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What does ‘co-production’ look like for food system transformation? Mapping the evidence across Transforming UK Food Systems (TUKFS) projects.

Naomi Shaw *School of Health Professions*

Charlotte A. Hardman *University of Liverpool*

Neil Bernard Boyle *University of Liverpool*

Joanne Craven

Bethan Mead *University of Liverpool*

et al. *See next page for additional authors*

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Shaw, Naomi; Hardman, Charlotte A.; Boyle, Neil Bernard; Craven, Joanne; Mead, Bethan; Morgans, Lisa; Mumby, Hannah; Pettinger, Clare

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What does 'co-production' look like for food system transformation? Mapping the evidence across Transforming UK Food Systems (TUKFS) projects.

Authors and institutional affiliations

Naomi Shaw – School of Health Professions, University of Plymouth, Plymouth, UK.

Charlotte A. Hardman – Department of Psychology, Institute of Population Health, University of Liverpool, Liverpool, UK.

Neil Bernard Boyle –School of Psychology, University of Leeds, Leeds, UK.

Joanne Craven - Independent Consultant, Edinburgh, UK.

John Dooley – School of Agricultural Sciences and Practice, Royal Agricultural University, Cirencester, GL7 6JS, UK.

Bethan R. Mead – Department of Psychology, Institute of Population Health, University of Liverpool, Liverpool, UK.

Lisa Morgans – School of Agricultural Sciences and Practice, Royal Agricultural University, Cirencester, GL7 6JS, UK.

Hannah Mumby - Independent Consultant, Exeter, UK.

Clare Pettinger – School of Health Professions, University of Plymouth, Plymouth, UK.

Abstract

Co-production is a collaborative way of working which emphasizes the exchange of diverse forms of knowledge in an equal partnership for equal benefits. Co-produced research is a key strategic aim of the UK Research and Innovation (UKRI) Transforming UK Food Systems (TUKFS) Strategic Priorities

Fund; this research programme brings together researchers, policymakers, industry, and communities to create positive change in the way food is produced, accessed, and consumed. However, more generally, there are diverse understandings of co-production, and a lack of consensus on what 'good practice' looks like. Therefore, this study aimed to identify and map examples of co-production methods employed across the TUKFS programme.

Two creative workshops (n=15 participants), conversations with TUKFS researchers and stakeholders (n=15), and systematic analysis of project documents were used to critically explore co-production activities within six TUKFS projects.

A range of co-production activities were identified. Findings highlighted areas of 'messiness' and complexity, challenges associated with applying co-production approaches, and practical solutions. Four key shared principles for co-production were identified: 1) RELATIONSHIPS: developing and maintaining reciprocity-based partnerships; 2) KNOWLEDGE: recognising the contribution of diverse forms of expertise; 3) POWER: considering power dynamics and addressing imbalances; 4) INCLUSIVITY: ensuring research is accessible to all who wish to participate. Opportunities for reflection and reflexivity were considered crucial across all these areas.

Findings contribute important insights towards a shared conceptual understanding of co-production for food system transformation research. This paper makes recommendations for researchers, practitioners, academic institutions, and funders working in this area of research and practice.

Keywords

Co-production; food system transformation; participatory research; creative methods; stakeholder participation

Introduction

The UK food system is failing to provide access to healthy, safe, sustainable, and affordable food for all citizens (Hunt *et al.* 2023). The ways food is currently produced, accessed, eaten, and wasted are exacerbating health and social inequalities while inflicting significant damage to our environment. Poor dietary patterns contribute to high rates of overweight and obesity in England (OHID 2023), with people living in disadvantaged areas disproportionately affected (Marmot *et al.* 2020). This burden of obesity-related illness to health systems is rising, with UK-wide costs to the National Health Service (NHS) projected to reach £9.7 billion annually by 2050 (PHE 2017). Concurrently, food production methods are contributing to greenhouse gas emissions and biodiversity loss, depleting natural resources and degrading soil health (Crippa *et al.* 2021; Dimbleby 2022). Recent events (e.g., Brexit, the Covid-19 pandemic, and conflict in Russia-Ukraine) have highlighted the UK food system's limited resilience to shocks that affect food supply and affordability (Caraher *et al.* 2023b; House of Commons Library 2022; Sanderson Bellamy *et al.* 2021), with concerns raised over the potential for future civil unrest due to food shortages (Jones *et al.* 2023).

There is an urgent need, therefore, for local and global transformation of the food system to sustain human and planetary health (Rockström *et al.* 2020). The concept of 'transformation' has been described as a qualitatively distinct, or fundamental change over time as a result of the contributions of a range of actors (Fazey & Colvin 2023; Fazey *et al.* 2018). It is argued that transformation towards sustainable nutrition security will require a systems approach with coordinated action at multiple levels (Caraher *et al.* 2023a; Ingram & Zurek 2018). Food systems transformation will also require fundamental changes to research and innovation systems (den Boer *et al.* 2021b), with a proposed shift towards transdisciplinary, inclusive, and participatory approaches (Calla *et al.* 2022; Schwarz *et al.* 2021). These approaches must acknowledge the complexity of interactions between actors and elements within the food system, through engagement with, and integration of, multiple stakeholder perspectives, in order to develop new solutions, policies and innovations based on

68 'sound' evidence (Bhunnoo & Poppy 2020).This should create a healthier food system that is
69 sustainable and resilient, yet fair and equitable (Schwarz *et al.* 2021).

