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PAPER

Local policies and interventions to reduce a city's carbon footprint using plant-based diets: bristol as a case study

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Abstract

Net zero strategies are needed to mitigate the effects of the climate emergency. Food systems are responsible for one third of global GhG emissions. This study explores policies and interventions that can be applied at a local level to decarbonise the food system in the UK, using Bristol as a case study. Online elite interviews were conducted with 12 key stakeholders (policymakers, communities, and businesses). Through their lenses, potential interventions were identified that could promote behaviour change and enable a shift towards low-carbon plant-based diets in Bristol. Interventions are presented in an impact-effort matrix and include action on public procurement, community market gardens and food choice architecture. Although stakeholders think these interventions could be impactful, they also identified significant barriers, such as the need for specific subsidies/funding, resistance to change, and misinformation that will need to be overcome for the interventions to be implemented. The discussion provides examples of how each stakeholder group in the study could get involved to address the interventions proposed by the interviewees, concluding that further research is needed to explore the perspective of other key stakeholders (e.g. public) and different layers of governance (e.g. regional) to reach more holistic and comprehensive outcomes.

1. Introduction

Global climate mitigation can only be achieved if low-carbon strategies are successfully implemented to reduce the current generation of anthropogenic greenhouse gas (GhG) emissions to reach the objective of Net Zero by 2050 (Pörtner *et al* 2022). The IPCC (2007) established the global warming potential (GWP) of several GhGs which allowed the use of carbon equivalent emissions (CO_2e) to bundle and compare different GhGs to understand their GWP under a common unit, thanks to the established 1–1 equivalence between CO_2 and GWP. For example, Methane (CH_4) has 25 times more GWP in a 100 yrs span than CO_2 (IPCC 2007) and therefore a unit of CH_4 equals 25 CO_2e. This paper will refer to emissions either by GhG or CO_2e depending on the source and will use the terms carbon emissions and carbon footprint as a generic synonym of CO_2e, following most literature (see Wiedmann and Minx 2008). The latest IPCC report states that the level of emissions reduction achieved this decade will have an impact for thousands of years, as it will determine whether global warming can be limited to 1.5/2 °C (IPCC 2023a, p 25). Half of the world's population currently lives in cities and these are responsible for over 60% of GhG emissions (Harris *et al* 2020). Behaviour change and challenging current patterns of consumption represent significant opportunities, as most household carbon footprints can be mitigated with already available low-carbon alternatives (Ivanova *et al* 2020). Supportive policies to enable behavioural and lifestyle changes, such as a shift towards more sustainable diets, can help reduce those emissions (IPCC 2023a, p 33). Therefore, changing consumers' behaviour in cities may have a key role to play in reducing carbon emissions. Food

systems[1] are responsible for a third of global anthropogenic GhG emissions, with agriculture and land use accounting for 71% of those emissions, and the remainder attributed to supply chain activities (Crippa *et al* 2021). Sala and Castellani (2019) identify food as the biggest area of consumption driving environmental impacts in Europe, above mobility or housing, with agricultural activities being the most important emitter of carbon equivalent emissions (CO_2e). The agricultural sector is the UK's 5th largest contributor to GhG emissions (BEIS 2022) and together with land use accounts for 12% of all UK CO_2e emissions (Skidmore 2023). However, those figures do not account for the emissions related to distribution, processing, consumption, and end-of-life disposal. Furthermore, Scope 3 emissions, which refer to 'emissions from sources outside the company's own control and emissions embodied in the production of goods and services' (Radonjič and Tompa 2018, p 363) and could represent the highest GHG impact in an organisation (Matthews *et al* 2008), are often disregarded and under-disclosed in the food industry, which can result in an underestimation on their impact (Schulman *et al* 2021). Consequently, the contribution of food production to emissions in the UK may be more significant than currently understood. Irz *et al* (2019) suggested more promotion of climate-friendly food is needed, and advised that the effectiveness of food-based recommendations varies from country to country. Several studies (WWF 2020, Bryant 2022, Dimbleby 2022, Dixon *et al* 2022) highlight the potential for plant-based (PB) food to reduce emissions in the UK. However, national and local policy remains limited on agriculture and feedstocks (IPCC 2023b, p 19) and does not support behaviour change towards more PB diets.

For this reason, the aim of this paper is to understand what kind of policies and interventions could support the change towards a more PB diet to help decarbonise UK's food system, from a local stakeholders' perspective, using Bristol as a case study.

The paper is structured as follows:

Section 2 provides background to the role of behaviour change and food systems to help with decarbonisation in the UK; also, why Bristol is a suitable city for this case study.

Section 3 presents the aims and the methodological approach.

Section 4 describes the participants and the results, including the recommended actions according to the stakeholders.

Section 5 explores how policymakers, communities and businesses can act to help normalise PB diets, driving behaviour change and decarbonising the food system at a local level.

Section 6 provides some concluding remarks and recommendations for stakeholders.

