

How can we enable synergic action to support sustainable transformations?

Eugyen Suzanne Om

Doctor of Philosophy

University of York

Environment and Geography

April 2025

***Dedicated to my beloved late father, Thinlay Dorji, who taught me
'I am'***

Thesis abstract

Transformations are occurring across our social and ecological systems, often in detrimental ways. Our systems are fragmented and silo-ways of working persist, inhibiting coherence of actions across different parts of our systems. As such, we need different approaches to align goals, interventions and policies for systemic change. We also require mindset and value shifts that align with a more sustainable future. There is also the need for the right kind of operational concepts to support systemic change and encourage collaborations across traditional socio-political boundaries. One such concept that could support systemic change, is the concept of synergy.

Synergy is generally defined as the interaction or cooperation between two or more agents, organizations or parts, that produces a combined effect greater than the sum of their separate effects. However, there is limited understanding of the concept of synergy and a critical research gap in understanding how to apply the concept of synergy in practice (i.e. synergic action) and its enablers. This thesis therefore explored the overarching question of how to enable synergic action to support transformations for sustainable futures.

Using a range of qualitative methods, this thesis resulted in three key findings that altogether provided five key insights that will enable synergic action to support transformations for sustainable futures. If we are to genuinely enable synergic action, we need to: 1) Foster type 3 synergic action; 2) Take a whole systems approach; 3) Build capabilities; 4) Foster intentional synergic action; and 5) Amplify action research and co-creative learning. Thus, we not only need to rethink what synergy entails and move towards new forms of synergic action but also explicitly engage with synergic action, further supported by particular kinds of capabilities. Thus, this research has practical implications for how diverse actors approach change and deliver synergic action to support transformations.

Acknowledgements

I would like to first thank my supervisors for providing strong guidance throughout the PhD. Professor Ioan Fazey has not only been a supervisor for my thesis but also a mentor who supported by personal development. He was instrumental in creating a safe space for independent learning and exploration. At the same time, he provided invaluable opportunities to work as part of a supportive team of researchers and practitioners. This greatly helped me grow not only as a researcher but also as an individual. I would like to also express my deep gratitude to my second supervisor, Dr. Esther Carmen. Apart from her valuable guidance during my thesis, particularly her support in using qualitative methods and guidance in writing papers, she also provided great mental and emotional support that helped me throughout my PhD journey. I much appreciate her kindness and her understanding.

I would next like to thank my TAP chair, Professor Sarah Bridle and Progression chair, Professor Bob Doherty for their feedbacks and support throughout each year which gave me confidence that I was on the right track. I would also like to thank my research team and the synergies working group who were patient in my exploration of synergy, for raising multiple questions and providing very useful insights and feedback on my work. It all greatly helped in clarifying, improving and shaping my research. These wonderful people are, Dr.Rebecca Newman, Sam Buckton, Lee Eyre, Professor Mick Cooper, Professor David Tyfield, Dr.Juan Pablo Cordero, Declan Jackson, James Fearnley, Dr. Gideon Baffoe, Luea Ritter and Dr.Stefan Cousquer. I would also like to thank FixOurFood for giving me the invaluable opportunity to be part of a very impactful project and for giving me the opportunity to work with a multi-disciplinary team. I would like to particularly thank Dr.Belinda Morris (Operations director) and Sophie Stewart (Programme manager) of FixOurFood, for their incredible support throughout my PhD.

I would like to deeply extend my gratitude to H3uni and its community. In particular, to Anthony Hodgson, David Adams, Bill Sharpe, Maija Grudule, Dimitra Roussakis and Judith Enriquez, all of whom shaped by thinking, nourished by being and shared their hope and love for the world. I am eternally indebted to you all for sharing with me the magic that is possible when we share our togetherness. I would like to particularly thank Anthony Hodgson for many one-one calls to explore the wonders of synergy and for sharing his wisdom which greatly help shape my thinking on synergy. I would also like to thank Bill Sharpe for his

guidance and support in introducing a new framework which has been integral to this thesis. I will always remember to 'sit in the mud'.

I would like to also thank my friends who are also their doing PhD's, Sarah Foster, Monica Isukapalli and James Westfield. I will greatly miss our chats, dinners and wine! Thank you all for sharing my worries and frustrations.

I would like to deeply thank my partner, Eddy Cheng, who now knows by research better than me, for his patience and love throughout this PhD journey and for providing a shoulder to cry on.

Lastly and most importantly I would like to thank my family without whom this PhD would not have been possible. To my mother Kencho Om, for her unending support for my studies and sending me food from home to keep me going. To my sister, Ugyen Tendril Zam, for her many calls and chats and importantly for her inspiring dedication to her own studies. And lastly to my dear father, Thinlay Dorji, who sadly passed during my PhD, without whom I would not have this life. His firm belief in the value of education and his dedication to ensure my sister and I received our educations to the highest level possible, fully funding our studies throughout our lives, including this PhD. I am deeply indebted and forever grateful to my father for all his teachings and guidance I have received throughout my life until now. I hold dear all that he's taught and like him, I also aspire that no matter what work I do, may it be of benefit to all beings.

Authors Declaration

I declare that this thesis is a presentation of original work and I am the sole author of the overall thesis. Three chapters of this thesis has been submitted to peer-reviewed journals. I can confirm that I was responsible for developing the theoretical framing, designing the methodology, carrying out all data collection and analysis, developing arguments, and writing and revising all chapters. Co-authors have been properly acknowledged and is reflected in the appendix.

Chapter 1 and 5: I wrote these chapters with supervisory support from Ioan Fazey, who provided guidance on structure and editing of text.

Chapter 2: I designed and undertook the majority of this research, including designing the research and collecting and analysing all data, and conducting the majority of the writing . Other contributions came from the following. **Professor Ioan Fazey** (PhD supervisor) who provided guidance on the aspects of the research design (refining research questions and analytical approach), intellectual input (on the concept of synergies) and editing of multiple drafts. **Dr. Rebecca Newman** contributed review and editing of multiple drafts of this chapter. **Dr. Anthony Hodgson** provided conceptual support in the early inception of the research. **Professor Mick Cooper**, provided conceptual support in the early inception of the research and later helped with review and edit of multiple drafts of the paper. **Dr. Esther Carmen** (2nd PhD supervisor) provided supervisor input and conceptual support in the early inception of the research and later helped with review and edit of multiple drafts. **Dr. Gideon Baffoe**, provided conceptual support in the early inception of the research and feedback on analysis of data. **Mr. Lee Eyre and Dr. Juan P. Cordero**, provided conceptual support in the early inception of the research and helped with review and edits of later drafts to the paper.

Chapter 3: I designed and undertook the majority of this work, including research design, data analysis, and write up. The main data for this chapter came from FixOurFood workshops, particularly from the three horizons workshops. Other contributions came from the following: **Professor Ioan Fazey** who provided guidance on the aspects of the research design, intellectual input and editing of multiple drafts. **Bill Sharpe**, provided guidance introducing and testing the Ambition Loop framework and editing of later drafts of the paper.

Lee Eyre, provided support in analysis of data, and helped with review and edits of later drafts to the paper. **Dr. Rebecca Newman**, provided review and editing of multiple drafts of this chapter. **Dr. Esther Carmen**, provided guidance on structure and method of the research and later helped with review and edit of multiple drafts of the paper.

Chapter 4: I designed and undertook the majority of this research. This included conceptualisation, design of methodology, gathering data, analysis and writing. Other contributions came from the following: **Professor Ioan Fazey** who provided guidance on the aspects of the research design, intellectual input and editing of multiple drafts. **Professor David Tyfield**, provided conceptual support, guidance on structure of paper and narrative and review of later drafts. **Professor Mick Cooper**, provided conceptual support and review of later drafts. **Mr. Lee Eyre**, provided support in analysis of data and helped with review and edits of later drafts to the paper. **Dr. Esther Carmen, Declan J. Jackson, Dr. Rebecca Newman, James Fearnley, Luea Ritter, Dr Stefan Cousquer**, all helped with review and edit of multiple drafts of the paper.

Table of Contents

1. Introduction.....	13
1.1. Background.....	13
1.2. Aims and objectives	14
1.3. Case study.....	15
1.3.1. Synergy in the food system	17
1.4. Approach	18
1.5. Structure of thesis.....	20
1.6. Personal approach to developing research skills	21
Chapter 2	23
2.1. Introduction.....	25
2.1.1. Importance of synergy	27
2.2. Methodology	29
2.2.1. Method and materials	29
2.2.2. Data analysis.....	30
2.3. Results	31
2.3.1 Overview	31
2.3.2 Attributes of synergy	31
2.3.3 The three approaches to synergy.....	33
2.4. Discussion	44
2.5. Conclusion	48
Chapter 3	49
3.1. Introduction.....	50
3.2. Background	52
3.3. The Ambition Loop Framework.....	55
3.4. Methodology	57
3.4.1. Case study	57
3.4.2. Approach.....	59
3.4.3. Method and materials.....	61
3.5. Results	63
3.5.1. Reinforcing loops.....	64
3.5.2. Supporting the influence of one action domain on another.....	67

3.5.3. Policy to support each action domain	70
3.6. Discussion	71
3.6.1. Supporting synergic action for transformation of the Yorkshire food system.....	71
3.6.2. Wider implications and limitations of the framework	73
3.6.3. Implications for synergic action	75
3.7. Conclusion	76
Chapter 4	77
4.1 Introduction.....	79
4.2. Background	80
4.3. Methodology, methods and materials	81
4.3.1. Approach	81
4.3.2. Case study	82
4.3.3 Methods and materials.....	83
4.3.3.1. Data collection	83
4.3.3.2. Data analysis.....	85
4.4. Results	85
4.4.1 Types of synergic action	86
4.4.1.1. Type 1: Non-systemic synergic action	86
4.4.1.2. Type 2: Non-systemic synergic action with multiple outcomes	88
4.4.1.3. Type 3: Systemic synergic action.....	88
4.4.2. Essentials for synergic action	90
4.4.2.1. Leadership for synergic action	91
4.4.2.2. Effective networking, partnerships and collaboration	92
4.4.2.3. Care and understanding	93
4.4.2.4. A systems approach to change.....	94
4.4.2.5. Intentionality for synergic action	94
4.5. Discussion	95
4.5.1. Types of synergic action	96
4.5.2. Essentials for synergic action	96
4.5.3. Intentionality for synergic action	98
4.5.4. Limitations and further research.....	100
4.6. Conclusion	100
Chapter 5	102
5.1 Research aims.....	103
5.2 Key Findings from Individual Chapters.....	103
5.3. Research limitations.....	105

5.4. Integrated Findings - How can we enable synergic action to support sustainable transformations?	106
5.4.1. <i>Foster Type 3 Synergic Action, systemic synergic action.....</i>	106
5.4.2. <i>Take a whole systems approach</i>	107
5.4.3. <i>Intentionality for synergic action</i>	107
5.4.4. <i>Building capabilities</i>	108
5.4.5. <i>Amplifying action research and co-creative research</i>	108
5.4.6. <i>Summary</i>	109
5.5. Methodological advances.....	109
5.5.1. <i>Novel application of research methods.....</i>	109
Ambition Loops	109
5.6. Future research	111
5.7. Conclusion	111
6. References.....	112
7. Appendix.....	135

List of Tables and Figures

Chapter 2

Table 1. Describes terms related to synergy.....26-27

Table 2. Presents case study examples of re-perception and the new opportunities that arose as a result of re-perception.....37

Table 3. Presents a summary of the three approaches to synergy.....42

Box 1. Presents an example of how this approach to synergy can be applied using the World Model as a game board in the Isle of Man39

Figure 2. Presents a re-design of the World Model as a game board for a project titled 'REIMAGINING our Biosphere' that was launched in the Isle of Man (Hodgson, 2025).....40

Chapter 3

Table 1. Actions needed to support reinforcing loops within the Food System Ambition Loop, derived from the 'offers and request' workshop that explored the transformative potential of the five action domains (Pg.67)

Table 42. Policy required to strengthen action domains.....68

Figure 1. Ambition Loop Framework (ALF) shows three key arenas for action in moving towards change; a) Political ambition and policies, b) Business and finance investments and c) Civic and market demand. The ALF is fundamentally a positive reinforcing loop symbolised by synergies between the three arenas of action. The arena for Political ambition and policies is in a positive reinforcing loop with Business and finance investments. The arena for Business and finance investment is in a positive reinforcing loop with civic and market demand. The area for Civic and market demand is in a positive reinforcing loop with Political ambition and policies..... 53