70 Consequently, there has been a recent emergence of creative 'co-production' approaches to food
71 system transformation research. Part of a family of participatory and transdisciplinary approaches,
72 co-production is a collaborative way of working, which emphasises the exchange of diverse forms of
73 knowledge and expertise in 'equal partnership for equal benefits' (Co-Production Collective 2021).
74 The concept has become increasingly popular within health and social care (Masterson *et al.* 2022;
75 NIHR 2019), sustainability science (Chambers *et al.* 2021; Norström *et al.* 2020) and, more recently,
76 food system research (Baungaard *et al.* 2021; Topi 2022). Such approaches offer democratic
77 agendas, empowering marginalised communities and stakeholders, and engaging them more fairly
78 in research processes and decision-making (Thomas-Hughes 2018a). Co-production may also
79 improve research quality, ensuring its relevance to 'real world' contexts, and identifying new
80 solutions that align with the needs of the populations they intend to support (Kok *et al.* 2021;
81 Maughan & Anderson 2023). These approaches are also proposed to enhance the legitimacy of
82 research outputs and processes and may stimulate collective learning and reflexivity (Kok *et al.*
83 2021) with multiple stakeholders to produce innovative community-identified responses and
84 solutions (Kreiling & Paunov 2021).

85 Co-produced research is becoming a requirement of research funders. For example, UK Research
86 and Innovation's (UKRI) Transforming UK Food Systems (TUKFS) Strategic Priorities Fund has a key
87 strategic aim of "*co-producing research across disciplines and stakeholders to provide evidence for*
88 *coherent policymaking*" (TUKFS 2023f) because it is considered a powerful pathway to impact for
89 societal problem solving. This call for 'co-production' of knowledge within the food system space is
90 intended to inform more transparent, resilient, and collaborative decision-making processes
91 (Howarth & Monasterolo 2017). Indeed, such approaches are already being applied in this context
92 elsewhere, where researchers are collaborating with industry partners, policymakers, citizens, and

farmers (Bogomolova *et al.* 2021; Utter *et al.* 2021; van Dijk *et al.* 2019). Co-production, however, is a concept that has been described as 'messy' (Thomas-Hughes 2018b) because there remains a lack of consensus on what it should look like. Similarly, other terms such as co-design and co-creation have been used interchangeably with co-production to refer to a range of participatory processes involving researchers, stakeholders, and other end-users of interventions (McGill *et al.* 2022). These are often contested terms known to have inconsistent international and discipline-specific contextual interpretations; as well as a potential risk of being tokenistic (Locock & Boaz 2019; Masterson *et al.* 2022; Smith *et al.* 2023). With such a "*crowded landscape of definitions*" (Locock & Boaz 2019), there are concerns regarding misappropriation of their use (Williams *et al.* 2020) and thus a cautious approach to implementation is required (Oliver *et al.* 2019).

There is considerable scope, therefore, to critically explore such methods in the context of food system transformation to better understand these less traditional approaches in terms of their values, aims, priorities, and expectations of working within different institutional and organisational cultures (Durose *et al.* 2023; Turnhout *et al.* 2020). Within the TUKFS programme, multiple research projects have objectives relating to 'co-production' with diverse food-systems actors, and a range of terminologies being used. With such diversity of implementation, it is important to reflect on how co-production is being employed. This study aimed to explore what co-production looks like for food system transformation research projects. It has identified and mapped examples of co-production, co-design or co-creation methods being employed within TUKFS projects to better understand how to implement, facilitate, and invest in future co-production research approaches.

Methods

DESIGN

As an exploratory study, design aspects comprised parallel activities of 'mapping' and participatory creative workshops, which were deemed ideally suited for assessing project experiences and understandings of co-production by researchers and project team members involved.

Creative methods were purposefully selected, employing playful, interactive activities to facilitate discussions about difficult issues, and as a tool to 'unpick' the messiness and complexity. Creative approaches are well known in food research to empower diverse individuals to build relationships and provide opportunities for collaborative learning (Flint *et al.* 2017; Pettinger *et al.* 2018; Pettinger *et al.* 2019). Furthermore, they "*provide essential space to be reflexive on research practice*" (Flint *et al.* 2017) so can inform knowledge mobilisation.

RECRUITMENT

Five researchers from TUKFS research projects (labelled i-v in Table 1) were part of the project team, effectively acting as 'gatekeepers' to reach relevant project members to represent and reflect upon the co-production activities within their respective projects. These activities are summarised as follows:

i) BeanMeals: co-designing systemic innovation to increase supply and demand for UK-grown navy beans (including whole-school engagement and co-designing games with school children) (TUKFS 2023e); ii) Cultured Meat: 'co-innovation with those potentially affected the most by the technology – farmers' (TUKFS 2023d); iii) FoodSEqual: 'co-production of healthy & sustainable diets for disadvantaged communities' (Pettinger *et al.* 2023; TUKFS 2023b); iv) Healthy Soil, Healthy Food, Healthy People (H3): transforming the UK food system 'from the ground up' via an integrated programme of interdisciplinary research and interventions including growing approaches and engaging with 'high risk groups' to identify pathways to increase fibre intake (Jackson *et al.* 2021; TUKFS 2023c); v) FIO Food: Public and Patient Involvement through lived experience and engaging with food retailers to support healthy and sustainable diets in people living with food insecurity and obesity (Lonnie *et al.* 2023; TUKFS 2023a).

