



More than meat? Livestock farmers' views on opportunities to produce for plant-based diets

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Abstract

Promoting plant-based diets as a response to climate crisis has clear implications for producers of animal derived foods, but surprisingly little research considers their perspectives on this. Our exploration focused on farming strongly associated with meat production in Wales, UK. Mindful of polarised debates around plant-based diets, we considered dietary transition as an opportunity to produce for new markets. The first aim was to identify whether transition towards plant-based diets might trigger transformation of livestock agriculture. Findings indicate a potential trigger event once livestock farmers are certain that consumer trends and climate mitigation require change. Livestock farmers who regard their meat as climate-friendly might resist transitions felt to unfairly disadvantage them. We then considered livestock farmers' likely capacity to produce plant crops, and how this transformational capacity might be enhanced. Participants highlighted forms of financial and environmental inflexibility, plus social norms regarding "good" Welsh farmers, combining to make transformation risky. Transformational capacity might be enhanced through leveraging occupational and place attachments by portraying plant crops as a revival of historic practices from traditional farming landscapes. Improved linking capacity will also be beneficial, as producing for new markets requires connections to new supply chains, and learning across divisions within rural communities. We present these preliminary insights to livestock farmers' attitudes and transformational capacity to inform future research with them to advance just agricultural transitions. Our study indicates potential to avoid confrontational discussion of dietary transition and we hope that others will pursue its focus on opportunities for farmers.

Keywords Dietary transition · Transformational capacity · Livestock farming · Just transition · Plant-based diets

Introduction

In 2019, researchers gained attention for their planetary health diet (Willett et al. 2019) with much focus on recommendations to reduce meat consumption in favour of plant foods (Table 2019). The authors were criticised for failing to understand implications for livestock farming or agricultural landscapes favouring it (Forgrave 2019). Many

livestock farmers receive calls for reduced consumption of animal products as a threat (McGregor and Houston 2018; Rodak 2020), calls which have become quite loud since the FAO highlighted livestock's climate impacts (Gerber et al. 2013). The IPCC suggested emissions reduction targets require reduced levels of livestock farming and changes to production (2022, 2023). Plant-based or vegan diets reliant on fruits, vegetables, cereals, nuts and legumes, became more central to climate debates (Arcari 2016; Kortetmäki and Oksanen 2020; Morris et al. 2021). In the UK some civil society actors promote associated dietary change (Dimbleby 2021; Morris et al. 2021). Product ranges and markets for plant-based foods have grown (Clay et al. 2020; Lonkila and Kaljonen 2021; Saari et al. 2021). But it is not clear who can produce more plants, with the literature largely silent on production dimensions of these diets (Lonkila and Kaljonen 2021).

Significant dietary transition would have huge impacts on producers of animal proteins (McGregor and Houston

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Fig. 1 Media campaigns promote Welsh landscapes and farming as a source of quality meat, materials produced by Hybu Cig Cymru, Wales' levy-funded meat promoter.

Source: <https://meatpromotion.wales/en/news-industry-info/download>



Fig. 2 Media campaigns promote Welsh landscapes and farming as a source of quality meat, materials produced by Hybu Cig Cymru, Wales' levy-funded meat promoter.

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2018). However, impacts on current producers, particularly traditional farmers, have been over-looked (Lonkila and Kaljonen 2021; Sexton et al. 2022). This gap is significant for those seeking to promote just agricultural transitions, which need to consider risks and opportunities for affected farmers (Blattner 2020; Morris et al. 2021). It is unlikely global livestock production will cease, rather markets will change, potentially favouring those promoting their products as natural, ethical and sustainable (Beef and Lamb NZ 2019; Burton 2019; Cusworth et al. 2022). Countries with significant livestock agriculture favour changing farming practices, rather than reducing production (Coles-Riley et al. 2023). But some farmers might transition out of livestock, changing what they produce. Available pathways require attention so transitions can be shaped by producers' voices (Morris et al. 2021). Just agricultural transitions mean that farmers "know that there is a future, livelihood, stability, and identity" for them (Blattner 2020, p. 56).

Wales, with its significant livestock sector and ambitious emissions reduction goals presents an informative context for researching farmers' perspectives on dietary transition. Agriculture occupies approximately 90% of Wales' land: 64% of land is permanent grassland, only 6% is used for arable and horticulture while sheep and cattle farming dominates the landscape (Welsh Government 2021). Land in Wales is predominantly categorised as "less favoured area" (LFA), meaning that climate and topography disadvantage agriculture (OECD 2002). These landscapes suit grazing,

making Welsh farming synonymous with meat, which is promoted as extensive and sustainable (Figs. 1 and 2). However, Wales' net zero ambitions may require farmers to change what they produce: some suggest Welsh agriculture cannot significantly reduce emissions without less livestock (Coles-Riley et al. 2023). Potential impacts on farmers' prosperity are contentious because agricultural communities are strongly associated with Welsh identity, culture and history (Coles-Riley et al. 2023). Threats to farmers' livelihoods are politically and culturally sensitive as agricultural communities are Welsh language strong-holds (Welsh Affairs Committee 2022). Despite this, reducing livestock numbers might not have to mean fewer farmers, as plant crops like potatoes and oats used to be more widespread (Graves 2022; Higgins 2021). More enterprises have recently introduced edible horticulture (Tyfu Cymru and Wheeler 2020), and Welsh Government has introduced financial support for growers, and diversification into horticulture (Welsh Government 2022).

