Identifying levers for change in UK grazing livestock systems

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Identifying levers for change in UK grazing livestock systems

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There is an urgent need for transformational change in global and UK agriculture. Current practices undermine the long-term future of farming and impoverish ecosystems in the UK and elsewhere. However, change is not happening at the scale and pace which is needed. Work by David Abson, drawing on ideas by Donella Meadows, explored this failure of progress and proposed a research agenda focused on transformational leverage points which influence sustainability. These points are centred on three realms of leverage: reconnecting people to nature, restructuring institutions and rethinking how knowledge is created and used in pursuit of sustainability. In this paper, these ideas are explored through a combined researcher/stakeholder workshop focused on transformational change in UK livestock systems. Workshop participants were asked to discuss and identify potential levers of change under the three realms identified by Abson. The multiplicity of levers identified and the interactions across realms emphasise the need for new kinds of knowledge creation which are highly transdisciplinary, as well as emphasising the complexity of levers which are likely to play a role in the transformation of livestock food systems in the UK and elsewhere.

KEYWORDS

levers, transformative change, agriculture, Abson et al. (2017), workshop

Introduction

Conventional agricultural systems, which currently dominate global food production, have evolved over the last 100 years in response to scientific advancements (e.g., the Haber-Bosch process) and government policies aimed at ensuring adequate food supply for current populations. However, today, agriculture is recognised as one of the main drivers of environmental degradation, contributing to biodiversity loss, soil degradation, water pollution and climate change (DeLong et al., 2015; Rippke et al., 2016; Horton, 2017; Withers et al., 2019). These impacts are beginning to undermine the long-term future of farming and in addition, agriculture must adapt to climate change. Thus, there is an urgent need for transformational change in both agriculture and global food systems (Vermeulen et al., 2018; Willett et al., 2019; Webb et al., 2020). Such change needs to consider the social, economic and environmental effects of food production alongside issues of social justice (Whitfield et al., 2021), especially if we want to meet the UN Sustainable Development Goals. While some argue that we may be approaching a tipping point (Pretty et al., 2018) for a widespread system redesign in agriculture that encompasses agroecological and regenerative approaches, it is

unclear what is needed to accelerate change that results in a shift towards this new agricultural paradigm in a socially just way.

Abson et al. (2017) claim that sustainability science is often focused on interventions which are tangible but essentially weak in terms of transformation potential, largely due to their singular focus on either environmental, social or economic goals. In this context Meadows (1999) and Abson et al. (2017) argue for an integrated systemic framework for tackling societal challenges in which science is better joined up across disciplines to research and identify effective (strong) "leverage points" i.e., places where adjustments may result in overall systemic change (Figure 1). Abson et al. (2017) proposed that strong interventions can occur across three key realms of "deep leverage": 1. "Re-connect": reconnecting people to nature to encourage sustainable behaviours while shortening feedbacks 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 for sustainability.

In the United Kingdom and other developed nations livestock numbers have fluctuated since the 1950s with increases until the 1980s largely driven by improvements in farming efficiency, animal breeding (Donald, 1973) and grassland productivity (Fuller, 1987). Subsequent changes in the UK and Europe were primarily driven by European Union (EU) agricultural policy agendas (Swinbank, 2018). Research in UK beef and sheep farming in recent decades has focused on animal productivity (Berry and Crowley, 2013), welfare issues [see Rioja-Lang et al. (2020)], improving biodiversity within grassland systems (Tallowin et al., 2005) and on rural economies (see Lowe and Phillipson, 2006). Very little research has focused on approaches to understanding livestock production within an integrated systemic approach which considers social, environmental, and economic aspects of production, although see Waterton et al. (2015).

In recent years, the negative impacts of livestock production on climate and on human health (Godfray et al., 2018; Willett et al., 2019), in particular their contribution to between 14 and 16% of methane and nitrous oxide (greenhouse gas (GHG)) emissions at a global level (Cusack et al., 2021) have placed livestock production in the spotlight and highlighted the need for more systemic research approaches. The research described here focuses on four primarily livestock-based projects which adopted such approaches and were part of the UK Global Food Security (GFS) research programme (Table 1). The UK system has many commonalities with livestock systems in other parts of the developed world but is particularly important in the UK as pasture (livestock grazed grass) is the most ubiquitous land use here, covering over 40% of the total land area. Identifying what needs to change in pasture systems and providing valuable research on key leverage points could therefore be very significant for the UK environment and for social and economic sustainability in rural areas, as well as for the provision of healthy livestock and accessible high-quality livestock products both for the United Kingdom and for export.

To better understand the potential for transformational change in UK livestock systems, the leverage-points framework of Abson et al. (2017) was applied to pasture systems in the UK within the context of research on these systems under the GFS programme. Academic representatives of five projects (four livestock focused and one focused on pollinators) came together with a diverse group of policy and agrifood business stakeholders (Table 1) in a two-day workshop to apply the leverage-points framework. The workshop aimed to explore whether the realms of 'deep leverage' identified by Abson et al. (2017) were relevant to the transformation of the UK livestock system as an example of a prevalent current food system in the developed world.

Approach

A workshop was held over 2 days from the 17–18th June 2019 in Edinburgh, with 25 participants, including an invited stakeholder group and researchers from five projects within the GFS programme (project details can be found in Supplementary Table S1). The invited stakeholders covered several different dimensions of pasture food systems from farm to fork (European Commission, 2020). The workshop and the approach taken, i.e., including both researchers and practitioners reflected the stated need for 're-thinking' research approaches as outlined above.

All attendees were informed about the aims and approaches to be taken within the workshop and provided with the paper by Abson et al. (2017) to read before attending. At the workshop, brief presentations were given by researchers and stakeholders participating in four pasture livestock projects funded under the GFS research programme (Table 1). Subsequently attendees were introduced to the Abson paper and to the aims of the workshop in terms of testing Absons' theory, i.e., to answer the question: Are the three realms of deep leverage Abson identified relevant to a transformation of pasture systems in the United Kingdom? On day 1, workshop attendees were divided into two randomly assigned groups to undertake an interactive session on identifying current issues around pasture systems in the United Kingdom. Participants in each group were asked to focus on the following questions:

- Do we think that pasture systems are in trouble? Or are they fine as they are?
- If they are in trouble, what are the key issues/problems with current pasture systems?

