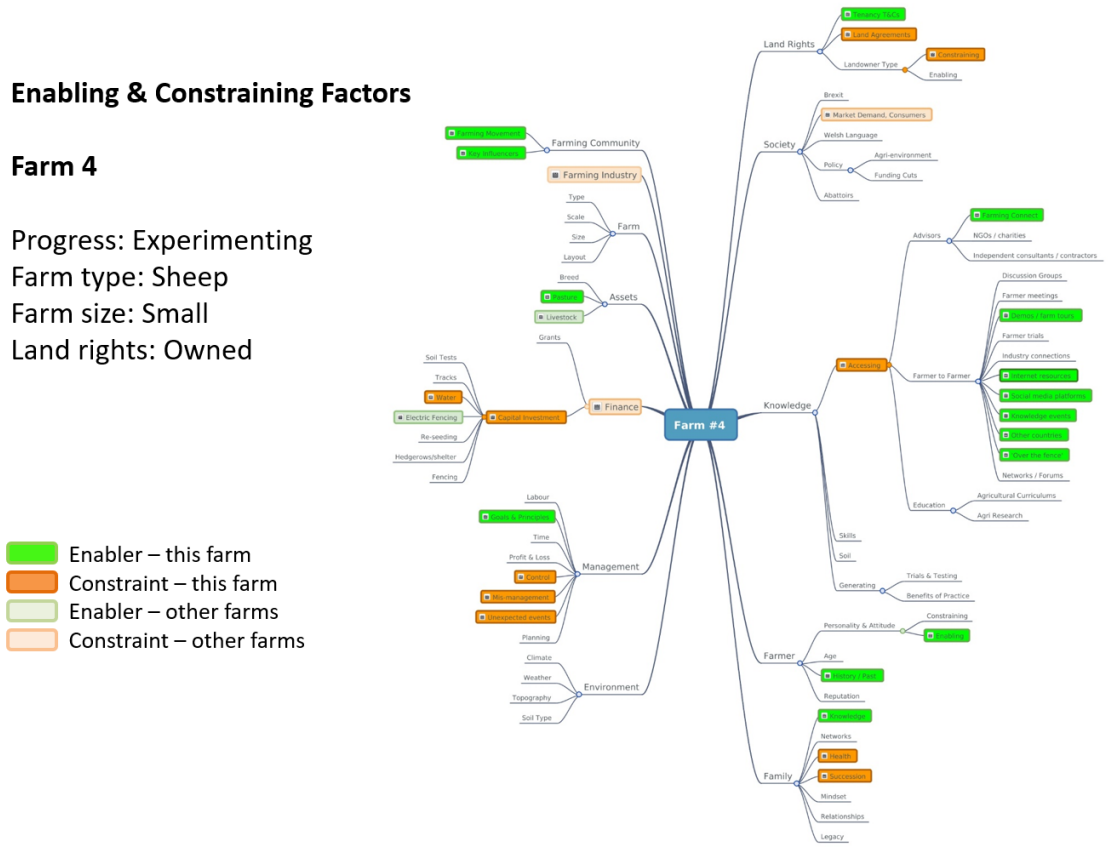
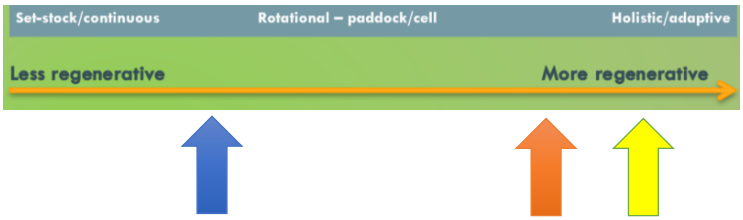


Figure 31 – Enabling and constraining factors described by Farm 4

Farm 5

Regenerative Scale



Farm 5 is a small, owner-occupied, 26 ha, lowland beef farm with access to a further 26 ha under conservation land agreements. The farmer started 'holistic planned grazing' at the farm in 2018, moving the cattle roughly every few days, depending on grass growth (orange arrow). Prior to this, the cattle were continuous 'set-stock' grazed at the farm (blue arrow). Under both grazing systems, no chemical inputs are applied to the pasture, and the cattle are kept outside all year except for calving. The farmer aspires to introduce more of a 'cell based' grazing system, and plans to install a water system in due course to enable this (yellow arrow). Sward diversity has the potential to improve, whether natural emergence or via re-seeding hence the farm is not considered fully regenerative as yet.

Farm 5 has found itself in mainly enabling conditions and is currently experimenting in holistic grazing a 32 head beef herd on 130 acres (of which, 65 acres they own; the remainder managed for conservation purposes). The farmer also supports a full-time job, working with parents to run the farm. They derive their income from selling a premium product direct to market. Their main constraint has been gathering enough confidence to make the change, and in winning over hearts and minds in the family. The change was enabled greatly by attending talks, courses and networking with peers. The farm has made considerable savings in the first year of the new grazing regime alone.

