A literature review of the social and economic impacts of land use change

Annie McKee and Naomi Beingessner

The James Hutton Institute

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Highlights

What is the report about?

This evidence review was commissioned by the Scottish Government to inform the development of mechanisms for integrated land use (i.e. bringing together different land uses in a region). This report therefore seeks to provide insights relevant to agriculture, forestry, peatland, and other policy areas and build understanding around possible land use change impacts for rural businesses, land managers, and local communities. This report outlines the findings of a literature review of social and economic impacts that can arise in relation to land use change. In this report we consider land use change to include both land cover and land management change and recognise that land use change is driven by multiple factors.

This report aims to provide insights relevant to ongoing Scottish Government policy around agriculture, forestry, and peatland, amongst others, in particular the developing Just Transition plan. The literature review is situated in the context of the debate regarding 'land sparing vs. land sharing', and the conceptualisation, discourse, and 'reality' of multifunctionality.

What did we do?

We carried out a literature review, including international literature. We undertook key word searches in online databases to identify academic and grey literature (where available in English) that focused on: (i) case studies of land use change in countries other than Scotland in the Global North; and (ii) review papers on the overarching topic of the 'social and economic impacts of land use change'. We excluded papers published earlier than 2000, and those that focused primarily on the impact on ecosystem services or the results of large-scale models, seeking instead to identify empirical evidence of social and economic impacts.

We focused on a spectrum of land use change, where land had previously been used mainly for agricultural production. The land use changes included: (i) agroecology; (ii) regenerative agriculture; (iii) agroforestry and intercropping; (iv) nature restoration or 'rewilding'; and (v) land abandonment. We present land use change case studies from Germany (biofuels), Japan (agrivoltaics), Canada (hydroelectricity), New Zealand (afforestation), and Australia (multifunctional land use change, with an emphasis on impacts from afforestation). Land use change impacts considered in this report include:

- changes to individual farm household incomes;
- resilience in agricultural production;
- rural economic opportunities (e.g. local food supply);
- population changes (including in-migration and population decline); and
- influences on community cohesion, access to land, knowledge, and innovation.

What are the main findings?

- Agroecology is reported as providing a range of economic benefits including reduced input costs for farmers, enhanced production resilience, access to current/future payments for ecosystem services. Social benefits include farmer wellbeing, peer-to-peer engagement, and new knowledge creation.

Challenges include a lack of advisory support, restrictions due to land rental prices, and changing farmer mindsets.
- Regenerative agriculture is considered to support increased farmer self-efficacy and wellbeing, as well as farm profitability and economic resilience, but challenges arise with regard to ambiguous definition.
- Agroforestry and intercropping can provide reduced cultivation costs and enhance net value of production, but the high cost of establishing agroforestry is highlighted. Social benefits include reducing rural outmigration, encouraging the establishment of cooperatives, and greater value placed on local or ‘indigenous’ knowledge.
- Nature restoration (or ‘rewilding’) provides apparent economic benefits including employment, new enterprises, and eco-tourism, as well as revenue-sharing opportunities for local communities, and compensation for land managers for wildlife related costs. Negative impacts include threats to local community land access, exacerbating inequalities, wildlife disturbance to crops and livestock, and uncertainty regarding community involvement and economic rationale.
- Land abandonment is associated with largely negative social and economic impacts, including loss of traditional and farming knowledge, displacement of rural livelihoods and declining farm incomes, weakening community cohesion.
- There is a lack of literature that provides detailed evidence of the social and economic impacts of specific land use changes, in particular the long-term impacts.

Concerns arise across the different country contexts regarding equity and social justice outcomes associated with land use change. To avoid exacerbating inequalities, the literature reviewed highlights the importance of maintaining social license[1] and the social acceptability of land uses through community consultation and participatory approaches to land use planning, as well as developing integrated and small-scale land use changes that provide direct community benefits. Furthermore, the literature emphasises the key role of financial and advisory support for farmers and land managers seeking to undertake land use transitions towards more ecologically sustainable models such as agroecology and agroforestry.

What needs to change in the future?

- Multifunctionality in land use and land management requires policy and subsidy support, including supporting farmer access to markets and value chains for products (e.g. agroecological agricultural produce), as well as knowledge networks and peer-support for innovation uptake. This has implications for the proposed agricultural support framework beyond 2025 and the four-tiered model (Scottish Government, 2023).
- Financial models should take account of the long-term nature and returns of alternative land management approaches, e.g. agroforestry systems.
- Strategic land use planning is necessary to avoid high quality farmland from being used solely for solar energy, recognising the balance of policy priorities regarding net zero and food production.

[1] The term ‘social license’ refers to the social acceptability or legitimacy of a particular activity, such as a land management approach or particular land use (see: Raufflet et al., 2013).

- Land use changes should be introduced at a small scale, providing input to local economies and benefit sharing with communities, in order to build and maintain community trust and landscape integration.
- Community-based impact assessments can help to avoid the negative impacts of land use change and enhance positive impacts.
- Consider complex and divergent impacts on different groups within rural areas (e.g. farmer vs. rural resident), and the inequalities that may arise through land use change for climate change mitigation (i.e. acknowledge and manage for the complexities of the Just Transition).
- Avoid developing policy responses to land use change based primarily on 'common perceptions of impact', due to the likelihood of misattribution of impact and influence of personal association (i.e. individuals' familiarity with land uses, or regional identity) rather than direct impact.
- Support long-term, participatory, inclusive, action-based social science, as well as standardised data collection methodologies, for the monitoring and evaluation of the impacts of land use change.

1. Introduction

1.1 Background

This evidence review was commissioned by the Scottish Government to inform the development of mechanisms for integrated land use (i.e. bringing together different land uses in a region). This report therefore seeks to provide insights relevant to agriculture, forestry, peatland, and other policy areas and build understanding around possible land use change impacts for rural businesses, land managers, and local communities. It aims to provide relevant information and evidence to inform discussions with Scottish stakeholders regarding the implications of land use change, and to contribute to development of the Land and Agriculture Just Transition Plan (due by the end of 2023). It must be noted that the economics of land use change vary within and between countries, therefore it is important to carefully consider any conclusions from this work in a Scottish context.

This project relates to research on the socio-economic impacts of 'green' land investment in rural Scotland, and draws on findings from the study 'Understanding the impact of scale and concentration of landownership: community perspectives from the south of Scotland' (Daniels-Creasey and McKee, 2022), amongst others undertaken by the James Hutton Institute and Scotland's Rural College project teams within the Rural Futures theme of the Scottish Government's Strategic Research Programme 2022-2027[2]. This project also links to earlier policy-responsive research on the 'Attitudes and drivers of behaviours of landowners/land managers towards Land use change associated with Climate Change Plan targets' (Sutherland et al., 2021).

1.2 Objectives

Considering contexts of land use/management change, the objective of this project was to gather evidence on:

1. What happened?;
2. What was the outcome?; and
3. What learning can we draw about the characteristics of a change which worked well/didn't work well.

The approach was to review literature (including international literature) and case studies of areas where there has been a change in land use/management. Figure 1 provides an outline of the process of change explored in this project (informed by conceptualisations developed by Hersperger et al., 2010).