Figure 2. Shows the Ambition Loop Framework as a tool in the second horizon of the Three Horizons framework as used in this case study for Yorkshire food system transformation..... 58

Figure 3. Process map showing key stages in creating the ambition loop for Yorkshire food system.....61

Figure 4. The Food System Ambition Loop is based on the Ambition loops framework with three distinct arenas of policy, businesses and consumers where actors operate. The pink circles show the three action domains that were mapped onto the three categories of actors of the ambition loops framework. The blue boxes show policies needed to support each action domain. Overall, the Food System ambition loop shows a positive reinforcing loop highlighting interconnections between action domains and required policy necessary for transformation of the Yorkshire food system..... 62

Chapter 4

Table 1. Interviewee and their roles within the Yorkshire food system.....82

Table 2. Examples of type 1 synergic action in the Yorkshire food system.....85

Table 3. Illustrates examples of type 2 synergic action.....86

Table 4. Actors in the Yorkshire food system that has the potential to catalyze synergic action...87

Figure 1. Illustrates Type 1 synergic action, non-systemic synergic action, where two or more actors come together to achieve a common goal.....84

Figure 2. Illustrates type 2 synergic action, non-systemic synergic action with multiple outcomes.....86

Figure 3. Illustrates type 3 synergic action, where certain actors have a better understanding of the system and facilitate the bringing together of relevant actors and resources for change.....87

Figure 4. The five essentials for synergic action. The inner ‘diamond’ shows the first four essentials for synergic action. The circle outside the diamond represents the overall importance and the need for intentionality for synergic action. The circle also represents the intention needed to bring the first four essentials together..... 88

Chapter 1

1. Introduction

1.1. Background

We are facing a global poly-crisis of climate change, geo-political instability, hunger, health epidemics, depletion of natural resource, biodiversity loss among many others (Inman and Inman 2023; Lawrence et al. 2024; McNamara and Bambra 2025). Many are calling for transformative approaches that entail radical changes of our systems that give rise to contemporary challenges (O'Brien and Sygna 2013; Fazey et al. 2018; Bentz et al. 2022). Transformative change thus refers to shifting existing systems and structures including fundamental shifts in values, mindsets, beliefs and cultures (Fazey et al. 2018; Scoones et al. 2020; Vogel and O'Brien 2022). However, there is still limited understanding of how to facilitate deliberate transformation while also holding space for what is already transforming (Bentz et al. 2022).

Core to supporting transformation is the need to better understand how to bring about more integrated forms of action (Scoones et al. 2020; Naito et al. 2022). This includes finding ways to go beyond siloed and fragmented ways of working (Hodgson 2019); encourage greater alignment and coherence between multiple parts/actors of the system (Carmen et al. 2023); bring together resources in order to achieve multiple effects (Leino and Puumala 2021); and work in transdisciplinary ways to enhance greater collaboration, creativity and innovation and support emergence of more positive narratives about change (Tschakert et al. 2016; Linnér and Wibeck 2021; den Boer et al. 2023).

One concept that can help address such needs, and advance understandings of how to support systemic change and transformation, is the concept of synergy. Synergy is often used as a buzzword in conversations. It is often broadly understood as 'the combined effect of two or more things that lead to outcomes that are greater than the sum of their separate effect' or ' $1+1=3$ ' (Buckminster Fuller 1982; Biavatti 2009; Corning 2012). It also often involves '*identifying* synergy between x and y interventions' (Ogola and Ouko, 2021; Renaud et al., 2022). Despite common usage of the term synergy, it is applied loosely and with very limited

consideration of the potential depth and its implications for helping overcome disconnected action. Although there is acknowledgement of the importance of synergies (Foran et al., 2014), there is still limited foundational understanding of synergy and its relevance for supporting systemic and transformational change.

There are four reasons why examining the concept, and its application, is important. First, synergy provides a potential stepping stone or entry point for researchers and practitioners to work with complexity and in taking a more holistic and systemic approach to change. Examining interconnected impacts of interventions allows for the emergence of new ways of thinking and approaching challenges and has been applied in fields such as business management (Al Qudaiby and Khan, 2013; Holtström and Anderson, 2021), medicine (Yang et al, 2014; Mukherjee et al, 2018;) psychology (Cooper 2019), ecology (Corning, 2003) and social policy (Carmen et al., 2023) among others. Second, working from a synergies lens provides potential for more effective and strategic action for change, such as by providing new ways to gather and re-distribute fragmented and limited resources and to help align diverse actors (Hodgson 2019). Third, the concept and its application has potential to support engagement with a diversity of perspectives and worldviews and stimulate collective action, such as engaging diverse voices for transformation of the transport system to be more sustainable and inclusive (McQueen et al. 2021; Jelti et al. 2023). Fourth, synergic approaches present a positive and hopeful way of working with complexity, as opposed to starting with overtly problem-based understandings. Thus, while the concept has potential, there has been limited critical engagement with the concept to identify and address gaps in understanding that may limit its application in practice. Failure to address this knowledge gap limits opportunities for much needed alignment of goals, resources, innovation and action, impeding potential for more effective and rapid responses to global and local challenges.

1.2. Aims and objectives

The aim of this thesis is therefore to understand how synergic action can support transformations to sustainable futures. To address the aim, the thesis explores three key research questions with each question addressed in a separate chapter of the thesis:

1. How is synergy currently understood in a context of transformational change? (*Chapter 2*). This involved a narrative review of the concept of synergy from across diverse fields of study.
2. What practical frameworks will help enhance strategic synergic action? (*Chapter 3*). This empirical study involved working with data from multi-stakeholder workshops to develop and apply a novel action-oriented approach to understanding synergic and systemic action.
3. How is synergy currently applied in practice and what are the key enablers for synergic action to support transformation? (*Chapter 4*). This empirical study entailed semi-structured interviews with strategic actors proactively pursuing systems transformation.

Thus, the overall aim and focus of the thesis is to explore in-depth, the concept of synergies and its application in practise to support systemic change and transformations. However, as the concept of synergy is understudied and understanding of its practical application and implications for systemic change and transformations limited, the thesis uses a case study to help explore the concept. Therefore, the thesis primarily uses a case study of Yorkshire Food system transformation to explore the three research questions, with core findings – conceptual, methodological, and practical contributions brought together in a synthesis (*chapter 5*) to inform new learnings and findings around the concept of synergies.

1.3. Case study

The UK food system is no longer fit for purpose and requires transformation to a more resilient and regenerative food system (Lang 2009; Doherty et al. 2022; Hunt et al. 2023; Buckton et al. 2024; Bridle et al. 2025). A report by Food, Farming and Countryside Commission 2024, found that the unhealthy food system cost the UK economy £268 billion every year. These cost include, health care and social care costs, costs due to lost productivity, environmental costs, supply and market inefficiencies among others (Hoenink et al. 2024; Papargyropoulou et al. 2024; Bridle et al. 2025) Diet related chronic diseases such as diabetes, cancer and various other ill-health are on the rise (FAO et al., 2020; Rockström et al., 2020). Domestic production of food is impacted by extreme weather and increasing reliance on imports of fruits and

vegetables poses supply chain and resilience risk (DEFRA, 2024). Additionally, households are increasingly becoming food insecure (DEFRA, 2024). The UK therefore needs radical changes in its food system.

Efforts to transform the Yorkshire food system provides a valuable and useful case study to explore synergies. The Yorkshire region has a diversity of farming systems and land cover (Buckton et al. 2024). It has the highest number of food and drink businesses in the UK and incorporates diverse elements of food production, supply and consumption (Doherty et al., 2021). There are multiple networks involving farming, business and academia, such as Yorkshire Agriculture Society, Deliciously Yorkshire, Yorkshire grain alliance, that are innovating towards a more sustainable food system (Ehgartner 2023; Deliciously Yorkshire 2025). Recently, there has also been new local food strategies and action plans, for example led by the North Yorkshire Council and Sheffield City Council (Treuerherz, S., Yap, C. & Rowson, S. 2023). However, Yorkshire also struggles with food system challenges such as food insecurity, lack of public awareness and interest, lack of political will for change (Power 2019; Buckton et al. 2024). The complexity of Yorkshire food system with a diversity of actors and complex challenges makes it a useful case study. Synergies between these diverse parts of the system will be necessary to support its transformation.

There are currently multiple food system transformation programmes throughout the UK funded by the UKRI (UKRI 2022). *FixOurFood programme* is one of the four research consortia funded by the UKRI that aims to transform the Yorkshire food system in collaboration with multiple partners and stakeholders across the region. For transformation towards a regenerative food system, the programme identified three entry points or subsystems; 1) Regenerative farming; 2) Hybrid business models and 3) Sustainable and healthy food for children (Doherty et al. 2022). This thesis utilises primary data collected with stakeholders of the Yorkshire food system within FixOurFood. The inherent complexity of a system calls for different perspectives and creative ways of working. The Yorkshire food system thus presents an opportunity to understand synergy and how to enable synergic action.

Overall, the food system provides context through which synergy is explored and investigated. The chapters therefore provide important insights for food system transformation, where the action-oriented work has been helpful for enhancing practice of food system change for food system actors. Yet the overall focus of the thesis – and the three primary chapters included

within it - is oriented towards the concept and application of synergy rather than on food systems per se.

1.3.1. Synergy in the food system

This section broadly explores how synergy is currently used in food systems literature. There is an increasing need to identify and enable synergies in the food system to ensure food security and for its transformation to a more sustainable and regenerative food system (Ingram and Zurek 2018; Zurek et al. 2021; Jagustović et al. 2021). Synergies in the food system broadly looks at how to achieve co-benefits across food system outcomes related to health, economy and the environment among others. Currently, synergy is explored in different domains of the food system such as in regenerative agriculture (Mishra et al. 2024; Jamil and Pearce 2025), technologies for climate smart agriculture (Jagustović et al. 2019; Ogola and Ouko 2021; FAO 2022), nutrition and health (Townsend et al. 2023; Swarnakar et al. 2024), sustainable food production (Neset and Cordell 2012; Tälle et al. 2019) among others. Synergy is also evoked when using nexus approaches (e.g. water-energy-food nexus) and when identifying synergies and trade-offs of interventions and policies (Parsons and Hawkes 2019).

There is wider consensus that identifying synergies is critical for food systems transformations (Fanzo et al. 2021; Ruben et al. 2021) . However, understanding of synergy is at its early stages in food systems research. Although the term is widely used, there is a fundamental conceptual gap in the use of synergies in food systems research. Often studies do not define synergies and assume what it is. Further, whilst various methods exist to identify synergies, it is context dependent and difficult to replicate. There is also a gap in understanding enablers for synergies to support food system transformations. Understanding synergies has the potential to give rise to new discourses, methodologies and processes and most importantly provides a different lens through which we understand the system. The lack of fundamental understanding of synergy in the food system thus leads to exploring synergies in other disciplines which is explored in the first research question of this thesis.

1.4. Approach

The thesis takes three ontological positions. The first ontology is that the world as we know it is complex, adaptive and uncertain i.e. it is a complex adaptive system. Complex adaptive systems have multiple and diverse interacting parts that adapt to changing environments, outcomes are not always predictable and are emergent (Holden 2005; Holland 2014; Preiser et al. 2018). To work with complex adaptive systems that are constantly interacting and adapting, we cannot see parts of the system as discrete, using reductionist ways of thinking (Holland 2014). Instead, it is critical to see the system as wholes where such wholes exhibit properties greater than the sum of its parts and which are continually evolving and adaptive to other changes happening around them (Inman and Inman 2023; Waddock 2025). Examples of complex adaptive systems are health systems (Ratnapalan and Lang 2020), transport systems (Rothengatter 2025), economies (Roos 2024) and food systems (Nesheim et al. 2015) the latter of which provides the context through which synergy is examined in this thesis. By taking this ontological position, synergy is then investigated in a way that recognises the interconnectedness and dynamism of complex adaptive systems.