2. Literature review

2.1. The role of behaviour change and PB diets to reduce carbon emissions in the UK

A number of independent studies on carbon emissions in the UK have identified mechanisms to reduce food sector carbon emissions such as technological developments or creating policies for behaviour change and a shift towards a more PB diet. This research focuses on the latter. A mix of policies that incentivise behaviour change can make a positive difference and mitigate the risk of surpassing environmental limits over relying on technological advance (Springmann *et al* 2018). For example, the Climate Assembly UK (2020) conclusions supported the idea of dietary change to reduce meat and dairy consumption, reducing therefore emissions from those industries. They noted that emission cuts of between 20% and 40% will be required to reach Net Zero. Education was identified as a key factor alongside making vegetarian/vegan products more affordable and high-carbon products more expensive. Barrett and Scott (2012) showed that a shift from high-carbon animal protein to low-carbon PB protein could save 846 million tonnes (Mt) GhG in the UK by 2050. Policy changes such as environmental and carbon labelling in food products or investing in protein meat alternatives, as well as importing policy ideas such as the EU meat tax proposal are regarded as important elements in securing the emission savings (WWF 2020). Catapult Energy Systems (2021) reported that investment in meat-free and dairy-free alternatives, could save from 8 to 19 MtCO2e/year, whilst promoting PB diets can help with the adoption of healthy diets guidelines, and to reduce carbon -intensive and non-linear (see Mathias *et al* 2020) use of farmed ecosystems (Everard *et al* 2021). Dixon *et al* (2022) showed in a comparative analysis of seven UK decarbonisation pathways that a shift towards PB diets could be a relevant measure in reducing carbon emissions.

The Climate Change Committee warned that current strategies will fail to reach Net Zero (CCC 2022). Policy gaps are highlighted by the findings of the Global Alliance for the Future of Food (2022), who

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[1] The term 'food systems' refers to the entire range of actors, elements and activities related to the production and consumption of food, as well as their environmental, economic and health consequences (von Braun *et al* 2021, p 30).

reviewed the national determined contributions (NDCs) of 12 countries, including the UK. NDCs set out emission reduction plans and could incorporate a food systems approach across their policies, to help meet the 2015 Paris Agreement. The review revealed that none of them included demand-side measures to reduce the carbon emissions from food, such as promoting PB diets or a reduction in the consumption of meat and dairy.

The National Food Strategy (Dimbleby 2022) recommended cutting back on animal protein and shifting towards a PB diet as one of the most effective ways to reduce carbon emissions and free up land for nature.

2.2. Food within the government's UK decarbonisation strategy

The UK published its decarbonisation strategy in October 2021, where the government committed to a systems approach that would help them to navigate the complexity of decarbonising the country and reaching Net Zero by 2050 (BEIS 2021). The document positioned livestock and nutrient management as the major contributors to carbon emissions in the agricultural sector (55 $MtCO_2e$), entrusting a reduction in emissions to improvements and innovation in farming practices (BEIS 2021) and to developing policies to support the deployment of technological and infrastructural solutions (BEIS 2021, p 129). However, as Röös *et al* (2015) pointed out, most GhG emissions from agriculture come from biological processes that are difficult to control (e.g. methane from ruminants), so technical measures and improved farming practices may never accomplish the reduction in emissions at the level needed.

The Sixth Carbon Budget on Agriculture and Land Use, Land Use Change and Forestry (CCC 2020) stated that policies are needed to promote a shift in dietary patterns and to reduce food waste, establishing PB options as the way forward both for climate mitigation, due to their significant lower GhG emissions, and for health purposes.

The National Food Strategy (DEFRA 2022) was created with the aim of generating a food system capable of supporting the delivery of Net Zero in the most sustainable way (BEIS 2021, p 117). However, it did not include policies or measures to support changing people's diets, disregarding the role of PB diets in the UK's pursuit to become Net Zero by 2050. Garvey *et al* (2022, p 3) established that the UK's consumption-based food emissions are 52% greater than its territorial account, which suggests that the consumption in the UK of certain food products has as big impact on emissions also outside the UK.

Whilst high in aspiration the forementioned UK decarbonisation plans often lack detail and implementation action, which has led the High Court to rule the plan unlawful (Purkayastha 2022). Livestock, particularly cattle, is singled out by the government to be the largest emissions contributor of the sector in their latest Net Zero Growth Plan (DESNZ 2023). However, none of the measures proposed mention a reduction in livestock or behaviour change/dietary shifts. While other sector emissions (e.g. transport) are projected to fall, agricultural emissions could rise to account for 30% of UK's emissions by 2030 (Skidmore 2023).

2.3. Bristol as a case study

Bristol, located in the South-West of England (Error! Reference source not found.), is the 11th largest local authority in England and Wales, with an estimated population of 472 400 and one of the most vibrant and successful economies in the UK (BCC 2022b). Bristol has declared its ambition to become Net Zero by 2030 (BCC 2019), twenty years earlier than the national goal, and released a One City Plan to escalate climate action beyond national ambitions (Bristol One City 2021). This ambition has been inspired especially during the past decade, where Bristol has demonstrated a strong interest in developing sustainable behaviours, including improving its food culture. The first Food Policy Council in the UK was created in Bristol in 2013 (Moragues *et al* 2013) following the baseline set by Carey (2013) in her report of the food system in Bristol. The Bristol Good Food Plan released in 2013 identified a substantial land area that could be used for agriculture in Bristol (Reed and Keech 2019). Carey's report was instrumental in Bristol achieving the Gold Sustainable Food City status in 2021 (Jones *et al* 2022).