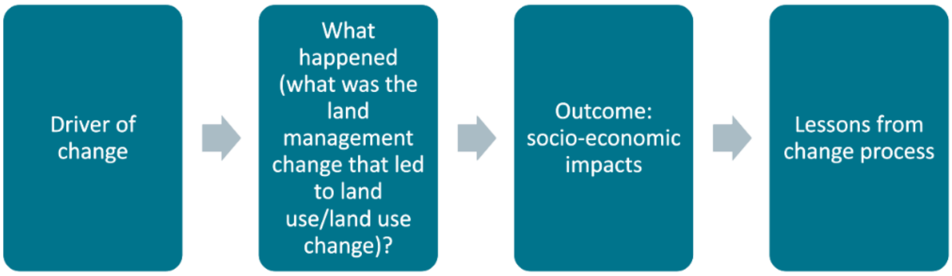

Figure 1 Land use change and impacts

[2] Including the Scotland's Land Reform Futures project: https://www.hutton.ac.uk/research/projects/scotlands-land-reform-futures

2. Methodology

This project involved an extensive review of academic and grey literature, where available in English, primarily located through key word searches using Web of Science, Science Direct, and Google Scholar. Literature searches focused initially on examples of land use change in Global North countries, given their greater relevance to Scotland (i.e. with regard to similarities of industrialised agriculture, landownership patterns, and declining land-based livelihoods). Key word searches sought to identify literature that detailed socio-economic impacts of the examples of land use change (or changes) in the case study countries. Searches also looked for other literature review papers on the overarching topic of 'social and economic impacts of land use change'. Other routes to identifying relevant literature included following citation pathways, using online tools such as 'Research Rabbit' and asking for advice on key references from other researchers with relevant expertise.

Key word searches were formulated as follows:

- Country-specific searches: land use change [or specific land use type] + country name.
- Review searches: soci* econom* impact* land use change (followed by refinements by topic area, journal type, and year).

We then identified relevant papers through reviewing titles (and where necessary, abstracts) from the first 500 articles listed under these search results. We excluded papers that had been published earlier than 2000, that primarily focussed on the impact of land use change on ecosystem services (without direct links to the social impacts of ecosystem service change), and where papers primarily presented analysis from large-scale models. This is because we aimed to identify empirical evidence of social and economic impacts (i.e. based on primary data collection, such as surveys and interviews), rather than forecasted or general trends.

Despite the high numbers of sources returned through these database searches, on closer inspection there were fewer than anticipated empirical research reports and papers that provided detailed evidence of the social and economic impacts of specific land use changes. Furthermore, limited studies have assessed the long-term impacts of land use change. This reflection is supported by other authors, who explain that the social impacts of land use change are considered to be less well understood, in comparison to economic and environmental outcomes (Helming et al., 2011). As Mukhlis and colleagues state: "*studies focusing on long-term agroforestry impact assessment remain very limited [including]…a lack of rigorous evidence of the long-term impact of agroforestry globally*" (2022: 6). Pettorelli et al. (2018) also highlight a lack of empirical understanding about the social impacts of 'rewilding'.

3. Literature Review Findings: Evidence of Social and Economic Impacts associated with Land Use Change

Land use and land use change (including land cover and land management changes) are central to addressing global sustainability challenges, not least the twin crises of climate change and biodiversity decline, as well as food security and poverty alleviation. This literature review has been structured to identify the range of impacts emerging from studies that focus on a spectrum of land use outcomes where conventional agricultural land use and management approaches (e.g. arable and livestock production) are changed. The land use changes addressed include: agroecology, regenerative agriculture, agroforestry and intercropping, nature restoration (or 'rewilding'), and land abandonment, as well as illustrative country case studies that explore the social and economic impacts of afforestation, renewable energy, biofuels, and multiple land use changes.

The initial literature review highlighted the following key points:

- Land use change may have multiple drivers, be non-linear, and land uses are often multifunctional.
- Land use change may have a relatively small 'footprint' but may have significant impacts (e.g. local to global) (see Meyfroidt et al., 2022).
- Impacts may be unevenly distributed spatially and socially, may be direct, indirect, and cumulative, as well as have differing timescales (e.g. afforestation has short- and long-term impacts).
- Land use change impacts may influence the social acceptability, legitimacy, or 'social license' of different land management approaches and land uses held by different stakeholders (and there may be social 'feedback loops').
- Actual and perceived social impacts depend on an individual's awareness of land use change and on their beliefs about the causes of social change, therefore highlighting the necessity of understanding perceived and actual change (Williams and Schirmer, 2012; Williams, 2011; see also Vanclay, 2020)[3].

We situate this evidence review within two key conceptual framings: firstly, ideas of 'land sparing' vs. 'land sharing', and secondly, discourse around sustainable multifunctional agriculture. These are discussed in the following sections.

3.1 'Land sparing' vs. 'land sharing'

Firstly, we recognise the relevance of the debate between ideas of 'land sparing' – "*where the land is separated for production and conservation*", or 'land sharing', "*where there is integration of production and conservation*" (Fischer et al., 2014 *in* Balfour et al., 2020:429). For example, research on the ecosystem services and dis-services of woodland expansion on grassland and arable farmland in Wales indicated that land-sharing strategies (e.g. agroforestry) provided more in place and local ecosystem service benefits, whilst land-sparing strategies (e.g. complete afforestation) provided mainly external ecosystem service benefits and were more

[3] "*Because people act on their fears and beliefs, and their outlook on life and perceived opportunities are affected, this gives rise to the adage that perception is reality, and that perceived impacts are real social impacts*" (Vanclay 2012 *in* Vanclay, 2020: 127).

likely to necessitate livelihood changes by private landowners and land occupants (Hardaker et al., 2021; see also: Jones et al., 2023).

3.2 Sustainable multifunctional agriculture

Secondly, the conceptualisation, discourse, and 'reality' of sustainable multifunctional agriculture is highly relevant to this evidence review. Multifunctionality may be defined as: "*a concept that seeks to capture the multiple benefits and services related to agricultural systems that should benefit human and non-human nature alike*" (Tilzey, 2003 *in* Bjørghaug and Richards, 2008: 101), or the "*existence of multiple commodity and non-commodity outputs that are jointly produced by agriculture*" (OECD, 2001 *in* Bjørghaug and Richards, 2008: 101), facilitating social, environmental, and economic sustainability at the farm level (see also: Helming et al., 2011). In their comparative study of Australian and Norwegian agricultural policy landscapes, Bjørghaug and Richards (2008) explained that whilst Australia showed weak multifunctionality in agricultural systems, Norway had strongly embedded this principle largely through subsidy support for farmers, based on an agreement between governments and farmers organisations. This approach is credited for sustaining biodiversity-rich and cultural Norwegian landscapes (Bjørghaug and Richards, 2008).

Modelling based on regional case studies in Germany indicated that the de-intensification of land use (e.g. reducing livestock production and increasing mixed woodland) could offer moderate benefits to local communities, and slightly improve indicators of 'multifunctionality' and 'equity' (Neyret et al., 2023). On the other hand, this study demonstrates that major land use changes occurring across Europe (e.g. large-scale afforestation and agricultural intensification) could lead to "*social conflicts and reduced multifunctionality*" (Neyret et al., 2023: 1). Neyret and colleagues advocate the use of participatory approaches for the identification and planning of land use change, and to support the 'balancing' of land use priorities (2023).

The following sections describe the key themes emerging from the literature relating to the spectrum of land use changes that may be anticipated as Scotland responds to multiple drivers of change, including climate change, as well as other environmental and social factors.

3.3 Agroecology

Agroecology is defined as a "*holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems*" (FAO, 2023: online). Stakeholder appraisal of four farming types in the South East of England concluded that agroecological farming may be the most multi-functional and 'best compromise', in terms of meeting the needs of people and nature, in comparison to conventional and rewilded land management systems (Balfour et al., 2020) (noting that there is a wide range of agroecological farm types[4]). Cole et al. (2021) identified five different agroecological farming approaches that are already ongoing in Scotland: agroforestry, low-input systems, organic farming, integrated farm management (IFM) and

[4] An example of agroecological farming undertaken on previously abandoned land in Spain by the Red Terrae network is described in: Beingessner, N. (2023). Alternative Land Tenure Models: International Case Studies and Lessons for Scotland. Scotland's Land Reform Futures project, June 2023.

regenerative agriculture. Cole and colleagues adopted a hierarchical approach where agroecology is the underpinning discipline and the different farming models align with a set of agroecological principles, noting the overlap between models and the practices that they involve (Cole et al., 2021).