Enabling & Constraining Factors

Farm 5

Progress: Experimenting
Farm type: Beef
Farm size: Small
Land rights: Owned

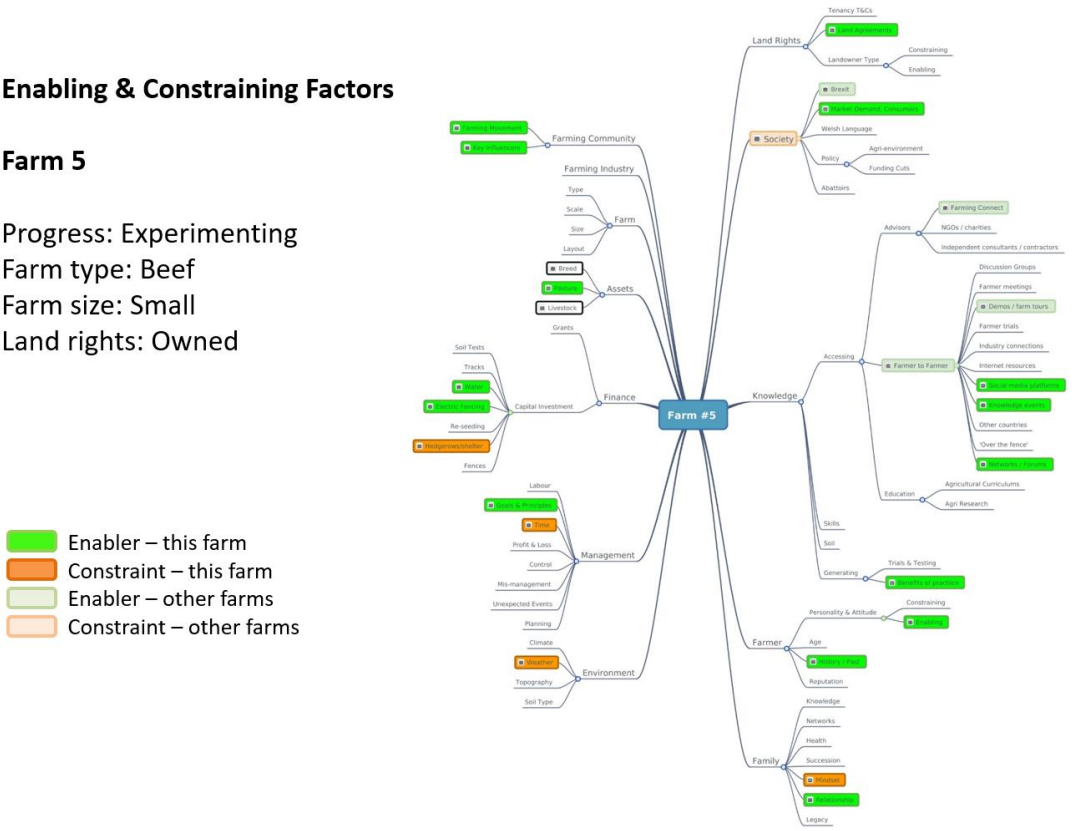
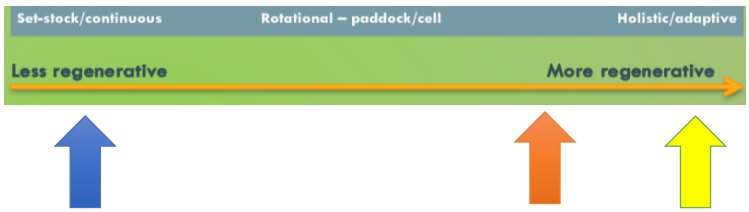


Figure 32 – Enabling and constraining factors described by Farm 5

Farm 6

Regenerative Scale



Farm 6 is a large, owner-occupied, 1214 ha, mixed farm. The farm is currently in a state of transition and is gradually introducing new regenerative practices in different aspects of the farm. This has been taking shape since the farmer took over the farm in 2018, although they have been pushing for change since 2014. The farm is in the process of re-integrating cattle grazing into the arable rotation. Gradually, rotational grazing systems are being introduced whereby the farmer is trying to lengthen the pasture recovery period, shorten the grazing period, and tighten up the grazing of the cattle (orange arrow). Prior to this, in the last few decades, the farm was a conventional, chemically intensive mixed farm (blue arrow). The livestock were continuously grazed separate to the arable crops. However, before this, 30 years ago, the cattle were grazed as part of the cattle rotation. The farmer is seeking to re-

introduce this practice; and to gradually reduce the farm's dependence on chemical inputs over the time, with the goal of introducing more diverse swards, and becoming nutrient self-sufficient and organic in due course (yellow arrow).

The farmer finds themselves in a mostly constraining environment (Figure 33), in particular with regard to challenging employee mindsets, the upfront investment costs required, encouraging new skills and knowledge among the farm team. The farmer is affecting change by providing training for staff, but is finding this harder than expected (in terms of changing mindsets, and finding them more entrenched than expected). The farmer is also actively playing a part in farming networks and regenerative farming advocacy.

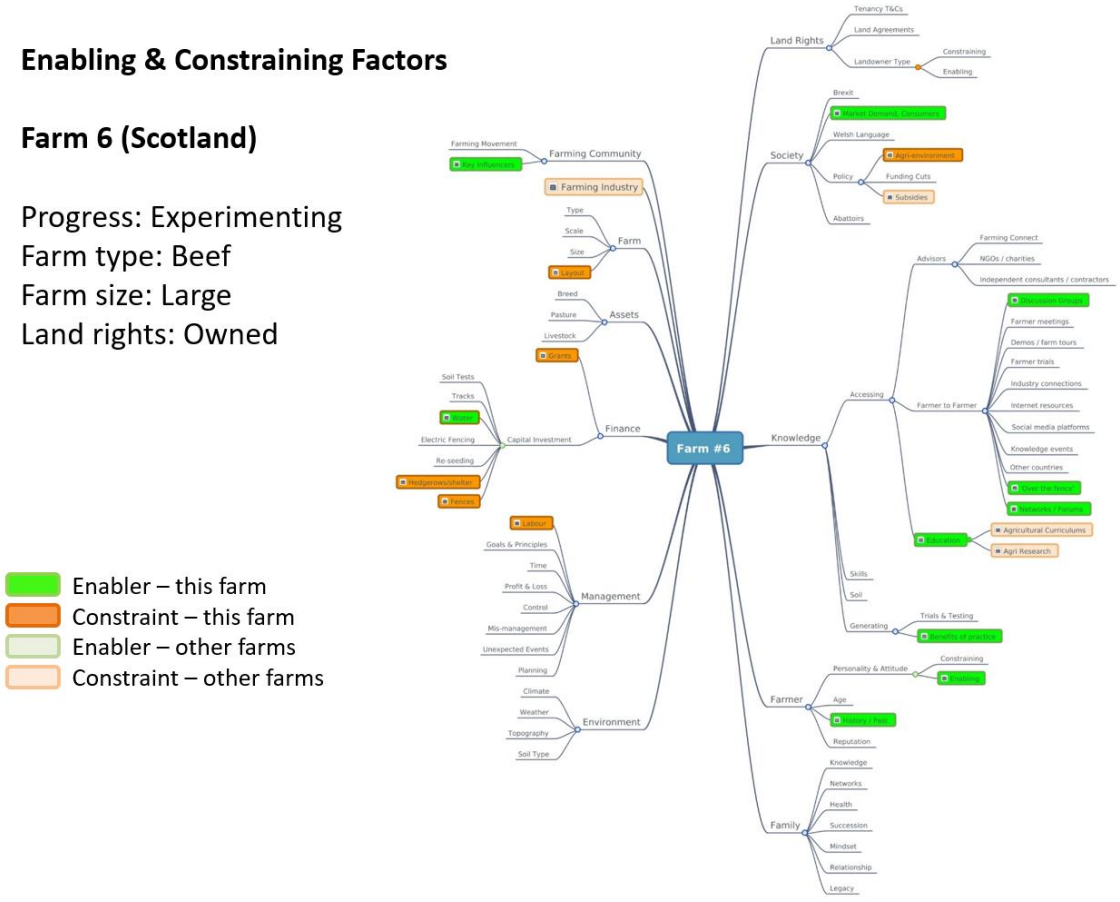
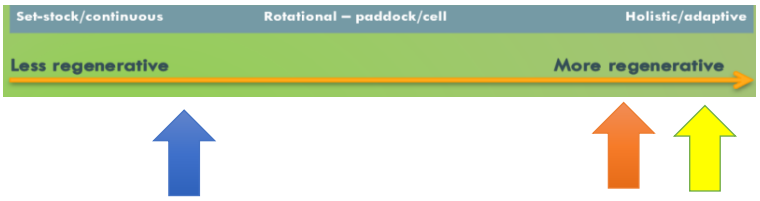