A case study in Bristol showed that not buying surplus food can be sixty times more effective than recycling to reduce emissions and prevent food waste (Eaton 2020). The study revealed that consumers buy and cook too much meat that is not consumed, estimating that 50% of the meat is thrown away. UK citizens consume 50% more protein than the amount recommended (WRAP 2021). These data indicate the demand does not and should not meet the elevated production levels. Producing less, closer to the actual demand, avoids food waste, and therefore more CO2e (DEFRA 2011). The relevancy of reducing meat and dairy products to reduce emissions is also reflected in the BEIS report (2020). The Bristol Climate Hub (2021)

maintains in their website that switching to a PB diet can save 0.8 tonnes of carbon emissions every year per person (a reduction of up to 73% individual food carbon emissions). The city was also proclaimed vegan 'capital of the world' in 2018 (García and Muñoz 2020).

Bristol is, therefore, an apposite case study for creating local policies to support PB diets as a way of reducing carbon emissions.

3. Methodology

3.1. Methodological approach

The empirical data used for this research come from primary and secondary sources following the two steps described below.

Step 1. A literature review (using secondary data) of peer-reviewed academic papers, independent reports, and government's policy strategies (e.g. policy briefs, infographics, scenario planning) was carried out to understand the potential role of PB diets on food decarbonisation in the UK. Google scholar was used as the search engine to identify relevant academic works following these searching criteria: (i) to use combinations of the following keywords: carbon emissions * UK * decarbonisation * food policy * net zero * food system; (ii) to consider works published after the 2015 Paris Agreement at the United Nations Framework Convention on Climate Change (see UNFCCC 2016); (iii) to exclude papers with a focus outside of the UK. Inclusion was decided considering relevance of the specific publication after reading the abstract and other sections when needed. In addition, specific non-academic works, such as decarbonisation strategy documents included in the review, were identified from references in the academic papers and retrieved from official government websites. Overall, forty publications were included for the review.

Step 2. Semi-structured elite interviews (primary data) to understand stakeholders' perspective towards local policies and interventions that could be designed to promote PB food and reduce meat and dairy consumption.

Selection of participants. The selection of participants was made through a stakeholder mapping exercise (informed by Step 1) to identify relevant UK organisations involved in food policy. The details of key representatives were identified in the organisations' websites and contacted via LinkedIn/email. The sample included representatives from academia, policymakers, businesses, and communities, and was diverse in terms of gender and age. A description of the sample is provided in table 1. A total of twelve interviews were carried out online between July and August 2022 in MS Teams until saturation was reached and similar responses were collected (Hennink *et al* 2017). Participants were given a project information sheet that explained the scope of the project, issues related to data anonymity and withdrawal procedure, as well as a description of the research task they were going to be involved in. They were asked to provide formal consent prior to taking part in the interview. Participation was voluntary, and ethics approval was obtained from the institution's ethics committee.

Research instruments. The interview guide included: (i) an agenda and scope of the project, to highlight the objectives of the interview; (ii) a brief presentation to provide some background information on net zero strategies and the potential role of PB diets; (iii) an ice-breaker activity to allow the interviewee to introduce themselves and explain the reason why they decided to participate in the project; (iv) a series of tasks to identify appropriate local policies in Bristol to achieve two main objectives: (a) meat consumption reduction; and (b) PB diet promotion. Each interviewee suggested two policies and explored potential barriers and drivers for a successful implementation; (v) a two-axes graph, to help the interviewee indicating the level of impact of each policy on meat consumption reduction/PB diet promotion, and the related level of effort required to implement that policy. This was informed by previous conversation on considerations towards drivers and barriers for implementation. Participants were also offered the opportunity to add any further comments and raised key points that were not discussed within the interview.

3.2. Data analysis approach

All interviews were recorded and transcribed, and data were anonymised using specific codes for each interviewee. Data was analysed through a thematic analysis to identify common patterns and themes (Guest *et al* 2011). The six-phases thematic analysis method (see table 2) was used, following Braun and Clarke (2006) data analysis approach from an inductive perspective.

Table 1. Participants' summary.

Interviewees	Expertise and experience	Stakeholder Group	Role
A	Sustainability and local food sustainable partnerships	Academics	Senior lecturer
B	Public nutrition and dietary behaviour	Academics	Senior lecturer
C	Rural policy and food strategies	Academics	Professor and director of research centre
D	Climate-smart food and innovation	Academics	Senior research fellow
E	Food sustainability	Policymakers	Senior role—Local authority
F	Plant-based agriculture and carbon models	Policymakers	Senior role
G	Sustainability and business partnerships	Businesses	Director
H	Food justice and community development	Businesses	Director
I	Sustainable systems food planning	Businesses	Consultant
J	Programme coordination and green practices	Communities	CEO
K	Community development and engagement	Communities	Projects' Coordinator
L	Sustainable food strategies	Communities	Director

Table 2. Six-phases thematic analysis approach (Source: 'table 1 Phases of thematic analysis' from Braun and Clarke 2006, p 87). Braun and Clarke (2006), reprinted by permission of the publisher (Taylor & Francis Ltd, http://www.tandfonline.com.)

Phase	Description of the process
1. Familiarizing yourself with your data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

4. Results

Thematic analysis identified three main clusters of themes, the role of policymakers, the role of communities, and the role of businesses. These themes are described in the next section.

4.1. The role of policymakers

Interviewees agreed that policymakers have a responsibility to help decarbonise the food system. They suggested public procurement interventions to make sure budgets are used to purchase low-carbon food. They also thought it was important to reward businesses that comply with certain sustainability standards. Lastly, another measure identified was to tax businesses that use imported meat. These measures are explored in sections 4.1.1–4.1.3.