Attendees discussed the answers to the questions in their group and wrote responses on sticky notes. The two groups then came back together to discuss responses and the findings (sticky notes) were consolidated under common themes by the whole group together and further discussed in a follow up session. On day 2, the two groups were asked to consider the following questions sequentially in three separate sessions:

- To what extent might institutional change influence pasture systems (restructure)?
- To what extent might reconnecting with nature influence pasture systems (reconnect)? and
- To what extent might knowledge production and use be important in re-orienting pasture systems (rethink)?

A final feedback session enabled participants to comment on/add to workshop outputs.

On day 2, discussions within each group were written down by assigned researchers and via a flipchart to capture key points. The outputs were subsequently grouped thematically by each group

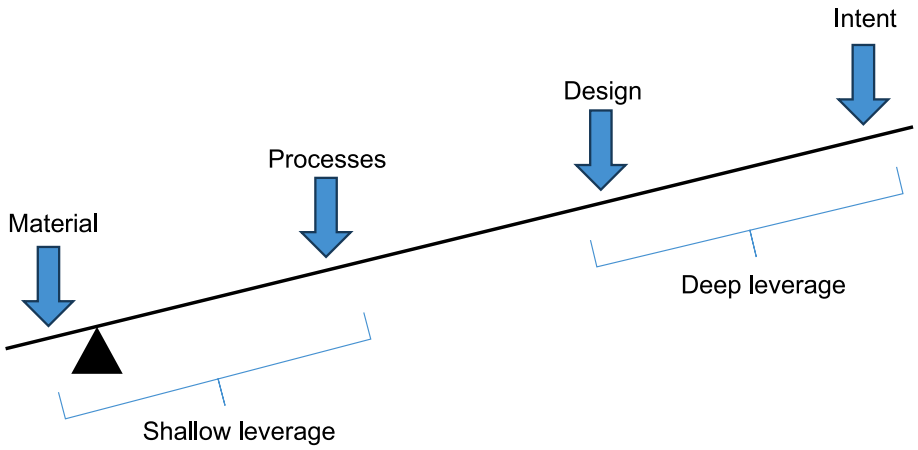

FIGURE 1
The leverage points framework presented here uses Meadows's (1999) 'Places to intervene in a system' to illustrate that shallow leverage points are concerned with changing materials and processes in a system whereas the deeper leverage points aim to change design and intent [see Abson et al., 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.

individually and, for key points, by the whole group in final discussion sessions within the workshop. Further consolidation of findings, bringing together all the findings from the two groups for each of the realms of leverage, was carried out by pairs of researchers shortly after the workshops.

Results and discussion

Results are captured in brief in Figure 2.

Identification of issues facing pasture systems

The first question was primarily designed to provoke discussion, all attendees recognised the need for changes in UK livestock systems. In discussion, participants indicated numerous issues currently faced by pasture systems; those that featured prominently are covered below under the following three broad headings.

Knowledge gaps and research funding structure

Participants considered that investment in research on pasture (livestock grazed grasslands) has lagged behind other areas of agricultural research—for example, that on arable land, which has seen huge investment in plant breeding to improve wheat yields over the last four decades. The perception was that this has led to large overarching knowledge gaps relevant to current challenges facing pasture-based food production. For example, questions regarding soil carbon sequestration under pasture, appropriate methodologies and data for Life Cycle Assessments (LCA) of pasture animals, or the potential benefits of diverse pastures for biodiversity and ecosystem functioning. There was a perception that current research funding is more focused on technological solutions aimed at primarily improving productivity/profitability and business development, as opposed to a potential lack of funding for bottom-up practice-based innovation towards outcomes that impact on farm environmental sustainability (such as healthy soils) and the delivery of public goods, not just profitability. A lack of funding for systems-based research approaches to pasture food systems was also perceived to extend to a lack of joined up thinking across farming sectors (such as arable and livestock) and research disciplines. Gaps were highlighted around understanding relationships between social structures, e.g., ownership and land management patterns and pasture livestock sustainability.

The value chain in food production and subsidies

The continued devaluation of the farmers' role in food production, partly because of vertical supply chain integration was seen as a key challenge for the future of pasture farming. Outside of what might be perceived as 'niche' areas of pasture production (e.g., organic), it was considered that models of expansion and further supply chain integration (as currently for large poultry producers who have their own feed mills, production facilities and logistics) could mean that a few very large producers end up setting prices and controlling the pasture-based production supply chain. It was argued that while this might be beneficial for the production of cheap food, in terms of long-term sustainability of systems and enhanced biodiversity or socio-economic cohesion, such a development could be highly damaging. The current model for livestock farming in New Zealand was cited as an example of supply chain integration, where one milk company, two meat companies and two major merchants control most of the market and can produce more and cheaper food, but at a high environmental cost, e.g., declines in water quality. Several participants identified that interventions in the supply chain that allowed farmers to realise the full value of their products were needed, e.g., farmers setting their own prices for products. The lack of processing facilities at local scales (e.g., abattoirs) was also raised as important in the context of value chains and access to local markets. The question was also asked as to who would be farming in 20 years' time? And how that would affect any potential agricultural transformation.

TABLE 1 Description of the four key pasture-related projects central to the workshop.