Exploring Welsh farmers' response to dietary transition begins to address the need for attention to producers' perspectives and opportunities for livestock farmers to change what they produce. Changing from farming livestock to plants is major, with enduring impact, considerable scale and complexity, effectively reorientating activity and resources (Sutherland et al. 2012). Such transformation is most likely in response to trigger events breaking farms out of established pathways (Sutherland et al. 2012). But farmers vary

in their transformational capacity for major changes (Eakin et al. 2016; Marshall et al. 2012, 2016). We apply these two conceptual framings to Welsh farmers' views of dietary transition, asking:

- 1) Is transition to plant-based diets an event likely to trigger transformation in livestock agriculture?
- 2) What is livestock farmers' capacity to transform what they produce?
- 3) How could transformational capacity be enhanced?

Our findings indicate how producers may respond to pressure to reduce livestock farming, whilst furthering understanding of transformational capacity. They indicate areas requiring further exploration to inform just agricultural transitions.

Literature review: triggers and capacities for transforming livestock agriculture

Research into how livestock farmers might become plant producers is lacking, but there is extensive literature on encouraging farmers to adopt changes, be they innovations (e.g. Klerkx et al. 2012), more sustainable operations (e.g. Dessart et al. 2019), or specific practices (e.g. Inman et al. 2018). A recent review on farmer behaviour change concluded that the complexity of farming systems can only be understood through attention to interactions between multi-level influences (Rose et al. 2018). A new model taking this holistic perspective combines frameworks from behavioural psychology, transitions and innovation studies (de Boon et al. 2022a). It reflects the complexity of influences on farmer behaviour, recognising their agency and interactions with social and political context (Olvermann et al. 2023). De Boon et al. highlight four societal dimensions which interact to shape innovation processes. At the macro level are grand structures like climate or macroeconomics forming the background of society at large, over which individual actors have limited influence. Macro level changes might directly or indirectly drive innovation. What they term "the foundation" encompasses factors found to aid or inhibit agricultural innovation. At the meso level these include the farm's immediate context such as its physical infrastructure and market. Micro level factors include the farm's adaptive capacity and psychosocial factors, such as willingness to change, attitudes to risk, self-identity and social norms. The fourth dimension is governance, highlighting processes and structures around public decision making, and their power dynamics. This framework centres on the hypothesis that the immediate context interacts with the farmer's innovative

capacity to determine the likelihood of them initiating change.

Whilst highlighting forces at play, no framework provides a formula for how farmers change, indicating a messy process (de Boon et al. 2022a). Behaviour change frameworks can flatten differences between types of decision, and are strangely silent on what constitutes behaviour, reflecting broader tendencies in social science for 'behaviour' to refer to wide-ranging actions, often without definition (Uher 2016). Changing what a farm produces is a significant, enduring alteration going further than many decisions, fundamentally altering livelihood activities; it requires frameworks tailored to this degree of change. Such change is what Sutherland et al. (2012) regard as major or transitional, meaning a change in farming trajectory that significantly reorientates activity and resources. Whilst minor changes do not radically alter the farm's focus, major ones redirect land, labour and capital. They hypothesise that farmers typically maintain practices and arrangements shaped by past conditions, changing only incrementally. Skills and investments are tied into markets and equipment, making it hard to alter course, a condition known as "path dependency". Farms' path dependency is often heightened by 'knowledge lock-in' and 'cultural lock-in' arising from training and cultures favouring established practices. Sutherland et al. suggest these lock-ins make farms unlikely to alter course until an event or opportunity prompts consideration of major change. These 'trigger events' cause farmers to realise the need to change their system to continue meeting their objectives. They can be positive (e.g. new market opportunity) or negative (e.g. sudden death), or combine multiple events. Awareness of triggers prompts farmers to assess a range of options, then re-configure their farming system, so it transforms (Sutherland et al. 2012). Within de Boon et al.'s framework, triggers would represent drivers of change at the macro or meso level which might stimulate innovation.

Climate emergency presents a range of potential triggers as farmers are encouraged to introduce low-emissions practices or production (Hyland et al. 2016), or enhance resilience (Wheeler and Lobley 2021). Researchers have considered farmers' responses to climate triggers in the USA and Australia, where drought necessitates transformation (Eakin et al. 2016; Marshall et al. 2016). Such research considers how farmers respond to negative climate triggers - a risk of harm to their operation - and how they could present positive opportunities to produce for new markets. Attention to plant-centred diets as climate response, makes it timely to consider whether this represents a trigger likely to prompt farm transformation.

Literature on farmer behaviour and innovation suggests triggers situated at the meso and macro level only effect on-farm change if the micro level is conducive, meaning

the individual is willing and able to change (de Boon et al. 2022a; Rose et al. 2018). Their capacity to change or ‘adaptive capacity’ requires the ability to mobilise existing resources to adapt, which varies with farmers’ skills, circumstances and attitudes (de Boon 2022). For major enduring changes, it is more appropriate to consider transformational capacity (Marshall et al. 2012, 2014). Where adaptive capacity relates to short-term changes, transformation entails longer term adjustment and greater effort (Moser and Ekstrom 2010), working towards a fundamental shift in the socio-ecological system (Marshall et al. 2012). Marshall et al. tailored understanding of adaptive capacity to larger changes transforming farm livelihood or production (2012). Such change is akin to major change (Sutherland et al. 2012), making transformational capacity a useful analytic frame for responses to trigger events.