4.1.1. Public procurement

Most interviewees suggested public procurement as one of the potential interventions, highlighting that public institutions such as hospitals, schools, or universities, have access to large budgets to spend in food and catering. A change in their meal's selection, favouring low-carbon alternatives such as PB diets through initiatives like 'meat-free Mondays', or reducing the amount of meat in dishes overall, could be impactful in decarbonising the food system in the city. Most interviewees agreed on the importance of introducing 'carrot' or incentive strategies prior to presenting harder approaches. Some interviewees agreed that replacing meat with PB products would reflect positively in the economy of those public institutions and the

nutritional quality of meals, and that Bristol represented a great city to implement this change due to its pro-sustainability tendencies. Some of the barriers identified revolved around the potential lack of commitment and sustainability awareness from senior decision-making levels, and reluctancy to enforce measures that attempt to change habits, resistance from consumers, political and reputational risks, and the lack of skills of procurement officers.

'If you can enforce a change in an institution, then gradually you can make an impact on changing the norm.'—L, Business.

4.1.2. Business rewards and incentives
Interviewees suggested that businesses should receive recognition for their efforts to be more sustainable and use low-carbon food alternatives. Interviewees considered that for businesses to be able to lower the price of their PB products, so that they are very competitive alternatives to animal products like meat or dairy, an intervention from the government is needed. They pointed out that even though there are already a few reward schemes in place (e.g. Bristol Eating Better Award), they can be improved to better reflect this change towards low-carbon alternatives.

'The Good Food Catering Policy Framework from Bristol City Council is a fantastic foundation for the Bristol Eating Better Award but needs more progressive targets.'—I, Community.

4.1.3. Imported meat tax
One of the interviewees proposed economically penalising businesses that use imported meat. On one hand, this would reduce food miles, and potentially benefit local farmers, becoming therefore a more popular measure among the general public. On the other hand, businesses would need to find other ways to satisfy people's needs, because meat would be less available, and they may consider cheaper alternatives to meat such as using more legumes and other PB food.

'Taxing meat that's coming from abroad would be very impactful since people would turn to cheaper alternatives, and therefore lower emissions.' -D, Academic.

4.2. The role of communities
Interviewees recognised the importance of involving communities in redistributing the allotment system, creating community market gardens, and using awareness groups to promote and increase the visibility of low-carbon food products. Sections 4.2.1–4.2.3 describe those measures.

4.2.1. Redistributing the allotment system
Bristol is planning to launch a new food growing and allotments strategy, and interviewees claimed that the council needs to make sure they create policies to involve schools, so that these spaces are used to teach children and teenagers how to grow PB options and connect them to their food. They also highlighted that individual allocations are often misused, so they suggested that the allotment system needs an update. Interviewees also believed that participation from local communities is vital for a successful implementation of a local food strategy about the allotment system; they considered planning policy to protect and designate local growing areas needs improving, especially in the cases of regeneration and new development projects, stating that a part of land should always be dedicated to growing food. Some enablers identified were that these measures could boost communities' social aspects and improve their relationship with PB food, which can lead to a change in their consumption behaviour. Interviewees also expressed some concerns about the acceptability of these proposed changes in the allotment system, with some individuals showing resistance to losing their spaces. A lack of awareness on how powerful redistributing these spaces can be was also mentioned.

'You cannot feed a whole city with local allotments, but its more about driving behaviour change and driving a cultural shift about their food.'—A, Academic.

4.2.2. Community market gardens
A particularly innovative intervention suggested by the interviewees was the development of small-scale market gardening projects linked to communities, making sure all of the 34 districts or wards in Bristol would have a market garden. Community markets could be used as places to teach people to cook and to

grow food, as well as gathering places to enjoy meals together. This approach, where climate is not the focus, can work better to change people's behaviour about food choices. One interviewee suggested that not labelling these meals as meatless or PB would improve people's acceptance, due to some existing negativity about PB food. Enablers identified by interviewees included the potential to use community and faith centres as the core for these markets, since they already have access to a large number of people including most vulnerable groups. They usually have suitable facilities (e.g. equipped kitchens) and access to land (e.g. faith settings are usually landowners) suitable for the activities proposed. This practical approach could influence other communities to do the same, interviewees emphasised it can be a powerful case-study with a huge media reach potential. Some barriers detected were the need for an initial economical investment to create a suitable infrastructure the difficulty to engage people to come to cooking classes and skilled people to run them.

'*Small scale market gardening linked with the health agenda would be an easier way to secure long term support and funding (e.g. green social prescribing—poor mental health people to be automatically referred to Eco-projects like that).*'—F, Policymaker.

4.2.3. Awareness groups
Another intervention suggested was the creation of awareness groups that can lead by example and organising social activities promoting PB food, making sure businesses understand there is demand for these types of products. Another interviewee added that these groups can also be used for cultural celebration and inclusion purposes with PB food as a facilitator, insisting on promoting this by using a holistic approach (e.g. including health, environment, ethics, flavour richness). Many communities have already plenty of PB options embedded in their cultures (e.g. Indian community) so this can be used to inspire other communities to learn from an already existing case. In addition, PB products are already eaten more than it is noticed in every community; the realisation of this fact can also be an enabler.

'*There are 91 languages spoken in Bristol, which reflects the multiculturality of the city. We need to make sure interventions are inclusive and represent these different communities.*' I, Business.