Project	Resilience in upland livestock systems (ResULTS)	RePhoKUs	Resilient dairy landscapes	Sustainable economic and ecological grazing systems_learning from innovative practitioners (SEEGSLIP)
Regions	Scottish Borders, Orkney, Isle of Skye/ North Uist, Yorkshire Dales, upland and island areas that are economically disadvantaged and physically remote.	Whole of UK food system, regional case study (Northern Ireland) and 3 catchment regions in the UK (Upper Bann, Welland and Wye).	Cumbria	UK
Livestock type	Beef cattle and sheep.	All livestock relevant to those geographical areas.	Dairy; most also had sheep and some beef.	Primarily focus beef cattle and sheep.
Pasture Systems	Upland pasture systems, including rough hill grazing and specialised machair grassland (found only in Ireland and NW Scotland).	All systems relevant to those geographical areas.	Predominantly perennial rye grass ley and permanent grassland which receives combination of slurry, farmyard manure and fertiliser.	Pasture Fed—Permanent grassland and temporary leys. High % organic certified or with low fertiliser inputs.
Focus	How beef cattle and sheep farmers can improve their resilience to environmental, economic, and social change, and impacts of actions on food supplies, natural resources and society.	Increasing the sustainability of phosphorus use in our food system and resilience to phosphorus 'shocks'.	Exploring the trade-offs between farmers' livelihoods, the natural environment and the stable supply of reasonably priced dairy products.	Economic, ecological and social sustainability of pasture fed systems. Learning from the practitioners.
Approaches	Absorbing the impact of changes, adapting to change and changing the food system.	5R Strategy: Realign P inputs Reduce P losses Recycle P bioresources Recover P in wastes Redefine systems	Develop an approach linking management of landscapes to business and society needs and produce evidence on delivery of public goods and impacts on common livestock disease dynamics.	Measuring the delivery of public goods, assessing the ecological status of land and assessing the social resilience of farmers and farmer support mechanisms.
Practices	Improved management, reduced supply chain length, adding value to products, attempts at 12-month supply, changes in stocking rates and breeds, reduced external inputs, management for public goods and group activities (e.g., purchasing rings, sheep management clubs).	Reducing reliance on supplementary feed. Better matching phosphorus soil inputs (manure and fertiliser) to grass demand and utilising 'legacy' P stores from historic high inputs. Improved bioresource management.	Hedge planting, tree planting, watercourse fencing, & nutrient management planning as part of Nestle-First Milk Premium scheme (private agri-environment scheme).	Adherence to pasture fed livestock association standards, 'mob' grazing approaches. Membership of the PFLA.
Outcomes	Improve incomes to farmers/crofters, maintain infrastructure by (sufficient numbers of active farmers), provide employment possibilities, maintain landscapes and biodiversity, maintain traditional cultures.	Decreased reliance on imported phosphorus in feed and fertiliser for food production. Increased phosphorus circularity. Reduced riverine phosphorus pollution.	Evidence of improved economic and environmental sustainability of dairy farming by use of public-private partnerships compared to agri-environment schemes.	Evidence of the economic, ecological and social sustainability of pasture fed systems. Evidence on specific practices and potential applicability to wider livestock systems.
Diversification	Tourism, forestry, energy generation, educational activities.	N/A	Tourism, farm visits, adding value to products, e.g., ice cream.	Individual farmers may have diverse income sources - e.g., tourism, farm visits

It was argued that the way that subsidies end up being distributed through the value chain, with subsidies paid directly to the farmer, resulted in input providers raising prices for farmers. Participants felt that agri-environment schemes (which will be the only source of subsidy within a few years) needed to become more effective at enhancing agriculture's environmental performance across all farming types.

Perceptions of food and pasture landscapes

A mismatch between how consumers purchase and eat food and food production was perceived to be a key issue. Participants noted that not only do just over 80% of the UK population live in cities, but intensification and consolidation of agriculture in recent decades has led to only a small proportion of the UK population being currently

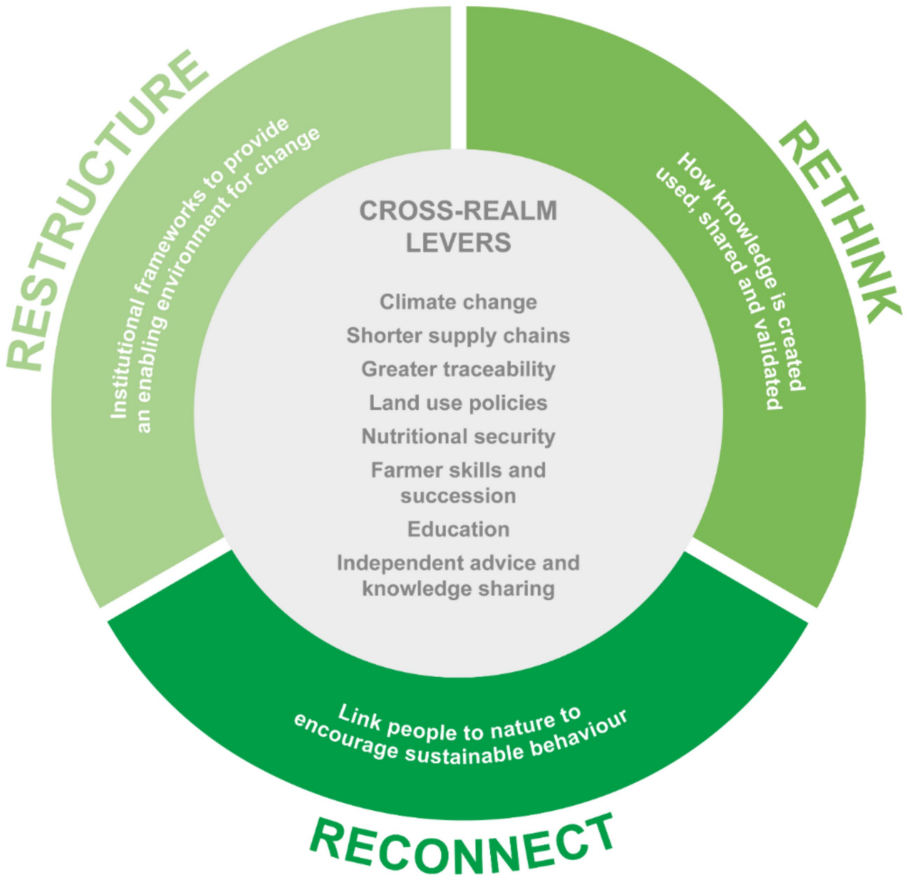

FIGURE 2
Summary diagram describing Abson et al. (2017) three realms of leverage and the cross-realm levers identified as important for grazing livestock systems.

involved in food production. They argued that consumers are getting further and further away from their food, physically, psychologically and emotionally, and as a result, consumers are disconnected from the farm and rural environments and have relatively little understanding or awareness of where or how food is produced and how different farming systems affect the environment and rural landscapes. Most consumers buy most of their food from supermarkets, a large proportion of which is highly processed, and they have little idea of whether that food has come from local farms or from farms across the other side of the world, particularly in ready meals. Without a better understanding of how and where our food is grown, consumers are not able to make informed decisions about the consequences of their food purchases on, for example, animal welfare, the environment and climate change. It was also perceived that consumers of landscapes (like those of food) had relatively little understanding of the role of farming in maintaining cultural and physical landscapes.

Leverage points

The outputs from the workshop have been aggregated under key leverage points within each of the three realms highlighted by participants as fundamentally important areas for research which can directly influence transformational change in pasture livestock systems, N.B. these are workshop outputs and hence we do not cite current literatures to support (or otherwise). Workshop participants also recognised that in many cases there was cross over among these realms and these are presented in Table 2. Examples of where research under livestock projects within the GFS programme is already addressing some of the key leverage points raised, are highlighted in boxes below.