Figure 33 – Enabling and constraining factors described by Farm 6

Farm 7

Regenerative Scale



Farm 7 is a small, owner-occupied, 16 ha, beef farm renting a further 24 ha. The farmer started rotationally grazing heritage breed cattle a few years, moving the cattle once a day (orange arrow). No chemical inputs are applied and the cattle are kept outside all year. The farm was previously let to a tenant farmer who continuously grazed fields but with little chemical inputs (blue arrow). The farmer has further aspirations to introduce a more diverse sward, and to implement further measures such as water management systems and agro-forestry (yellow arrow).

The farmer finds themselves mostly in an enabling environment (Figure 34); they have full financial and management control of the farm, with sufficient capital investment available to make changes on the farm. There are no land agreements not land rights issues to contend with. The main constraint initially around farmer reputation, being different from neighbouring conventional farmers. But over time, this became a positive and now neighbouring landowners are asking the farmer to take on their land, as they can see the positive effects regenerative farming is having on the land.

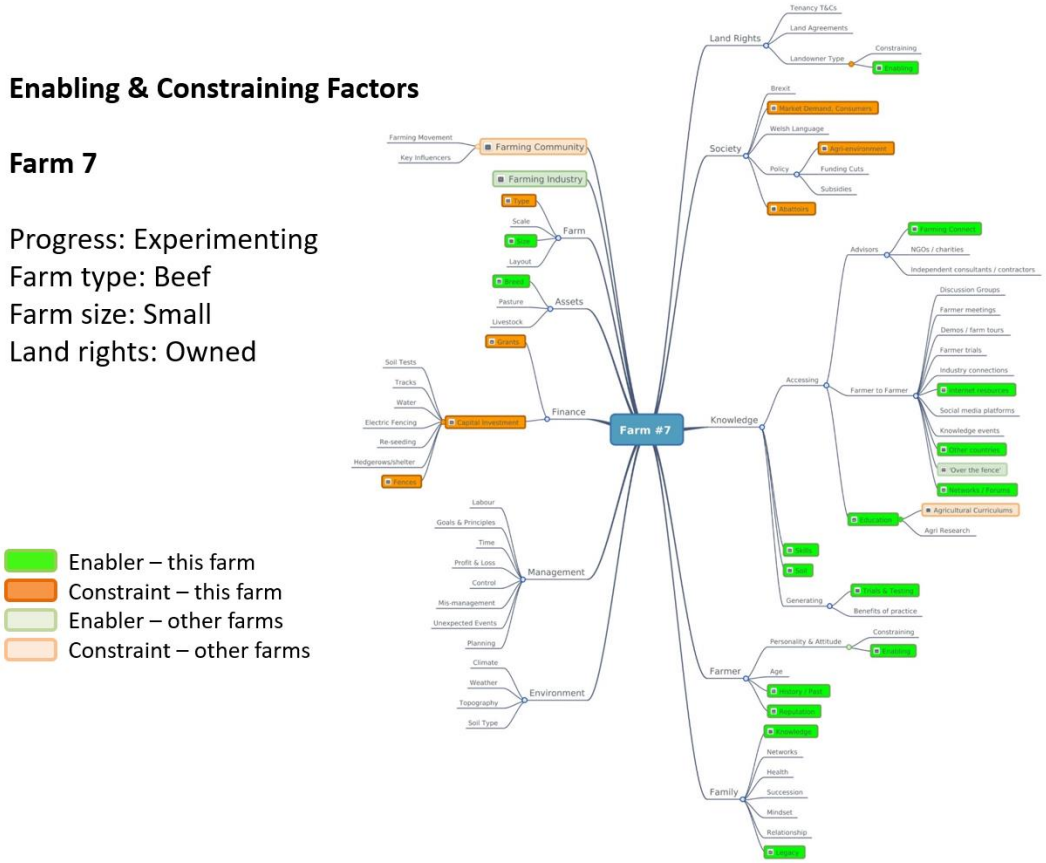
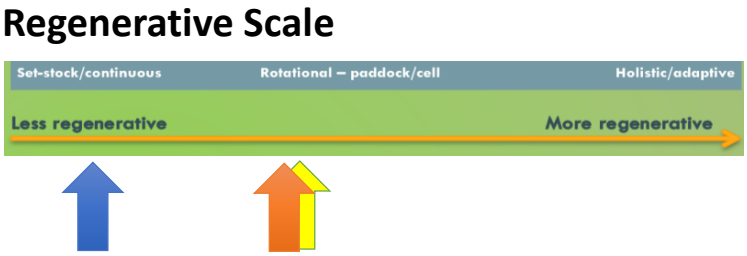


Figure 34 – Enabling and constraining factors described by Farm 17

Farm 8



Farm 8 is tenanted, 404 ha, lowland, dairy farm comprised of three partnerships in 'shared equity' dairy units. The farm established a 'New Zealand' style rotational dairy grazing system in 2010, which depends on considerable chemical inputs (orange arrow). The cows are grazed on a low-diversity sward, principally ryegrass. Prior to that, the farm intensively 'set stocked' grazed sheep and suckler cattle (blue arrow). Lambs were intensively finished indoors. The farmer has no further aspirations to change grazing management (yellow arrow).