TABLE 1 HERE

PROCEDURES

Preliminary 'co-production oracle' workshop

An online interactive half-day workshop was held on 7th July 2023 on Zoom led by a creative facilitator (HM; https://hannahmumby.co.uk/). The workshop involved the five co-investigators (projects i-v, Table 1) and the project research assistant (n=6 participants in total). Workshop discussions focused on the project vision, consideration of 'good practice' co-production definitions in reference to existing frameworks (Smith *et al.* 2023) and mapping activity ideas. The unique 'co-production oracle' card deck was introduced to identify and discuss issues associated with co-production approaches for food system transformation (Figure 1). These cards were developed as part of HM's previous research, and each card features a theme relating to co-production issues (e.g., the 'PRIVATE PARTY' and the 'COLONISER', Figure 1), with question prompts to assist groups with exploring new perspectives for complex problems within collaborations (Mumby 2022).

FIGURE 1 HERE

Mapping activity

This activity was implemented between July and October 2023, to identify and explore examples of co-production activities occurring across the recruited TUKFS projects. A mapping template (Table 2) was co-developed by the research team to structure the collation of relevant data regarding these activities. The template was informed by existing guidance and literature on co-production theory and methodologies from a variety of disciplines including health and social care, sustainability, and sports science (Co-Production Collective 2021; INVOLVE 2019; Leask *et al.* 2019; Liaison 2020 2022; N8 Research Partnership 2016; Norström *et al.* 2020; Smith *et al.* 2023).

TABLE 2 HERE

To identify relevant data for each represented TUKFS project (Table 1), a systematic analysis was conducted of project websites, bibliographic database searches (e.g., Web of Science), and web

searches (e.g., Google Scholar) using TUKFS project names as search terms. This included examination of journal articles, blog posts, podcasts and videos with content related to co-production activities. Additional information was provided by project co-investigators to consolidate this search. All relevant information was extracted into a mapping template for each project (or work package within a project) (Table 2).

During the mapping activity, investigators within each project with experience of co-production activities were identified for involvement in subsequent 'mapping' conversations. Co-investigator gatekeepers or project leads circulated emails to identify people involved in co-production activities across work packages. During this process, members of a sixth TUKFS project came forward to share their co-production approaches (Table 1, project vi).

Mapping conversations (n=13) were conducted using Teams (Microsoft) or Zoom (Zoom Video Communications) individually or in pairs, with participants (n=15) including academic researchers, project team members and a food partnership coordinator involved in six TUKFS projects (projects i-vi, Table 1). Conversations ranged from 40-100 minutes; and included questions from the mapping template, focusing on consolidating already available information. These informal conversations (or semi-structured interviews) were considered an appropriate method to gather further details to supplement the mapping, due to their flexibility in allowing participants to direct the flow of discussion, and for ease of communication to share perspectives (Clark *et al.* 2021; Swain & King 2022)

All mapping conversations were audio-recorded with transcriptions generated using Microsoft Stream or Zoom functionality. Transcripts were checked for accuracy, with relevant co-production activity information extracted and added to a separate mapping document for each project or work package.

Key findings were then systematically collated using Miro (a digital collaboration platform) (Miro 2024) and categorised as follows:

- aspirations or perceptions of what co-production should look like for food system transformation;
- barriers and challenges experienced;
- and any solutions, strategies, and facilitators for using these approaches.

Where possible, data were mapped to key co-production values or shared principles highlighted in other literature (Co-Production Collective 2023; INVOLVE 2019; Norström *et al.* 2020; Smith *et al.* 2023) and cards from HMs 'Co-Production Oracle' (Figure 1) card deck (Mumby 2022).

Consolidatory 'oracle' workshop

A half-day in-person creative consolidatory workshop was hosted at a UK university (20th November 2023), to share and validate the findings of the mapping activity, involving academic researchers and project team members (n=9) from across the selected TUKFS projects (Table 1). Individuals who had participated in project conversations were invited, as well as researchers and non-academic partners identified by project co-investigators during the mapping activity.

Using a range of practical creative tasks, involving flip chart paper, post it notes, pens and other art materials (including the 'co-production oracle' cards, Figure 1), participants were asked to collaboratively consider the key aspirations, challenges, solutions, and facilitators that had been identified through the mapping activity. Discussions were recorded by collating them onto the existing Miro board (Miro 2024) which was visible during the workshop. Opportunities were provided to either validate or question this data using sticky dots and post it notes – this part of the process was captured and visually represented to co-create an output called the 'messy map' (link to OSF).

SYNTHESIS AND COLLATION

Where possible, data from mapping conversations and workshop discussions were categorised to four key co-production values which have been identified in the literature on co-production:

Relationships, Knowledge, Power, and Inclusivity (Co-Production Collective 2023; INVOLVE 2019; Norström *et al.* 2020; Smith *et al.* 2023). Under each heading, relevant data were grouped as "Perceptions of the ideal or gold standard", "Barriers and challenges", and "Solutions, strategies and facilitators." (link to 'messy map' on OSF).

Data collated from the mapping activity were also used to synthesise 11 case study examples of co-production activities being delivered across 6 TUKFS projects (Table 3). Further information about each of these case studies is available within a complementary online toolkit (available from: https://www.plymouth.ac.uk/research/synergy) which has been co-developed alongside the current article to support the practical application of co-production approaches within food systems research.

Ethical approval

Ethical approval for the study was obtained from the Faculty of Health Research Ethics and Integrity Committee (FREIC) at the University of Plymouth (Project ID: 4435). Prior to workshops and conversations, participants were provided Participant Information Sheets and gave informed consent for their involvement.