Re-connect

Abson et al. (2017) suggest that a greater connection between people and nature may act as a lever for sustainability transformation. Workshop participants similarly emphasised the need to re-connect people with nature and food, including the impact of consumption decisions on wildlife and human health. Participants identified the following four main groups of people and levers for change as important for being re-connected with pasture systems:

Reconnecting farmers (with the ecology of their land and production systems)

Workshop participants highlighted farmers working together to create and share knowledge as important for changing farmers'

TABLE 2 Areas in which levers were identified across all three key realms of leverage (cross-realm levers as titles in shaded boxes).

Shorter supply chains		
Re-think	**Re-structure**	**Re-connect**
• Farmers have the skills to engage with and provide produce to local markets. • Consumers understand the benefits of buying from short supply chains.	• Consistent supplies of high quality local food produced in sufficient quantity for private businesses and public procurement. • Availability of local slaughter facilities; local dairies	• Consumers connect with provenance (tourism can be a facilitator) • Consumers respond to environmental concerns, (e.g., plastics, climate change) by buying local • Farmers add value to their produce • Public sector food providers to take social and environmental sustainability into account (e.g., Preston model)[a]
Block chain for greater transparency and traceability		
• Agri-food sector understands how its use will affect their supply chains. • Consumers understand what its value is to them and how it can help them make informed choices on buying food.	• Policies to ensure that provenance and sustainability are traceable for all food ingredients. • Forming public-private partnerships to enhance transparency.	• Retailers provide clearer labelling with origin and production method, and social/ environmental impact • Consumers are enabled to exercise validated food choices.
Climate change		
• Farmers create, share and use new knowledge to re-think their pasture based systems in order for them to be climate resilient. • Consumers understand the climate change impacts of the food they are eating and differences between pasture-based and more intensive systems. • Researchers increase understanding and share knowledge on the potential for pasture based systems to adapt to and mitigate climate change.	• Agricultural, environmental, transport (logistics) & food/plastic/water waste policies designed to reduce climate change and actively mitigate against it. • Coherence among policies.	• Farmers adapt p management to improve climate resilience. • Consumers realise that production systems affect the environment (and GHG emissions) differently and buy accordingly. • Agri-food businesses are concerned about the resilience of their supply chain. • Policies have led farmers to re- evaluate their perception of trees and livestock.
Land use policies		
• Creation of new knowledge on the benefits of environmental goods and services allowing their integration in policy and regulation. • Institutions (DAERA, Natural England, Scottish Environment Protection Agency etc.) should be informed by scientific research that is not just production focused.	• Joined-up government environmental strategy for the food, energy and water nexus. • Coherence among post-BREXIT agricultural payments, incentives for forestry/renewables and regulations for environmental protection/ conservation.	• Farmers' perception of the role of pasture shifts to value natural capital more. • Native breeds encouraged through agri-environment scheme and economics
Nutrition security, including food security and safety		
• Provide evidence of the nutritional and health value of pasture produced food. • Cross system knowledge to link human and environmental health. • Consumers have better awareness of nutritional and health value of pasture produced food.	• Raising and enforcing policy/legal requirements, industry norms and public procurement priorities for food safety and nutritional value. • Adapting the UK EatWell guide to include these issues.	• Consumers reconnect to nutrition security and food safety (e.g., through the UK EatWell guide). • Public sector food providers to take nutrition security and food safety into account.
Farmers' skills & succession		
• Facilitating farmer skills/knowledge through training, e.g., in food processing and business to add value to basic products.	• Market arrangements which reward farmers with adequate returns as part of encouraging younger generations to see farming as a promising career pathway.	• Formation and propagation of farmer groups with a vision of ensuring agricultural sustainability in the future.
Education		
• Embed change from an early age with the educational curriculum, linking people with the natural and farming environment. • 'Train the trainers' in existing knowledge sharing systems (e.g., agronomists) so advisors are aware of sustainable transformation goals. • Changes to the agricultural education syllabus that promote sustainable farming practice.	• Education policy that includes healthy eating and environmental sustainability. • Existing monitoring farm networks need to be adapted for agroecological practices/ principles • Policies requiring farmers to monitor ecological aspects of their practices.	• Promote initiatives that reconnect citizens' with where their food comes from and with grazing livestock systems (e.g., farm visits). • Promote food and farm tourism linking citizens with pastures. • Provide facilitation/funding for farmer group learning and reconnection to alternative environmentally sustainable farming practices.

(Continued)

TABLE 2 (Continued)

Shorter supply chains		
Re-think	Re-structure	Re-connect
Independent advice/knowledge sharing		
• Develop new knowledge sharing systems that link scientists with practitioners.	• Decouple agricultural advisory/extension services from product sales. • Free reliable public extension services.	• Reconnect farmers with reliable independent advice towards ensuring agricultural sustainability in the future, e.g., Farmer led, NGO led and Private-public partnerships.

[a]https://www.preston.gov.uk/article/1339/What-is-Preston-Model.

connections with soil, ecosystems and different patterns of pasture management. Farmer groups can also benefit from external research input and policy initiatives which have a focus on future sustainability and the delivery of public goods. This has the potential to change farmers' perceptions of their role and thus reconnect them with their farming ecosystem and change how they value different parts of their farming enterprise and potentially, change pasture management strategies.

Agri-environment schemes (such as the DAERA Environmental Farming Scheme) and economic drivers which can reconnect farmers with native breeds that thrive better on native pastures than continental breeds could be impactful if payments are sufficient. By changing breed, farmers reconnect with what the land can produce without high external inputs (move from intensive to extensive systems that are more reliant on grass to feed animals) and see soil as an asset that they need to manage and value.

Recent extreme weather events are changing farmers' perceptions by showing them that their farming systems are vulnerable to climate change and they need to adapt. As a result of this some farmers are reconnecting to their environment by, e.g., increasing sward diversity to enhance resilience to drought and flooding or deciding to include trees in their pasture systems.

Reconnecting citizens

Participants identified many initiatives which have been started with the aim of reconnecting citizens' with where their food comes from and with grazing livestock. These include Open Farm Sunday, Agricultural shows, Farm access (via agri-environment schemes), and social media events. Some of the initiatives aim to inspire, engage and educate young people about the journey from farm to fork through positive stories.

Tourism can be an important lever in re-connecting citizens with nature, pasture farming and food. Re-connection can be on a passive basis, of observation while driving past in the car, or can be more active, where facilitated by farmers or organisations which encourage tourists to engage with farming. For example, farm stays on working farms can allow citizens to reconnect with farming, e.g., feeding lambs or watching cows being milked. Tourists may also have the opportunity to try local food and improve their understanding of provenance, e.g., Beef from Highland cows, Welsh Lamb. Organisations that support this, e.g., Scotland Food and Drink are thereby providing a lever for change. There are, of course, potential downsides to encouraging tourism, namely that excessive numbers of tourists can degrade landscapes or provide negative critiques of what they see, sometimes due to limited understanding of farming practices.