Case study research on agroecological farms across the UK has highlighted the direct benefits to farmers who have transitioned to this land management approach, which include: "*decreasing their reliance on costly inputs, enhancing production resilience, and improving access to current and future payments for ecosystem services*" (Chanarin et al., 2022: 4)[5]. Benefits also include improved wellbeing and job satisfaction, primarily related to reduced workloads because of no longer being required to till, spray, process feed, reseed or fertilise pasture (Chanarin et al., 2022). Similarly, farmers reported their satisfaction in observing the positive environmental changes on their land as a result of an agroecological approach, as well as improvements to animal welfare, and the strengthening of local supply chains. Indeed Chanarin et al. highlight apparent social and economic benefits of agroecology beyond the farm level, including creating 'diverse and meaningful' jobs for new people on farms, providing nutritious local food, and supporting greater connection between people and nature (2022). However, case study participants also highlighted challenges to agroecological transitions, including:

- a lack of advisory support for new entrants;
- the high cost of establishing agroforestry;
- the potential for high rent prices requiring tenant farmers to seek maximum economic returns; and
- the challenge of changing farming mindsets (i.e. that lower yields are compensated by lower costs) (Chanarin et al., 2022).

This study also reported challenges in gathering agroecological performance data, and the necessity to increase data collection (and sharing) to inform agroecological management decisions, as well as to validate and communicate the benefits of agroecology (Chanarin et al., 2022). This finding is reiterated by Cole et al. (2021) who highlight the lack of system-based research that captures the economic, environmental, and social impacts of agroecological farming[6].

Research on the outcomes of pasture-fed livestock systems[7], an activity that is one form of agroecology, indicated "*observable social benefits, both in terms of farmers' individual motivations and perceptions, and active peer-to-peer engagement which foster learning and innovation*" (Norton et al., 2022: 12). This research highlighted a range of social goods generated through knowledge exchange associated with pasture-fed livestock groups, including trust, social capital, gaining new knowledge, as well as a positive sense of purpose, autonomy, and agency by participating farmers. These benefits in turn contribute to innovations on farms in terms of time and labour required, benefits to animal health that reduced veterinary bills, and reduced requirements for physical infrastructure and capital on farm (Norton et al., 2022).

[5] However, Landert et al. (2020) concluded that agroecological farms did not have higher economic profitability in general.
[6] Although it should be noted that Landert et al. (2020) did undertake a systematic review of 51 agroecological farms across Europe using three sustainability assessment tools (Landert et al. 2020).
[7] Including farms producing meat from livestock fed only on pasture and pasture-base forages.

Economic evidence from this study illustrated that the impact of this system varied, with some farmers doing less well financially (e.g. where they had high variable costs), whilst others' were reflective of non-pasture-led systems. Those who were producing beef suckler cows appeared to achieve better economic outcomes than averages from the UK Farm Business Survey (Norton et al., 2022).

3.4 Regenerative agriculture

Regenerative agriculture is defined as: "*an approach to farming that uses soil conservation as the entry point to regenerate and contribute to multiple provisioning, regulating, and supporting ecosystem services, with the objective that this will enhance not only the environmental, but also the social and economic dimensions of sustainable food production*" (Schreefel et al., 2020: 5). The core principles include stopping soil tillage, avoiding creating areas or periods of bare soil, fostering plant diversity, and integrating livestock and cropping operations on the land (LaCanne and Lundgren, 2018; after Rodale 1983). It is considered a 'socioecological farming system' and philosophical farming approach that encompasses others such as holistic management, low-input farming, and biodynamic farming (Brown et al., 2021), or 'nested' with conservation, organic and sustainable agriculture, related to approaches such as permaculture and agroecology (Wilson et al., 2022). Regenerative agriculture is criticised for being overly broad, with tensions between process and outcomes, where it can lack specificity for local contexts, and lack clarity for the individual farmer in how they can contribute to its objectives[8] (Newton et al., 2020; Schreefel et al., 2022; Wilson et al., 2022; Page and Witt, 2022). A further challenge is reported to be resentment around the use of the term 'regenerative agriculture' reflecting the use of techniques that have been developed by indigenous peoples, therefore their adoption by conventional farmers can be viewed as appropriation (or perhaps insufficiently recognising the history of the farming approach) (Wilson et al., 2022). Other authors claim that regenerative agriculture is insufficiently mature for a clear definition to have emerged or for claims of the benefits of this farming approach to have been rigorously tested (Page and Witt, 2022).

Some research indicates that regenerative agriculture involves a trade-off between environmental performance, which increases, and farm profitability, which declines due to reductions in livestock numbers and/or yield reductions in conjunction with increased labour, particularly during the early stages of a regenerative transition (Schreefel et al., 2022). Others report, positive impacts on farm economics. For example, LaCanne and Lundgren (2018) found that despite having lower grain yields, a regenerative system was almost twice as profitable than conventional corn production in the US. This difference was due to the costs associated with seed and fertiliser in the conventional system, and the higher revenue generated from the grain and other products (e.g. meat production) in the regenerative system. They concluded that: "*profit was positively correlated with the particulate matter of the soil, not yield*" (LaCanne and Lundgren, 2018: 1).

In another study, farmer interviewees "*described finding economic success since transitioning to regenerative agriculture, and the greater emphasis was on economic*

[8] Providing 'solution spaces' rather than single options are suggested as a route to support farmer decision-making considering regenerative objectives and the farmers' intrinsic motivations (Schreefel et al., 2022).

resiliency: sustaining their livelihoods and that of future generations" (Wilson et al., 2022: 7). Participants in this study emphasised the importance of the economic resilience of farming to the revitalisation of rural communities, and that regenerative agriculture led to changing working conditions on farms, increasing 'ownership, control and governance' within farming systems, and contributing to social justice and equity in agriculture (Wilson et al., 2022). Higher quality food is also a reported outcome of regenerative agriculture, contributing to health and nutrition goals (Wilson et al., 2022).

Further positive impacts of adopting a regenerative approach identified are in relation to the farmer's sense of self-efficacy[9] and contributing to improved wellbeing (Brown et al., 2022; Brown et al., 2021). Related qualitative research detailed how graziers practicing holistic management reported higher capacity for adapting to changing and adverse conditions (e.g. drought), in comparison to conventional farmers (Sherren et al., 2012 *in* Brown et al, 2021). Brown et al., (2022) caveat their findings, highlighting that they are unable to determine whether "*it is the use of regenerative agriculture that increases farming self-efficacy, or if having higher levels of farming self-efficacy increases the likelihood of adopting regenerative agriculture to begin with*" (Brown et al., 2022: 10). Nonetheless, these findings concur with earlier studies that describe positive feedback loops, whereby outcomes of wellbeing and improved self-efficacy reinforce the adoption of new farming practices such as regenerative agriculture (Gosnell et al., 2019; Saxby et al, 2018; Perry and Davenport, 2020 *all in* Brown et al., 2022: 10). These findings also indicate the need to prioritise the enhancement of farming self-efficacy and farmer wellbeing as prerequisites for transitions to regenerative agriculture or other sustainable agricultural practices (Brown et al., 2022).