The second ontological position relates to the nature of the kinds of change that are needed for contemporary times. Given the pace, nature and scale of global challenges, systemic or transformative change is needed. Reducing harm to sustainable levels are insufficient for addressing most complex problems (Fazey et al. 2018; O'Brien et al. 2025) because they tend not to address the issues underpinning contemporary challenges. New kinds of systems - such as those that are regenerative (Doherty et al. 2022; Buckton et al. 2023) - need to be established rather than efforts seeking to reform existing systems (O'Brien et al. 2025). This highlights that we need new kinds of approaches - such as synergic forms of action -to effect change.

The third ontological position underpinning this thesis is that people are viewed as having agency to enact system change. Although there are challenges of current structures and norms inhibiting systemic change and transformations, individuals are considered to have agency, even if only through collective forms of action (Koskela and Paloniemi 2023). Change agents that apply purposive action in an attempt to prevent or generate change (Fischer and Newig 2016) can take a variety of roles, from being farmers, managers of an organization, actors in local authorities, or leading the direction and activities of NGOs. Scientists and research communities are also viewed as active agents of change, such as through the development of

new forms of knowledge that can catalyse change (Marciniak et al. 2024). Change agents can also be intermediaries such as by being mediators or brokers of knowledge formation or action (Kanda et al. 2020; Calla et al. 2024). Through such work, this thesis takes the position that it is then possible to enhance capabilities for supporting change across personal, social, relational and strategic spheres to steward transformation (O'Brien 2012; Page et al. 2016). Change agents are already enabling important shifts in our systems including supporting mind-set shifts, embedding future thinking and awareness through imagining and visioning among other important endeavours (Waddock and Steckler 2016; Riedy and Waddock 2022).

Overall, the three ontological positions - that contemporary challenges arise in complex adaptive systems, that this in turn requires transformational approaches to address issues underpinning these challenges and that it is possible for people to have a degree of agency in stewarding systemic change - provide the lens through which synergy is investigated. This in turn then requires particular epistemological approaches.

The first epistemological approach underpinning this research is constructionism (Bryman 2015). This view understands that meanings - such as interpretations of complex systems - are socially constructed and shaped by constant interactions and relationships, and that much of what is understood of complex systems will be subjective. This view is helpful for the study of synergy because there are varying understandings of synergy dependent on the context and what constitutes as synergic outcomes are often subjective. Following on from this, much of the research method in this thesis is qualitative and inductive, allowing for new and subjective insights to emerge from the data. Rather than testing theories, this thesis seeks to establish new meanings and insights. In this thesis, chapters 2 and 4 broadly align with the inductive approach.

Research approaches where the researcher aims to 'stand from the outside looking in' (Umpleby 2014) under the notion that research can be 'objective' is not, however, sufficient to fully understand how to support action and change. Instead, more action-oriented approaches are required to learn about how transformation can be supported (Fazey et al. 2018). In addition to more traditional approaches (Chapters 2 and 4) this study therefore applied a second-order oriented approach where the researcher is viewed as being part of the system under investigation (Umpleby 2014; Fazey et al. 2018). This second-order orientation was applied in Chapter 3 to develop and test the application of the Ambition Loop Framework. Here, extensive

and engaged work with the stakeholders of the Yorkshire Food system was carried out in multiple workshops to identify key actions and relationships needed to support food system transformation.

These epistemological positions then led to the application of different, specific methods. Chapter 2 was inductive and used an integrative review method. Chapter 3 was more action-oriented and applied and tested the use of the Ambition Loop Framework and collected data from workshops to support synergic action. Chapter 4 was again more inductive and used and analysed data from semi-structured interviews. The study overall also drew on a number of heuristics such as the Three horizons framework (Sharpe et al. 2016) and the World Model (Hodgson 2020) to help explore synergies.

Finally, the thesis is structured around the submission of research articles, with each of the main chapters being presented as a paper. This approach was motivated by my desire to learn how to produce research papers as part of my training in how to conduct research, including through collaborations with others.

1.5. Structure of thesis

Chapter 2 addressed research question 1: How is synergy currently understood in a context of transformational change? This is an important research question because the term synergy is loosely used, often as a buzzword. There is also very limited conceptual foundation of synergy in literature. The aim was to look across different scientific disciplines to gain an understanding of how the concept of synergy is understood and currently used. This therefore involved a narrative literature review covering 14 disciplines resulting in two key findings; 1) the three attributes of synergy; and 2) the three views of synergy. The chapter discusses advantages and limitations of each view with implications for approaching transformative change.

Chapter 3 addressed research question 2: What practical frameworks will help enhance strategic synergic action? This is a corresponding critical gap which follows on from the first research question that addressed the limited conceptual understanding of synergy. There is

insufficient understanding and research on the practical application of the concept. Thus, there is a need to understand how to use methods and frameworks to help understand the system differently such that it enables strategic synergic action. To address this gap, we applied a novel framework, the Ambition Loop Framework, to a case study of Yorkshire food system transformation. Using co-creative and participative methods, this chapter presents the ‘Food System Ambition Loop’ as its key finding. This chapter demonstrates how diverse stakeholders of the Yorkshire food system can align in their goals and actions in a more synergic way, guided by the framework. The work discusses implications of the application of the framework for Yorkshire food system transformation and wider implications of the framework for synergic action.

Chapter 4 addressed research question 3: How is synergy currently delivered and what are the key enablers for synergic action to support transformative change? This research question is important as there is a need to understand how actors are already approaching change synergistically and learn from them. There is also a need to understand the key conditions needed to enable synergic action. This study therefore involved conducting 22 semi-structured interviews with diverse stakeholders of the Yorkshire food system to understand how they approached synergic action. It resulted in two main findings; 1) Three types of synergic action; and 2) The five essentials for synergic action. This chapter further discusses the implications of the three types of synergic action for change makers and implications of the five key essential to support synergic action for transformation.

Chapter 5 provides a synthesis of all key findings in this study and examines how this thesis addressed the overarching aim. It also highlights key conceptual and methodological contributions and key lessons learned during the research processes. Finally, it outlines the need for further research.

1.6. Personal approach to developing research skills

Given the complexity of the concept, in addition to applying more traditional methods, the research also required developing a more embodied and experiential understanding of synergy. To do this, I undertook the following:

1. Qualitative research methods training offered by the Department. These helped me understand qualitative research and research methods
2. Courses with H3uni.org and the Systems school. These enhanced my understanding of systemic change, systemic approaches, and allowed me to better understand the relationship of synergy with systems change.
3. Training in facilitation skills. This helped me develop better understanding of synergic action. The first part of the training was ‘foundations in facilitation skills’, with the Association of Facilitators. The second training was the Three Horizons Framework facilitator training. Both were instrumental in helping me understand capacities and capabilities needed to bring about participative collaboration which is a key element of delivering synergic action. Additionally, as part of the FixOurFood programme, I attended and supported multiple Three Horizons workshops which helped me see and understand the notion of ‘action on the ground’ with a diversity of stakeholders. Together, these aspects helped me develop better understanding of relationships between participation, collaborative action and synergic action.
4. Participation in multiple conferences. This enabled me to test and refine my conceptual understanding I was developing. This included presenting at international conferences in Helsinki and in Sydney and which included academics and practitioners of systemic change. The conferences further helped deepen my understanding and appreciation of using different forms of knowledge and knowing e.g. indigenous knowledge, for transformative change and its implications for synergies.
5. I engaged in a paper writing group. This helped me further develop and refine my ability to convey my thinking and conceptual understanding. The writing group included 8 different researchers held every 6 months, with each researcher clarifying ideas, testing methods, improving structure of papers.

Thus, to progress this research, participation in all of the above were important for shaping my understanding of the concepts of synergy, synergic action and transformation as outlined in this thesis.

Chapter 2

Chapter 1 highlighted the need for transformative change amidst ongoing global challenges. It foregrounded the need for more integrated forms of action, going beyond silo-ways of working and encouraging coherence across the system to enhance greater collaboration. It thus introduced the concept of synergy as a novel approach to support transformative change. However, there is a research gap in the conceptual foundations of synergy and, its application in practise. The thesis thus aims to explore the concept of synergies through a case study of Yorkshire Food Systems transformation. Thus, chapter 1 introduced the Yorkshire Food system transformation as a case study to explore the research aim and described the limited understanding of synergies in food systems research. It further outlined three key research questions that will help address the overall aim of the thesis.

Chapter 2 thus addresses research question 1: How is synergy currently understood in the context of transformational change? Whilst 'synergy' is used in various everyday conversations and has become a buzz-word in research and policy, there remains a lack of understanding of the conceptual foundations of synergy. This chapter therefore aims to address this and involves a narrative literature review spanning 14 disciplines.

This chapter has been submitted for peer review to scientific journal Sustainability Science and is currently under review.

Om, E.S., Fazey I, Newman, R., Hodgson, A., Cooper, M., Carmen, E., Baffoe, G., Eyre, L., Cordero, J.P. (In review). Synergies: Understandings in a Complex World. *Sustainability sci.*

2.Synergies: Understandings in a Complex World

Om, E.S., Fazey I, Newman, R., Hodgson, A., Cooper, M., Carmen, E., Baffoe, G., Eyre, L., Cordero, J.P. (In review). Synergies: Understandings in a Complex World. *Sustainability sci*

Abstract

We are currently in the midst of rapid environmental, social, political and economic change. However, efforts to adapt to this change are typically slow and incremental. There is a need for coherent action across all levels of society to stop the rapid degeneration of our planet and society. One way to enhance coherence is by bringing deeper awareness and understanding to the concept of synergy. Whilst the term synergy is often used, there is a lack of understanding of what it really means both conceptually and in its application. This paper addresses this gap through an in-depth narrative review, covering 14 disciplines. We identify three key attributes of synergy, highlighting its magnitudes, spatial and temporal scales, and the possibility for both positive and negative synergy. The findings also involve three broad conceptual understandings of synergy – as an ‘outcome’, a ‘process’ and as perceived wholes, each with strengths and limitations. Defining synergy as an outcome is useful in informing future actions. Defining synergy as a process and as a whole, has the potential to maximise efficient use of resources, engender greater connectivity, enhance creativity and inform strategic planning for enhancing governance conditions and policy impact. To our knowledge, this review is the first to bring together a comprehensive understanding of synergy and has implications for cross-disciplinary research and practice, particularly to those working with change in large, complex systems.

Key words: Systems change, Transformation, Complexity, Partnerships, Holistic approaches, Futures

2.1. Introduction

The impacts of global societal challenges, such as those arising from climate change, biodiversity loss, poverty, rapid urbanisation, food insecurity, obesity, mental health illnesses among many others, continue to grow and show limited signs of abating (Ogden et al., 2013 (Rockström et al. 2020, 2023; Folke et al. 2021). These challenges could be viewed as symptoms of the unsustainable and fragmented processes that contemporary societies have developed and continue to reproduce (Fazey et al., 2021b). It is also as a result of a ‘poly-crisis’, a term used to describe crisis’s in multiple diverse global systems that interact in a complex system that then generates greater negative impact (Lawrence et al. 2024; McNamara and Bambra 2025). Whilst there has been an increase in forward-facing and solutions-orientated research, many of the resultant recommendations only support incremental change (O’Brien, 2012). In practice, transformation of our social, economic and political systems cannot occur using traditional approaches underpinned by the same kinds of thinking that created these problems (Haberl et al., 2011; Fazey et al., 2018b; (O’Brien et al. 2025). There is a need for different ways of thinking to address fragmentation and support rapid systemic change (O’Brien, 2012; O’Brien and Sygna, 2013; Fazey et al., 2018b, 2021a; Fazey and Leicester, 2022). In recognition of this there has been a movement towards synergistic research, deemed important to reduce negative outcomes through the identification of synergies and trade-offs and promote integrated approaches to governance and planning (Liu et al. 2018). For example, studies apply nexus approaches and examine actual and potential areas of integration between various policies, strategic plans and interventions to identify how greater synergic outcomes may be achieved (Hoff, 2011; Kerber et al., 2021; Fisher and Rucki, 2017). Thus, there is a strong need for joined-up action and synergies to match the scale and speed of current crisis’s. However, there is a lack of conceptual depth and understanding of synergy, constraining the potential for more synergic forms of action.