Findings

1) Preliminary 'co-production oracle' workshop

Participants considered the vision for this research, with discussions stressing a shift in focus away from the concept of 'good practice'. Instead, participants articulated the importance of capturing the diversity of co-production approaches used in TUKFS projects and exploring perceptions of 'messiness.'

> *"Mapping the messiness really is what it's about" (Participant N, Preliminary 'co-production oracle' workshop)*

In addition, participants were keen that this research would share 'stories' of co-production, using clear, accessible language to describe activities and practical recommendations.

2) Mapping activity

This activity highlighted the diversity of co-production activities across the TUKFS programme, with significant variation in how these approaches are described and implemented (see Table 3). Within the six TUKFS projects included, researchers are currently engaging with a range of non-academic partners from different food system settings, including farmers, food partnerships, school children, people living with food insecurity and obesity, policymakers, retailers, as well as community members and groups. Non-academic partners were noted to be engaged in varied research activities, including the co-design of workshops, co-development of interview and focus group materials, research methods, retail strategies, visual outputs (e.g., videos) and food products, interpretation of results, and in the dissemination of findings. Conversations highlighted a range of rationales for conducting co-produced research, including motivations to give under-represented or marginalised individuals and groups a 'voice', connecting real people with lived experience or practical knowledge to decision makers, as well as empowering communities, building capacity and new relationships. Several participants were motivated by the notion that co-produced research may enhance the applicability of findings, with greater potential for implementation and impact.

TABLE 3 HERE

Despite heterogeneity in the terms used to describe co-production activities and their implementation in varied food system contexts, when the data gathered in mapping conversations and workshop discussions were combined, shared ideals for co-production, common challenges and solutions aligned with four key thematic areas (OSF link). These included the importance of 1) RELATIONSHIPS: developing and maintaining partnerships based on reciprocity, 2) KNOWLEDGE: recognising the contribution of diverse forms of expertise, 3) POWER: considering power dynamics and addressing imbalances, and 4) INCLUSIVITY: ensuring research is accessible to all who wish to

participate. These four areas were noted to be highly interconnected and overlapping. The 'messy map' (OSF link) illustrates the findings from the mapping activity and consolidatory workshop discussions. Detail on findings is provided below under these four headings: Relationships, Knowledge, Power, and Inclusivity.

RELATIONSHIPS – developing and maintaining partnerships based on reciprocity

The development of partnerships based on trust and reciprocity was considered an essential component of co-production activities. Relationship building was felt to be facilitated by frequent interactions, such as social activities, sharing food, and by taking an interest in partners' lives outside of the project, with one participant observing:

> *"And I think there is this invisible element…which we all do in a way is...care and listening just chatting. Being interested in people… finding the time at the beginning of the session to check in and say what's up, what's going on for you." (Participant E; mapping conversation)*

However, relationship building was thought to require a significant investment of time and resources which was hindered by a lack of opportunities to build relationships outside of funded projects or prior to the development of grant applications, and by short funding timescales. Funding structures often meant research objectives were identified by academic researchers, with several participants highlighting their concerns around projects with researcher-led agendas, and noting potential challenges to investment from non-academic partners within projects with goals that had not been jointly identified:

> *"The agenda's already been set, and it's then how can you work in co-productive ways that are valid, if that agenda has already been set." (Participant A; preliminary 'co-production oracle' workshop)*

Additional challenges were noted, with one participant highlighting issues of community fatigue and negative prior experiences of research involvement:

"It's an incredibly crowded space and there's a real risk of over researching and fatigue...actually lots of people don't want to take another Zoom call from a researcher" (Participant I; mapping conversation)

In consequence, identifying mutual benefits for all those involved and ensuring frequent interactions and follow-up (for example, through sharing and discussion of research findings) were highlighted as key principles for co-production, particularly for building trust with partners:

"I think there's got to be a bit of give and take, whether it's access to facilities, or to show we're not there just to measure and go, it's some kind of shared give and take." (Participant A; mapping conversation)

Perceived benefits for non-academic partners included training opportunities, access to resources and equipment, the creation of new networks, the development of transferable skills, knowledge, and increased confidence. Other positive outcomes of project interactions were also shared by participants, for example:

"I feel like that there's a collateral benefit in doing this kind of stuff with kids in terms of making them feel that they matter…. a lot of them reported feeling important and really proud." (Participant D; mapping conversation)

In multiple projects, remuneration or payment in vouchers were noted as important to ensure fair recognition of partners' contributions. However, institutional processes for remunerating partners were often described as time-consuming to set up and administer, and participants were keen to identify means to limit bureaucracy for partners claiming remuneration.

Personal qualities including openness, empathy, and listening skills were described as facilitators to relationship building, and partnerships in several projects were also supported by trusted individuals in 'gatekeeper' roles who bridged the gap between academics and partners. These individuals

frequently had pre-existing connections with partners, and enabled researchers to build rapport and trust with partners more quickly.