3.5 Agroforestry and intercropping

Agroforestry has long been identified as an approach to sustainable land use and management that can produce biomass for biofuels and energy, as well as enhancing the ability of agriculture to sequester and store carbon (Lassoie et al., 2009; Saraev et al., 2022). Agroforestry is described as involving the "*deliberate integration of woody vegetation (trees and/or shrubs) as an upper storey on land with pasture (consumed by animals) or an agricultural crop as the lower storey*" (Mosquera-Losada et al., 2016 *in* Pantera et al., 2016: 1). Other types of agroforestry include alley cropping (e.g. integrating hardwood species with agricultural crops), integrated riparian (river) systems, windbreaks and 'forest farming' (Lassoie et al., 2009). In turn, intercropping is the simultaneous cultivation of at least two crop species, with the aim of achieving "*spatial and/or temporal complementarity*" (Burgess et al., 2022: 145). Pantera et al. (2016) concluded that the *"intercropping of high value tree systems can help to reduce cultivation costs*" (pg. 344; e.g. reducing fertiliser volumes, maintenance and mowing costs, etc.) and enhance the net value of production from farmland through the optimisation of primary and secondary crops, as well as ecosystem service provision (Lassoie et al., 2009).

Through an examination of research undertaken in the UK, Saraev and colleagues concluded that there was 'strong evidence' that agroforestry in the UK is largely financially viable, and that agroforestry systems tend to generate positive net income

[9] Self-efficacy is understood as the ability of an individual to make decisions and their sense of confidence, as well as "*an individual's perceptions and beliefs about their capabilities to achieve particular pursuits and roles*" (Bandura, 2006 *in* Brown et al., 2022: 3).

for farmers (Saraev et al., 2022). This finding was caveated with several conditions, including the time horizon under consideration (e.g. recognising high establishment costs), whether or not farmers can receive payment for ecosystem services relating to the societal benefits of agroforestry (interlinked with sufficiently high carbon market pricing), as well as other context-specific aspects (Saraev et al., 2022). These elements include the diversity and value of arable crops planted in alley-cropping systems, the type of business (or businesses) used to manage an agroforestry system, and the variable prices of agroforestry outputs and the costs of inputs (Saraev et al., 2022). This report also highlights that establishing agroforestry may be inhibited by social, cultural, and regulatory barriers, including cultural resistance and lack of practical skills.

Considering the experience of rural communities primarily in developing countries, Mukhlis et al. (2022) assert that agroforestry can play a role in enhancing smallholders' income, increasing food security within the household, promoting gender equality and supporting cultural activities (e.g. community participation in developing innovations). Other impacts included the development of cooperatives, reducing rural out-migration (i.e. through enhancing farm incomes), whilst also leading to in-migration in potential areas of conservation (which may be considered a negative impact). Critically, Mukhlis and colleagues explained that the impact of agroforestry (either positive or negative) depended upon the knowledge held by rural communities of good agricultural practices and agronomy (2022).

A study of agroforestry within an integrated land management initiative in Spain was perceived as contributing to wildfire mitigation, improving regional economies, personal and local wellbeing, as well as counteracting land abandonment (Wolpert et al., 2022). Contributing to tackling depopulation was reportedly a primary motivator for land managers undertaking collaborative agroforestry at a landscape scale, and these authors highlight social cohesion and increased collaboration as outcomes of this initiative (Wolpert et al., 2022), in turn contributing to community empowerment and self-efficacy (Górriz-Mifsud et al. 2019 *in* Wolpert et al., 2022).

Focussing on the United States, Lassoie and colleagues (2009) consider agroforestry a route to revitalising rural communities that may have social and economic pressures, through enhancing agricultural production. Similarly, this type of land is perceived to be attractive for smallholders and those entering agriculture, who may be willing to undertake the level of labour-intensive land management required. Other 'social variables' that are purported to benefit from conversion from mono to multi-/ intercropping include: increased nutrition, climate awareness, social development, economic diversification, and increased resilience (i.e. 'reduced recovery time following disaster') (after Burgess et al., 2022). Furthermore, it is suggested that agroforestry may encourage greater awareness and value placed on indigenous knowledge, as well as landowner stewardship (i.e. fulfilling ownership responsibilities to ensure healthy ecosystems for future generations) (Lassoie et al., 2009).

Economic and social impacts of multiple cropping systems such as agroforestry and intercropping rely on the presence of markets of sufficient scale, and economic incentives are the primary factor in encouraging transitions to such alternative cropping systems, including subsidies, financial support, or cost-share programmes (Burgess et al., 2022). Specifically, regarding agroforestry, uptake is supported through "*improving farmer access to markets and value chains for products, supporting financial models which acknowledge the long-term returns on agroforestry systems, and improving participatory and inclusive research*" (Agroforestry Network, 2018 *in* Burgess et al., 2022: 153).

3.6 Nature restoration, or 'rewilding'

Adapting land management approaches for the purposes of nature conservation is a key land use change occurring across Europe in which land may be owned specifically for the purposes of nature restoration or 'rewilding' as it can be termed. This report utilises the term 'rewilding' in a Scottish context, recognising the wide use of terms such as ecological or ecosystem restoration which are also relevant but outwith the scope of this literature review[10]. A recent definition of rewilding produced by James Hutton Institute researchers for the Scottish Government explains that:

"*Rewilding means enabling nature's recovery, to achieve more resilient and autonomous ecosystems that reflect and respect Scotland's society and heritage.*

Rewilding is part of a set of terms and approaches to landscape and nature management; it differs from other approaches in seeking to enable natural processes which eventually require little management by humans.

As with all landscape management, rewilding should be achieved through processes that engage and ideally benefit local communities, in line with Scotland's Land Rights and Responsibilities Statement, to support a Just Transition" (Waylen and Marshall, 2023).

However, as Pettorelli (2018) and colleagues explain, one of the main barriers to successful rewilding is the perceived negative impact on local communities, including reducing access to land. Rewilding impacts on local communities may be unevenly distributed and could worsen existing inequalities. For example, whilst some may be disadvantaged due to the impacts of 'enhanced wildlife' disturbing crops and livestock, others may benefit due to opportunities for ecotourism or other ecosystem services (Pettorelli et al., 2018). This finding is reiterated by Wynne-Jones et al. (2020), who highlight a tendency for socially-exclusive models of rewilding in the UK (e.g. offering expensive visitor experiences, or located far from urban centres). This was of concern in the Scottish context, with particular attention paid by study participants to the social justice aspects of rewilding, and claims reported of employment opportunities and support for new enterprises as a result of rewilding projects (Wynne-Jones et al., 2020). Further, Pettorelli and colleagues explain that whilst the North American conservation model prohibits private individuals from gaining personal benefit from wildlife, there are policy levers that could support positive rewilding projects with wider public benefit. These include: (i) providing more flexibility to private landowners with regard to hunting locations and periods; (ii) reducing tax burdens for owners who maintain their land as wildlife habitats; and (iii) liability protection for landowners who permit recreational access (Pettorelli et al., 2018). Further community benefit may be

[10] There is a large literature on the social and economic impacts of nature restoration processes, which is outwith the scope of this literature review.

derived through sharing revenue from hunting permits, and compensating ranchers (i.e. farmers) for wildlife-associated costs (Pettorelli et al., 2018).

Scottish perspectives on rewilding include a strong narrative that rewilding could provide new, and arguably more viable land uses and land management approaches, with associated employment benefits, whilst also sustaining existing economic relationships that people have with land (Martin et al., 2021). The participants in this study were clear in their view that rewilding in Scotland would not lead to displacement or disengagement by existing local communities, although there was a lack of clarity around the role of involving local people in land management decision-making relating to rewilding (i.e. beyond volunteers or visitors), which raises questions regarding governance and transparency of rewilding. Furthermore, these authors highlight that within their Scottish-based study, "*a detailed economic rationale for rewilding at large scales was, however, largely absent*" (Martin et al., 2021: 6) and "*how a rewilding-based rural economy might work was not clearly articulated*" (Martin et al., 2021: 9).