The concept of synergy is often not foregrounded in such studies or defined simplistically. When defined, the concept of synergy is often understood as the interaction or cooperation that leads to outcomes with effects that are greater than the sum of the individual parts the more common definition, ‘whole is greater than the sum of its parts’ (Corning, 2012; Jaffe and Febres, 2016). Synergy is conceptually important as it highlights the possibility for cohering interventions in policy and for helping achieve key societal needs such as,

sustainable development, agriculture, to generate value-added effects of efforts well beyond additive benefits. Put simply it draws attention to how small actions can lead to large impacts. The notion of synergy also provides a more positive and hopeful framing for action compared to, for example, analyses of ‘trade-offs’. Using an understanding of synergies to coordinate new coalitions of actors and resources increase efficiencies and support greater alignment of action (Duguma et al., 2014; Bauer and Friesl, 2022). Identification of synergies may also help uncover potential entry points for systemic forms of intervention and transformative change.

Whilst there is a small but growing body of literature applying the concept of synergy, it is largely focused on identifying synergies ex-post to then inform future planning. This approach for identifying synergies has been applied in diverse fields, for business mergers and acquisitions (Tripathy, Mishra and Gupta, 2020; Bauer and Friesl, 2022; Wang, Abdullayeva and Hoang, 2024), medicine (Li et al., 2021; Iida et al., 2024), evolution (Corning, 2017, 2021), energy (Zhou et al., 2024; Schipfer et al., 2024), mental wellbeing (Cooper, 2019, 2023) and climate adaptation (Dabaieh et al., 2024; Duguma et al., 2014). However, to fully harness an understanding of how synergies can support systemic change, there is a need for a greater conceptual understanding from an ex-ante perspective. The aim of this review is to explore the diverse, multidisciplinary literature applying the concept of synergy to understand how it is currently understood and applied to draw out key implications for how ‘synergic action’ (combinations of actions that are intended to generate synergy) might be approached and enhanced to overcome complex global challenges.

The paper first presents a background explaining the significance of synergy in a complex and interconnected world. It then outlines the integrative review methodology used to select literature and analysis. Findings present the three general attributes of synergy and the three approaches’ to synergy found across literature. We then discuss these findings and its implication in supporting systemic change for more sustainable futures. To our knowledge, this is the first review that provides an overarching understanding of synergy to support synergic forms of action for systemic change. We therefore expect this work to have wide and cross-disciplinary relevance for those interested in finding more effective and holistic ways to work with change in complex systems.

2.1.1. Importance of synergy

The term ‘synergy’ comes from the Greek word ‘synergos’ to mean ‘to work together’ (Castell, 1999). Synergy broadly refers to the “cooperative effects produced by the relationship among various forces, particles, elements, parts or individuals in a given context-effects that are not otherwise possible” (Corning, 2003, p.2). It is also more commonly explained as when ‘the whole is greater than the sum of its parts’ (Upton, Janeka and Ferraro, 2014). However, synergy does not always mean that the ‘whole’ is always greater than the sum of its parts, ‘whole’ can also be simply *different* than the parts (Buckminster Fuller, 1982; Corning, 2003). Synergy is also used synonymously with other terms such as win-win, cooperation, partnerships, symbiosis among others as shown by table 1. However, synergy is the ‘unique combined effects’ produced by the process of cooperation and partnerships that lead to outcomes that are greater than the sum of its parts (Corning, 2003). Terms such as those in table 1 do not emphasise the unique combinations that are needed for synergy. Synergy further foregrounds the *added value* that emerges as a result of combining and aligning various efforts which the other related terms do not highlight. Examples of synergy can be found everywhere: for instance, the table salt we consume i.e. the combined effect of Chlorine and Sodium; in medicine and healthcare, where the combined effect of using atropine and prednisone works as anti-inflammatory drug to treat eye inflammation and in various guises; in nature where bees work to pollinate plants to produce food (Corning 2003). Many such examples of synergies exist around us however there have been very few conceptual studies which focus on synergies for future planning.

Table 1. Describes terms related to synergy

Related terms to synergies	Dictionary definition	Research use
Synergy	“the combined power of a group of things when they are working together that is greater than the total power achieved by each working separately” (Cambridge dictionary)	More broadly used in business mergers and acquisitions, management and organisational studies , where working together in particular ways is crucial for change (Jasińska 2020; Bauer and Friesl 2022)
Win-Wins	“A win-win situation or result is one that is good for everyone who is involved” (Cambridge dictionary)	Mainly used in strategic management studies, where both parties derive positive benefit such as in mergers and acquisitions (Ansari et al. 2006)

Cooperation	“the act of working together with someone or doing what they ask you” (Cambridge dictionary)	Work on cooperation tends to focus on alignment of values, goals, actions and mutual benefit. For example, behavioural experiments such as game theory, models of cooperation show how incentives impact decision and behaviour (Quan et al. 2023)
Symbiosis	“a relationship between two types of animal or plant in which each provides for the other the conditions necessary for its continued existence” (Cambridge dictionary)	Mainly used in biology that emphasises mutual dependence. “Refers to close and often long-term interactions between organisms of different species” (Angelard and Bever 2013)
Multi-way Linkages	“Forming of connections between things” (Cambridge dictionary)	Mainly captures structures of relationships between actors and entities. An example is linkages between academia and industry for sustainable development (Khalili et al. 2015)

It has been suggested that hyper-specialisation of today’s world prevents the understanding of synergy (Buckminster Fuller, 1982; Topps and Busia, 2005). This specialisation can be seen in economic, political and social spheres creating fragmented and siloed societies (Tett, 2011; Revez et al., 2022). Siloed ways of thinking and working are common and further contribute to the fragmentation and incoherence of interventions and policies to our current challenges (Carmen et al., 2023). This can result in inefficiency and unintended consequences (Duffy and Cook, 2019). Examples of an increasing awareness of the limits of siloed approaches is the momentum that continues to develop around multidisciplinary and cross-sectoral collaboration (Machalaba et al., 2015; Leiren and Jacobsen, 2018) and transdisciplinary research (Serrao-Neumann et al., 2015; Oyinlola et al., 2018; Leiren and Jacobsen, 2018), to better support understanding and action for solving complex global challenges. Different frameworks and methods such as nexus frameworks (Cremades et al., 2019), systems thinking and modelling (Sterman, 2002), Three horizons framework (Sharpe et al., 2016), leverage points (Abson et al., 2017) among many others continue to strengthen the underlying epistemology. However, whilst an orientation towards understanding and working with synergies is implicit, a more explicit foregrounding of synergy is needed to support more intentional synergic action.

Understanding synergy may have transformative impacts for guiding greater coherence across social, economic and environmental policy domains. For example, achieving policy

coherence has been critical for achieving the 17 Sustainable Development Goals (SDG) (Coscieme, Mortensen and Donohue, 2021). However, despite the importance and need for policy coherence, siloed thinking and incoherence still persist, inhibiting the achievement of the SDGs as per recent assessment of progress (DESA 2024). Understanding synergy also has great potential for enhanced creativity and innovation, particularly in groups and organisational settings, as creativity emerges from different perspectives and ideas that build on to one another for a creative outcome (Karsidi et al., 2017; Jasińska, 2020). This can go on to support the emergence of group wisdom that can lead to effective decision-making outcomes (Folk, 2022). There is also some evidence to suggest that working with synergy supports resource optimization through sharing of information, skills, and finance that then leads to cost efficiency (Tantalo and Priem, 2016). Synergies also provide an optimistic framework: although ‘trade-offs’ will always exist, there arises the opportunity to reframe trade-offs as dilemmas and thereby harness possible win-win solutions. Starting with an understanding of synergy is the potential entry point for beginning to think and act systemically to tackle complex problems and move towards transformative change.

2.2. Methodology

2.2.1. Method and materials

There is a lack of literature relating to the conceptual foundations of synergy and limited clarity about the concept in many studies. A broad exploratory appraisal of how synergy is applied in different types of literature is therefore useful to begin to build a better understanding of what synergy is and is not. We therefore carried out an integrative review. An integrative review seeks to assess and synthesise literature with a purpose to generate new theoretical frameworks (Torraco 2005; Snyder 2019). It is particularly useful for emerging topics which have not yet undergone comprehensive review such as the case for the concept of synergies, and aims to offer a new perspective on the topic (Torraco 2005).

Initial searches were performed in Web of Science and Scopus using key search terms ‘synergy’, ‘synergistic effects’, ‘multiple outcome’, ‘win-win’ and ‘cooperation’ in the title, abstracts and keywords. However, this highlighted the general use of the search terms and yielded a large number of papers that used the key words but did not delve deeper into the concept of synergy. This led to an informal exploration on Google scholar of the concept

which led to literature in the fields of Business management and Medicine that delved deeper into the concept of synergy.

A key component of the search strategy was a backward and forward snowballing approach which was iteratively applied (Jalali and Wohlin 2012; Wohlin 2014; de Lima Bezerra et al. 2014; Badampudi et al. 2015) whereby the reference list and citations from relevant literature were used to identify new literature. This approach is particularly deemed helpful where search keywords are general terms that could be broadly used in many different contexts which was the case for this review (Mourao et al, 2020). Based on the initial exploration of literature, the criteria for inclusion and exclusion were developed. The criteria were as follows for inclusion: a) synergy was defined; b) explored synergy at a conceptual level and: c) the concept of synergy was applied with other key concepts such as trade-offs and nexus thinking. Following the inclusion criteria, 108 papers and 6 books were selected from years 1982-2024, across 16 broad disciplines and key conceptual ideas linked to the term synergy qualitatively appraised and synthesised. The search yielded literatures in the fields of Medicine, Biochemistry, Physics, Business Management and Accounting, Organisational management, Environmental sciences (including climate science), Engineering, Ecology, Energy, social sciences, Psychotherapy, Systems science including Food systems research, Policy coherence, Goethean science and Quantum physics.

2.2.2. Data analysis

For analysis, a thematic approach was used which involves exploring patterns relevant to the research questions and developing themes by grouping data around key underlying ideas and meanings (Saldana 2025). Analysis involved two overlapping phases to address each research question. The first phase focused on exploring the broad characteristics of synergy. Initially this involved descriptively coding data to summarise segments of text (the first cycle), which were then refined and grouped based on key configurations using pattern coding (Saldana, 2025). Patterns across the data were then further explored using analytic memos that supported deeper reflection and critique perspectives to be applied to the data aid (Bingham 2023; Saldana 2025). This resulted in the three broad themes, grouped in terms of different attributes of synergy found across the literature, thus highlighting three broad attributes of synergy.

The second phase of analysis explored the different ways synergy was applied across various disciplines. This included a similar process of inductive thematic analysis as the first phase

with two coding cycles (descriptive and pattern coding) and use of analytical memos to explore and refine themes. Visual mapping techniques were also used to explore, reflective, compare and refine developing themes. Further, an advisory group was created involving nine academics from different disciplines with some experience using the concept of synergies in their own work, such as in psychotherapy, policy and SDG's, meeting with the lead researcher regularly to help explore and refine initial findings, thus increasing internal and external validity (Bryman 2015). Initial findings were shared with the advisory group in advance and specific questions posed by the lead researcher to guide discussions to test understanding and sense-checking emerging themes and sub themes. Insights and critiques identified through these group discussions were then reviewed and applied to further inform and strengthen the analytical process. This led to development of the conceptual framework involving the three approaches to synergy.

2.3. Results

2.3.1 Overview

Three general attributes of synergy and the three broad approaches to synergy applied in literature were identified. The three attributes highlight the magnitudes of synergy, the spatial and temporal scales of synergy and positive and negative synergies. The three approaches to synergy are 1. Synergy as an outcome; 2. Synergy as a process; and 3. Synergy as perceived wholes. These findings, and the implications for supporting radical change and navigating complex challenges are explained below.

2.3.2 *Attributes of synergy*

Overall, studies together highlight three important attributes of synergies. The first characteristic is that they can be of different magnitude. Magnitude here refers to the varying levels or scales of synergic outcomes. For example, different land use interventions and policy instruments can lead to varying magnitude of synergic outcomes of reduced deforestation and sustainable land use, depending on the combination of interventions applied (Lambin et al., 2014; Delacote and Angelsen, 2015). Business management studies meanwhile, show that synergic outcomes from mergers of two companies include cost

savings from economies of scale, tax benefits and increased debt capacity which can vary greatly depending on the nature of the companies merging (Loukianova, Nikulin and Vedernikov, 2017; Baldi and Trigeorgis, 2009; Hamza, Sghaier and Thraya, 2016). This indicates that particular combinations of interventions can have varying impacts on the magnitude of outcome which will be critical when planning and strategy.