Although this farmer feels they are mostly in an enabling environment (Figure 35); this is perhaps a reflection of the farmer's limited aspiration to become more regenerative, lacking interest in regenerative farming. They were the most 'conventional' thinker of all those interviewed for the research. They have experimented with rotational grazing solely as a way to increase grass yield and utilisation for their dairy system. They share financial and management control of the farm in the shared equity structure, meaning they are more or less free to do as they wish with their partner's agreement. Considerable investment was going into the farm, with the building of new cattle shed and dairy parlours. The main constraint for this farmer, with regard to moving more along the regenerative spectrum, was a lack of motivation, knowledge and interest in becoming more regenerative.

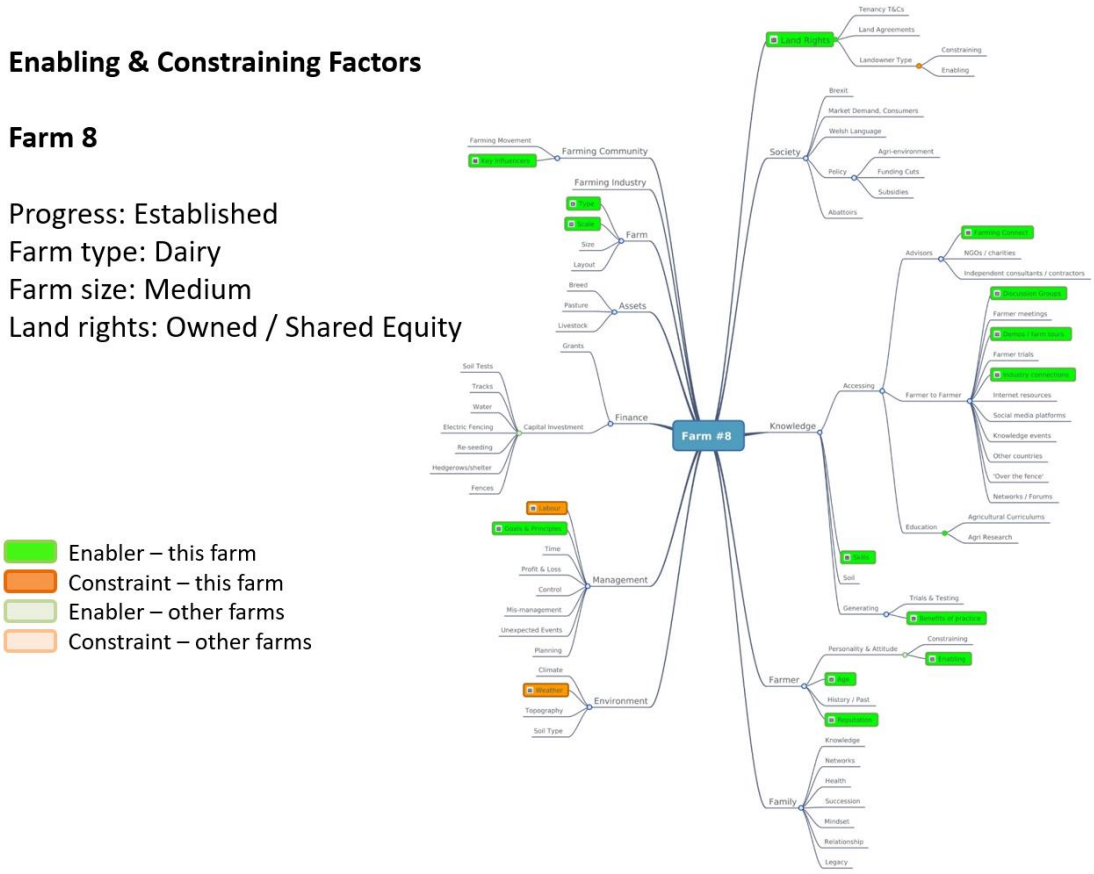
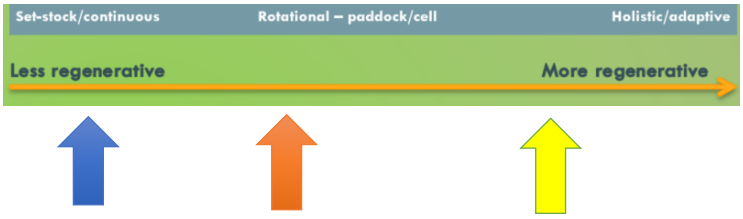