4.3. The role of businesses
Businesses were also identified as key players in reducing the carbon footprint of the food system in Bristol. Measures identified to do this were making vegan menus the standard option, adding carbon emissions among the most relevant factors when making decisions (e.g. cost, calories/health indicators) and establishing partnerships to trial changes in how food is placed inside businesses (food choice architecture). Interventions are detailed in sections 4.3.1–4.3.3.

4.3.1. Making vegan menus the standard
Some interviewees highlighted the possibility business have to make an impact by simply establishing PB options as the standard, referring to meat options as secondary choices. One of the interviewees added that they had organised an event with more than 200 people where they decided to offer PB food as standard, with the possibility of opting out and having meat, but no one did. Businesses can become evidence of the advantages using more PB options as the main option. Interviewees identified economic benefits for businesses from reducing meat use. They also highlighted as enablers the need for businesses to reduce their carbon footprint and improve their ethics using more sustainable alternatives. The main barrier identified was resistance to change, lack of consequences for not adhering to low-carbon food strategies, and public low familiarity with certain foods, which can have a negative effect on their perceptions reflecting adversely on businesses.

'*Having vegan food as the norm, with people having to opt out, would have a great impact and help standard businesses that are not really thinking about their carbon footprint.*'—G, Business.

4.3.2. Focus on carbon emissions
Interviewees established that carbon emissions need to become one of the priorities for businesses when they make decisions about their menus. They suggested information related to carbon emissions linked to the plate can be included, following the example of calories. The main driver for businesses to turn their

attention to their carbon footprints was identified as reputational risks, where businesses have pledged that they will become more sustainable. A shift towards low-carbon options might have a beneficial economic impact as well. A barrier for carbon emissions to be effective when included in menus can be that people are much more concerned about calories and may choose to ignore other labels. Another barrier was that PB processed food is yet not identifiable as healthier, or better for the environment, so there might be some lack of trust in choosing based on CO_2 labels.

'Obesity is a topic everyone is familiar with for a number of years already, it might weigh much more than the climate or health in general'—B, Academic.

4.3.3. Food choice architecture
One of the proposed interventions by the interviewees was to change the way food is placed in businesses to favour PB products. This intervention would increase its impact by having different businesses and brands involved, acting from a collaborative and pre-competitive level. It is a matter of prioritising these options and remarking how good they are (e.g. carbon emissions, health, price). One of the interviewees stated it is also important to frame these changes as experimental, looking for better acceptance. Partnerships of businesses, and the council acting at the same time, were said to be able to mitigate the negative effects of potential bad press. There is also space for economic gains due to reducing usually more expensive meat products. Thanks to Bristol's commitment to the United Nations Sustainable Development Goals, the council can convene retailers within an area of Bristol to experiment and learn together (e.g. profitability of the model). One of the barriers identified was partners struggling to get permission when belonging to a national command chain. There would also be a need for high-level long-term commitment from businesses and institutions to achieve results, and local officials might not feel empowered enough to pursue this kind of agenda.

'With a collective approach, businesses can build a high level of trust from customers.'—C, Academic.

4.4. Interventions to prioritise
Interviewees were asked to position their chosen interventions in an 'Impact-Effort' matrix, considering the effort it would take to implement the proposed measures, the impact they would have on behaviour change and therefore on reducing carbon emissions from each stakeholder groups' perspectives. Figure 1 represents the main interventions identified by the interviewees.

'Standard vegan menu', which means PB food to be the default option when offering food in public and private organisations, was identified as the intervention that requires less effort, while providing the greatest impact. Together with this intervention, a change in the criteria used to allocate public money to food purchases towards low-carbon PB options (e.g. 'public procurement') was also included into the quick wins. These two interventions should be the ones to be prioritised, according to stakeholders.

Interventions that might have a similar impact, but would require greater effort in terms of implementation include: creating specific incentives, and improving existing rewards to businesses that are committed to be more sustainable options through the use of PB products (e.g. 'Business rewards and incentives'); taxing businesses that use imported meat (e.g. 'Imported meat tax'); and adding carbon emissions to indicate the carbon footprint of the meal(s) in a menu, in order to inform end-consumers and enable businesses to measure their footprint (e.g. 'Focus on carbon emissions').

According to the interviewees, another impactful intervention, which might require a higher effort, is the establishment of 'Community market gardens', which would potentially engage a broad number of people and would therefore have an impact in driving behaviour change. Changing the way products are positioned and displayed to favour those with a lower carbon footprint (e.g. 'Food choice architecture') would also have a good impact on behaviour change, especially if this is a shared policy among different businesses within the same geographical area. The establishment of 'Awareness groups', such as the vegan food and drinks groups was considered helpful, but not as impactful as the other measures. Finally, it is worth noting that even though 'Redistributing the allotment system' was indicated as less impactful than the other measures, it was still considered as an important intervention that can support changing behaviour towards more PB diets and should therefore be included into a potential action plan.