Re-wilding, which has been the subject of recent popular publications (Monbiot, 2013; Tree, 2018) has captured public attention and can help reconnect citizens with nature, although not always with grazing livestock. Iconic examples, however, such as the Knepp estate (Tree, 2018), can emphasise a specific role that grazing animals and pasture may have in such contexts. The role of grazing livestock in maintaining specific valued biodiversity (e.g., on chalk lands, salt marshes and machair) can also potentially reconnect citizens with nature.

Reconnecting consumers

Consumers are influenced by a number of different actors, including governments, supermarkets, media and farmers. Participants felt that linking consumers to healthy diets which support nature through environmentally sustainable practices could provide a lever for change in practices, although it was acknowledged that price is a key driver. Direct buying from farms or through local shops, including value-added products, such as ice cream or cheese, allows consumers to reconnect with food provenance and grazing livestock, but may not be practical for large numbers of farms.

Public sector food providers, such as schools, hospitals and care homes for the elderly may be able to take such decisions on behalf of their consumers. UK Initiatives encouraging public sector organisations to provide a healthy diet, sourced locally with sustainability criteria in mind include local food hubs, and initiatives by non-government organisations (NGO's), such as, a Food for Life initiative and Dynamic Food Procurement (Soil Association, 2020). Such changes require a change in mindset for those in charge of procurement in local and central governments but appear to be supported by national government in the UK (House of Commons Environment Food and Rural Affairs Committee, 2021). There may also be practical issues in realising aspirations, such as schools needing to be supplied with ready prepared vegetables as they lack the infrastructure to process vegetables themselves.

Supermarkets could promote and market much more of their food in specific ways which enable consumers to make choices according to their values. Appropriate and accessible labelling (see also Re-think c below), positioning on shelves and promotion campaigns can also lever new connections between consumers and producers. Novel forms of labelling, such as increased use of QR codes indicating provenance and production method could be used.

Media (including social media) enables the communication of values and can precipitate a reconnection between consumers/citizens and farmers or farming more generally. For example, media and social media, campaigns by NGO's and research outputs have changed individuals' perception of how ruminant livestock contribute to greenhouse gas (GHG) emissions and climate change and thus their behaviours, including the need to eat less meat and dairy. This has generated debate as to which sort of livestock systems has least impact on GHG emissions and could encourage reconnections to low input

pasture-based systems. Similarly, media coverage around trade deals post-BREXIT reconnects consumers with how food is produced in different countries, potentially to different welfare, hygiene and environmental standards. Purchasing decisions could then switch to buying grass fed low input livestock from the United Kingdom.

Consumers can, in theory, have a large impact on the types of production system practised, but this relies on consumers having clear knowledge about systems and their impacts. This is challenging, as the impacts of production systems are complex and are usually communicated in simplistic terms, e.g., 'eat local' or even 'eat local and seasonal'. Increased recognition of the value of ruminant livestock, for example, in the creation of specific high-nature value pastures (see reconnecting citizens, below) could change consumer perceptions as to what sort of meat to eat, rather than whether to eat meat or not. This may be more difficult to achieve in ready-made meals where sources of ingredients are often difficult to establish. Sometimes reconnections are unexpected and happen because of drivers in other spheres. For example, the desire by consumers to use less plastics, has led to them to reconnect with milk delivery in glass bottles often from local dairies and thus local dairy herds; hence re-connecting the consumer with the local pasture-based producer.

Reconnecting agri-food businesses

Participants noted that agri-food businesses are reconnecting with the landscapes they source their raw materials from, recognising them as the 'natural capital' on which their businesses are reliant and understanding the need for resilient supply chains in the face of climate change and other pressures (see Box 1). This has been highlighted by a recent United Nations Environment Programme report (United Nations Environment Programme, 2021). A switch towards valuing and enhancing the natural capital underlying production could provide a strong lever for transforming livestock systems (see Box 1).

BOX 1 Reconnect case study.

Recognition by agri-food businesses that the loss and degradation of natural ecosystems they rely on for their raw materials brings operational risk has led to commitments to reverse nature loss and restore natural systems upon which their economic activity depends. The Nestle-First Milk partnership aims to secure the long-term supply of milk to its processing plants by paying farmers a premium for their milk if they carry out specific practices/interventions that aim to protect water bodies, improve biodiversity, reduce greenhouse gas emissions, antibiotic use and on-farm plastics, and increase soil carbon. Thus, farmers are also re-connecting with new ideas and practices around how they manage their pastures, soils, and livestock. The Resilient Dairy Landscapes team is evaluating the impact of the Nestle-First-Milk scheme, by assessing the delivery of public goods from Landscape Enterprise Networks (LENs) via empirical data collection and modelling of interventions funded under the scheme, such as planting hedges and fencing waterbodies. Results show, for example, that hedgerow planting within the scheme occurred at double the rate of public agri-environment schemes.

BOX 2 Rethink case study.

Recent examples of successful co-innovation approaches include the "Field-lab" model currently being applied within the UK Innovative Farmers programme, led by the Soil Association. In these projects farmer groups work with an academic researcher to design approaches to test farm innovations which they plan to, or are already, adopting. The Sustainable Economic and Ecological Grazing Systems_Learning From Innovative Practitioners (SEEGSLIP) project has built on some of the approaches used in these initiatives and on the development of a research group, established by the Pasture Fed Livestock Association to foster research questions and priorities for further exploration with academic partners. This engagement is contributing to new concepts and research agendas whilst also helping to monitor and demonstrate the factors affecting the uptake and success of interventions.

Re-think

Abson et al. (2017) point to the fundamental importance of re-thinking how different types of knowledge interact, and how they can be drawn-upon to foster sustainability. This relates to how knowledge is (a) *created*, (b) *shared* and (c) *used* in society, and how developments in each of these areas can influence transformation processes (Berkes, 2009). Workshop participants highlighted the following levers within each of these three categories of knowledge:

Knowledge creation

Engaging farmers in research for immediacy and impact

Taking a co-innovation approach in research process(es) which values the inclusion of tacit knowledge, encourages end-user engagement and can increase the relevance, immediacy and impact of research (e.g., through engaging with farmer knowledge, see Box 2).

Facilitation funds are a key aspect of such co-innovation approaches, enabling farmer and (sometimes) researcher time to be covered. Facilitation Funds (Agency, R.P, 2020) can also provide a valuable framework for farmer interaction, allowing for management of the natural environment at a landscape rather than single-farm scale, helping to achieve greater improvements than individual holdings could on their own (e.g., through the generation of wildlife corridors).