KNOWLEDGE – recognising the contribution of diverse forms of expertise

Recognition that partners are experts, and the value of different perspectives and forms of knowledge were themes that recurred across multiple conversations and workshop discussions:

> *"I always consider them to be the source of knowledge...they do know a lot, and some of them, they've been farming for more than 50 years..." (Participant K; mapping conversation)*

Participants often described partners as assets, and were keen to support them to work in areas that utilised their interests and expertise, rather than assuming partners need to be involved across all research activities:

> *"Our community food researchers are the ones going out to speak to the community. They know the community; they know what the community needs." (Participant N; preliminary co-production workshop)*

While several participants reported the potential for uncomfortable conversations among diverse groups, many acknowledged the value of opportunities to bring together different types of knowledge (e.g., lived experience, academic, practical). For example, one participant noted:

> *"When you're a practitioner, you don't have time to relate to theory, and so having that space to have those conversations with people that are paid to think about that is really useful." (Participant J; mapping conversation)*

Conversations highlighted concerns regarding external perceptions of the quality of co-produced research, due to knowledge hierarchies within the academic community that value unbiased, objective positions over lived experience or other diverse types of knowledge. This was thought to result in a lack of recognition for co-produced outputs in research communities and academic institutions, with the focus still on traditional formats such as peer-reviewed academic papers. In

addition, participants noted challenges to ensuring fair recognition for non-academic partners, for example, as co-authors of publications.

POWER – considering power dynamics and addressing imbalances

Sharing power more fairly in the research process was considered a key principle of co-production, with participants noting aspirations for joint identification of problems and goals, and non-academic partners involved from the start in co-developing and writing grant applications. Shared goals were exemplified as important:

> *"We are all different. We have different goals. We have different backgrounds, different histories. But we work together for the shared goals. So, we basically try to find that shared goal, and then we adapt and be flexible on both sides." (Participant K; mapping conversation)*

The complexity of power dynamics both between and within groups of researchers and non-academics in co-produced research was noted, with one participant commenting that partners "*come with existing relationships and incredibly complex local politics*" (Participant E; mapping conversation), and these may influence power dynamics even when strategies are used to address imbalances. Furthermore, one participant lamented dominant voices in group discussions, which often created tensions within collaborations:

> *"On some occasions those voices have been more dominant than the local… residents who …come in and so we've had to try and think of strategies to try and mitigate that." (Participant E; mapping conversation)*

Strategies perceived as helpful in mitigating power imbalances, included consideration of language use (e.g., avoidance of jargon), selection of meeting locations (e.g., away from school for children, or university campus for community members), and choice of clothing (e.g., wearing less formal

clothing in community or school settings). Facilitation skills were also valued in multiple projects, for example, one researcher noted their importance in project discussions with partners:

> ""So *people get something out of it and being aware of tensions, or overpowering people, or quiet people." (Participant B; mapping conversation)*

Furthermore, involving non-academic partners in decision-making was considered a key aspect of addressing power imbalances, however, it was noted that shared decision-making could be challenging and time-consuming. For example:

> *"It may be rewarding, but it's not fun. You need to persuade people to give up time, but also to give up time to a process which might be challenging." (Participant D; mapping conversation)*

INCLUSIVITY – ensuring research is accessible to all who wish to participate

To ensure the inclusion of multiple perspectives, many participants emphasised that opportunities for involvement in co-produced research should be accessible to all who wish to participate, with barriers to engagement minimised. Inclusivity in TUKFS projects was thought to be facilitated through provision of support for attendance at project activities (e.g., travel expenses and cover for childcare costs), careful consideration of the timing of meetings, use of creative methods (e.g., collage), the creation of safe spaces to ensure partners feel comfortable sharing their perspectives, and use of a variety of communication strategies to accommodate a diverse range of needs. For example, in one project, a researcher described use of props in meetings with farmers:

> *"In these meetings we brought, you could say props, understanding that people don't engage in the same way, so working around this big print out of the landscape was extremely useful because it was very easy for the farmers to just grab a pen and start finding their own fields, and have a conversation around this object." (Participant L; mapping conversation)*

However, meeting the needs of a diverse group could also be challenging, with one participant sharing that:

> *"you can feel quite pulled…in supporting different needs" (Participant E, mapping conversation)*

Several participants noted the importance of reflecting on who might have been excluded from co-produced research, with one project noting their use of stakeholder analyses to identify these individuals or groups. Recruiting non-academic partners from hard-to-reach groups was often found to be challenging, due to the time needed to identify and engage with these groups, and the requirement to balance this with other demands, as highlighted by this participant:

> *"We have very good representation from certain sections of the city….but we know that there are important gaps and we realized very early on that we weren't going to have sufficient resources, time being the key one, to really address these things." (Participant I; mapping conversation)*

3) Consolidatory 'oracle' workshop – additional findings

Participant discussions at the consolidatory workshop further highlighted the complexity and messiness of implementing co-production activities within TUKFS projects. Participants noted the shifting and complex nature of power dynamics within and between groups of researchers and non-academic partners, as well as the extensive diversity of perspectives and needs within a group. Discussions stressed that groups of non-academic partners are far from homogeneous, and that researchers and stakeholders involved may have multiple identities. When using co-production approaches, participants felt that there was a need to adapt to non-linear research processes, and to be aware of detail while also taking a systems perspective:

> "*You need 3D goggles!*" *(Participant E; Consolidatory workshop*).

Consequently, a 'one size fits all' approach was felt to be unsuitable in co-produced research, with iteration and adaptation required for each context. For example, while provision of accessible, jargon-free information was felt to be important for inclusivity, concerns were also raised regarding potential oversimplification as some non-academic partners may appreciate and prefer detail and complexity. Similarly, participants from several projects were keen to identify an ongoing legacy for partners beyond the end of a project. Participants also agreed there was a need for a joint identification of long-term mutual benefits and that these should be tailored for different individuals and communities, according to their needs, motivations, and circumstances.