Figure 1. Impact- Effort graph.
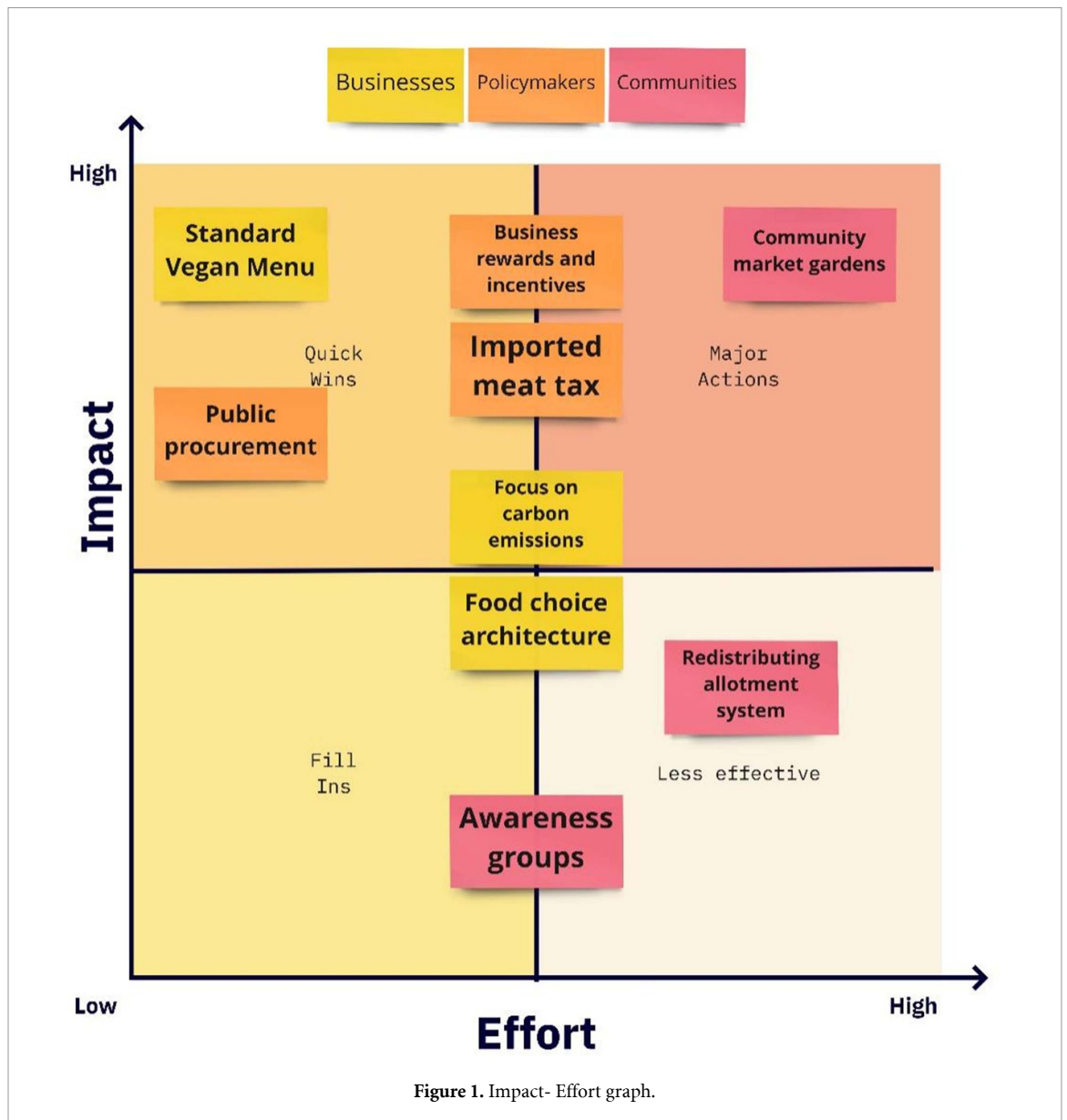
5. Discussion and policy implications

This section explores how these interventions could be integrated and applied in Bristol to reduce demand-side emissions by favouring a behaviour change towards PB diets, with a focus on how three different sets of stakeholders (policymakers, communities and businesses) could support them to enable the normalisation of PB products consumption. Interventions provided by the interviewees can help normalise PB products consumption and positively change people's relationship with food, enjoying the multiple benefits of switching towards a more PB diet. Although meat-eating remains as the dominant practice and social norm in wealthy Western countries such as the UK (Koch *et al* 2019), there is an upward trend on PB food consumption and acceptance (Jallinoja *et al* 2018). In order to boost that trend, policymakers, communities, and businesses can intervene to normalise PB food and help cities, like Bristol, to overcome barriers towards the adoption of more PB diets. Some of these barriers are motivational, such as the fear of risking changing social practices, identified as one of the biggest turndowns in the acceptance of PB diets (Niva *et al* 2017). Other adoption barriers are of a structural nature, such as a lack of availability and exposure of PB products (Jahn *et al* 2021). Policymakers, communities, and businesses can help to overcome these barriers.

5.1. Policymakers' response
Policymakers, such as Bristol City Council, can help normalise these products' consumption by specifying how budgets need to be spent on food purchasing by institutions using public funds. This intervention is in

line with policy recommendations made at a national level to increase the offer of alternative diets in the public sector (Green Alliance 2019) and follows an example set by other councils in the UK. Oxfordshire County Council adopted a policy to exclusively serve vegan food at events, and even though the measure was controversial and faced a motion, the motion has not been successful, and they continue serving vegan food to fight climate change (BBC 2022).

Bristol City Council could also take other measures such as endorsing the Plant Based Treaty like Edinburgh, Norwich or Haywards Heath, the first in the UK to endorse the treaty in July 2022 (Vegconomist 2022). This initiative fights climate change through supporting a shift towards healthier and more sustainable PB diets, supported by over 1000 organisations, more than 900 businesses and 61 000 individuals, including MPs and Councillors from Bristol. Bristol City Council could use the PB treaty demands to help them shape policies.