Marshall et al. (2012, 2014) suggest farmers’ transformational capacity depends on:

1. how risks and uncertainty around transformations are perceived and managed,
2. the extent of skills in planning, learning and reorganising for transformation,
3. the level of financial and/or psychological flexibility to undertake transformational change; and,
4. an interest and willingness to contemplate and undertake transformational change.

Additional influences are attachment to place and occupation which can be central to farmer identity; strong attachments reduce the likelihood of drastically changing farm system or location (Marshall et al. 2012; Marshall et al. 2014).

In Marshall et al.’s work the interplay between individual and context is rather under-developed. Eakin et al. (2016) addressed this through greater attention to how institutional context around decisions influences actors’ cognitive capacities. Institutional factors include policy mechanisms (e.g. financial incentives), and how knowledge circulates. These are shaped above the level of the individual, so Eakin et al. conclude that capacity to transform depends on the farmers’ ability to build links and act collectively, perhaps to influence policy, or collaborate on innovation. This view beyond the individual usefully aligns with de Boon et al.’s framework: the farmer’s micro-level (cognitive) transformational capacity interacts with meso (institutional) context, as the foundation influencing responses to macro-level climate emergency. Complex multi-scalar interactions indicated by de Boon et al. suggests ‘willingness to change’ should not be overly individualised, and that flexibility may take various forms. We therefore analyse farmers’ responses to the potential trigger of dietary transition, alert to factors

influencing transformational capacity, signs of occupational and place attachment, institutional influence and other social context. Our data suggests further nuances to transformational capacity, and potential mechanisms to enhance it amongst farmers.

Methods

To explore livestock farmers’ attitudes towards transitioning to plant-food production, we combined: online survey, semi-structured interviews, and online workshop. The bilingual online survey targeted livestock farmers in Wales (September 2021-February 2022)¹, comprising multiple choice and free text questions. It was promoted via social media, farming organisations, and at the Royal Welsh Agriculture Show. 24 valid responses were received. Despite the low response rate, the survey was useful during the workshop where participants discussed the results. We present relevant results to indicate the varied views livestock farmers may have on dietary transition, contextualising other data. This was collected through 12 semi-structured online interviews with three categories of interviewee: four representatives of farming / policy making organisations with professional expertise in agriculture (Stakeholders), seven farmers with mixed livestock and plant crops (Plant-producer), and one livestock farmer (Farmer). Recruitment for these and the workshop was via opt-in on the survey, targeted invitation and snowball sampling. The online workshop involved 13 stakeholders and farmers.² We facilitated discussion of opportunities and challenges around producing more plants in Wales, using case studies of plant producers as elicitation tools. A shared digital space kept live notes so participants could add written contributions. Interviews and workshop discussions were transcribed, then analysed thematically using NVivo. Analysis was an iterative process, combining key steps of describing and classifying data, whilst seeking connections to concepts from the literature (Kitchin 2013). Initial analysis was reviewed and supplemented by the second researcher; researchers discussed their analysis to agree key themes. Working simultaneously with data and literature, the conceptual framing emerged during analysis and was refined alongside the results.

We faced the challenges of investigating the controversial topic of dietary transition (Morris et al. 2021), with farmers feeling demonized by proponents of plant-based diets (Harries 2019; NFU Cymru 2023). We framed our

¹ All participants were offered to contribute in either English or Welsh, no one opted for Welsh for interviews or workshop so translation was not required.

² Several participants were both farmers and representatives or staff of stakeholder organisations.

Table 1 Characteristics of survey respondents

Farm Location	% Survey Respondents (Total = 24)	Production	% Survey Respondents
Powys	33.3%	Livestock Only	79.2%
Gwynedd	16.7%	Mixed farming	16.7%
Conwy	20.8%	Horticulture	4.2%
Pembrokeshire	12.5%	<i>Agri-environment scheme</i>	
Anglesey	8.3%	Within a scheme	45.8%
Denbighshire	4.2%	Not within a scheme	54.2%
Carmarthenshire	4.2%		
Farm Characteristic		<i>Primary income stream</i>	
<i>Size</i>		Sheep	62.5%
< 20Ha	8.3%	Beef	16.7%
20-50Ha	20.8%	Non agricultural e.g. tourism	12.5%
50-100Ha	37.5%	Work outside the farm	4.2%
100Ha+	33.3%	Horticulture	4.2%
<i>Proportion of farm holding Less Favoured Area (LFA)</i>		Poultry	0%
0% LFA	29.2%	Single Farm Payment	0%
1-29% LFA	17.6%	Dairy	0%
30-59% LFA	23.5%		
50-89% LFA	29.4%		
90-100% LFA	29.4%		

investigation carefully, focusing on agricultural pragmatics not ethics: not whether farms should produce meat but how they could produce plants. During conception, stakeholders advised that terms like ‘plant-based foods’ alienate farmers, through association with the ‘vegan lobby.’ Research materials therefore used neutral terminology about change to foster constructive debate. Explicit reference to reducing meat consumption might have increased our response rate, attracting defendants of livestock farming. Equally, it might have deterred livestock farmers from participating. We believe the workshop’s optimistic tone where participants sought to identify solutions would not have been possible within a more controversial framing. We echo Morris et al. (2021) that researchers must be conscious of language and questions regarding meat.