Figure 35 – Enabling and constraining factors described by Farm 8

Farm 9

Regenerative Scale

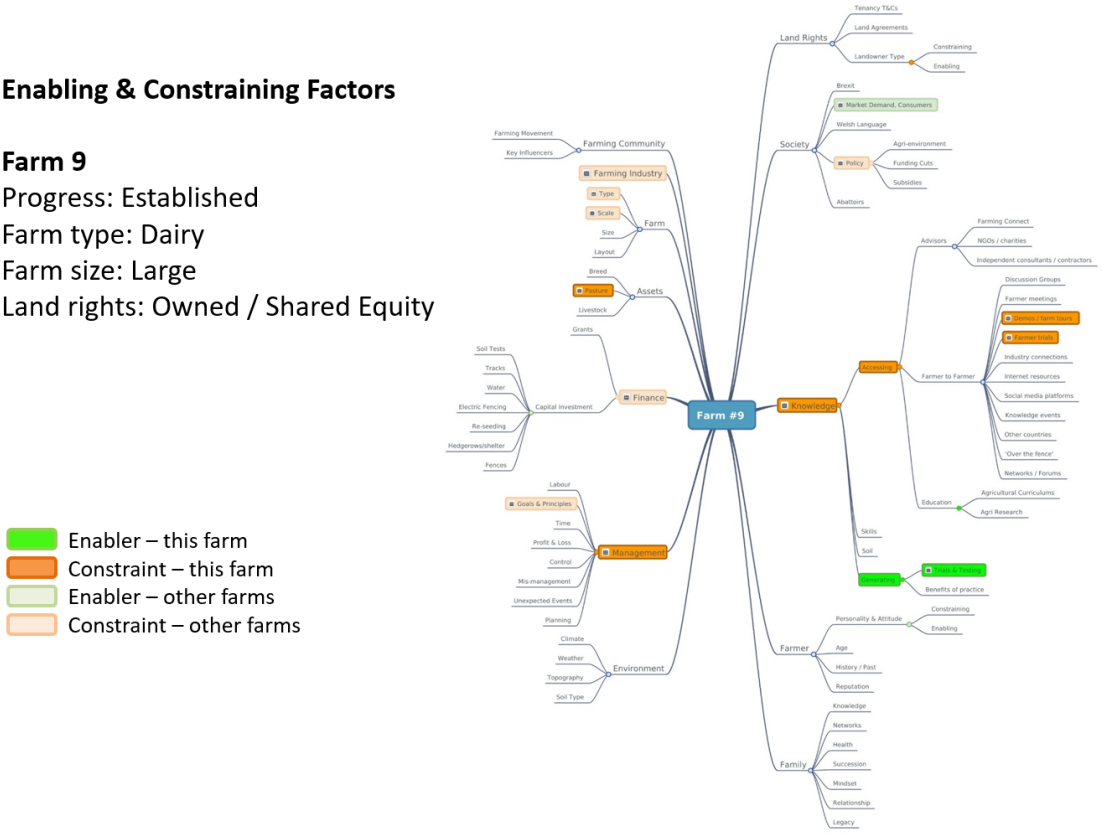


Farm 9 is a large, owner-occupied, 2000 ha, lowland dairy farm comprised of various 'shared equity' dairy units. The farmer is a significant landowner, with a further 6500 ha under various tenancies. The farm moved to a New Zealand style rotational grazing system in 2001, resting the grass from 21 days in the summer to 100 days over winter, when the cows are indoors (orange arrow). Prior to this, the farm used a set stocked grazing system (blue arrow). Significant chemical inputs are applied. There is potential to improve pasture diversity and the farmer currently has some trials underway (yellow arrow).

The farmer finds themselves mostly in a constraining environment (Figure 36); despite having significant investment capital to make changes on the farm, they lacked the evidence to inform the change to more regenerative practices on the farm. The farmer sought clear business confidence to take the risk and seemed frustrated by the lack of available knowledge and insights from conventional farming advisory services, especially studies in dairy systems in Wales. As such, the farmer was starting their own trials on their own land to answer the question: can I reduce synthetic inputs on the land and maintain grass yield? At the time of interview, they were willing to consider a reduction in grass yield, if there was a saving in synthetic inputs. Further contact with the farmer in 2022 confirmed that the farmer had indeed managed to do these: achieving a grass yield of 12t per ha (dried weight) with less than 100kg nitrates per ha (15t per ha was needing closer to 300kg nitrates per ha), and on another plot they managed to get 11t grass yield per ha with no nitrate input. The farmer quoted in 2022: "We can now see a path forward toward achieving our goals which is exciting. We can only go so far with ryegrass dominance, but herbal leys are not durable enough, we need things like cocksfoot and tall fescue in the mix, and to focus on per hectare and not per cow production".

Enabling & Constraining Factors

Farm 9
Progress: Established
Farm type: Dairy
Farm size: Large
Land rights: Owned / Shared Equity



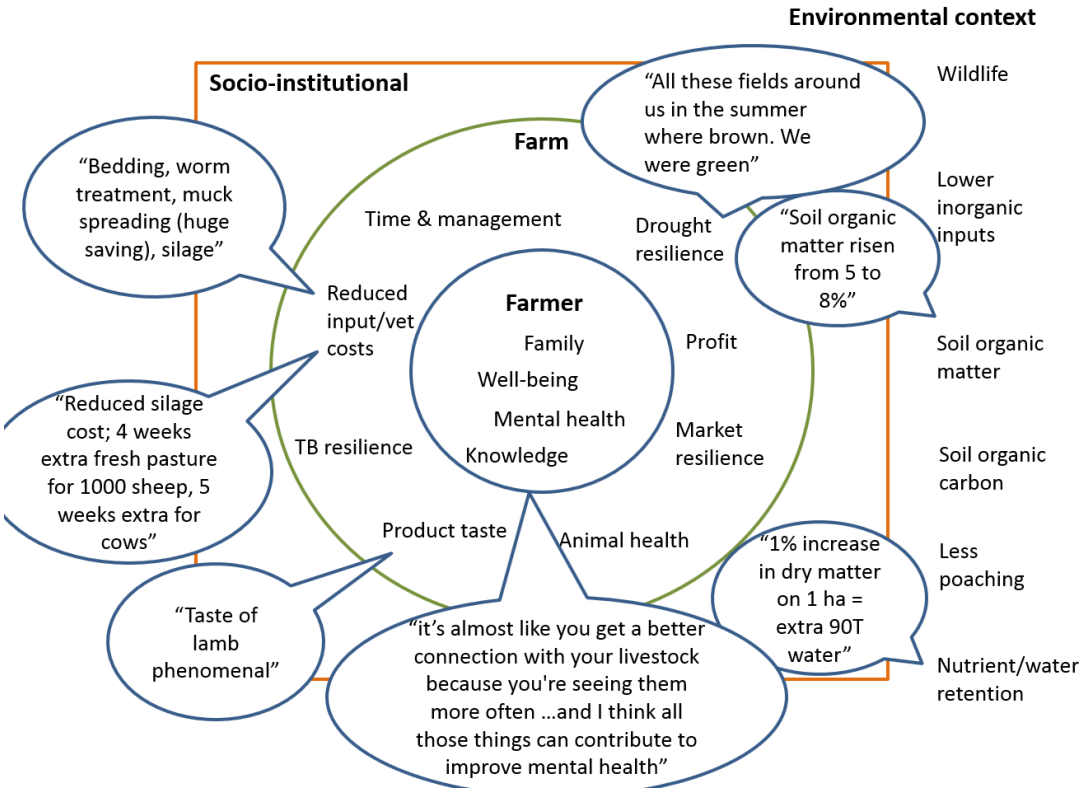
Enabler – this farm
Constraint – this farm
Enabler – other farms
Constraint – other farms