It is important to note that, even though endorsing these types of initiatives is not legally binding, actions to comply with the regime must be made, although this is often not the case (Lightfoot 2012). Bristol City Council would need to establish goals and measurable objectives, with clear actions and ways of monitoring their progress. There are three different sets of standards referred to within the policy framework of Good Food and Catering Procurement Policy (BCC 2018). 'Good Food Standards' are the minimum requirement for catering and food contracts in public procurement in Bristol; depending on the contract value, the silver 'Soil Association food for life served here' reward accreditation, upon which the good food standards were built, should also be obtained within the first 12 months of the contract. Providers are also expected to have achieved the gold 'Bristol Eating Better' award. All these awards could benefit from being updated to include more low-carbon food criteria and strengthen their sustainability goals.

The Good Food Standards encourage the use of in-season and fresh products (BCC 2018); however, they do not consider low-carbon food options at any level, the promotion of PB products or a reduction in meat use. The minimum score for the silver award (Soil Association 2019) is reachable even when not considering any of the actions towards low-carbon options present, such as balancing out meat dishes using PB products. The same issue is identified in the gold award. It is also worth noting that Bristol City Council's direct provision of food and catering is only expected to have achieved the Bristol Eating Better gold award (BCC 2018), with no significant plans for this to change. The new healthy and sustainable procurement policy and strategy (BCC 2022a) includes some actions to encourage the uptake of PB options. This link between public procurement to these standards may indicate that some effort is being made to use caterers that comply with a certain standard, but higher standards may be needed to decarbonise Bristol.

5.2. Communities' response

Communities can be stimulated to increase their self-reliance on food while improving their knowledge of food and cooking skills, tackling food insecurity, and potentially reducing costs due to the lower intake of meat products. It is worth considering the beneficial health implications coming from their increase of PB food intake, which has the potential to be linked to the health system agenda looking for funding opportunities and looking at reducing the carbon footprint and food waste. PB food allows also a reduction in the risk of exclusion for some groups because of religious dietary observances.

There are also awareness groups (e.g. Vegan Food and Drinks in Bristol) which try to promote veganism by showing there is a demand for vegan food, while creating a community, and which help businesses by promoting and educating them, while raising awareness on the need for PB options. However, as gathered from the interviews, these groups need to be more inclusive to make sure they help change other people's perspectives instead of making them feel excluded, creating resistance to change. It is important to highlight that none of these measures require involvement from central government, which facilitates their implementation at a local level and the need to take a holistic approach (e.g. considering cost, health, social implications) when designing strategies to reduce carbon emissions, avoiding focusing only on climate to achieve the necessary behaviour changes.

Communities in Bristol can help normalise PB food by including interventions at the core of initiatives such as the Bristol Community Climate Action Project. This initiative, pioneered by Bristol Green Capital Partnership in collaboration with community organisations across the city such as Ambition Lawrence Weston (ALW), is taking community-led climate action in a three-year city-wide project. ALW community climate action project demonstrator proposal 'Grow, Cook and Eat' estimated a potential annual carbon saving of 25.6 tonnes CO_{2e} during the three-year project by maximising local growing opportunities and upskilling the growing and cooking skills of their community members. It is worth noting that 23.0 out of 25.6 tonnes CO_{2e} savings from the plan come from reducing food waste, aiming to engage with 100 households from their district (Personal communication).

Although ALW's project proposal states that if 50 meat eaters stopped eating red meat there would be an estimated annual carbon savings of 34.4 tonnes CO_{2e}, adding that for every meat-eating person that went

vegan this could save 1.03 tonnes CO_{2e}, they aim to engage with only 10 people to shift their diets towards more sustainable ones (estimated annual carbon savings of 2.6 tonnes CO_{2e}). Given that the project's primary workstreams are 'Growing to reduce carbon emissions' and 'Reducing your Carbon Footprint in the Kitchen', the potential to positively impact carbon emissions from achieving changes in people's diets feels underexplored. More work towards engaging people to shift their diets could be considered, acknowledging that collaborative aspects of community-supported agriculture can influence a reorientation of values and practices, giving people access to more sustainable choices (Standal and Westskog 2022). Considering the great potential of these types of initiatives, communities from other districts and wards could replicate and expand the great work started by ALW, adding the creation of community market gardens (which could have a positive impact on people's perceptions and familiarisation with horticulture and the consumption of more PB diets) and awareness groups with the objective of improving the health, economy, and carbon footprint of their residents. Local vegan food success stories may represent an underexplored opportunity to bringing people closer to PB food.

5.3. Businesses' response

Businesses can also help normalise these products consumption in different ways. Menu redesign was identified in a systematic literature review carried out by Stiles *et al* (2022) as the best strategy to decrease animal-sourced protein and/or to increase PB protein in food service settings. This is supported by Perez-Cueto (2021), who suggested that menu design and innovative meal design can contribute to improve the acceptance and intake of PB meals.