Second, synergy can occur at different spatial (the extent or size of an area) and temporal scales (the duration or time frame). For example, synergy can occur at a molecular level from medicinal components (Yang et al., 2014; Chandran et al., 2017; Mukherjee, Banerjee and Kar, 2018), at organisation levels in mergers and acquisitions (Fiorentino and Garzella, 2015; Garzella and Fiorentino, 2017) or at a district, national, regional and global scales from interventions and policies for sustainable development (Fuso Nerini et al., 2017; Bandari et al., 2022; Pedercini et al., 2019) as examples of synergy occurring at different spatial levels. Further, implementing multiple actions at the same time and in the present moment does not guarantee an outcome right away—instead, it could present itself at a later point in time or at different temporal scales. Taking the example of business mergers and acquisitions, the synergies of merging two companies can manifest as greater profit at a later point in time although not right away. Combined, this highlights the spatial and temporal nature of synergy and has implications for how and when synergic outcomes might be identified, suggesting the need for long-term planning.

Third, synergy can be positive and negative. Most examples that are given throughout this paper are examples of positive synergies which refers to positive achievement of desired outcomes that are greater than the sum of the individual parts. However, there are also negative synergies also known as ‘dysergy’ (Corning 2003; Cooper 2019). The whole greater than sum of the parts are not always positive. In other words, multiple forces acting together can also lead to negative consequences. Some examples are anthropogenic climate change as a result of industrialization and agricultural revolution among various other reasons, cars on the road causing traffic jams and delays, people coming together to cause riots. A more prominent example is the ongoing poly-crisis, where crisis in global systems such as economic, environmental, political, financial, food and energy system among others interact and exacerbates negative global public health outcomes, among others (McNamara and Bambra 2025). Further, dysergy can also refer to a whole that is *less* than the sum of the parts, where adding two or more parts will lead to less overall benefit (Cooper, 2019). A

particular example is described in couples therapy where person A and person B value and want different things in their relationship. Person A might want greater passion, but person B might just want downtime which creates problems in their relationship, pointing to benefits that are less than the sum of the parts. (Cooper, 2019). It is therefore important to consider negative synergies to raise awareness about potential incompatibilities and avoid blind spots and unintended consequences.

The next session presents section presents the approaches to synergy highlighting how synergy is currently understood and approached in diverse literature. The three attributes of synergy described in this section is relevant to all approaches to synergy however has different implications depending on the approach as highlighted in the discussion section.

2.3.3 The three approaches to synergy

The three approaches to synergy are described below as synergy as outcome, synergy as processes and synergy as perceived wholes.

2.3.3.1. Synergy as an outcome

Studies that demonstrate synergy as an outcome tend to come from fields of research such as business mergers and acquisitions, medicine, biochemistry, engineering among others. Here, synergy is recognised by its outcomes. Understanding in the literature of synergy as an outcome involves the combination of two or more agents that generates outcomes that are greater than the sum of the separate effects. Here, an agent refers to both human and non-human entities and interventions, and synergy is recognised by the outcome of multiple actions. This view of synergy was primarily discovered in studies of business mergers and acquisitions, medicine, engineering, biochemistry, climate adaptation among others (Loukianova, Nikulin and Vedernikov, 2017; Fuso Nerini et al., 2017; Mukherjee, Banerjee and Kar, 2018; Schipfer et al., 2024). There are several examples of synergy as an outcome, for instance, an African study found crop management interventions (e.g. new crop varieties) and soil management interventions (e.g. mulching and fertilizers) resulted in significant synergistic outcome of increased crop yield and increased income (Akinyi, Ng'ang'a and Girvetz, 2021). Similarly, a study of energy systems demonstrated how the combining of different energy sources (e.g. concentrated solar power with coal, natural gas or biomass)

resulted in synergic outcomes of energy saving, lower costs, better energy dispatchability, meeting changing energy demands and revenue maximisation, compared to single energy sources (Peterseim et al., 2014; Forsberg, 2009). In these two examples, synergy was recognised by identifying and measuring outcomes of pre-determined actions.

Studies viewing synergy as an outcome used a diverse array of methodologies including quantitative, qualitative and mixed methods. For instance, solution scanning was used to identify effective actions to achieve the sustainable development goals (Baffoe et al., 2021). Alternatively, propensity score matching was used to identify synergies between different agricultural technologies (Wainaina, Tongruksawattana and Qaim, 2018). Further, a discounted cash flow valuation was used to identify financial synergies between mergers of two companies (Kalsie and Nagpal, 2017). This indicates that the methods used to identify synergy are entirely dependent on the context of study and may not be exactly replicable in other contexts.

Despite the importance of the concept, many of the studies examined in this review lacked a strong conceptual foundation to their understanding of synergy. Most importantly, the studies that focused on synergy as an outcome provided very little understanding of how any observed synergic effects emerged and tended to identify synergy *after* interventions rather than show any evidence of explicit consideration of synergy in design. Most of this outcome-based research lacked focus on the interconnections and relationships that may lead to better synergic outcomes and how this affected the outcomes. Finally, studies paid limited attention to the way they had made boundary judgments i.e. what was, or was not included in their investigations, highlighting the need for greater rigour or attention to the subjective nature of synergy.

This view of synergy has two underlying assumptions. First, synergy is understood as an *outcome* of two or more interacting agents and second, synergy can be identified post hoc and can be quantified. From this view of synergy in research, the key question broadly asked was ‘how can we identify synergy after an intervention?’ and ‘what methods do we use to quantify synergy?’. Understanding of synergy as an outcome, which has been the focus of most studies of synergy, is relevant to understand and inform effective future decisions as synergies are identified post-hoc. Yet, despite this potential, greater attention is needed to

understand the process of achieving synergic outcomes which brings attention to the second view of synergy.

2.3.3.2. Synergy as a process

The second broad understanding of synergy focuses more on the process that enables synergic outcomes and is strongly linked to studies that have explored how to work with complexity and complex challenges, specifically from fields of organisational development (Shrivastava and Ramamohan Rao, 2014; Krishna Kumar, 2024), project management (Lalmi, Fernandes and Boudemagh, 2022), sustainable development (Coscieme et al. 2021) psychology (Cooper, 2019; Manago, Sell and Goar, 2019) and more generally in social science research (Jasanoff, 2004; Fielding and Fielding, 2008; Olkhovaya et al., 2016). This understanding of synergy focuses on synergy as an iterative and adaptive process where cooperative interaction of two or more agents leads to outcomes that are greater than the sum of the individual parts.

From this view, synergy is not just understood as an outcome but also as a continual process of implementation and learning about how to support multiple actions and activities - some of which may already exist and some which may be new – to enable synergic outcomes to emerge. This view of synergy was found broadly within participatory action planning, policy coherence processes and within systems approaches to change where co-creative framework and methods were used. For example, the Three Horizons framework was used with multiple stakeholders across Yorkshire to support food system transformations (Buckton et al., 2024). This makes a striking example as co-creation of visions and collaborative action through iterative processes was carried out in multiple workshops to achieve the synergic outcomes of actions for a regenerative food system (Buckton et al., 2024). Further, iterative processes that deliver synergic outcomes were also found within transforming health systems (Micsinszki et al., 2022), transport systems (Zhang, Li and Wang, 2023) including change management (Broillet, Barchilon and Kampf, 2012), psychotherapy (Law et al., 2022) among others.

Furthermore, studies looking at policy coherence for sustainable development stress the need for policies to mutually reinforce policy goals such as reducing poverty, income inequality, energy efficiency among others (Bandari et al. 2022). To achieve the sustainable development goals which is framed in a context of complex, adaptive and dynamic world, continual process of implementation and learning is also key for a few reasons. First, policies

can be piloted and improved upon depending on evidence and new learnings (Hughes et al. 2020; Winter 2020). It further builds knowledge, capacities and provides learning opportunities for institutions and policy actors for future decisions. Second, monitoring policy interventions across multiple areas can lead to early detection of un-intended consequences and minimise risks (England et al. 2018; Nimptsch 2020). A recent study looking at achieving policy synergies also highlight the need for more integrated approaches building on existing policy interconnections, strengthening integrative capacities for policy actors and using collaborative spaces for collective decision making (Carmen et al. 2023).

Synergy viewed as a process highlights two main actions or processes that may enhance the likelihood of achieving synergic effects. First, maximising cooperation and quality of relationships between agents (human or non-human) is critical for enabling synergic outcomes. For example, for successful community-based sustainability initiatives it was critical to maximise cooperation and strengthen community through building respect, integrity, honesty and creating spaces to test new ideas (Carmen, Fazey and Friend, 2024). Another example can be found in building and maintaining relationships within and outside of organisations for the success of the organisation (Weymes, 2002; Akkas, Chakma and Hossain, 2015). Further examples can be found in nature where colonies of bees and ants cooperate with each other to survive (Corning 2003). Therefore, process of maximising cooperation and nurturing and strengthening the quality of relationships can enhance the likelihood of better synergic outcomes and in reducing fragmentation and silo work. The implication is therefore in exploring different types of cooperation through forming new connections with groups or partners that are not usually considered.

Within this view of synergy, iterative learning and testing was deemed as critical for evaluating actions and reshaping them where necessary. This process was thought to enable better identification of synergic outcomes as well as possibilities for effective use of resources and skills. For example, in ‘agile project management’, especially in IT and software development, there are multiple iteration processes. Project managers are required to be flexible to constant changes, challenges and opportunities within a project system (Fernandez and Fernandez, 2008). Agile project managers use various strategies that focus on individuals and interactions, facilitate the project rather than control it, constantly involve clients, and iteratively test and adapt products (Fernandez and Fernandez, 2008; Al Maamzi

and Tawfik, 2022). This iterative process creates space for testing methods to determine what kinds of actions will have effective synergic outcomes.

From our learnings, synergy as a ‘process’ is underpinned by two main assumptions. First, building quality relationships for collaboration through participatory or co-creative methods is key for successful outcomes. Good relationships based on mutual trust act as a catalyst in driving synergic action. Second, iterative processes and learning by doing is key as it will directly affect the type of outcome. The key question here is ‘how can we design adaptive and creative processes that can lead to better synergic outcomes? By viewing synergy as a process in research, there is greater potential for developing understanding of how synergic outcomes might be better achieved. Yet a process-oriented view as described above can also be misleading as it lacks a more holistic understanding of what constitutes the system in which interventions may be taking place, its associated dynamics and how synergy is already involved. This then leads to a third way of approaching or understanding synergy, which is to understand it as the ‘whole’.

2.3.3.4. Synergy perceived as wholes

The third approach to synergy was identified as synergy as perceived wholes. The key focus of this approach is, when the whole of a system can be ‘seen’ within boundaries, it provides a fundamentally different way of understanding the relationships of the different components of a system, therefore providing different opportunities for synergies. It further provides an understanding of how the interaction between components give rise to emergent properties that are unlikely to be understood or noticed without such re-perception, and new opportunities for supporting systemic forms of intervention. Studies that took such a holistic approach to synergy often included deeper conceptual and philosophical exploration than those associated with the other two approaches to synergy that focused on outcomes and processes. Studies taking more holistic approaches were linked primarily to the fields of, for example, systems science (Stermann, 2002; Stroh, 2015; Voulvoulis et al., 2022), Goethean science (Bortoft 1996), and quantum physics (Bohm, 2005). Such work was also often informed by second-order science where the researcher is part of the system of study and where it was recognised that how we perceive the whole system or situation directly affects how we intervene in a system (Midgley, 2008; Umpleby, 2014; Hodgson, 2017, 2024). The basis of synergy through systemic re-perception is therefore, when a system is viewed and understood as a whole within set boundaries, new opportunities emerge to reconfigure

relationships and work with that system more effectively. This is fundamentally different to the reductionist approaches that tend to look for parts - which are an artificial notion when one understands the world from a more holistic perspective, and which are associated with disjointed decision-making processes.