Figure 36 – Enabling and constraining factors described by Farm 9

Appendix 4 Farmer observations of regenerative farming

The farmers described numerous benefits of the regenerative grazing practices they were using (whether established or experimenting in). These are captured in Figure A3.1, together with selected quotes and described in more detail below. Care has been taken to describe only actual, experienced benefits here (rather than anticipated benefits). These findings mirror and extend the evidence of farmer observations in Wagner et al. (2023) who conducted similar interviews with fifteen 'mob grazing' farmers in the UK.

Figure A3.1 – Benefits of regenerative grazing as experienced by farmers



Benefits to the farmer

The farmers talked about benefits in terms of **improved well-being, family relationships** and **gaining knowledge**. Specifically, Farmer 4 talked about how forward and pro-active planning, means that other personal and family goals can be achieved; meaning less stress and greater well-being for himself and family members. Farmer 5 talked about having a better connection with animals, having more time, and linked this to **mental health** improvements. Farmer 2 spoke about "becoming a grassland geek" and the joy of passing knowledge onto children (as they are out most days helping to move the livestock). Several of the farmers spoke about the importance to them, of being involved in every step of the production process, right through to product delivery. Suggesting that the product provenance was of real importance to them;

and that somehow, closer engagement with the livestock through more regenerative grazing practices, contributed to their feelings of being part of this.

Benefits to the farm

It was in this context, that farmers highlighted most benefits – to the farm business. They spoke about the **quality of product**; Farmer 4 talked about how the taste of the lamb has improved "phenomenally", resulting in increasing demand for box sales. A few of the farmers spoke about even though you're out moving the livestock more often, it actually frees up **more time over all** (for example, as you're not "messing about with machinery" or housing, or animal health problems so much as before). The use of "simple, adjustable practices that permit other goals to be achieved" is allowing the farmers to plan ahead (reportedly, much more than other farmers); which allows more time to plan more diversification on the farm.

All of the farmers spoke about the improvements to **animal health**, gained from a) closer, more regular, monitoring of the animals on a daily basis, much more closely than before, allowing the farmer to act sooner: "I know my ground much better, I know my animals much better". Farmer 4 made the distinction between actual health and superficial health of the animals: "stock ewes are wormed up to the kazoos, grey unhealthy looking dung", making the point that when stock ewes are first brought to the farm, they look healthy but their dung tells a different story. Three other farmers felt that their cattle were in better condition as a result of the new grazing system. One specifically said that because the cattle are not being worked so hard as they previously were in the conventional, high input, system; profit per head of cattle has increased despite milk yield decreasing per head. One felt that the farm was now **more resilient to Tuberculosis (TB)** (as, for example, no longer any piles of feed to attract badgers).

One particularly interesting insight, was that three of the farms felt that they were now **more drought resilient** since introducing more regenerative grazing practices. Two farmers noted that in the drought of 2018, surrounding farm fields burnt off in the heat, whilst their fields stayed green. One farmer noted "we're able to stand drought much better. I think a lot of that is to do with the dry matter, the organic matter in the soil has increased, so it's holding more water. I remember back in 1976 and in that drought, the farm just went brown. We were using high levels of nitrogen at the time and of the course the grass roots were close to surface of the soil. Now the grass roots are down feet".

The farmers also reported **lower costs** and thus **higher profit per head** of livestock (although one farm did note the trade off against lower yield). Farmer 5 reported an extra two months of

fresh pasture and therefore no silage costs last year. Farmer 2 reported reduced silage costs (due to an extra month's grazing for 1000 sheep and five weeks' extra grazing for 50 cows). Farmer 5 reported reduced costs in terms of reduced bedding, worm treatment, muck spreading ("that's a massive saving") and silage. More profit made one farmer feel "more **economically resilient**" to market price volatility. Farmer 2 reported a financial benefit, "basically savings of £10/12 per head by feeding off grass alone". Farmer 3 is part of a local grazing group and knows that their farm has much lower costs and produces much more dry matter per hectare compared to non-organic conventional farmers in the group. The same farmer reported lower costs from less reseeding the pasture due to **less poaching** from cattle hooves (because of infrastructure associated with the regenerative grazing system - new tracks and water system) and also because the cattle are rotated more, they are on the same ground less often. He said that some leys had been down 20yrs and are still producing good quality dry matter ("big change") despite using no inorganic inputs now. The increase in livestock health, and closer day-to-day engagement with the livestock was felt to be resulting in a "dramatic reduction in veterinary costs".

With regard to managing the farm, the farmers spoke about seeking flexibility, or resilience, in the farm system to deal with unexpected consequences: "so if I need a reserve for drought or whatever". Encouraging diversity on the farm was one considered way of achieving this: "stacking of enterprises". In terms of resilience, the farmers made reference to:

- Changing weather (drought affecting grass growth and feed crops, flooding from heavier intense rainfall, increasing fluke burden). Many farmers made 20-50% less silage last year (2018) than usual due to drought
- Milk price volatility
- TB risk to cattle
- Brexit uncertainty
- Legacy of poor farm management.