The low response rate to our survey reflects the suggestion that British farmers are difficult to engage in research (Hyland et al. 2016; Davies et al. 2019; White et al. 2021). The shadow of the Covid-19 pandemic and imminent UK exit from the EU (Brexit) created considerable uncertainty for farmers, perhaps reducing willingness to engage with research. Online data collection essential under Covid-19 restrictions may have excluded less digitally competent farmers (Davies et al. 2019, p. 13). Most farmer participants were interested in plant-production, suggesting a self-selection recruitment bias. We believe our small sample remains important for proving potential to investigate livestock farmers’ responses to dietary transition without getting stuck at the impasse of defending meat production. Future research should engage a broad range of farmers and stakeholders, including other actors in meat supply chains.

Table 2 Survey respondents’ priorities for the future of their farm

Theme	Count (Respondents could list numerous priorities)
Profit and income generation	10
Economic viability / increasing margins	5
Environmental benefits (soil, carbon, biodiversity)	4
Working less / retiring	4
Livestock quality	3
Succession	2
Diversification	2
Expand production	1

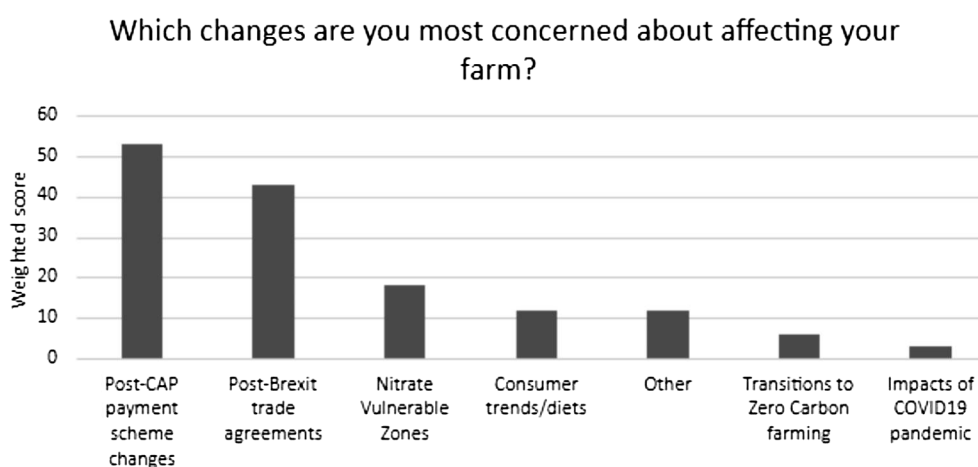
Dietary transition as potential trigger event

In this section we present findings regarding perceived impacts of dietary transition on livestock farms; the small survey sample (Table 1) indicates the potential range of views. As Hyland et al. identified (2016), Welsh farmers take various positions towards climate change according to their productivist or environmental orientation. Responses reflect this diversity, suggesting strong economic priorities (Table 2).

The likelihood of transformation is indicated by farmers’ assessment of their future: most survey respondents expect to be farming in ‘broadly the same way’ for five years, with few preparing for drastic change, and none expecting to exit farming. This suggests respondents did not perceive an imminent need for transformation. Respondents were most concerned about changes related to Brexit (Fig. 3, post-CAP payment schemes, trade agreements). Legislation on Nitrate

Fig. 3 Survey respondents' ranking of future concerns³

³ Respondents selected which of the listed options they were most, second and third most concerned about. Responses were combined and weighted so primary concerns are scored more highly

**Table 3** The spectrum of farmer opinions on the effects of dietary transition

Response to reduced meat consumption in Wales	No. of farmers
Positive - expect people to continue eating quality meat	7
Positive - could / do produce plant crops	3
Negative - expect lower demand for Welsh meat	5
Negative - limited opportunities to produce plant crops	3
Neutral - don't accept consumption will decline	3

Vulnerable Zones was imminent, hence its prominence. These pending, potentially dramatic risks out-weighed longer-term trends such as consumer diets and net-zero, as farmers have limited capacity to consider all pressures simultaneously (Hyland et al. 2016).

To trigger transformation, an event must prompt realisation that the farm system cannot meet its objectives unless it changes (Sutherland et al. 2012), as farmers recognise conditions becoming problematic for their business (de Boon et al. 2022a). Interviewees suggested dietary transition is not yet triggering:

I don't think any of them would be thinking about changing the production system in anticipation of consumers moving to a more flexitarian or vegetarian, vegan diet. I think your mainstream livestock and dairy farmers wouldn't see it as an opportunity at all (Stakeholder).