Synergy as perceived wholes that begins by seeking to understand the whole leads to two important possibilities. The first of these is that previously unseen emergent properties can be identified. Emergent properties are “not evident in the individual components of a system but show up when combining those components” (Salzer, 2009). For example, chemists found that when separating atoms out of a compound (e.g. H₂O) a separated atom never explained the behaviour of the whole compound (Buckminster Fuller 1982). Another example is how different components of an aeroplane are brought together in such a way as to enable it to fly, radically changing the relationship between humans and the planet (Buckminster Fuller 1982). Flight - an emergent property - cannot be reduced to its parts. Synergies between components make emergent properties possible (Corning 2012). Emergent properties thus arise due to the specific synergistic combination and interaction of parts.

Understanding emergent property is helpful for three key reasons. It helps make sense of: patterns or behaviours in the system that cannot be explained by only looking at the parts (O’Connor 2020; Axelsson 2022); anticipate new system behaviours to minimise risk (Axelsson 2022) ; support deliberate synergic design (Lanhoso and Coelho 2021). The second possibility from perceiving the system as a whole is the identification of new opportunities for more effective synergic action, such as when working with community health, circular economies, and food systems (table 1).

Table 2. Presents case study examples of re-perception and the new opportunities that arose as a result of re-perception

Case studies	Re-perception impact
Community mental health eco system	Re-perception of mental wellbeing as a whole-community responsibility in Italy resulted in three key outcomes; a) closed down traditional psychiatric hospitals; b) created therapeutic communities embedded within neighbourhoods; c) developed crisis response systems. This re-perception was revolutionary in that it completely changed mental health care (Foot, 2015)
The circular economy movement:	Shifting perspective from a linear and extractive economic model to one that eliminates waste and pollution, circulates products and regenerates nature. Through this re-perception and taking a whole systems approach, the Ellen MacArthur Foundation revealed opportunities to help and engage

Ellen MacArthur Foundation	with businesses, governments, cities, international institutions, universities among many others to build circular economy capacities, tools and enabling conditions. It further created opportunities to redesign products that are good for both people and the planet, transforming the way we think about economies. (Ellen MacArthur Foundation, 2025)
The Conscious food system alliance	Change in perception from technological fixes to food system issues to a focus to cultivate inner capacities to support systemic change and regeneration. The alliance offers a community of practise as well as incubates projects that cultivates conscious food system practises, changing the ways we perceive solution to change (CoFSA, 2022)

Re-perception and identification of more synergic forms of action can then be supported by a variety of methods and tools. Box 1 describes an example of such a heuristic called the World model and how this was applied to explore more sustainable forms of development in the Isle of Man (figure 1, Box 1). The World Model inherently represents intuitive holism and synergy which seeks to cultivate participants' holistic perspective by focusing on the 12 nodes of consideration which are crucial for a healthy and sustainable society and planet at every level of organisation (Hodgson 2012).



Figure 1. Presents the World Model showing the twelve nodes that are essential for a healthy and regenerative society and planet at every level of organisation (Hodgson, 2025)

Box 1. Presents an example of how this approach to synergy can be applied using the World Model as a game board in the Isle of Man.

The World Model was gamified into a ‘World Game’ titled REIMAGINING our Biosphere by Ali Hodgson, who was the Isle of Man UNESCO Biosphere Artist in Residence 2023-2024, a year-long position in collaboration with UNESCO Biosphere Isle of Man and Manx Wildlife Trust, with the main aim of helping inspire people to connect, understand and act for biosphere through creative public engagement. The world game was used to develop the capacity to imagine a nature-positive future for the Isle of Man and later led to raising awareness about the co-benefits of moving towards Net Zero targets in collaboration with the Isle of Man Government's Climate Change & Transformation Team. During the residency, the game was played with over 500 people across various age ranges and groups of people, from children to policymakers. The components of the human and ecological system that make up the Island’s biosphere was shown in the form of a giant game board (figure 2) that could then be interacted with through different collaborative exercises.

The world game helped contain the complexity of the many systems that make up the Isle of Man. Different iterations of the game were designed to work in different environments, timespans and groups of people, and many of these versions included facilitated exercises that helped people move through a process of first understanding the single node topics, then gradually building up to understanding interconnections between smaller sets of them, right through to exploring the whole board and the patterning, opportunities and tensions that emerge from looking at the whole system. These processes helped participants gradually move from a reductionist perspective to a whole systems understanding. The sessions also incorporated the power of imagination and creative play to help envision new and hopeful futures for the Island. This process resulted in aiding re-perception of what could be possible and an increased awareness of the systemic patterning that is inherent in the human/ecological system that they are part of, which for many players of the game, was a very new way of thinking.

The World Model and associated application as the World Game was applied in the Isle of Man (Box 1), helping residents and government officials to re-perceive the present and future in a different way. Through using this approach, the complexity of the Isle of Man was viewed in a more holistic way, opening possibilities and opportunities for more unified action between the government and the public. Introducing the world game has enabled participants to experience interconnectedness; begun to shift language around change, going from a reductionist to a systemic language; begun to help shift negative perceptions around net-zero towards new perceptions of what net-zero means, that it can be more than just reducing emissions. This has opened future possibilities for speeding up action on net-zero and shifting framing from government enforced action to co-creation. The world game further provided an opportunity to break down interdisciplinary and inter-generational barriers, creating a level playing field which resulted in 're-cognition', the acknowledgement of what was and a new recognition of the different and new relationships that can emerge. In short, while it is still early in the process, through approaching synergy as re-perceiving the whole and applying appropriate methods to do so, action that has potential for enhanced, effective and integrated outcomes are beginning to be achieved.



Figure 2. Presents a re-design of the World Model as a game board for a project titled 'REIMAGINING our Biosphere' that was launched in the Isle of Man (Hodgson, 2025)

This example highlights that, synergy as perceived wholes is more than understanding the different parts and interconnections of a system: It is also about transcending the existing system through re-perceiving it, allowing for identification of hidden risks and new opportunities for supporting systemic change (Burt, 2010; Hodgson, 2017). This involves helping those making decisions - whether they be the public or others, collectively understand - through creative dialogues between actors - how their own higher order perceptions shape the emergence of a particular system and how effective action arises from helping create fundamental shifts in how they re-orientate themselves. For the best possible synergic outcomes, reflexive processes of re-patterning and re-learning and actively exploring how a reconfiguration of parts might reveal new synergies is then required (Hodgson, 2019).

2.4. Discussion

Table 2. Presents a summary of the three approaches to synergy

Approaches to synergy	Description	Core assumption	Research logic	Core questions	Implications for action
Synergy as outcomes	Synergy recognised by identification and measuring outcomes post-hoc	Synergy is understood as an outcome resulting from the cooperation of two or more agents Synergy can be identified post-hoc	Prescriptive methodology Focus on post-hoc identification of synergy Common focus on quantification of synergy	What are the outcomes and how can we identify synergic outcomes after an intervention? What methods do we use to quantify synergy?	Post-hoc analysis of synergies can inform better action in the future
Synergy as process	Synergy recognised as an iterative and adaptive process where cooperation of two or more agents leads to outcomes that are greater than the sum of the individual parts	Quality relationships and cooperation between agents' key to enable synergic forms of action Iterative learning, testing and creative processes are key	Enabling participatory methods Focus on learning by doing and iterative processes Quantitative and qualitative approaches are commonly applied	How can we design adaptive and creative processes that can lead to better synergic outcomes?	New forms of intervention/action are needed Unconventional ways of cooperation are needed
Synergy as perceived wholes	Synergy recognised through perceiving whole systems, recognising emergent properties and re-perceiving the system differently for a radically different synergic outcome	Need a holistic perspective and recognise emergent properties Re-perception of the system aids systems transformation	Second order approach is necessary to enable researchers to re-perceive the system and its interrelations	How can we understand whole systems and use different methods to re-perceive the system?	Repatternning of perspectives/worldview to understand the whole Acting differently to bring about a new pattern of relationships

The aim of this review was to understand how the concept of synergy is approached in literature for action to overcome complex global challenges. Our review therefore presented three general attributes of synergy and three approaches to synergies. The three attributes have implications for systemic action such that long term planning, testing combinations of actions and bringing awareness to both negative and positive synergies increase the potential to enhance synergic forms of action and therefore the potential for more impactful synergic outcomes. The attributes also have implications for the three approaches to synergy. The spatial and temporal nature of synergy invites actors such as policy makers, change makers, institutions among others to recognise the need for certain structures and evaluation processes to identify where and how synergies are occurring and track synergic outcomes overtime. The extent to how this is carried out will however depend on the kind of approach taken for synergy. For example, evaluation processes from an outcomes approach will differ from a whole-systems approach. This applies to the magnitude of synergy i.e. the process one takes to measures the magnitude of synergy will differ between the three approaches to synergy. Determining positive and negative synergies will also depend on how one sees the system which will impact what is considered positive or negative synergies. Thus, the three attributes apply to all three approaches to synergy however depending on the approach to synergy, the attributes may have different implications.

The three approaches to synergy, as summarised in Table 1, highlights three key implications in dealing with complex problems. Synergy as an ‘outcome’ has implications in raising possibilities for better action in the future and forms the basis for new learning and evidence. Studies reinforce the need for evidence in policy formulation (Andrews, 2017; Mayne et al., 2018; White, 2019) and identification of synergies post-hoc provides a frame of reference and evidence to inform policy and future research. Synergy as a ‘process’ has implications for building quality relationships and implementing adaptive and iterative learning processes such as by using participative methods to enhance the possibilities for better synergic outcomes (Chulvi et al., 2012; Mumford, Medeiros and Partlow, 2012). This leads to questions for research on how can different structures and processes be developed that support iterative and adaptive learning. Synergy as perceived wholes has implications for how we view and understand systems in a more holistic way and therefore has implications for how one perceives the system of study. It requires a radical shift in mindsets and worldviews to view the system as a whole (Midgley, 2008; Hodgson, 2017). It points to the importance of developing cognitive capacity to observe systems differently to look for

emerging patterns and look for opportunities for new synergies (Espejo 2002; Hodgson 2019). However, this view is the least understood and requires much deeper exploration.

Although the three approaches to synergy provides a helpful way to frame action towards systemic change, it has its limitations. First, synergy as process and synergy as perceived wholes is much difficult to implement in practise. Synergy as perceived wholes will require a fundamental shift in mindsets in the way we view complex problems. This requires re-training in how we view systems, risks and solutions to help support systemic change. It further requires expert facilitation skills to help guide such mind-set shifts, which are very few and currently limited. Second, synergy through as process has its own challenges relating to building trusted relationships, co-creative and participative methods which can be time-consuming and often needs long-term engagement. However, this approach to synergy is already happening and makes a good starting point to work with synergies. Additionally, although there may be intentions for positive synergies, without proper alignment of goals, resources and strategy among others, it may also lead to negative unintended consequences that can give rise to conflict and inefficient working patterns.

Overall, there are limited epistemological foundations of synergy and limited understanding of how to effectively achieve synergic action for systemic change. There is a need therefore for deeper exploration and further research. Our review highlights the need for different methods to support holistic thinking and enable synergic forms of action for systemic change. To initiate synergic forms of action it is critical to engage diverse perspective to foster creative tension (Burt, 2010). Fostering creative imagination and visioning further enables synergies to manifest such that signals of what may occur are recognised earlier, differentiated from forecasting, but also relaying on intuition to better enable planned action (Hodgson, 2024). There is a growing consensus and body of literature that highlights the need for holistic, integrative and transdisciplinary approaches to deal with complex problems (Fazey et al., 2018a; Bentz, O'Brien and Scoville-Simonds, 2022; Shahid, 2024). This has led to the development of methods and approaches such as the World Model (Hodgson, 2012), Three Horizons Framework (Sharpe et al., 2016), Hexagon mapping (Sharpe, 2020), The Wheel of Wisdom (Adams, 2020), Leverage points (Abson et al., 2017), Back-casting (Bibri, 2018) and Ripple effect mapping (Nobles et al., 2022). Our findings advocate for the use of such methods for identifying synergies to enable effective action in a context of increasing

uncertainties and complexity. This is relevant to transdisciplinary researchers and practitioners to inform intentional action when dealing with synergies.