Literature exists regarding '***agricultural rewilding'*** or 'agricultural wilding', which is proposed as being positioned conceptually between agroecology and rewilding (Corson et al., 2022). As Corson and colleagues describe, agricultural rewilding may offer a multifunctional model suitable for livestock farming, as it involves the "*restoration of ecological processes with some degree of agricultural production, most often of herbivores*" (2022: 2). In this regard it links closely to regenerative agriculture (see Section 3.4). Agricultural wilding, however, involves the integration of wild crops and plants to improve biodiversity outcomes in agricultural landscapes (Vogt, 2021). Again, there appears little empirical investigation of the social and economic impacts of these land use changes. Agricultural wilding (or 'wild productive systems') is stated as likely to provide commercial benefits (i.e. through the production of wild foods, that have market, social and cultural value), as well as social impacts in terms of motivating and encouraging conservation and ecological restoration activities by land managers (Vogt, 2021).

3.7 Land abandonment

The abandonment of agricultural land can range from a gradual process that leads to the underutilisation and subsequent end of agricultural activities, when land is left unmanaged and there is no apparent plan for future land management, or where farmland is permanently changed to unmanaged grassland, successional scrubland, or young forest (Subedi et al., 2022; see also Ruskule et al., 2013). It should be noted that abandonment of farmland is not anticipated in Scotland. Ensuring that land (and buildings) considered to be abandoned, vacant or derelict do not cause harm to both rural and urban communities is a key part of the Community Empowerment (Scotland) Act 2015.

Nonetheless, land abandonment has been a feature of agricultural system change across Europe for several decades (cf. Quintas-Soriano et al., 2022). It is a complex and multidimensional process that results due to diverse environmental, economic, social, political, and cultural factors (Dimopolous et al., 2023). International reviews (concentrating on Europe and Asia) have reported that the social and cultural consequences of agricultural land abandonment include the "*loss of traditional skills and knowledge of farming and the disappearance of local practices like labour* *exchange systems*" (Subedi et al., 2022: 6), as well as weakening social cohesion in communities (Chaudhary et al., 2018 *in* Subedi et al., 2022). Land abandonment in Mediterranean regions is reported as impacting negatively on quality of life for local people, as well as causing the displacement of rural livelihoods, loss of local identity and local knowledge, as well as the loss of agricultural and forest products (Quintas-Soriano et al., 2022). In addition to the negative impact of land abandonment on farm business incomes, it is also believed that "*widespread farmland abandonment is likely to increase the risk of food insecurity not only at the local level, but also at the national level*" (KC and Race, 2020 *in* Subedi et al., 2022: 12).

4. Land Use Change Case Studies

This chapter presents a short overview of land use change case studies from Germany (biofuels), Japan (agrivoltaics), Canada (hydroelectricity), New Zealand (afforestation), and Australia (multifunctional land use change, with an emphasis on impacts due to afforestation).

4.1 Germany – Experiences of land use change for biofuel expansion

Beginning in 2003-04, liquid biofuel production in Germany – biodiesel and biogas being the most significant – grew rapidly, encouraged by tax incentives, and quickly surpassed European Union 2010 targets aimed at lowering greenhouse gas emissions. Biofuels rely almost entirely on first-generation feedstock – starch and sugar crops – with waste end residue making up a small minority (IEA 2022). In 2017, approximately 14% of Germany's arable land produced energy crops for biofuels (Fachagentur Nachwachsende Rohstoffe, 2019) and additional feed is imported to meet quotas in some areas.

Most literature on bioenergy focuses on greenhouse gas emissions metrics and economic performance. There is little empirical evidence for the socio-economic impacts of biofuel expansion in Germany; considerations such as social tension, concentration of income, capacity building, and health impacts are largely found in literature on Africa and Asia (Robledo-Abad et al., 2017). However, it is clear that some regions in Germany have benefited economically from job creation and crop demand (Guenther-Lübbers et al., 2016). Biofuels have increased land rents and prices in some areas in Germany (Appel et al., 2016). Negative socioeconomic impacts documented include: a shift from livestock farming to maize/rapeseed and resulting loss of agricultural jobs in Germany (Guenther-Lübbers et al., 2016); decreased property values near processing plants in Denmark (Bourdin and Nadou, 2020); larger-scale land use homogenisation and decrease in crop diversity in northern Germany (Csikos et al., 2019) resulting in perceptions of negative effects on landscape aesthetics[11], experiences in nature, and sense of place in lower Saxony, Germany (Riechers et al., 2022). However, Guenther-Lübbers et al., 2016 caution that (to date) there had been more research on negative than on positive impacts.

While there is no firm agreement among researchers on the effect of biofuels on food security, it has been a concern of critics for decades and this was heightened by the recent Russian invasion of Ukraine (Guenther-Lübbers et al., 2016; Kyllmann, 2023). Venus et al. (2021) cite studies showing that land for biogas feedstock production has resulted in reduced cultivation of traditional crops and animals and an increase in food prices. Prompted by concerns about food and biodiversity, the current German environment minister aims to phase out first-generation biofuels by 2030 and increase second-generation contributions – primarily feedstock made from non-food plant material. In 2013, about 85% of biogas plants in Germany were operated by farmers (Appel et al., 2016). Some studies show that biogas production, if primarily using

[11] It is noted that other studies show enhanced landscape qualities and amenities associated with land use change for renewable energy (see, for example, COST Action TU 1401 (cost-rely.eu).).

waste, can in best-case scenarios be a form of circular economy[12] and provide additional farm income and employment (Bourdin and Nadou, 2020; Guenther-Lübbers et al., 2016). However, while biofuels are generally seen to have positive environmental impacts on greenhouse gas emissions, the social and economic impacts expressed in justifications for their expansion – energy security, job creation, decentralisation of the energy system, and rural development – have not manifested to any significant degree (Hunsberger et al., 2017; Murnaghan, 2017).

4.2 Japan – Solar energy systems on farmland

Agrivoltaic systems are those in which solar energy installations co-exist with crop or livestock production in the same area. This dual use of farmland offers a possible solution to competition for land between energy production and agriculture. Conceived of in the early 1980s, agrivoltaics began to gain traction in the 2010s, and are now considered by many "*a technically and economically practical use of agricultural land*" (Pascaris *et al.*, 2021). They can provide an additional revenue stream to farmers or reduce agricultural operations' use of fossil-fuelled electricity and have been shown to have other benefits to farmers (dependent on crop, soil type, and other geographical considerations) such as reducing evapotranspiration[13] or replacing netting used to protect crops from hail damage, with solar panels (Trommsdorff *et al.*, 2022; Agir, et al., 2023).

In Japan, the first agrivoltaic farm was established in 2004 by a pioneer of the concept, Akira Nagashima (Tajima and Iida, 2021). The 2011 earthquake and Fukushima Daiichi Nuclear Power Plant disaster provided impetus for the decentralisation of energy. The Japanese government introduced a feed-in tariff in 2012, a support program for agrivoltaics in 2013, the liberalisation of the electricity market in 2016, and have established a goal of 22-24% of electricity from renewables by 2030 (Irie et al., 2019; Irie and Kawahara, 2022; Nakata and Ogata, 2023). In addition to addressing energy issues, Agrivoltaics are "*seen as a solution to rural economic decline*" (Chiengkul, 2023). Japanese rural areas have a decreasing population, aging society, and decreasing agricultural incomes (Irie et al., 2019) and the resulting abandoned farmland is a major concern (Tajima and Iida, 2021). By 2018, 31% of approved cases of farmland conversion to agrivoltaics was on 'devastated' farmland (Tajima and Iida, 2021) and more than 2000 systems have been installed and 3474 agrivoltaic systems approved as of 2021 (Nakata and Ogata, 2023). The installations are small-scale, with 89% under 0.3 hectares in area (Trommsdorff et al., 2022). Farm operators own the agrivoltaic systems and there is a requirement of a certain rate of self-consumption of energy from the installation (Tajima and Iida, 2021).