Survey respondents pay minimal attention to public debate on reducing meat consumption, with only a quarter 'quite concerned' about impacts on their business. If dietary transition is a peripheral message, it is unlikely to impact decision making (Sutherland et al. 2012). Those who have acted on their concern were more likely to work with organisations to advocate for meat production than change production. When asked how reduced meat consumption in Wales would affect the farm business, some judged it problematic

whilst others saw opportunity (Table 3). The significance of export markets for Welsh lamb and beef (Hybu Cig Cymru 2021) might explain farmers' optimism. But how problems are defined and who frames them affects their assessment of change (de Boon et al. 2022a). This is significant given some livestock farmers challenge GHG emissions data or locate responsibility elsewhere (Hyland et al. 2016). Our responses included challenges to data on GHG emissions and dietary trends, indicating suspicion of potentially partisan pro-vegan sources.

Producers able to promote their meat as climate-friendly might retain market share even if global consumption declines (Burton 2019; Cusworth et al. 2022). Welsh farmers might aspire to this:

In Wales, its extensive livestock grazing and it doesn't have the same amount of environmental damage as livestock agriculture in other parts of the world. And I think a lot of farmers feel that's underappreciated. And I think they're right (Stakeholder).

Some argue that problematic livestock emissions are not from extensive grazing in Wales (Harries 2019). A tendency to exceptionalise Welsh livestock is known in relation to animal welfare (Heffernan et al., 2008), suggesting Welsh farmers see themselves as part of the 'ethical meatscape' of low-impact meat (Baumann et al. 2023, p. 2). However, Welsh livestock's compatibility with net zero is contested (Coles-Riley et al. 2023). Indeed, some argued for dietary transition:

there's no point in fighting against more plant-based foods and vegan[ism], it just needs to be an opportunity that's created there rather than thinking of them as a threat (Farmer).

And saw transformation as inevitable:

I think we can't continue to consume meat with the developing areas of the world consuming what we consume and have things like grain-fed cattle. So, I think more enlightened, younger farmers know that the tide will change [...] I hope they do start to change their view and stop being antagonistic to something that does have to happen (Plant-producer).

Some interviewees were adamant that farmers resisting change are misguided as their current business model is unsustainable, suggesting they regard dietary change as trigger event. A stakeholder involved in policy making suggested government leans this direction:

Welsh ministers would be very keen to see more diversification in agriculture, cropping and horticulture, for lots of reasons not least because there is a strong body of opinion that thinks that livestock and dairy production does contribute significantly to greenhouse gas emissions and climate change.

This suggests that farmers might be encouraged to trigger transformation by institutional context.

Our findings suggest limited signs that transition to plant-based diets is triggering transformation of Welsh livestock farms. Reasons include scepticism regarding the scale of dietary transition, and the belief that Welsh meat will continue to have a market. Farmers may not judge their operations as sensitive to this change (Eakin et al. 2016). Changes coinciding with the research might have influenced participants to deprioritise dietary transition as immediate challenges reduce farmers' capacity to address longer-term change. Dietary transition may yet become a trigger event. Actors hoping to trigger transformations in livestock farming should note suspicion of emissions data perceived as associated with anti-meat lobbies. Trusted data will be required to persuade farmers of the need to act (Hyland et al. 2016). This should convey that farmers will bear a fair burden of responsibility for agricultural transitions (Blattner 2020). Livestock farmers seem to vary in their assessment of dietary transition as threat or opportunity, for reasons we explore next.

Livestock farmers' transformational capacity

Having considered potential for dietary change to trigger transformation, we turn to farmers' capacities to transform. Individual capacity to change must coincide with a conducive context (Rose et al. 2018). A strong theme from participants was that willingness to change is insufficient:

I feel quite passionately that there's a need to do it - but we have to be realistic about how easy it is to do as well (Stakeholder).

Analysis suggests reasons it will be difficult include various psycho-social factors limiting transformational capacity; these coalesce around three themes.

Theme 1: farm landscapes as inflexible environments

Livestock farmers' views towards dietary transition depend on the nature of their farm as indicated by two contrasting survey comments: "My whole business depends on people eating meat"; "We have capacity to grow crops". The former is threatened by plant-based diets which present opportunity for the latter. Of survey respondents not currently operating horticulture, less than half felt they could (n=8), with the remainder suggesting their land is unsuitable. One interviewee suggested upland farmers feel most threatened by dietary transition because "for a lot of them, there is no alternative" (Stakeholder). This reflects a common opinion that Welsh landscapes suit livestock grazing:

in terms of food production, we're fairly limited really because of the climate and the soils. The thing that grows best here is grass - that's what the climate and the soils are suited to best of all (Farmer).

Those who have begun horticultural enterprises amidst traditional farming have been told:

'you're growing vegetables in Wales? that'll never work, cos only sheep work around here.' It's such a bad misconception (Plant-producer).

Upland farmers limited by land suitability lack resources for adaptation (de Boon et al. 2022a).

The nature of Welsh landscapes suggests environmental inflexibility might limit transformation, but as the previous quote indicates the environment may be more flexible than some assume. Workshop participants cited an upland horticultural farm as evidence that LFA environments *are* flexible. Others noted that homogenised production is recent, as 60 years ago most upland farms were mixed. One stakeholder studied historic patterns of production and identified significant arable in areas now focused on livestock. One participant had experience of this:

We've been growing oats or barley every year for the last 13 years now. Dad always grew a field of barley up until the late 70's and then the advice you got from

the professionals was to specialise in doing one thing and intensify your grass production (Farmer).