Our results also add support for taking a second order science approach to facilitate a better understanding of how to intervene in a highly complex and changing system (Kläy, Zimmermann and Schneider, 2015; Fazey et al., 2018b). Second order science is understood to be part of and not separate from the system of study (Hodgson, 2009; Fazey et al., 2018a). It acknowledges that the way in which a research problem is perceived affects the research design and therefore affects how we are intervening (Fazey et al., 2018a). The second order thinking considers the interveners' mental models, beliefs and values that ultimately influences the system of study impacting any changes taking place within the system (Umpleby, 2014; Hodgson, 2024). This is widely recognised and accepted in the fields of social science and humanities; the researcher is not independent of the research design, directly or indirectly informed by their mental models, and therefore affects how research is conducted and its outcomes (Aufenvenne, Egner and Von, 2014; Audet, 2014). Second order science thinking by default orients the intervenor to re-perceive the system in relation to their mental models. This then has implications for how one perceives the 'whole' as it would include the intervenor themselves and therefore impacts how synergic forms of action are designed. This has further implications for researchers in implementing practices to gain a deeper understanding of themselves in relation to their world of research and therefore how they decide to intervene. This suggests that adopting a second-order science approach is critical for interpreting and understanding synergies for systemic change.

This study has presented the three distinct, but interlinked views of synergy. The review demonstrates that whilst the concept of synergies has been applied across many disciplines, in the context of systemic change, understanding how to work with synergy needs to go beyond the boundaries of science. Furthermore, it also needs to go beyond understanding synergies as mostly positive outcomes. There is limited awareness as to how synergies can also be negative and can lead to negative outcomes as described in the attributes section. This may potentially lead to overlooking blind spots when trying to effect change. Thus, understanding negative synergies may provide opportunities to understanding root causes of problems and patterns of negative relationships that may exist.

This calls us to engage with diverse methods, knowledge and thinking. As a result of our review findings, we propose that desired synergic outcomes for systemic change requires processes which enable a deeper understanding of the system, supported by second order science approaches. Though this conceptualisation of the three approaches to synergy provides a more advanced understanding, there are still gaps in our understanding of its application for radical change. There is a need to focus future research on how synergic forms of action are currently carried out in practice. Action-orientated research is needed to explore new methods that will facilitate the ‘bringing together’ of actors and actions for synergic action. Further research is also needed to understand the practise of re-perception for synergies and more deeply explore what really constitutes synergic action and seeing synergy as a feature of the system of study.

2.5. Conclusion

The aim of the study was to understand the concept of synergy and how it could be approached and enhanced to support action in overcoming global challenges. The review presented the three attributes of synergy and the three approaches of synergy to provide key learnings. The attributes point to the broad nature of synergy and provide a starting point for understanding synergies that will ultimately influence action for change. All views of synergy support more transdisciplinary approaches and demonstrate opportunities for more effective innovations and resource allocation. Further, the three attributes and the three approaches to synergy in itself is synergistic such that they exist simultaneously in any instance of synergy to some extent. Thus, an important contribution of this paper is to recognize the holistic nature of synergy and to provide a synergistic sense of what it really means to study and work with synergy in practice and research. Our study suggests that to date most studies of this construct have been limited by too narrow understanding and definitions of attributes and approaches. Thus, the findings of this review can support deeper reflection on the use of the term synergy to increase its practical utility and alignment with objectives. It is also helpful for researchers to reflect on synergy when dealing with complex challenges as it encourages both researchers and actors to recognise themselves as part of the system they are intervening in. Thus, all three views of synergy have their merits and limitations. The application of the views will be dependent on the aim and context of research including the type of change we are aiming for to inform effective synergic action.

Chapter 3

Chapter 2 answered the research question of how synergy is understood in the context of transformational change. It thus presented the general attributes of synergy and the three views of synergy- as outcome, process and whole. This has implications for how researchers and practitioners approach change through a synergies lens. Depending on the view of synergy, the pathway of action is likely to differ. It highlights the usefulness of identifying synergies post-hoc for future interventions, grounds the need for more iterative and co-creative processes and learning by doing. It underlines the importance of building quality relationships to foster synergic action and to take a more holistic approach to change in addition to re-perceiving our systems. The chapter thus introduced the notion of synergic action i.e. combination of actions that are intended to generate organizations. However, there is a research gap in understanding how to support synergic action, the application of the concept of synergy in practice.

Given the need to apply the concept of synergies in practice, chapter 3 addresses research question 2, what practical frameworks will help enhance strategic synergic action? It takes the notion of synergic action further by introducing a framework to cohere actors and action in a more synergic way. The focus of this chapter is therefore on how to synergistically cohere actors and action for change.

This chapter has been submitted for peer review to scientific journal Sustainability Science.

Om, E.S., Sharpe, B., Fazey, I., Eyre, L., Newman, R., Carmen, E., Cishe, A. (Under review). Synergic action and system transformation: The Ambition Loop Framework. *Sustainability Science*

3.Synergic action and system transformation: The Ambition Loop Framework

Om, E.S., Sharpe, B., Fazey, I., Eyre, L., Newman, R., Carmen, E., Cishe, A. (Under review). Synergic action and system transformation: The Ambition Loop Framework. *Sustainability Science*.

Abstract

Despite recognition that interconnected and complex challenges facing people and planet require systemic approaches, siloed action and policy persist. New frameworks, methods and tools to support more holistic ways of cohering action are thus needed to better tackle such challenges. This study presents a novel synergic orientated approach that applies the Ambition Loop Framework. The framework is an actor-based tool to help design coherent action for change and focuses on three distinct arenas of action i.e. policy, business and consumers. We critically explore how the framework can be applied to encourage and enhance synergic forms of action. We do this through a case study of food system transformation in Yorkshire, UK. Findings from the development of the Food system ambition loop for Yorkshire highlight the importance of aligning actors across the three arenas of action, building new relationships and strengthening existing ones and emphasise the critical role of policies and political leadership to stimulate transformation. The framework is useful to practitioners and researchers by offering a more dynamic and interconnected view of a system to guide the development of synergic actions as a core part of transformative strategies in complex systems.

3.1. Introduction

Societies across the world are facing multiple interconnected challenges, ranging from climate change, biodiversity loss, poverty, food insecurity, energy crisis, and health adversities among many others (O'Brien and Sygna 2013; Liu et al. 2015; Scoones et al. 2020). Overcoming such challenges cannot be achieved through minor adjustments and reforms, and instead deeper ways of engaging with system dynamics are required for

supporting transformative types of change (Vogel and O'Brien 2022). Such transformations require finding new patterns of behaviour (Fazey et al. 2018), applying new kinds of concepts and approaches, and addressing underlying existential issues – such as a sense of purpose and meaning (O'Brien and Sygna 2013). Ineffective approaches and siloed based approaches persist (Leiren and Jacobsen 2018; Masud and Khan 2024), leading to costly unintended consequences and impact (Axon and Morrissey 2020; Suckling et al. 2021). More holistic approaches are therefore needed (Voulvoulis et al. 2022; Inman and Inman 2023; Fourat et al. 2024), including commitment to integrative action, policy coherence and alignment across different aspects of society (Coscieme et al. 2021) and frameworks and tools to support more joined-up action and coherence (Naito et al. 2022; Tomai et al. 2024).

'Synergies' provides a useful framing for encouraging more integrated and holistic action for transformational change. While there are different ways of understanding organizations (Om et al, 2024; Corning, 2003; Cooper, 2019), it can be broadly understood as two or more elements combining to generate outcomes greater than the sum of the effects of the individual parts (Corning, 2003). An example would be various components of an airplane coming together to enable it to fly (Buckminster Fuller, 1982). Another example is how bees in a colony cooperate for their survival (Corning, 2003). In the case of working with complex societal challenges, a critical question remains about how intentional forms of synergic action – i.e. the combinations of intentional actions that are intended to generate outcomes that are greater than sum of individual actions– can be enabled to support the kinds of changes needed to transcend the issues facing people and our planet. While there are often calls for integrative approaches (Fazey et al. 2018b; Vogel and O'Brien 2022), many studies and approaches lack the conceptual depth and thinking that lend themselves to working in synergic ways.

This study therefore applied the concept of synergies as a stepping stone towards applying more holistic approaches in practice. This is needed considering the urgency and complexity of the challenges societies are now experiencing. The concept of organizations on its own is insufficient – we also need frameworks to guide the application of this concept to inform the design of system wide transformational strategies. One framework that could help create a practical bridge between the concept of organizations and the need for transformational change strategies is the Ambition Loop Framework (ALF). However, few codified examples of the application of Ambition Loop Framework exist , and none within the context of

supporting food system transformation. This paper therefore aims to show how the application of a novel framework, the Ambition loop framework, can be used to encourage and enhance synergic forms of action. In the following sections we first explain the concept of organizations and introduce the framework as a way to support synergic action. Second, we outline our research approach and introduce the case study. Findings are then presented about how the framework has the potential to enhance synergic action to support strategies aimed at system transformation. The implications of the approach for both food system change and more broadly for transformation are then discussed.

3.2. Background

‘Synergies’ has been invoked in, and applied across, many disciplines, including evolutionary studies (Corning 2003), business management (Bauer and Friesl 2022), psychotherapy (Cooper 2019a), medicine (Yang et al. 2014), and policy studies (Carmen et al. 2023). Applying the ideas of organizations through synergic action provides potential for a more holistic way of working within complex challenges (Castell 1999; Espejo 2002). While there are limited published examples, synergic action – in theory – can potentially lead to action that results in outcomes that are greater or more effective through collaboration than through individual effort. For example, collaboration between different actors in the energy sector lead to significant reduction of coal powered energy in the UK (Pearson and Watson 2023). Additionally, it also encourages creative use of limited resources, and enhances innovation (Persaud 2005; Pakeltienė and Ragauskaitė 2017). Finding ways to support synergic action offers a gateway to more holistic thinking and action. In general, however, how synergic action is approached significantly depends on the way in which the concept of synergies is understood.

There are three broad ways in which synergies has been understood across disciplines. First, synergies can be understood as an outcome where the combined effects of two or more elements result in outcomes that are greater than the sum of the effects of the separate parts (Om et al, in review). Such understandings lead to studies that focus on identifying synergies after interventions have been implemented, such as examining whether a merger of two businesses led to the outcomes of reduced cost and more profit (Al Qudaiby and Khan 2013) or how a combination of different agriculture methods generated additional yield and profit

(Rosenzweig and Tubiello 2007). Such outcome-focused understandings of synergies – based on post-hoc analyses – tend to view organizations in causal and linear terms. The insights are then used to help identify recommendations for future actions to bring about multiple benefits.

Second, synergies can be understood as a process, where continual iteration and implementation of actions is conducted in a way that generates a synergic effect. In this perspective, studies tend to focus on understanding relationships between parts of the system and the quality of connections and relationships across socio-political boundaries that enable new forms of change to occur (Carmen et al. 2023). For example, increasing participation by co-creating urban design with multiple stakeholders is intended to enable a synergic outcome of access and improved mobility in cities for greater distribution of benefits across social groups and thus enhancing impact (Leino and Puumala 2021). Taking a process view of synergies often implies a need for co-creative and participatory processes among different actors. Compared to viewing synergies as an outcome, when it is viewed as a process the focus orientates towards how different activities can be woven together to co-create effects greater than the sum of the parts.

Finally, synergies can also be understood as perceived wholes'. Here, starting by seeing the system as a whole within certain boundaries provides a different way of understanding relationships between components, therefore providing different opportunities for synergies. The emphasis is then placed on transcending current understanding (which tends to come from a more silo-based approach) so that the system of interest is perceived differently. This then potentially leads to identification of a different kind of action (Bortoft 1996; Hodgson 2017). An example of such a method is the use of the World Model often known as the World Game or the World Mandala, to gain a holistic view of complex system, integrating 12 key elements crucial for a healthy and sustainable society (Hodgson, 2012). When a system has been understood through such a holistic lens, new opportunities for collective action can emerge. The approach has been played as a game, for example, to imagine a different future for the Isle of Man (Hodgson 2024) which enabled participants to see previously unknown connections and relate to their sense of place differently. This helped participants open up their own holistic thinking and saw potential in using the world model in their own work, for example, in integrating different environmental strategies in business, and for use in nursing homes and schools among others. Re-perception of a system through a holistic lens using

tools such as the world model creates opportunities to re-conceptualise problems, thereby increasing potential for effective synergies of any interventions.