Benefits to the farm environment

The farmers spoke about various benefits to grass and soil. Farmer 4 was using regenerative grazing as a tool to suppress weeds and to create more grazing area (nettle areas have changed into grass), and also as a tool to **create new topsoil** on rock patches. Farmer 3 had noticed far less poaching of soil; specifically stating that **organic matter has risen from 5-6% to now 8-9%,** and that a 1% increase in dry matter on a hectare of land will **hold an extra 90 tons of water**: "we've got the equivalent of an Eden Valley Reservoir here in North Herefordshire". Other farmers noted that "our organic matters are definitely rising", and "**holding the nutrients in the soil much better"** Two farmers felt the regenerative grazing had resulted in

improved environment for birds (swallows, swifts, curlews), due to there being more worms and bugs in the soil for them "the worms are there in such abundance". Only one farmer made a connection to water quality, stating that it had not got any worse when they would have expected it to (due to heavier use of slurry as fertilizer in the new system). This highlights the potential for hidden benefits to the environment, which are less easily observed.

No benefits to the socio-institutional context were raised.

Appendix 5. Legislative and policy context in Wales

Introduction

This research is backlit by a strong legislative and policy context in Wales which requires the prioritisation of the sustainable management of resources, and the benefits this provides to the well-being of society. Resonating through the legislation and supporting policies, is a clear 'systems thinking' steer. Whilst perhaps not overtly 'systems thinking', a more systemic approach is clearly encouraged. This is framed by seven 'well-being goals' (Figure A5-1) which stretch across, and bring together, the social, environmental and economic domains. The legislative and policy context goes on to encourage:

- an emphasis on pro-active intervention
- attention on connectivity and relationships rather than the components themselves
- and a focus on creating adaptive, responsive systems to stressors and shocks.

This is explained more below.

Legislative context in Wales

Revised and refreshed in the last ten years, the legislative context in Wales is framed **by three key acts** as summarised in Box 1. These three acts are designed to work together, with references between them, with the aim of providing a more efficient means to regulate, enforce and encourage the sustainable management of natural resources in Wales.

Box 1: Legislation in Wales

Well-being of Future Generations Act (2015)

This provides a legally binding common purpose (the seven Well-being goals), placing a duty on Local Health Boards, Public Bodies, and both National and Local Government, to improve the social, economic, environmental and cultural well-being of Wales; safeguarding natural resources for future generations.

Environment (Wales) Act (2016)

This introduces an integrated approach, to overcome the systemic difficulties previously faced by environmental policy making. The Act provides a framework to ensure that managing resources sustainably is of principal importance throughout the legislative process, hoping to be more effective at making actionable change to increase ecosystem resilience.

Planning (Wales) Act (2015)

This was enacted to strengthen the plan-led approach by introducing a new legal framework for ministers to prepare a national land-use plan, known as the National Development Framework. The framework sets out the national land use priorities and infrastructure requirements for Wales to be aided by the Planning Acts provision of more streamline procedures which consider larger-than-local, cross-boundary issues.

The Well-being of Future Generations Act (2015) sets out **seven Well-being Goals** which all decision-making in Wales should work towards delivering. These focus on inclusivity, prosperity and resilience across social, environmental and economic domains.

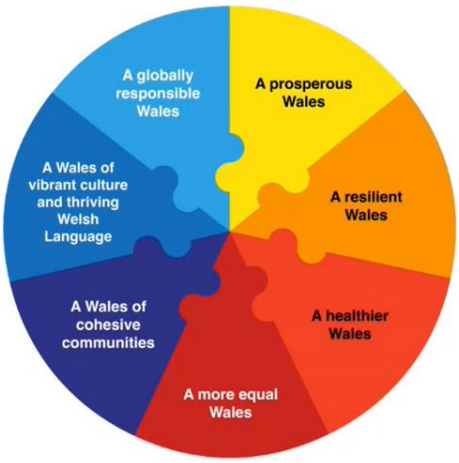


Figure A5-1: Wales' seven Well-being Goals as set out in the Well-being of Future Generations Act (2015)

To support the delivery of these goals, Natural Resources Wales has defined **nine Sustainable Management of Natural Resources (SMNR) principles** (Figure A5-2). These chime strongly with 'systems thinking' especially, for example, with regard to adaptation, appropriate scale, devolvement of decision-making, and resilience.

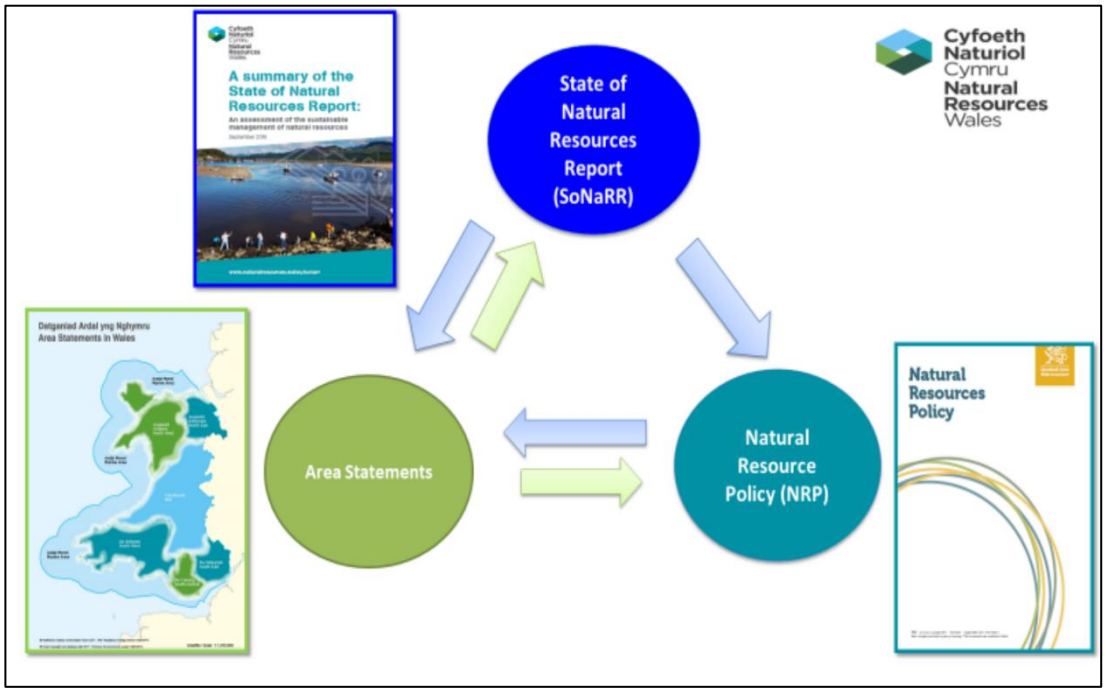
Figure A5-2: Wales' Sustainable Management of Natural Resources (SMNR) principles which promote a 'systems thinking' approach