Working with innovative farm systems through monitor farms (farms set up with recording instruments for demonstration purposes) can allow for the application of real-world context in research / demonstration. Work within SEEGSLIP (Box 2) is an example of research funding moving towards supporting engagement and evidence creation with a particular group of innovative practitioners.

Re-focusing research funding

It was considered that re-aligning research programmes to recognise the socio-ecological context of food systems innovation can promote systemic change, e.g., through identifying "what works" in a specific socio-technological or socio-ecological context. Collaborative effort between classic "end-users" and "researchers" in devising research topics, methods and routes to dissemination (or co-production of solutions) have been features of previous successful United Kingdom and European research programmes [e.g., the UK

Sustainable Agricultural Research Innovation Club (SARIC), EU Fabulous Farmers].

Support for "low-tech" or "tacit knowledge-intensive" innovations for the transformation of pasture landscapes was considered likely to prove more beneficial for system transformation than current high-tech focused funding opportunities. A re-alignment of research priorities to lever innovation towards end-users' needs through collaboration at all levels from topic identification, to project evaluation and implementation is required.

Knowledge sharing

Newly created or existing knowledge is only valuable if effectively shared with the end users and appropriated by them. Understanding how knowledge flows between stakeholders in pasture food systems could provide a key leverage point for achieving sustainability transformations in pasture systems. Traditional top-down extension (public -sector) and agronomy (private sector) services are currently perceived to be contributing to the 'status quo' of unsustainable practice and could therefore be incompatible with sustainability transformations. Shifting these conventional systems of knowledge sharing towards more sustainable practices and adopting new and innovative approaches (as below) could be a key lever for changing practices.

Facilitating peer-to-peer knowledge sharing

Similarly, to knowledge creation and co-innovation which involves farmers, farmer-to-farmer knowledge exchange can improve the transfer of local knowledge that considers context-specific capabilities, drivers and barriers. Examples of UK networks are included above, other network include those supported by EU projects (e.g., AGROMIX and AGFORWARD) and Quorum Sense in New Zealand. Workshop attendees considered farmer-led knowledge sharing activities to be not particularly well supported within research activities.

Increasing the use of social media for knowledge exchange and building relationships between producers and consumers

Platforms such as Twitter and YouTube are now routine channels for knowledge exchange among communities of practice - in particular among the farming community where their popularity has been marked, enabling effective knowledge sharing and outreach. Driving the uptake of such platforms (e.g., through agricultural training and extension services) could further equip farmers with tools needed to reach a wider community of practitioners. In addition, social media connects farmers with consumers and the food production system so they can develop relationships with the farmers producing their food. Fostering these connections between different elements of the food chain can inform consumer purchasing decisions that support sustainable pasture management. The potential negative role of social media in disseminating fake information on pasture systems was also acknowledged by participants.

Knowledge use

How and where knowledge is applied can fundamentally determine its influence. Practical examples of levers that could encourage developments in this area were given at the workshop in the following areas:

Structures and incentives for knowledge application

Retailers are working with suppliers to provide accurate data targeted at practical issues relating to sustainability and resilience, including indicators relating to water-use, soil health, biodiversity, waste and food quality, e.g., in the United Kingdom, Marks and Spencer's Plan A (M and S, 2021).

Accountability and messaging

Self-regulation and monitoring, even at a basic level, can lead to an increased awareness of externalities (positive and negative) linked to a particular farming approach and the adoption of follow-on measures to address any impacts. The producer-led Pasture for Life standards encourage a re-thinking of the farm system with a view to reducing environmental impact through a self-regulatory framework based on published standards. Farmer-led monitoring (e.g., through the use of Soilmentor, a farmer focused web app that provides a framework for the evaluation of soil health) can also help to influence the uptake of sustainable practice and facilitate change towards environmentally sustainable practices.

Re-structure

The leverage points framework proposed by Abson et al. (2017) covers both 'soft' and 'hard' institutions (Oberthur, 2019), although not described in those terms. Workshop outputs indicate that structural elements of the food system, e.g., configurations of the supply chain should also be included as a source of potential levers. Levers identified in the workshop are included under these three headings below:

Hard institutions

It was felt that leaving the EU offered strong leverage opportunities for the UK in four main areas, namely, trade-deals, impacts on standards, access to foreign labour and agricultural subsidies. The impacts on standards of production provide potential levers for restricting or accepting imports which could either maintain or undermine existing standards of sustainable production and animal welfare which, in the UK, are some of the highest in the world. Negotiations about UK access to EU markets for livestock products constitute levers with significant impacts on UK producers, e.g., UK sheep and lamb production rely heavily on European export markets (Bevan et al., 2019). Conversely, access of US markets and Australian markets to UK consumers pose a threat to UK production and the standards (e.g., high animal welfare) which underpin it; however, trade agreements were made with these countries. In terms of access to foreign labour, decisions about EU free movement were anticipated

to be and have proved to be, an important lever. The UK was reliant on the EU for labour, including skilled veterinary practitioners and meat processing specialists and is now choosing to provide training and higher wages to encourage UK nationals to take up these [meat processing roles. Finally, agricultural subsidy regimes have provided levers for shifting subsidy towards payments for public goods (see also reconnecting farmers a)], within World Trade Organisation constraints and ensuring adequate payment for their delivery. This reverses historic support payments focused on food production and ensures a forward focus on agri-environmental protection. In this respect, policies which ensure that subsidies for land management are received by those managing the land rather than landowners will help to make farming viable for tenant farmers, thereby ensuring more sustainable land management practices.

Problems which have arisen from existing policies provide further leverage opportunities; for example, land reform and forestry policies including tax incentives (Scotland); provide an opportunity for policy makers to address issues (such as tree planting on agricultural land) which are resulting in tensions between landowners and tenants (see Box 3). Participants felt that a general lack of coherence across policy areas needs to be addressed to ensure effective consideration of food systems. In Wales, integration of policy on food, land use, health and the environment have been pulled together under the Wellbeing of Future of Generations Act (Welsh Government, 2015) which is a powerful lever for guiding practitioners in rural development. In terms of public and private policies around healthy eating, regulations are required as levers to ensure that food reaching retail outlets is safe, nutritious and does not cause environmental damage thereby influencing private policies which reflect that. Similarly existing waste management regulations, both public and private, need to change in order to provide potential levers for ensuring minimal waste and creating a circular economy from field to fork.