Difficulties with implementing a 'gold standard' approach for co-production in practice were also highlighted, due to constraints related to limited time, resources, funding requirements, existing academic structures, or values. This sometimes led to feelings of 'paralysis' and more often, a need to compromise on the joint identification of shared goals, flexibility, and creativity within a project. Participants felt it was important to be realistic and clearly communicate what might be possible to achieve within available time and resources.

Creation of frequent opportunities for reflection and reflexivity relating to all aspects of co-production processes was considered crucial. In particular, consideration of assumptions about roles, biases and inherent power hierarchies in research processes was highlighted, with a need for constant questioning by all those involved regarding 'who decides?'. For example, 'who decides' what constitutes a research priority, who needs to be involved and when, what represents a 'mutual benefit' or an important legacy for a research project, or whether language should be simplified for research to be more inclusive.

Discussion

Co-production approaches are increasingly being employed in research on food system transformation. However, there is a general lack of consensus on what co-production should look

like, and a need to consider discipline-specific contextual interpretations and applications of co-production approaches. The current study aimed to critically explore co-production activities within food system transformation research projects. It has identified and mapped examples of co-production, co-design or co-creation methods being employed in selected research projects within a major programme of funded research on transforming the UK food system. Through use of creative workshops, mapping conversations, and systematic analyses of various project documents relating to six food systems projects, a range of co-production activities were identified with varied objectives and motivations, and diverse partners, food system activities and methodologies. Despite this heterogeneity, however, practical solutions and shared ideals for co-production were also identified that aligned with four literature-informed thematic areas: relationships, knowledge, power, and inclusivity.

One overarching finding is the diversity and complexity of co-production approaches when applied within food system transformation research. Indeed, co-production has emerged as being inherently 'messy' (Thomas-Hughes 2018b) and multifarious in nature, dependent on multiple factors including, but not limited to, the context, the contributing participants, and the overall aims of the shared research or project. Co-production approaches are not static – their dynamic aims, narratives, relationships, and timescales can all shift during the process. The food system itself is a complex network of interconnected actors and activities (Hasnain *et al.* 2020; Parsons *et al.* 2019) and this emphasises the critical importance of taking a systems perspective to co-production (Midgley 2016) acknowledging the complex power dynamics, diversity of perspectives, and non-linear research processes. This conceptual messiness within food system co-production meant that the case studies identified and analysed in our study did not obviously correspond to existing typologies of co-production from other disciplinary areas (Smith *et al.* 2023). Taken together, these findings further reinforce the view that there is "*no single formula or method for co-production*" and that it should be "*principles driven rather than being a fixed set of tools or techniques*" (INVOLVE 2019).

Furthermore, arising from this complexity and messiness of processes, our findings highlighted challenges particularly when trying to put notions of a 'gold standard' approach to co-production into practice. For example, aspirations for flexibility and creativity in processes can contradict the need for academics to follow pre-determined (traditional) methods outlined in funding applications and meet requirements for outputs, with greater value placed on academic publications over other forms of output (Durose *et al.* 2023). Others have noted a "*theory-practice gap*" and a need for pragmatism and compromises for co-production to be practical within the available time and resource (Durose *et al.* 2023; Facer & Enright 2016; Farr *et al.* 2021). Our findings highlight the need for continuous reflexivity and reflection to fully consider the complexity and messiness before, during and after any co-production activity. Reflexivity is critical for ethically sound and socially relevant transformative research (Minna *et al.* 2023). Indeed, reflexivity is a way of dismantling oversimplified thinking about food systems and embracing complexities to explore the transformative potential of the different ways knowledge about food systems is constructed (Sharp 2019). Without this reflexivity and reflection, the risk of tokenism is accentuated, as is methodological inertia whereby co-production approaches are not optimally planned, and their quality is called into question.

Notwithstanding, our findings have also enabled extraction of thematic principles and shared ideals within co-production approaches for food systems transformation. These are literature informed and consistent with values for co-production from other disciplinary areas (see (Co-Production Collective 2023; INVOLVE 2019; Smith *et al.* 2023)). Our four thematic areas: relationships; knowledge; power and inclusivity, have already received extensive critique by food systems scholars who adopt participatory and co-production methodologies. Each is briefly considered below with practice insights provided.

Relationship building is a complex and vital part of any partnership within food system research projects. Community relationships, for example, can be facilitated by shared identities, support and

trust (Colistra *et al.* 2019) and require relational collaborations (see Pettinger *et al.* (2023)) and consideration of power dynamics (Arnold *et al.* 2022). Rather than focus on 'problems,' collaborations should foster specific skills that appreciate and mobilise assets, skills and talents (IDeA 2010). Our findings drew specifically on the personal qualities needed to forge relationships when delivering these methods.

Knowledge is crucial in societies and matters in co-production (N8 Research Partnership 2016). The nature and location of knowledge varies across food system stakeholders, and collaborative projects need to value diverse types of knowledge to yield richer understanding and build capabilities (Pope *et al.* 2021) to realise transformative change. Our findings suggest that there remains a question over the perceived quality of co-produced knowledge as research outputs.

Power dynamics are crucial considerations for all food system processes and are based on relationships; whether between retailers and consumers (Nicholson & Young 2012); supermarkets and farmers (Ogutu *et al.* 2020) or academics and community members (Andress *et al.* 2020). As we have shown above, relationships are complex – our findings also observed some interesting tensions emerging between partnerships with different motivations, expectations, and priorities. This has been critiqued in relation to communities and industry by Gardiner and Mantravadi (2023). Indeed, neglecting the role of power dynamics in this field can actually undermine the promise of food system transformation (Carriedo *et al.* 2022). Our findings highlighted strategies to overcome and manage power dynamics, such as language use and ensuring equitable but realistic decision-making practices.