Since agrivoltaics are a recent land use change, and research focus has been on technical and economic implantation issues, there is a lack of empirical studies of socioeconomic impacts and more research on the 'perceived' impacts of agrivoltaics. Impacts range from individual, to community-level, to national. Irie and colleagues'

[12] "*A circular economy is one which has transitioned from a linear 'take, make and dispose' model of consumption to a circular approach, which emphasises reduced use of resources, recovery of components and valorisation of waste products*" (Hague et al., 2023: 4).

[13] Evapotranspiration is the "*loss of water from the soil both by evaporation from the soil surface and by transpiration from the leaves of the plants growing on it*" (Encyclopaedia Britannica online: https://www.britannica.com/science/evapotranspiration; Accessed: 19.7.23; Last updated: 2009).

2019 study includes a small sample of farmers with agrivoltaic systems who provided individual-level impacts, which they saw as positive overall, including stable income and being able to maintain steady agricultural production that kept them from abandoning farmland. There are some examples of very specific economic benefits to certain farmers. Tajima and Iida (2021) describe how high value matcha tea grown in agrivoltaic systems attracted new environmentally-motivated international buyers. Elsewhere, Mamun *et al.*, (2022) cite a study on vineyards in India that suggested agrivoltaics could increase agri-tourism.

At a wider scale, a survey of over 500 stakeholders in Japan – including farm operators and employees, and rural residents with varying knowledge and experience of solar energy – showed that agrivoltaic systems were viewed positively in terms of energy security and were likely to be accepted locally (Irie et al., 2019). However, in the literature on agrivoltaics in Japan possible negative effects have been identified, including environmental and neighbourhood amenity risks (e.g., sunlight reflection, landscape degradation) and agricultural land loss or conversion (Irie et al., 2019). Nakata and Ogata (2023) discuss two negative impacts seen with some agrivoltaics: food crops are sometimes abandoned for ornamentals or spice crops that are more shade-tolerant in order to maximise power production, and contributions to the local economy may not be significant depending on where inputs are sourced. In southwest France, an agrivoltaic project was cancelled because of similar fears that energy production would be prioritised over agriculture on the land, that energy companies would drive up land prices, and good land would be used for energy production (Carrausse and Arnauld de Sartre, 2023). The latter two fears are addressed in Japan by the facilitation of small-scale systems and regulation of land classes on which installations are allowed (Tajima and Iida, 2021). A government regulation also prohibits agrivoltaics in areas where they might have a negative effect on land values or affect the efficiency of nearby farmland use (Irie et al., 2019).

Small-scale systems are preferred over solar farms for several reasons. Japanese residents criticised large solar installations for contributing little to local areas through low lease fees on land and an insufficient fixed property tax (Irie and Kawahara, 2017). In Spain, smaller installations were associated with integration in the landscape, protection of biodiversity, and community trust (Campos et al., 2023). Conducting workshops with German stakeholders before and after an agrivoltaic system installation to increase the social responsibility of the project through open, responsive deliberation, Trommsdorff *et al.* (2022) found that decentralised systems integrated with the landscape and powering farms or communities were seen positively as contributing tangible, local benefits. Campos et al. argue that “*historically large-scale energy transformations have meant also energy-related social injustices*” (2023) as large-scale actors have more influence on policy makers and can inhibit solar energy at the local scale to the detriment of equitable clean energy access, citizen participation, and benefit-sharing with communities (Sareen and Haarstad, 2021). Small-scale agrivoltaics may more successfully address these issues.

4.3 Canada – Impacts of hydroelectric development in remote areas

Since its first hydroelectricity project in 1881, Canada has had decades of hydroelectric development, with projects providing 60% of domestic electricity needs in 2021 (Pimentel da Silva et al., 2021a). This includes mega-projects such as the under-construction Site C dam in British Columbia, the third of three dams on the

Peace River, projected to generate 5,100 gigawatt hours annually and flood 5,340 hectares of land (Pimentel da Silva et al., 2021b). There are also years of associated research on socio-economic and environmental impacts. As these large projects are located in remote, rural areas, typically populated by Indigenous peoples, they affect fewer people, but impacts can be severe: displacement of communities, flooding of large areas, and destruction of land-based livelihoods. Marginalised peoples feel the effects more strongly, and these effects are exacerbated by the relative lack of infrastructure, resources, and capacity in remote areas (Stienstra et al., 2019). Other negative impacts, also common in 'boom towns' where the population rapidly increases when large developments are built, include: increases in violence, drug/alcohol use and crime[14] (Keeyask Hydropower Limited Partnership, 2012; Pimentel de Silva et al., 2021a) and stresses on infrastructure from large influxes of workers (Stienstra et al., 2019). The physical effects can include the collapse of fisheries due to mercury contamination and sediment (Lavoie and Hébert, 2022) and loss of traditional ecological knowledge (Willow, 2017).

Local benefits include: increased employment (mostly for men, and mostly in the construction phase) (Steinstra et al., 2019); and resources provided in compensation agreements, such as training opportunities and funding for infrastructure and the continuation of traditional land use activities (Pimentel da Silva et al., 2021b; Lavoie and Hébert, 2022). A few studies show how negative impacts can be mitigated and positive impacts increased with community-based impact assessments that sustain long-term consultation, participation, and partnerships with affected communities (Lavoie and Hébert, 2022; Pimentel da Silva et al., 2021b). Schafft *et al*. (2019) caution that impacts of energy development vary by degree of rurality/isolation of the area, available infrastructure, governance capacity, and historical factors such as the previous experiences of resource development in the area.

4.4 New Zealand – Conversion of farmland to pine forest

Over recent years, there has been an increase in the conversion of beef and sheep farmland (primarily upland pasture) to pine forest plantation in New Zealand. A key driver has been incentives associated with climate change reduction policies, not least the country's Emissions Trading Scheme[15], in addition to the favourable economic conditions of commercial forestry (in contrast to sheep farming in particular). This land conversion has been estimated to be around 50-60,000 ha each year (over the past 2-3 years) and reported impacts on farming and rural communities include: the loss of farming and other rural employment; outmigration of farming families; and decline in secondary services, such as agricultural machinery providers, veterinary services, or shearing contractors (Newton and Espiner, 2019; Wreford et al., 2021). The potential risk of greater rural poverty is also a concern associated with this land use change. Increasing land values are causing land access concerns for existing and new entrant farmers. Research commissioned by the levy body Beef and Lamb NZ found that the Net Present Value (NPV) of 'carbon forestry' was greater to the landowner than livestock farming, but farming provided greater local spending and employment than

[14] While these problems are exacerbated by the effects of colonialism on Indigenous communities, increases are also associated with rapid population growth in rural communities due to employment in similar developments (see, for example, Ruddell and Ortiz, 2015; Jones and Mazer, 2021).

[15] See: https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/ (Accessed: 19.7.23; Last updated: 19.6.2023).

forestry (Harrison and Bruce, 2019). This research concluded that the relative profitability of forestry would lead to significant land use change, which is a concern for other land users (Harrison and Bruce, 2019).