Specialisation was driven by policy and economic drivers:

since we joined the common market the agricultural subsidy system, the Basic Payment system, has rewarded farmers just for owning land and that's allowed the spread of a monoculture, of sheep rearing, and has provided a disincentive for the more traditional forms of agriculture (Stakeholder).

Between 2020 and 2021, 57% of income across farm types came from the Basic Payment Scheme (Senedd Research 2022). These payments have underpinned livelihoods (Arnott et al. 2021) tied to sheep farming, suggesting institutional rather than environmental inflexibility. Payment schemes are a form of lock-in shaped by the dominant regime, inhibiting the motivation to produce differently and limiting financial flexibility (Mylan et al. 2019; Sutherland et al. 2012).

Strong associations between livestock farming and Welsh identity (Coles-Riley et al. 2023) suggest perceived environmental inflexibility is also influenced by occupational attachment. Some farmers are highly committed to livestock:

there's a proportion who are so passionate about what they've been doing for the last 50 years or whatever that they find it - it's a bit like asking them to fly to the moon, I guess. They are really so passionate about their Texel flock or their Welsh Black beef flock and they've, in a sense, forgotten that they used to do something different as a family (Stakeholder).

Farming families feel responsible for land passed down through generations, so resist change (McCarthy et al. 2022). Some farmers' place attachment may date to 1947 legislation which enabled land purchases:

it actually meant an awful lot of farmers who had been tenant farmers probably for maybe 1,000 years perhaps, they were actually able to buy their farms and it empowered them. So that land is very precious to them. It's not something they've just inherited and take for granted. They had to wrestle it from their landlords in a sense, and they were lucky to be able to do that (Stakeholder).

Such strong land attachments discourage transformation (McCarthy et al. 2022). Farm landscapes' transformational

capacity therefore derives from psycho-social and environmental factors.

Participants noted that those introducing plant crops are often newcomers to rural Wales, whilst long-standing farming families have place attachments entwined with livestock:

It's a lot more than just the farming. We have farms that been in families for generation, it's all about being part of the social network and keeping communities going as well as just the farming. And yeah, and so people are very worried about changing. And people who farm livestock, particularly sheep and beef, they do it because it's partly a way of life and they have pride in their animals, and they like their animals. They don't do it to earn a lot of money because it's not a high income, so they won't necessarily want to change to a completely different way of farming when that's been part - it's part of culture as well as part of a livelihood and job, it's more than just a job I think, well I know yeah (Farmer).

These farmers might be more willing to change if transformation beyond livestock was demonstrated to be traditional, some participants suggested:

You can learn from the past and look to the future, then we can have a lot more varied agriculture here in Wales (Stakeholder).

This would harness attachment to traditional farm practices and places to encourage transformation.

This theme concurs with previous studies that psychological inflexibility is shaped by place and occupational attachments (Marshall et al. 2012; Eakin et al. 2016). It highlights that the lack of access to suitable land is a form of resource constraint limiting innovative capacity (de Boon 2022). But this inflexibility is associated with institutional context and place attachment, so might be psycho-social rather than environmental, particularly for farmers occupationally attached to livestock.

Theme 2: 'bad farmers' grow plants

Occupational attachment is also apparent in our second theme, which situates it amongst social relations. Social status derived from being perceived as a good farmer is known to influence farmers' decisions, with the likelihood of adopting innovation increasing if it is perceived as what good farmers do (Burton 2004). Farmers who produce plants are conscious of how others perceive them:

Is the social acceptability part of this? We live in very conservative rural areas, and actually doing something different might not only be a risk personally, but it might be a risk in terms of people thinking you're an idiot. Everyone thinks I'm an idiot round here (Plant-producer).

This participant was aware of being perceived as an outsider, reflecting divisions in rural Welsh communities hostile to English incomers (Cloke et al. 1998). Incomer identity is associated with unconventional ideas about farming, which traditional farmers disparage as hippy idealism, or hobby farming – the antithesis of good farming:

I think horticulture has probably historically been seen as the poor relation, and I think, unfortunately, it was taken over by the community movement for a while which probably ostracised commercial farmers to think 'Well, it's nothing to do with us, we don't need to get involved' (Stakeholder).

Horticulture has not featured in Welsh notions of a 'good farmer', reducing farmers willingness to embrace it.

These sentiments suggest livestock farmers' identity and social norms reduce transformational capacity. These psycho-social influences also affect flows of knowledge which are integral to change processes (de Boon et al. 2022a). Farmers able to build social links can access knowledge to increase their transformational capacity (Eakin et al. 2016). In Wales these links are inhibited by social divisions:

I'm an Englishman doing weird stuff in Wales, and actually I'm never, ever gonna go and tell a local farmer what to do (Plant-producer).

If successful plant producers are not associated with identities and communities valued by other farmers then dissemination of the innovation is inhibited, because farmers are most likely to adopt change demonstrated by trusted peers (Gatto et al. 2019; Padel et al. 2020). According to participants, trusted organisations who might enable knowledge flows (Hyland et al. 2016; Rose et al. 2018) are not currently connecting plant and livestock farmers. They suggested that Farming Connect, a publicly funded independent advisor should:

They already have the respect of a lot of farmers. So I think they could actually be very powerful in normalising organic or regenerative agro-ecological farming and being like, 'no, this is what normal, serious farmers do, not just hippies' (Farmer).