Principle	Role of Environmental Screening and Assessment
Manage adaptively	Monitoring and audit of projects and their environmental effects feedback in to future projects. (i.e. Continual improvement)
Appropriate spatial scale	The options appraisal or consideration of alternatives determines the study area. Economic, technical and environmental aspects feed into this to ensure that the options/alternatives and their effects are considered at the appropriate scale.
Collaboration and engagement	Internal and external stakeholder engagement starts early and continues throughout project development. Opportunities to pursue multi-disciplinary approaches should be sought.
Public participation in decision making	Public engagement through drop in sessions at key stages in the project or engagement with community or user groups. Consenting route publicises project proposal for most projects.
Relevant evidence	Considers broad environmental baseline and trends with and without project implementation.
Take account of benefits and intrinsic value of natural resources and ecosystems	Identify ecosystem services and intrinsic values provided by the ecosystems and natural resources in the study area. Environmental screening and assessment should help us understand and maximise delivery of wider benefits.
Short, medium and long term consequences	Consider environmental effects throughout the life of the project both directly and indirectly. Planning, construction, operation & decommissioning. Taking into account the evolution of the environmental baseline e.g. climate change.
Prevent significant damage to ecosystems	The environmental screening and assessment should help us avoid, minimise and/or mitigate any negative effects. Where significant damage is unavoidable, proportionate compensatory measures should be identified and secured.
Building resilience of ecosystems	The environmental screening and assessment must consider the effects of a project on the resilience of ecosystems through taking into account their diversity, connectivity, scale, condition and adaptability. Then, through options appraisal and input to design, seek to proactively maintain and enhance the resilience of those ecosystems. This goes hand in hand with our S 6 Biodiversity and Resilience of Ecosystems duty.

The Environmental (Wales) Act 2016 introduces **an iterative process** to help monitor progress towards the SMNR in Wales (Figure A5-3). This is based on three new policy products, which inform each other and are regularly updated to inform decision-making. These are:

- **State of Natural Resources Report (SoNaRR**) – NRW will produce and review this every 5 years (last published April 2021). This sets out a national evidence base for the sustainable management of natural resources. Currently, there are no ecosystem in Wales is showing all the attributes of resilience, which is impacting on the ability of ecosystems to provide benefits for Well-Being.
- **Natural Resource Policy (NRP)** – Welsh ministers must then consider the evidence provided by SoNaRR when preparing the NRP. The NRP defines the priorities, challenges and potential opportunities facing Wales' natural resources, recognising the pressures placed on natural resources and aims to provide solutions to alleviate from such stressors. The current policy has three priorities: delivering nature based solutions; increasing renewable energy and resource efficiency; and taking a place-based approach.
- **Area Statements** – Seven of these are produced for seven geographies in Wales (6 terrestrial, 1 marine) which are evidence based, and set out the key challenges and solutions for a given area to improve its SMNR. They are linked very closely to the UK National Ecosystem Assessment (UK NEA, 2011).

Figure A5-3: Iterative and informed process, recycled every 5 years, to inform sustainable management of natural resources in Wales



Ecosystem resilience in Wales

The legislative and policy context in Wales places a clear emphasis on 'ecosystem resilience'. This is defined as "an environment that can respond to pressures by resisting, recovering or adapting to change; and is able to continue to provide natural resources and benefits to people" (NRW, 2020). This clearly resonates with 'systems thinking'. It goes on to describe five

key aspects of ecosystem resilience: diversity, extent, condition, connectivity and adaptability (see Box 1).

Box 1 – Wales ecosystem resilience principles (NRW, 2016)

Diversity: "Diversity matters at every level and scale, from genes to species, and from habitats to landscapes. It supports the complexity of ecosystem functions and the cascade of interactions that deliver services and benefits, so diversity is important for enhancing the capacity of the whole system to adapt to future change."

Extent: "Extent or the size of an ecosystem will affect its capacity to adapt, recover or resist disturbance. Fewer species can survive in a smaller patch, and the demography of species is altered when habitat is lost, leading to species loss and ecosystem decay."

Condition: "The condition of an ecosystem is affected by multiple and complex pressures acting both as short term "pulse" and longer term "press" types of disturbance that affect the resilience of ecological communities and their capacity to resist, persist or recover (Bender et al., 1984). The pressures can disturb both the biotic (biological) and abiotic (environmental) factors associated with a habitat or species."

Connectivity: "Connectivity refers to the links between and within habitats, which may take the form of physical corridors, steppingstones in the landscape, or patches of the same or related vegetation types that together create a network that enables the flow or movement of genes, species and natural resources (often referred to as an "ecological functional network"). Environmental factors such as geology, soil type or hydrological links affect sea or landscape connectivity. For any given species, connectivity is related to the relative distance that species can move to feed, breed and complete lifecycles that may need different environments."

Adaptability: "Adaptability differs from the other attributes because it is part of the definition of resilience rather than an attribute that supports it. However, its inclusion in the Environment (Wales) Act is important because it emphasises one of the most important features of resilience: dynamism and the ability to adapt to change. Adaptability cannot yet be quantified in an equivalent way to the other attributes and so it is not used it in the assessment of resilience in this SoNaRR."

Conclusion

The legislative and policy context in Wales embraces 'systems thinking' through its focus on well-being goals, resilience principles and area-based decision making. Whilst not perhaps as 'systems' orientated as it could, or should be; the legislative and policy context gives a clear steer to make decisions and to plan interventions around core systems principles including adaptability, inclusiveness and a context based understanding of challenges and possible solutions.