An area of contention regards the amount of employment generated from the existing/former beef and sheep farms in comparison to the plantation forestry (and over what timescales), with different stakeholder interests drawing on different reported figures, making accurate comparison difficult (Personal communication, 2023)[16]. A critical difference is the duration of employment, with forestry jobs only available locally during key periods (for example, planting, pruning, and harvesting), therefore encouraging transient populations. A similar concern relating to time and duration is the permanence of land use change for carbon sequestration, and the perceived impact on rural communities (in other words, reducing options for future land use change). The risk is that landownership may change over time, but the forestry plantations will remain as a permanent land use, retained by incoming landowners to avoid having to repay the original carbon credits accrued.

On the other hand, some Māori land trusts, which were granted ownership of 'high country' (upland) areas, as a result of post-colonial resettlement and compensation programmes, are considered to be well positioned to benefit from land value increases associated with the carbon market around forestry. This opportunity is described as a mechanism to resolve the under-utilisation of some Māori-owned land, as well as reconnecting Māori communities with their land, providing purposeful employment and supporting climate resilience for future generations (Personal communication, 2023). Other Māori tribes (iwi), however, may be less able to benefit from the potential economic and social benefits of this land use change, as a result of land fragmentation (due to individualised ownership), lack of resources and governance. Forestry landholdings smaller than 50ha are excluded from the Emissions Trading Scheme, as is forestry established before 1990 (Wreford et al., 2022). This influences land that was retained by Māori, much of which incorporates native forestry; therefore, this exclusion may be considered to be in contravention of the Treaty of Waitangi settlement process. Without coordination support and political will for these iwi and hapu (sub-tribes) to form new land governance structures (e.g. land trusts), it is likely that inequalities will persist as a result of New Zealand's colonial history. The conversion of agricultural land to forestry in New Zealand therefore provides a valuable illustration of the challenges surrounding a 'just transition'.

4.5 Australia – Social and economic impacts of multiple land use changes

In Australia, research undertaken during 2006-2009 sought to understand the impacts and experiences of social change in relation to the growth in the use of land for dairy farming, arable crops, blue gum plantations (*Eucalyptus globulus*) and rural residential development (Williams and Schirmer 2012; Schirmer et al., 2008). In part due to tax regulation revisions, there has been a shift away from joint ventures and on-farm

[16] A key study in the Scottish context that involved an economic comparison between an established commercial forest in the south of Scotland and the equivalent area of agricultural land found that forestry supported the same number of jobs as farming, although the economic output of forestry was much higher than that of agriculture, as described: "*the study indicate[s] that…forestry generates around three times the economic output of hill sheep farming before subsidy payment. Forestry also results in almost double the level of spending the local economy as agriculture*" (Bell, 2014: 3).

forestry towards plantation afforestation (Barlow and Cocklin, 2003). Longitudinal and mixed-methods research found that the establishment of forestry on farms had no reported impacts on the number of people living in rural properties, in contrast to land leased to forestry that led to population reduction, and the sale of land to a plantation company that contributed to changing populations (i.e. previous residents moving out and new residents moving into an area). Areas where plantations were established also saw a decline in population, but it is not clear to what extent this related to changing land use (e.g., plantation forestry) (Williams and Schirmer 2012; Schirmer et al., 2008). As Barlow and Cocklin (2003) explain, plantation forestry differs from agricultural land use in part because it involves new forms of landownership, power dynamics, and control (for example, commercial timber companies purchasing or leasing entire farms), and leads to substantial changes to the production landscape. Indeed, a lack of community consultation by forestry companies was interpreted as an indication of changing power relations with new land use actors, and the disempowerment of existing communities (Barlow and Cocklin, 2003).

Social impacts were further experienced in the changing membership of community organisations (e.g., the rural retained fire service and/or sports clubs). In addition to population change (including population decline as well as in-migration), concerns were expressed that afforestation in particular may exacerbate issues of rural decline, and the loss of services, already experienced within small rural communities (Schirmer et al., 2008; Barlow and Cocklin, 2003). This impact on local infrastructure was also anticipated to influence the 'practice' of community, in other words reducing opportunities for interaction and reinforcing social identities (Barlow and Cocklin, 2003), which likely influences the willingness and ability of incoming populations to integrate (or be integrated) within the community (Schirmer et al., 2008).

These studies highlight issues of misattribution, as participants were "*more likely to associate negative socio-economic impacts to prominent land use changes rather than those that are less visible or dominant in local discourse*" (Williams and Schirmer, 2012: 546). Another study of perceptions of land use change in Australia indicated that personal associations with land use and a sense of regional identity may be more significant than factors such as the visual, social, and environmental impacts of land use change (Williams, 2011). Subsequently these authors recommend against "*basing policy responses primarily on common perceptions of impact*" (Williams and Schirmer, 2012: 547).

5. Conclusions

This evidence review has drawn on international academic and grey literature to identify the range of social and economic impacts resulting from types of land use change that may be anticipated (or is already occurring) in Scotland. There are limited long-term empirical studies addressing social and economic impacts of land use change internationally. This wide-ranging literature review (although not exhaustive) provides insights into potential, perceived and actual impacts on local communities, farmers, and rural economies related to a spectrum of land use changes, including land abandonment, nature restoration or 'rewilding', agroecology, agroforestry, and intercropping. A summary of these identified impacts is presented below in Box 1. Positive impacts of land use change include:

- Reduced cultivation and input costs for farmers therefore improving farm resilience.
- Improving access to nutritious local food and strengthening supply chains.
- Reducing rural depopulation and encouraging in-migration, for example through new employment and enterprise opportunities, and the revitalisation of rural communities.
- Improving farmer wellbeing, self-efficacy, peer-to-peer learning and innovation.
- Greater awareness and value placed on local and indigenous knowledge, and landowner stewardship.

Negative impacts of and challenges associated with land use change are reported as to include:

- High costs associated establishing agroforestry or restrictions facing tenant farmers due to high land rental prices.
- A lack of advisory support (e.g. for new entrants) and the challenge of changing farming mindsets.
- The risk of reducing access to land by local communities (e.g. in the context of nature restoration or 'rewilding'), and uncertainty regarding community involvement in decision-making with regard to land use change.
- Uneven impacts of land use change exacerbating existing inequalities and land use change may be socially exclusive.
- Land use changes may have unclear economic rationale (e.g. rewilding) or unproven benefit claims (e.g. regenerative agriculture).

Country case studies relating to specific land use change processes provide detailed analyses of the social and economic benefits and negative impacts associated with these land use changes: biofuel expansion (Germany), farmland used for solar energy (Japan), hydroelectricity developments (Canada), so-called 'carbon forestry' (New Zealand), and multiple land use changes (Australia). The key impacts arising from these case studies are summarised in Box 2. Whilst context specific, the case studies describe positive impacts of land use change including:

- Rural economy benefits including job creation, increased land prices, and improvements to farm incomes (e.g. production of high value crops).
- Increasing agricultural production and diversification opportunities (e.g. agritourism).

- Avoiding land abandonment and resolving land underutilisation.
- Maintaining rural populations and providing resources (e.g. compensation agreements).
- Creating a circular economy, contributing to energy security, and reconnecting people with the land.

Negative impacts of land use change in these case studies are varied, and include:

- Loss of agricultural and other rural employment, decline in secondary services, and outmigration or displacement of farming and other rural communities.
- Perceived environmental, amenity, and landscape degradation (noting that other examples show enhanced landscape qualities and amenities).
- A shift away from traditional food crops and livestock, and the potential for farmland to be used for energy production.
- A loss of traditional knowledge, impacts on indigenous populations, and community disempowerment.