Workshop participants were keen for farming organisations to collaborate more across perceived divisions between traditional and alternative communities. These suggestions confirm linking as an important component of transformational capacity (Eakin et al. 2016). But this theme also highlights how social norms within divided communities inhibits linking.

Theme 3: seeking market certainty

The third theme centres on financial flexibility, suggesting it has multiple dimensions hindering farmers' transition to plants, including its influence on risk assessment. The first mode of financial flexibility noted by participants is capital availability: producing plants requires investment in equipment, recruitment and infrastructure. Farmers must be able to lever investment to transform production (Marshall et al. 2012; Midmore et al. 2001). The second mode of financial inflexibility participants highlighted is potential for unprofitable production and income loss. Strong meat prices and public financial support mean livestock farmers currently have viable incomes, reducing the will to change. Participants suggested farmers will only invest when confident of financial returns, which require guaranteed markets and supply chains, the third dimension of financial inflexibility:

Livestock farmers know how to market their livestock, they know when they're ready, they know where to take them, whether market or abattoir or wherever, they know all that. That doesn't transcribe to knowing how to market your vegetables. I think a lot of people would, enjoy marketing veg boxes to local people, but just be really daunted about how to go about something like that (Plant-producer).

These three aspects of financial inflexibility – capital, income, and supply chains – create considerable uncertainty around transformation:

So there's a risk around capital, financing, funding, all of that. There's a risk around the knowledge you need to do this well. There's a risk around will there be a market, will there be customers for my products? There's a risk around how much labour will I need, will I be able to find the labour? So it's doing a risk analysis and thinking about what we have at our disposal to minimise those risks for people (Stakeholder).

Current supply chains are a path dependency limiting willingness to change (Sutherland et al. 2012).

Uncertain financial impacts present considerable risk, which participants suggested must be reduced before

farmers will transform. They require certainty that transformation will be profitable, hence the proposed solution of support with business planning. Participants also suggested certainty could be reduced by connecting farmers to established markets for plant crops:

rather than everybody who does growing having to go and do all the legwork for their own marketing and getting a supply chain in place, the way forward is to let the people who've established the supply chains deal with that side of things (Plant-producer).

Producer cooperatives were supported for similar reasons, suggesting linking which could enhance financial flexibility. This theme suggests multiple modes of financial inflexibility, and how they interact with farmers' risk assessment around transformation. It also indicates practical solutions proposed by participants, explored further below.

Discussion: can livestock farmers' transformational capacity be enhanced?

Farmers are more likely to adopt simple innovations compatible with the existing farm system (Jones 1963), whilst significant, enduring reorientation requires trigger events (Sutherland et al. 2012). Dietary transition might trigger transformation of livestock agriculture, but does not yet concern all livestock farmers. Farmers typically plan 3–5 years ahead, not investing in slower changes, particularly those perceived to have uncertain impacts (Wheeler and Lobley 2021). Uncertainty that plant-based diets are increasing or that markets for their meat will decline, discourages livestock farmers from changing. If extensively produced meat has a future market (Burton 2019; McGregor and Houston 2018), Welsh livestock farmers may not need to transform. Those who disagree will require data on extensive agriculture's climate impacts from impartial, trusted sources to convince them otherwise. Transformation will also need to be understood as part of just agricultural transitions (Blattner 2020).

Our data suggest livestock farms have varying levels of transformational capacity to produce more than meat. Participants emphasised the need for a farm-by-farm approach. They also expressed views in line with the finding that some farmers are more open to change (Cullen et al. 2020; Dessart et al. 2019). Farmers' capacity to change depends on their farm, their resources and perceived ability to change (de Boon et al. 2022a; Marshall et al. 2012). But it is important to look beyond individual farm attributes to the broader context (Eakin et al. 2016), considering how micro, meso and macro level factors interact (de Boon et al. 2022a). Our

findings indicate several factors might inhibit Welsh livestock farmers' transformational capacity. Social interactions and norms - who farmers interact with and how they regard others in rural communities - reduce willingness to change, because farmers consider how innovation affects prestige amongst their peers (Gatto et al. 2019; Jones 1963; Padel et al. 2020); social norms potentially deter diversification (Bonke and Musshoft 2020). These psycho-social influences include norms of good farming (Burton 2004), which for many Welsh farmers exclude horticulture. Uncertainty around transformation includes how peers will perceive it, including risks of being deemed a bad farmer (Sutherland et al. 2012). Producing plants would require new farmer identities and personal networks (Padel et al. 2020). Social relations also reduce transformational capacity because of place and occupational attachments, which are relational (McCarthy et al. 2022). The institutional context of investment and policy (Eakin et al. 2016; Olvermann et al. 2023) has created path dependencies (Sutherland et al. 2012) which support livestock farming, although participants highlighted signs of government encouraging mixed farming.

Environmental and financial flexibility potentially constrain transformational capacity; both are influenced by perceptions: assuming Welsh landscapes unsuited to plant crops and risks around unfamiliar supply chains. These perceptions locate control over production decisions beyond the individual (Marshall et al. 2016). Participants suggested they could be altered by targeted communication highlighting environmental and financial opportunities beyond livestock. This will need to be mindful of limits to information-based behaviour change initiatives (Rose et al. 2018), and what farmers value about their occupation (McCarthy et al. 2022). Farmers respond best to advice from neutral insider sources and peers (Heffernan et al. 2008; Inman et al. 2018).