Effective certification schemes backed by evidence to show environmental sustainability could provide strong levers for system change, e.g., organic certification (see also Rethink c). Policies to regulate GHG emissions on farm under Net Zero legislation are also likely to have a future impact. Similarly private policies (e.g., by supermarkets) to achieve net zero emissions from supply chains will drive change, as will voluntary policies adopted by industry bodies like the National Farmers' Union which has launched a GHG action plan in England.

Hard institutional levers also relate to price mechanisms and market arrangements. Much of our food is embedded in globalised supply networks and food prices need to reflect the environmental and social costs of provision in order to avoid exporting negative externalities overseas, e.g., the environmental and social costs of soya provision for livestock should be reflected in livestock food prices. Local foods in short supply chains may, for example, be produced using inputs such as soy and hence do not necessarily avoid the export of such externalities. In terms of market arrangements, the introduction of measures which minimise risks of market fluctuations (e.g., in world prices) to producers, such as the introduction of contracts that ensure adequate returns, may be a lever for change. Contracts could, for example, include costs involved in assessing farm level public goods delivery (through consultancy or advisory service charges) or the costs covering the provision of feed.

Soft institutions

The workshop identified levers based around 'soft' institutions which are essentially the 'unwritten rules of the game'. The workshop participants indicated aspects related to changing markets, success criteria and rewards and the benefits of co-operative ventures, as detailed below.

In order to move away from markets where goods are exchanged rapidly without a good understanding of production methods (spot markets), towards markets based on longer-term sustainable relationships, it is important to identify levers which promote mutually beneficial relationships between producers, suppliers and customers. Such levers include accountability, transparency and more efficient feedback mechanisms along the supply chain. Currently, the proliferation of private certification schemes and the imposition of supermarket sustainability requirements on farmers (as eligibility criteria) leads to farmers being disproportionately burdened with the cost and bureaucracy of trying to deliver sound environmental sustainability. This, combined with low prices for products, which barely cover the increasing costs of production (e.g., labour, straw, inputs), leads to subsidies to farmers leaking to upstream and downstream actors. Aligned with this move, a key lever for change in soft systems/institutions would involve improved public understandings of the whole agri-food system and the roles of supply chain actors (other than farmers) in ensuring environmental sustainability. Transparency across the system should ensure that farmers are recompensed for their roles in the system thereby making farming more appealing for all, but in particular, as pointed out in the workshop, for younger farmers.

Another potential lever for producers would be a move away from the commodification of livestock products and a stronger emphasis on issues of local provenance and market specialisation. This may be supported by producer innovation, local markets/outlets or shifts in policy for larger retailers. Some larger retailers (supermarkets) in the United Kingdom already adopt such policies.

Other issues include the over-emphasis by beef and sheep farmers on last year's yields and prices achieved (usually at auction markets) based on subjective aesthetic criteria rather than objective criteria such as actual net profit margins. A shift in emphasis towards objective success criteria including re-designed carcass criteria at abattoirs would provide a lever towards ensuring the production of high quality nutritious and tasty food that better fits the consumers' and retailers' criteria. Some farmers' lack of attention to actual profit margins results from insufficient on-farm monitoring of production costs and the lack of performance (quality) measures based on objective criteria. It is therefore important to identify levers which promote better monitoring of performance and profit margins and which link profit to performance records. The beef and sheep industry could learn from the dairy industry in this respect.

Finally, increasing the number of co-operatives would strengthen the bargaining power for UK farmers [who tend to trade alone, as compared to French farmers (Filippi and Triboulet, 2011)], providing a lever for influencing relationships with processors, retailers, and consumers. However, it is apparent that in the UK there is little trust in the potential for building effective co-operatives and a correspondingly low commitment to existing schemes in the UK (MacMillan and Cusworth, 2019).

Structural elements of the food system

Structural elements of the food system are subject to the influence of both hard and soft institutions but give rise to a range of potential levers across livestock food systems ranging from changes to farm structures and types, to the role of farming in rural communities and changing abattoir arrangements (see Box 3).

In the United Kingdom, as in many developed countries, agriculture has become both increasingly intensified and specialised which has resulted in a decline in mixed farming systems and a substitution of labour for capital. This has resulted in a marked disconnect between pasture and arable farming (especially in the lowlands) with many farms exclusively one or the other, rather than mixed. This specialisation of farming has also contributed to a decline in the ecological diversity of agricultural landscapes. Levers for changing the polarisation of these systems may include the occurrence of problems such as weed issues or poor soil quality on arable land that could be ameliorated by the inclusion of grassland and livestock in rotations, or the high costs of importing straw from arable to grassland systems. Hence, some arable farmers are trialling the introduction of leys or cover crops and livestock to address these issues. Workshop participants considered that, while there may be constraints to widespread adoption of more mixed farming approaches (e.g., lack of expertise and infrastructure), if such approaches prove beneficial for the delivery of public goods and high-quality food, policy levers may be used to support such a transition back to mixed farming systems.

Participants questioned whether there is a missing middle in the structure of livestock farming in the UK which threatens its survival? At one end of the scale there are a number of fragmented small units (some of them being crofters/smallholders or part-time farmers) and at the other relatively fewer large industrial-scale farming units. Small to medium family-run farms create higher diversity in the landscape which is generally positive from a public goods (including animal welfare) delivery perspective and result in improved skills transfer and maintenance. Concerns were raised at the workshop over potential increases in contract farming with contractors having little incentive to maintain long-term productivity or minimise environmental damage on the land they farm. Levers (discussed above) which ensure that farmers are adequately recompensed for farming in ways which enhance the delivery of public goods as well as high quality produce, could provide more incentives for farmers (and indeed contractors) to run viable businesses as their sole source of income and ensure the retention of skilled livestock labour, which is crucial, especially in our tougher, upland landscapes. Family or small-scale farming is also under threat because of its decreasing attractiveness as a career pathway, and because of the high costs of land which make it even harder for young people/new entrants to come into the industry.

The structure of our rural communities and their services and facilities (schools, shops, pubs) are heavily reliant on the farming industry. Farming plays a key role in maintaining attractive landscapes, and in some cases provides a requirement for public infrastructure (such as roads) to be maintained all year around. Diminished or unaffordable rural infrastructure and transport systems limit the ability of young people and low-income workers – farmers and labourers to live and work in the countryside. Support for affordable rural housing for farm workers and maintenance of community infrastructures provide important levers for maintaining food production in these areas.