Businesses are becoming more sustainable and food choice architecture can help to decrease their emissions (McCarty and Faber 2022). Interventions showing how low-carbon PB food can be tasty and nutritious can help increase these products' demand in other environments too. The results from this research also suggest that an indication of carbon emissions on the menu might encourage people to make more sustainable choices. However, Filimonau *et al* (2017) highlighted that carbon values are seen positively but not fully understood, suggesting the need to reinforce public knowledge on the climate significance of food choice. The findings of this research suggest that an inclusion of health indicators such as calories to the dishes in the menu might distract people from considering other indicators such as carbon footprint. This is in line with Filimonau *et al* (2017), who found that provenance of ingredients, nutritional and calorific values were significantly more important than carbon footprint value in consumers' choice.

Introducing PB dishes in a menu might be expensive when using alternative protein options such as tofu, seitan, or tempeh, as they are not mainstream yet. Enforcing an imported meat tax, attempting to level up the price of meat and PB alternatives, is a measure in line with other research carried out (Wirsenius *et al* 2011, Säll and Gren 2015, Stoll-Kleemann and Schmidt 2017); however, it may fall off-limits from what a local government can do (Power *et al* 2020). It is also worth noting that applying a carbon tax can be a first step in recognising the impact livestock has on the environment, as happened in Denmark (Caro *et al* 2017), but other strategies may be needed to decrease the consumption of imported meat and palliate the effects on the full range of other ecological impacts (Allen and Hof 2019). For instance, restaurants could use cheaper unprocessed PB protein sources, such as legumes (Santo *et al* 2020). Legumes could also be a solution to fix atmospheric nitrogen (N_2), since they have the highest protein per N footprint, which makes them a great protein alternative (Pierer *et al* 2014). Unlike with legumes, Varela *et al* (2022) found that consumers perceive processed PB protein alternatives as neither healthy nor sustainable and highly processed industrial food (e.g. texturized-soy burgers). It is worth noting that recent studies (e.g. Bryant 2022) indicate that processed PB protein alternatives are healthier and more environmentally sustainable than animal products.

6. Conclusion

This research provides a state-of-the-art review on the role of PB diets in decarbonisation strategies in the UK and at a local level in Bristol and identifies local interventions and policies to help decarbonising the food system in a city, from a multi-stakeholder perspective, using Bristol as a case study. Current national and local decarbonisation strategies do not regard PB diets as an important contributor to decarbonising the food system, despite the multiple experts' recommendations to include them at the core of decarbonising the food system. The findings of this study provide policies and interventions that policymakers, communities, and businesses can use to play a key role in decarbonising Bristol's food system. Interventions include a change in public procurement, the creation of community market gardens or food choice architecture experiments among others. The most impactful interventions identified were making vegan menus the standard choice, reviewing public procurement to include more policies that favour PB products, as well as reviewing guidelines to reward businesses, and starting market community gardens in different wards

around the city. These and other measures were included in an impact-effort matrix that can help to create the most effective strategy.

This research represents a novel contribution to knowledge in the following ways:

- It considers a bottom–up approach to decarbonise the food system, where local policies and interventions could be used to set examples and help reaching Net Zero by 2050.
- It provides a set of specific interventions that can be used to drive behaviour change towards PB diets, and therefore indirectly contribute to decarbonising the food system.
- It presents the views of different stakeholders, providing a diverse perspective on the topic.
- It opens up a dialogue and provides fresh perspectives towards decarbonisation plans in the UK, with special attention to stakeholder engagement and co-design.

6.1. Recommendations

Table 3 provides recommendations specific to each of the stakeholder groups included in this research, summarised from the Discussion section. These recommendations are transferable to other geographical areas, both in the UK and in other countries.

Table 3. Recommendations to the stakeholder groups to reduce carbon emissions through using PB diets.

Recommendations for policymakers	Recommendations for communities	Recommendations for businesses
- Explore additional requirements for public procurement, including a review on criteria to consider carbon emissions. - Strengthen the essential conditions of rewards with measurable targets, and the re-evaluation of non-core targets to increase the attention towards PB low-carbon food. - Empower and upskill officials to make decisions. - Lead by example and commit council direct provisions to use PB as standard, framing the measure by focusing on low-carbon emissions instead of veganism/reducing meat.	- Community leaders (e.g. churches, community centres) from different wards in the city to lead projects that include market gardens where different groups of people can gather, grow food, learn how to cook, and enjoy meals together, using PB food as standard. - Reach out to the local government to link these market gardens with a redistribution of the allotment system.	- Study the possibility of making PB their default food options, integrating carbon emissions at the core of their strategies. - Use trials and partnerships to evaluate the effect of prioritising PB product placement and advertising.

6.2. Limitations and further research

Although this research represents a valuable contribution to knowledge, there are some limitations that should be acknowledged. For example, a more comprehensive stakeholder mapping strategy to identify stakeholders should be included in further work. A multi-stakeholder workshop or focus-group could also be included in any future work.

Furthermore, future research might include exploring the views of stakeholders from a regional and national perspective to understand potential differences across the country. This might take into consideration, for example, challenges and implications related to local economies that might be more reliant on animal-based products. Trewern *et al* (2022) established that efforts to reduce meat consumption without supportive and holistic policies can be detrimental for nature (e.g. farmers start exporting more due to the reduction of meat consumption in the UK). These issues indicate there is a need to also consider including engagement and consultation with other stakeholders not present in this study (e.g. general public, farmers). Considering the important role end-consumers play, it would be also interesting to explore their perception towards the proposed interventions and understand what factors might drive their behaviour (e.g. behavioural/ psychological studies).

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary information files).

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