This suggests participants were right to say transforming livestock farming will be difficult, so how might it become easier to produce plants? Table 4 presents our summary of mechanisms finding consensus during the workshop, framed in relation to transformational capacity. Conditions enhancing livestock farmers' transformational capacity (A), might be encouraged through support (B) informed by understanding of the context (C). In (D) we highlight what our findings suggest about transformational capacity.

As indicated in (A) participants were clear not all livestock farms will transition to plant production, because of personal attitudes or lack of resources. Ability and willingness to change must intersect (de Boon et al. 2022a; Mills et al. 2013). Willingness to change varies with personal priorities and dispositions to risk (Dessart et al. 2019). Deciding to change is mentally demanding (Davies et al. 2019), confounding lock-in (Sutherland et al. 2012). But

Table 4 What will enhance livestock farmers transformational capacities?

A Conditions enabling transformation	B Support Required	C Considerations	D Learning about transformational capacity
1. Farmer open to change	Peer networks promote opportunities and successes. Organisations communicate that change is required soon.	Promote change as return to historic patterns of mixed farming to lever occupational attachment. Need to counter perceptions of horticulture as bad farming and limited by environmental inflexibility.	Willingness to change is socially influenced. Place attachment can cause perceptions of environmental inflexibility.
2. Understanding of the opportunities and how to implement them	Advice, data and case studies from trusted organisations. Engagement with new entrants and innovative farmers.	Communication needs to penetrate farmers' busy lives and information overload. Organisations need to collaborate across the traditional-newcomer divide.	Understanding opportunities is a dimension of skills and learning for transformation. Social divisions and identities can inhibit knowledge flows.
3. Risks to the business are understood and mitigated	Whole farm business planning. Producer organisations / cooperatives guarantee a market.	Surety of supply chain is key. Business plan needs to align with farmer's values and priorities.	Financial uncertainty is a key influence on risk assessment. Business planning is a key skill for transformation.
4. Farmer confident and skilled to work in different ways	Collaboration with people skilled in other operations. Financial support to attend training.	May not suit everyone.	Individual resources for change can be increased through cooperation.
5. Financial resources to invest in new infrastructure, and to ride out payback period	Capital grants. Revenue funding for establishment and running of cooperatives / food hubs.	Need flexibility in funding mechanisms – scale and type of farm.	Financial inflexibility has multiple modes.

willingness to change is not solely psychological; as apparent across the themes in our analysis, most factors affecting transformational capacity are social or relational. Even conditions seeming to centre on the farmer (A1, A2 and A4), are shaped by relations to others, and might be enhanced by making enabling links, for example to supportive peers or producer cooperatives (B).

Investment capacity (A5) is a known constraint on innovation (Wheeler and Lobley 2021); as is concern with financial viability and the new venture's profitability (Barnes and Toma 2012; Midmore et al. 2001). Our findings suggest uncertainty about markets and supply chains for new products reduce financial flexibility and heighten risk perception (A3). Participants suggested easing transition into new supply chains through cooperation between producers and with intermediaries already engaged with these markets. This supports Eakin et al.'s suggestion that capacity to link and build collective action enhances transformational capacity (2016). Enabling links might be market as well as policy oriented.

Farmers who look to peers to validate business decisions might be convinced by successful plant-producers (A1, A2), as peer promotion of innovations uses social norms to lever change (Dessart et al. 2019). But potential to link plant-producers with livestock farmers is limited as they occupy distinct networks; trusted agents 'inside' the farming community were proposed as intermediaries. Powerful place and occupational attachments might also be levered to encourage transformation. Historic records and family

memories of plant production across Wales demonstrate that farming more than meat is possible *and* traditional. Farmers valuing tradition may become willing to change through understanding transitions towards plant production as reviving past practices and landscapes.

Conclusion

It is imperative to understand the needs and perceptions of actors significantly impacted by agricultural transitions. This research is a preliminary investigation of how livestock farmers regard transitions towards plant-based diets. Our approach indicates that social scientists should not be deterred from investigating what can be a highly polarising topic, particularly if they address opportunities to transform, and acknowledge the need for just transitions. Our findings highlight collaborations to plan just transitions require robust data on dietary trends and agricultural emissions, as farmers are suspicious of information regarded as partisan, and want to be sure those most responsible act first.

Dietary transition might become an event triggering transformation of livestock agriculture, but farmers vary in their assessment of the need to change. Whilst their production system remains profitable the financial risks of entering new supply chains discourage change. Livestock farmers' capacity to transform towards plant production varies, shaped by interactions between complex influences across micro to macro levels. Their transformational capacity is

reduced by several modes of financial inflexibility, and perceptions of inflexible farm environments. These perceptions are shaped by attachment to place and occupation, as well as psycho-social factors associated with the esteem farmers seek from peers. However, attachments might be levered to encourage transformation, by portraying plant production as a traditional farm practice. Enabling transformation also requires work to build links between farmer networks to enable knowledge flows between producer types. Fostering links between producers and market actors could also enhance transformational capacity by reducing supply chain risks. We hope these insights to livestock farmers' potential responses to dietary transition and their transformational capacity indicate potential for further investigation by those keen work with farmers to support just agricultural transitions.

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