Finally, workshop participants highlighted that increasing regulation around abattoirs and sourcing from single abattoirs by supermarkets have contributed to the closure of a network of small and local abattoirs which serviced the livestock industry, resulting in a cascade of issues across the livestock food system (see Box 3). Levers which address those issues may, for example, include the introduction of mobile slaughter units or the need to rethink regulatory restrictions around animal movement to minimise food miles.

BOX 3 Restructure case study.

The Scottish Government is attempting to co-ordinate policy initiatives through its Land Use Strategy, however interviews carried out in the ResULTS (resilience of upland beef and sheep production) project identified areas where policy interactions have had unintended consequences:

In the Scottish Borders, tenants gaining the 'right to buy' has led to landowners renting out less land for agriculture and using incentives for forest creation on the remaining land. This has made it even harder for young people and new entrants to take up agriculture.

In Orkney, ferry transport of live animals to markets in mainland Scotland are subsidised, but transport of meat is not, thus advantaging abattoirs on mainland Scotland. This has contributed to the loss of the local abattoir on Orkney, and consequently disadvantaged the ability to promote Orkney products.

Cross realm levers

During discussions a number of subject areas came up under all of the 3 realms. Eight of these key areas have been highlighted in Table 2 where short summaries of leverage points for change in UK pasture food systems under each of the three realms are outlined. For example, workshop outcomes indicated that the challenge of climate change could provide leverage points for a re-thinking of pasture-based systems for farmers, consumers and researchers, a restructuring of government policy to meet those challenges and a reconnection between multiple stakeholders and the natural resources which underpin production.

Discussion and conclusion

This paper describes the outputs of a workshop which aimed to explore whether the realms of 'deep leverage' identified by Abson et al. (2017) were relevant to the transformation of the UK livestock system as an example of a prevalent current food system in the developed world. Workshop attendees, with vested interests in both carrying out and using research to improve the sustainability of livestock food systems, together considered pasture livestock systems using this framework. The three key realms outlined within the framework by Abson et al. (2017); re-think, re-connect and re-structure, proved an effective approach for identifying leverage points which may help to shift livestock systems towards a new more socially, environmentally, and economically sustainable agricultural paradigm.

Research process

Many of the issues raised, and levers identified within the workshop, have already been recognised in the literature (Lang et al., 2012; Cornell et al., 2013; Ives et al., 2018; Melchior and Newig, 2021) and in practice, however, the workshop brought them together in a unique way which envisages their inter-twined roles in transforming pasture livestock food systems. Providing a space and the time for interaction between researchers and representatives of the livestock food system focused on different aspects of the same problem proved a very effective way to share and generate knowledge (see Waterton et al., 2015). The workshop indicated the importance of recognising that pasture-based livestock food systems are viewed through multiple 'lenses' by the different stakeholders engaged in them. The workshop was thus a way of 're-thinking' systems beyond the boundaries of any one stakeholder or academic discipline. It proved to be an effective way of testing an academic concept, eliciting excellent contributions from all participants.

Workshop outcomes revealed the depth and breadth of complexity surrounding these systems, highlighting the narrow framings which often accompany research seeking to influence the sustainability of these systems and the need for broader integrative stakeholder-engaged research approaches which take account of the global nature of such systems (Ingram, 2011; Zeitoun et al., 2016). This included the importance of ensuring that research framings ensure that 'socially just' solutions are prioritised, i.e., those which fairly distribute the costs and benefits of food and public goods along the entire supply chain. It showed the inequalities in power that frequently exist between stakeholders in these systems which cut across all realms of leverage (Abson et al., 2017), and often affect farmers most (Norton et al., 2016).

Are there deep leverage points which could help transform United Kingdom (and other) livestock systems?

Findings from the workshop indicate that many of the levers identified are already being trialled around the periphery of pasture systems (in niches), and indeed some are being evaluated by scientific research. Despite that, their influence on transforming the system remains largely insignificant, indicating that they are either shallow levers, or may just be taking time to effect long-term change. Findings also revealed significant barriers to transformative change, not least the vested interests of large businesses, in keeping within the current neoliberal economic paradigm which currently rewards unsustainable practices (Holt-Gimenez and Altieri, 2013; Altieri et al., 2017). Because of barriers like this, it has been argued that unpredictable catastrophic change is needed to drive positive transformation, e.g., the impact of extreme events like COVID-19 (which had not arisen at the time of the workshop) and might have been predicted to force change in food systems (Garnett et al., 2020; Grandori, 2020; Bisoffi et al., 2021). However, while COVID may have driven temporary changes in the food sector (Jones et al., 2022) and revealed uncomfortable truths about the fragility of the food system, radical system transformation has not yet happened.

Potentially other levers which sit outside the pasture system, but within the food system, may strongly influence the system, such as the demand for meat and milk and broader dietary change, e.g., the growth of veganism (Kortetmäki and Oksanen, 2020). Since the workshop, new potential levers in the UK include national policy developments, such as the National Food Strategy (Dimbleby, 2021) and the recent Environment Act (UK Government, 2021) alongside the expansion of more bottom-up initiatives like 'regenerative' farming approaches, e.g., see Groundswell.[1] The extent to which these levers can influence change is yet to be revealed, but they provide hope, not least because of their recognition of the need for system-level approaches.

Conclusion

Workshop outcomes indicate that scientists engaged in the business of providing evidence to support transformational change in food systems can usefully build on the concepts of Meadows (1999) and Abson et al. (2017) to think broadly, with stakeholders, about systemic change. The complexity of the system, as revealed by the multiplicity of potential levers for change identified in the workshop (and those outside of it referred to here), and the interactions between them indicate that transformation in livestock food systems will result from multiple actions that consider all of: dietary change and food accessibility, impacts on biodiversity and carbon, social structures in rural areas, business sustainability across the supply chain and on cultural and physical landscapes as well as potentially on catastrophic unpredicted events (such as COVID-19). Recognition that livestock systems were about more than food, were voiced by Donald back in 1973 (Donald, 1973):

> "Since society at large has other interests as well (*besides* 'efficient food production'), there is a case for initiating an articulate and scientific study of the facts, methods and principles of livestock policy with a view to identifying national priorities."

This highlights something of a lack of progress in the past 50 years and strengthens the need for transformative scientific approaches ('re-thinking') to help underpin transformative change in livestock systems.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

LN: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. AB: Writing – original draft, Writing – review & editing. PC: Writing – original draft, Writing – review & editing. CL: Investigation, Methodology, Writing – original draft, Writing – review & editing. SR: Writing – original draft, Writing – review & editing. LS: Conceptualization, Writing – original draft, Writing – review & editing.

1 https://groundswellag.com/

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1366204/full#supplementary-material

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