Inclusivity supports the need for future research to use a more expansive lens to realise a fully 'democratised' food system (Cachelin *et al.* 2019), one that embraces diversity and respects variability in knowledge, with the aim of creating more lasting solutions to inherent social problems within the food system (Moore & Swisher 2015). Our findings stipulate the need for inclusivity to be embedded from the very start of a project. This requires sensitively considered (financial) support

for project partners, with transparent and streamlined ethical processes (Largent & Fernandez Lynch 2017; Surmiak 2020) which avoid unnecessary institutional research bureaucracy (Jones 2022; Smith *et al.* 2023). Also important is creating a safe space for co-researchers, which is free from "*externally determined and rationalised top-down agendas*" (Wheeler 2018). Such spaces are safe for exploring less traditional creative arts-based methods, to empower and inform collaborative ecological citizenship (Roe & Buser 2016).

Strengths and limitations

Strengths of our approach include our systematic mapping and analysis of co-production activities across the TUKFS research programme which has offered new valuable insights into current practices within the field of food system transformation research. The UK food system is characterised by inequalities of access and imbalances in power, with prevalent food insecurity, as well as low agency for most stakeholders (Brooks *et al.* 2017; Hunt *et al.* 2023; Pettinger *et al.* 2023). In the true spirit of co-production methodologies, we deliberately selected less traditional and more creative approaches to collect our data. Our use of conversations and creative 'co-production oracle' workshops (Figure 1) and co-creation of a 'messy map (OSF link) provided rich exploration of collaborative research experiences. Such creative approaches are known to challenge elite models of research and subvert top-down expertise towards more democratically inclusive quests for knowledge (Richardson 2014). Our findings exemplify this and are also translated into visually accessible formats to provide resources and practical tools for researchers and practitioners (toolkit and 'messy map').

There are some inherent limitations, however, due to the tight timeframe available for this exploratory research. Perspectives on co-production were predominantly gathered from academic researchers, with few other food system stakeholders involved, meaning we did not obtain the diversity of relevant voices included (Garcia-Gonzalez & Eakin 2019). Future research, therefore, needs to engage a broader range of non-academic partners and additional TUKFS projects, to open

up dialogues (Calla *et al.* 2022) that can develop future transdisciplinary collaborations within this space. Furthermore, the 6 TUKFS projects included in this research (Table 3) are currently ongoing, meaning a full appraisal of their co-production outcomes and impacts was not possible. A further limitation was that one researcher collected and analysed the data, which might have introduced bias (Morse *et al.* 2002). However, we held regular team meetings to discuss synthesis and the second consolidatory workshop permitted a collaborative appraisal of findings, which went some way to mitigate this.

Finally, we use the term "co-production" throughout this study, yet we introduce this term with some caution (Oliver *et al.* 2019; Williams *et al.* 2020). There might have been scope to explore participants' perceptions of co-production as a term. Although outside the scope of our study, this perhaps warrants deeper investigation from different disciplinary perspectives.

Recommendations for research and practice

Table 4 shows recommendations for research and practice drawn from our study findings and interpreted from our observations of the processes involved.

Table 4 here

Conclusion

This project has explored what co-production looks like for food system transformation research. It has identified and mapped examples of co-production, co-design or co-creation methods being employed in selected research projects within a major programme of funded research on transforming the UK food system. Through use of creative workshops, mapping and conversations, findings have enabled a shared conceptual understanding of co-production methods and their application to food system transformation research. This paper highlights one overarching consideration to embrace the messiness and complexity inherent in these approaches. It also exemplifies core practice and research principles to consider when applying these approaches. These

include valuing the contribution of diverse forms of knowledge and expertise, developing reciprocal partnerships, addressing power imbalances, and ensuring research participation is accessible to all. Deep reflection and reflexivity are highlighted as crucial parts of each stage of the process. Finally, recommendations are made for researchers, practitioners, academic institutions, and funders working in this area to support them in better application of co-production methods.

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Conflict of Interest statement

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Data availability statement

Data available on request from the corresponding author.

ORCID

Naomi Shaw: https://orcid.org/0000-0001-7387-1809

Charlotte Hardman https://orcid.org/0000-0002-0744-6019

573 Clare Pettinger: https://orcid.org/0000-0001-7182-9463

574 Bethan R. Mead: https://orcid.org/0000-0002-9294-517X

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Tables

Table 1. TUKFS projects recruited and their involvement across research activities.

TUKFS project		Preliminary 'co-production oracle' workshop	Mapping activity conversations	Consolidatory 'oracle' workshop	Case study created
i)	BeanMeals	X	X	X	X
ii)	Cultured Meat and Farmers	X	X	X	X
iii)	FoodSEqual	X	X	X	X
iv)	Healthy Soil, Healthy Food, Healthy People (H3)	X	X	X	X
v)	FIO Food	X	X	X	X
vi)	FixOurFood		X		X
vii)	Social Enterprises as a Catalyst for Healthy and Sustainable Food Systems			X	

Table 2. Mapping template used to collate details of co-production activities across 6 research projects within the TUKFS programme.	
Key area	**Questions**
WHO?	Who is facilitating co-production activities? Who is involved in co-production? Who are the partners? How have partners been selected or recruited?
WHY?	What is the rationale for co-producing research? What is the intended contribution to food systems transformation?
WHAT?	How is co-production defined within the project? What literature, guidance or frameworks have informed processes?
WHEN?	What stages of research or project activities are partners involved in?
HOW?	How does co-production happen? What strategies have been employed to build relationships based on reciprocity, ensure power and decision-making is shared more fairly, incorporate diverse forms of knowledge, and ensure participation is inclusive?
EVALUATION, MONITORING and REFLECTION	How are co-production processes being appraised? What opportunities are there for the project team to reflect on the co-production process?
IMPACT/VALUE of co-production	Have beneficial outcomes of co-production been identified?
KEY LEARNING	What has been learned from the process?