A key theme arising from across the literature review and case studies is that the impacts of land use change may be unequally distributed: socially, spatially, and temporally. Concerns arise across different contexts regarding equity and social justice outcomes associated with land use change. To avoid exacerbating inequalities, the literature reviewed highlights the importance of maintaining social license (i.e. legitimacy) and the social acceptability of land uses through community consultation and participatory approaches to land use planning, as well as developing integrated and small-scale land use changes that provide direct community benefits. Furthermore, the literature emphasises the key role of financial, wellbeing, and advisory support for farmers and land managers seeking to undertake land use transitions towards more ecologically sustainable models such as regenerative agriculture, agroecology, and agroforestry. These are timely insights during a period of legislative reform and land policy reform in Scotland; further proposed policy recommendations are presented below.

Box 1: Social and Economic Impacts of Land Use Change (*positive* / <u>negative</u>)

Agroecology

Positive impacts:

Decreased input costs for farmers
Enhanced production resilience
Improved access to current and future payments for ecosystem services
Improved wellbeing and farmer job satisfaction
Improvements to animal welfare and reduced veterinary bills
Strengthening of local supply chains
Creation of novel and meaningful jobs for new people on farms
Provision of nutritious local food
Supporting greater connection between people and nature
Peer-to-peer engagement fosters learning and innovation
Trust, social capital, new knowledge, purpose, autonomy and agency gained by farmers
Reduced requirements for physical infrastructure and capital on farm
Variable economic impacts depending on farm type and farmer knowledge

Challenges:

<u>Lack of advisory support for new entrants</u>
<u>Tenant farmers restricted in approach due to high rent prices</u>
<u>Challenge of changing farmer mindsets</u>

Regenerative agriculture

Positive impacts:

Farm economic resilience and profitability, contributing to rural community revitalisation
Improving working conditions on farms, contributing to social justice and equity
Provision of high-quality and nutritious food
Impacts on farmers' sense of self-efficacy contributing to improved wellbeing

Challenges and negative impacts:

<u>Lack of clarity in definition inhibits farmers in understanding how to contribute</u>
<u>Concerns regarding appropriation of farming techniques historically created by indigenous peoples</u>
<u>Lack of rigorous testing of benefit claims</u>

Agroforestry and intercropping

Positive impacts:

Reduce cultivation costs and enhance net value of production
Enhance smallholders' income
Increase household food security and nutrition
Promote gender equality and support cultural activities
Encourage development of cooperatives
Reduce rural out-migration and encourage in-migration
Revitalise rural communities
Increase climate awareness, social development, and resilience
Greater awareness and value placed on indigenous knowledge
Increased landowner stewardship

Challenges and negative impacts:

<u>High cost of establishing agroforestry</u>

Nature restoration or 'Rewilding'

Positive impacts:

Opportunities for ecotourism and other ecosystem services
Employment opportunities and support for new enterprises
Revenue sharing opportunities for local communities
Compensation for farmers for wildlife-associated costs
Could provide more viable land uses and management approaches
Sustain existing economic relationships with land

Box 1 (continued): Social and Economic Impacts of Land Use Change (*positive* / negative)

Nature restoration or 'Rewilding'
Challenges and negative impacts:
Reducing access to land by local communities
Uneven impacts could exacerbate inequalities; may be socially exclusive
Wildlife disturbance to crops and livestock
Uncertainty regarding community involvement in governance and decision-making
Unclear economic rationale

Land abandonment
Negative impacts:
Loss of traditional skills and knowledge of farming
Loss of local practices (e.g. labour exchanges)
Weakening of social cohesion in communities
Reduced quality of life
Displacement of rural livelihoods
Loss of local identity and local knowledge
Loss of agricultural and forest products
Negative impacts on farm incomes
Increasing risk of food insecurity locally and nationally

Box 2: Case Studies of Land Use Change (*positive* / negative)

Germany – impacts of biofuel expansion
Positive impacts:
Rural economy benefits through job creation and crop demand
Increased land rents and prices
Creation of a circular economy
Provide additional farm income
Negative impacts:
Shift from livestock has led to loss of agricultural employment
Decreased property values near processing plants
Negative effects on landscape aesthetics, experiences in nature, and sense of place
Reduced cultivation of traditional crops and animals; increase in food prices

Japan – solar energy systems on farmland
Positive impacts:
Providing stable farm incomes
Avoidance of farmland abandonment
Potential to increase production of high value crops (e.g. matcha)
Potential to increase agritourism
Perceptions of energy security
Negative impacts:
Environmental and neighbourhood amenity risks (e.g. sunlight reflections, landscape degradation)
Abandonment of food crops for ornamentals or spice crops that are more shade tolerant
Insignificant contributions to local economy
Potential for high quality farmland to be used for energy production

Canada – hydroelectric development
Positive impacts:
Increased local employment (mainly for men and during construction phase)
Resources provided in compensation agreements (e.g. training opportunities, infrastructure funding, continuation of traditional land use activities)
Negative impacts:
Displacement of communities (in particular, indigenous communities)
Destruction of land-based livelihoods
Increases in violence, crime, and health problems
Stresses on infrastructure from large influxes of workers
Collapse of fisheries due to mercury contamination and sediment
Loss of traditional ecological knowledge

New Zealand – conversion of farmland to pine forest
Positive impacts:
Employment opportunities associated with forestry management phases
Indigenous landowners may benefit from land value increases, resolve land underutilisation and reconnect communities with their land
Negative impacts:
Loss of farming and other rural employment
Outmigration of farming families
Decline in secondary services
Potential for greater rural poverty
Increasing land values restricting land access for existing and new entrant farmers
Reducing options for future land use change
Potential benefits may be restricted due to indigenous land fragmentation, lack of resources and governance
Risk of persistent inequalities between indigenous and settler landholders

Box 2 (cont.): Case Studies of Land Use Change (*positive* / negative)

Australia – multiple land use changes, including afforestation
Positive impacts:
Forestry integrated into existing farms had no impact on farming/rural populations
Negative impacts:
Farmland sold or leased to commercial forestry companies led to population change or decline
Lack of community consultation by forestry companies led to changing power relations and community disempowerment

6. Policy recommendations

To achieve multifunctional, sustainable, and integrated land use in Scotland, the following recommendations have been derived from the preceding literature review:

- Multifunctionality requires policy and subsidy support. It may also be necessary to support farmer access to markets and value chains for products (e.g. agroecological agricultural produce), as well as knowledge networks and peer-support for innovation uptake.
- There is a need for support for financial models that take account of the long-term nature and returns of alternative land management approaches, for example agroforestry systems or transitioning to agroecology.
- Strategic land use planning is necessary to ensure the balance of policy priorities regarding net zero and food production.
- It is important to ensure that land use changes are introduced at a small scale, providing input to local economies and benefit sharing with communities, in order to build and maintain community trust and landscape integration.
- Ensure that community-based impact assessments involve long-term community consultation, participation, and partnerships, in order to mitigate the negative impacts of land use change, and enhance positive impacts (after Lavoie and Hébert, 2022; Pimentel da Silva et al., 2021b).
- It is critical to consider complex and divergent impacts on different groups within rural areas (e.g. farmer vs. rural resident), and the inequalities that may arise through land use change for climate change mitigation (i.e. acknowledge and manage for the complexities of the Just Transition).
- Avoid developing policy responses to land use change based primarily on ‘common perceptions of impact’, due to the likelihood of misattribution of impact and influence of personal association rather than direct impact.
- Support long-term, participatory, inclusive, action-based social science, as well as standardised data collection methodologies, for the monitoring and evaluation of the impacts of land use change in Scotland.

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