CHALLENGES, BARRIERS, MESSINESS	What issues have been identified? What might facilitate 'good practice' in co-production? Are co-production activities perceived as 'messy'?

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Table 3. Case studies (n=11) of co-production activities from 6 TUKFS projects
Co-producing knowledge about systemic innovation processes (BeanMeals)
Co-designing a bean-themed game with school children (BeanMeals)
Whole school engagement in BeanMeals: Collaboration with teachers, school cooks, lunchtime supervisors and caterers
Working with farmers to identify the threats and opportunities of cultured meat technology (Cultured Meat and Farmers)
Co-designing retail strategies with people with lived experience of obesity and food insecurity: the role of Public and Patient Involvement groups (FIO Food)
Co-creating a local food action plan for Sheffield with ShefFood (FixOurFood)
FoodSEqual community food researchers: co-producing healthy and sustainable food systems in Plymouth (FoodSEqual) (Pettinger *et al.* 2023)
Co-designing a regenerative agriculture trial with farmers (H3)
Developing partnerships with community organisations: promoting dietary fibre intake in people from disadvantaged communities (H3)
Sharing good practice and learning through co-production with local food partnerships (H3 and FixOurFood)
Creative school engagement with FoodSEqual Plymouth

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Table 4. Recommendations for research and practice	
1	Researchers and practitioners need to embrace the 'messiness' and complexity of co-production, tailor co-produced activities to their specific contexts and acknowledge the diverse needs of non-academic partners.
2	Investment in time and resource is crucial for researchers and practitioners as well as institutions and funding bodies to ensure the infrastructure is optimised and enabled for co-production activities to be given the due consideration (capacity and capability) they deserve. This includes boosting the perceived value of co-production outputs and processes within the academic research community and providing opportunities for stakeholders to work alongside researchers to identify research priorities and co-produce funding proposals.
3	Competencies and skills required: A variety of roles and skills are needed for co-production, including personal skills (openness, empathy, and listening skills to build trust and bridge the gap between academics and partners), and facilitation skills (Chambers *et al.* 2021; den Boer *et al.* 2021a; Facer & Enright 2016). Training might be required for up-skilling of researchers and partners.
4	Principles: consider knowledge; relationships; power and inclusivity. Strategies are needed to manage power dynamics; create equitable and safe spaces for collaboration; and optimise ethical remuneration processes (Andress *et al.* 2020). Deep reflection and reflexivity should be included across all stages of the co-production process.
5	Future research should:

- Maintain the use of creative participatory methods (Pettinger *et al.* 2023) to meet 'non-linear' processes and optimally engage and empower participants.
- Include wider diversity of food system actors to foster the transdisciplinary lens required for food system transformation. Taking a wider systems perspective would stimulate reflective learning about the relevant plurality of underlying values, perspectives assumptions and institutional power structures (Schwarz *et al.* 2021).
- Explore co-production as an outcome in itself, considering the shift required towards valuing the *process* of working co-productively (e.g., new relationships built, capacity development, confidence etc).
- Consider how to measure whether co-production activities have been 'transformative'?
- Consider engagement in wider political contexts (Fazey & Colvin 2023; Turnhout *et al.* 2020)

Figure legends

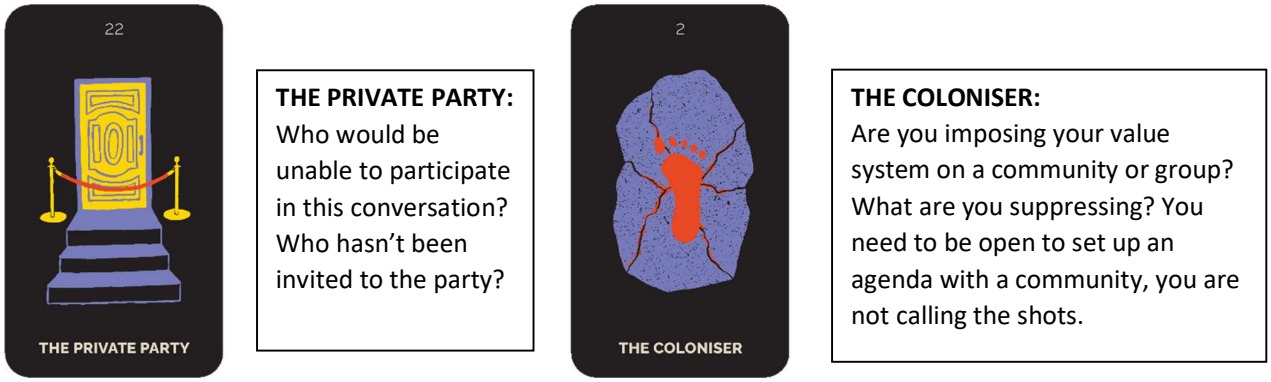

Figure 1. Examples of 'co-production oracle' cards with prompts. Reproduced with permission from Hannah Mumby (Mumby 2022)