The three different views of synergy each bring different approaches to action, which in turn have different implications for how systemic change and transformation – such as in energy, transport, or food systems – might be supported to transcend critical and major challenges (e.g. to get to low carbon futures or address structural inequalities). Importantly, however, examining synergies as outcome or process can be limiting. This is because it can lead to a narrow focus on current deficiencies and/or identifying possible actions with multiple potential benefits. Although this can be useful, it does not attend as much to the underlying systemic nature of challenges (Om et al, in review). Systemic action is thus more likely to occur when synergies is viewed as a property of the whole, as it leads to a different way of understanding both the system of interest and its challenges, and thus has potential for a more transformational outcome.

Overall, viewing change through the lens of synergic action provides possibilities for going beyond simple problem analysis to identifying and supporting creative, integrative action. While there is growing attention to more holistic ways of working (Kumah et al. 2020; Shahid 2024) there are, however, still limited examples of applying synergic action and frameworks that can support it. In this paper, we therefore introduce a novel approach – the Ambition Loop Framework– to help orientate the development of strategies aimed at guiding transformational change towards synergic forms of action. The framework thus leans more towards understanding synergy as process and as perceived whole as it encourages strengthening new and old interconnections and for understanding the wider environment, the system of actors and their interrelationships for planning more holistic and integrated action.

3.3. The Ambition Loop Framework

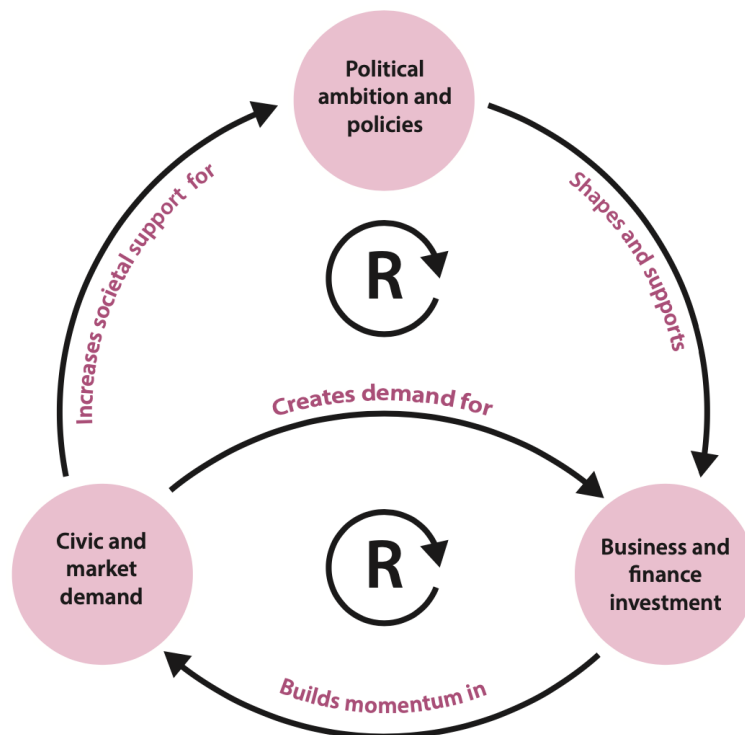


Figure 1. Ambition Loop Framework (ALF) shows three key arenas for action in moving towards change; a) Political ambition and policies, b) Business and finance investments and c) Civic and market demand. The ALF is fundamentally a positive reinforcing loop symbolised by ORGANIZATIONS between the three arenas of action. The arena for Political ambition and policies is in a positive reinforcing loop with Business and finance investments. The arena for Business and finance investment is in a positive reinforcing loop with civic and market demand. The area for Civic and market demand is in a positive reinforcing loop with Political ambition and policies.

The Ambition Loop Framework (ALF) (Figure 1) is a potential tool to help strategically orientate synergic action. The framework was first used to foster ambition for climate action in COP24 meetings (Dickerson et al. 2018), where the approach helped bring businesses and policy makers together to support bold climate action (Dickerson et al. 2018). Continuing this legacy, ‘Ambition Loop’ became an organisation founded by UN High Level Climate Champions, Gonzalo Muñoz and Nigel Topping (Ambition Loop, 2024). This organisation was established as a global NGO based in Chile, aiming to inspire transformative change through radical collaboration (2024). Based on this original work, the Framework was further developed by Bill Sharpe to include consumers or co-producers of a system (Future Steward, 2021) and is loosely based on the model to support co-production developed by Rafael Ramirez and Richard Norman (Normann 2001). To our knowledge, this extended Framework has not previously been applied in practice.

The ALF is fundamentally about harnessing the agency of three different kinds of strategic groups of actors and how they may come together to co-create better synergic outcomes. These actors work within the primary arenas of: a) ‘Political ambition and policies’; b) ‘Business and finance investments; and c) ‘Civic and market demand’ (Figure 2). These include actors who govern, such as policy professionals (Preuß 2001), actors seeking to produce goods and services to create value such as businesses or corporations, and actors who make use of what is produced i.e. consumers or co-producers of a system (Nam and Hwang 2019; Yildirim 2022). The three arenas are chosen based on key actors considered relevant to guiding large systemic change (Wittmayer et al. 2017). Further, in stakeholder theory, these arena of actors are often identified as key groups to work with to intervene in a system (Kujala et al. 2022) and they are also the three component sub-systems of any socio-technical system.

An example that aligns with the framework is that of increasing sustainable sources of energy. Policies that incentivise certain business investments can lead to greater procurement of renewable energy (Dickerson et al. 2018), which in turn helps to achieve policy targets such as reaching net zero carbon (Obobisa 2022). This relationship is reinforced over time by more policy support for businesses in the form of grants and tax incentives to procure further renewable energy (White et al. 2013). This then tends to build momentum for consumers through reduced cost for renewable energy which helps create further demand for more sustainable energy, thereby supporting businesses and encouraging policy support in increase sustainable energy sources that benefit governments, businesses and consumers (Stokes and Warshaw 2017).

The strength of the ALF therefore lies in its focus on three distinct sets of actors coming together to identify pre-existing and new synergic relationships. It has a strong focus on how relationships between actors can be enhanced and reinforced to support more systemic change. In this way, the ALF focuses on understanding the reinforcing effects of the three core arenas of action, as shown by ‘R’ in Figure 2. The framework is thus similar to creating a reinforcing causal loop, as is commonly done in systems approaches (Sterman 2001). The focus of the framework is, however, not on creating elaborate conceptual system models with multiple loops. Instead its focus is to help foreground three critical arenas of action and actors needed for system change, helping develop understanding of how effects and relationships

between actors can be enhanced to support change at scale. The ALF is thus inherently an actor-based approach.

Overall, the framework helps change-makers identify key relationships and understand how different actors influence each other with the goal of helping to prioritise action. The ALF is therefore inherently *synergic*, operating through a lens of organizations as a process and as a property of the whole. It helps actors ‘see’ the system of action and their activities more as ‘a whole’ and helping guide synergic action by helping those involved attain greater strategic focus on how to reinforce effects between system actors. The potential significance for supporting synergic action of the ALF has not been explored and so far the application of the ALF has been limited. This study therefore applies the Framework to a real case where regional-scale food system transformation is being supported. Through the case study, wider implications are then drawn.

3.4. Methodology

3.4.1. Case study

We explored how synergic action – using the Ambition Loop Framework – can support food system transformation across the large region of Yorkshire, in the UK. Food systems are composed of complex interactions between health, policy, culture, environment, economy and society (Bhunoo and Poppy 2020). In the UK, food systems are economically important contributing £147.8 billion in 2022 and employing 4.4 million people in 2023 (DEFRA 2024). However, the UK faces an increasing food and nutrition security crisis and the 2024 UK Food Security Report (DEFRA, 2024) highlights key concerns in maintaining food security. The UK continues to rely strongly on imports of fresh fruit and vegetables, with extreme weather patterns and declining natural capital threatening domestic food production (DEFRA, 2024). These issues are exacerbated by increasing food prices, increasing cost of living, effects of the COVID-19 pandemic on the economy and the current unstable global geopolitical climate (Jagtap et al. 2022; DEFRA 2024) exposing vulnerabilities within the UK food system. Addressing these major challenges cannot be achieved by simply improving or adjusting the current system (Fazey et al. 2018). Instead, deeper systemic and transformational change will be needed for an alternative to emerge that is better able to

support healthy and sustainable diets, reduce environmental impact, and support diverse purpose-led businesses and equitable and fair supply chains (Hasnain et al. 2020).

Against this backdrop, the Yorkshire food system has the highest concentration of food and drinks businesses in the UK, and is the biggest county in England with a high diversity of land use, soils and farming systems (Doherty et al. 2022; Buckton et al. 2024). The Yorkshire and Humber region has a population of 5.5 million and is a hub for food system innovation (e.g. regenerative farming) with strong and growing farmer and agricultural innovation networks (Buckton et al. 2024). However, Yorkshire is also a microcosm of wider challenges with high food insecurity. It is thus, a system that is facing complex, uncertain and evolving challenges which makes a very useful case study to explore synergic action.

Food system change in Yorkshire has been explored and begun to unfold through the UKRI-funded FixOurFood research programme (Doherty et al. 2022) which is the entry point to this study. FixOurFood takes a food systems approach, using three entry points or subsystems to cohere actions across the Yorkshire food system: 1) Healthy eating for children in schools and early years settings; 2) hybrid food economies; and 3) regenerative farming. This is further supported by action and research into policy and modes of governance to support transformation (Doherty et al. 2022).

This study builds on previous research within the FixOurFood programme involving a multi-stakeholder futures process using the Three Horizons framework (Buckton et al. 2024). The Three Horizons framework (figure 2) is a heuristic to help work with complexity (Sharpe et al. 2016). The framework has three key horizons or ‘three lines on a graph’, that stand for the past, present and future. The first horizon (H1) represents business as usual. The third horizon (H3) represents the desired future and the second horizon (H2) represents innovations and activities between the first and third horizons that will eventually lead to the desired future (Sharpe et al. 2016). Using this framework, FixOurFood engaged with 114 experts and 68 different organizations across Yorkshire through multiple workshops to capture insights about the current challenges of the food system (Horizon 1), the desired future food system (Horizon 3), and critical domains of action for supporting transformation (Horizon 2) (Buckton et al., 2024). Findings highlighted that the current Yorkshire food system is associated with poor and unequal nutrition, limited public awareness about better food, a narrow profit-driven mindset of big food businesses, and lack of leadership, agency and

resources for transformation, among other challenges (Buckton et al., 2024). In contrast, a future food system was envisioned by different stakeholders to be one with a thriving regenerative farming community, greater biodiversity, a public reconnected to nature and food, holistic and cohered government policy, distinct regional food identity and affordable nutritious food for all (Buckton et al., 2024).

Five primary action domains i.e. key actions that will support transformative change, from the second horizon, were identified in this earlier work for supporting this transformational shift: 1) enhancing supply chain connectivity and innovation to support diverse hybrid business ecosystems; 2) scaling environmentally beneficial and regenerative farming; 3) empowering citizens to reshape food demand; 4) providing trusted, accessible knowledge support for standards and incentives; and 5) supporting schools and young people as drivers of long-term change. However, it was also recognised that these action domains required coherence, coordination and mutual support across them for their maximal effect. The relationship between the different action domains and how their interaction and relationship can be strategically enhanced to better enable systemic change was then explored (Buckton et al., 2024). This is where the Ambition Loop Framework was tested with the intention to create an Ambition Loop that showed key actions and relationships needed to support and catalyse transformation of the Yorkshire food system.

3.4.2. Approach

This study builds on these previous work, drawing on data from the Three Horizons Framework, particularly working with the second horizon, the domain of action (Buckton et al. 2024), to build an Ambition Loop to provide further support for strategic action. Therefore, in this study, the use of the Ambition Loop Framework relies on the Three Horizons framework, to create an Ambition Loop for the Yorkshire food system. As shown by figure 2, the Ambition Loop Framework is situated in the second horizon of the three horizons framework. The Ambition Loop framework thus relies on data from the second horizon which further relies on exploration of the first and third horizon of the three horizons framework. The Ambition Loop Framework thus acts as a useful tool to get into action in the second horizon to get to a desired future within the three horizons framework.

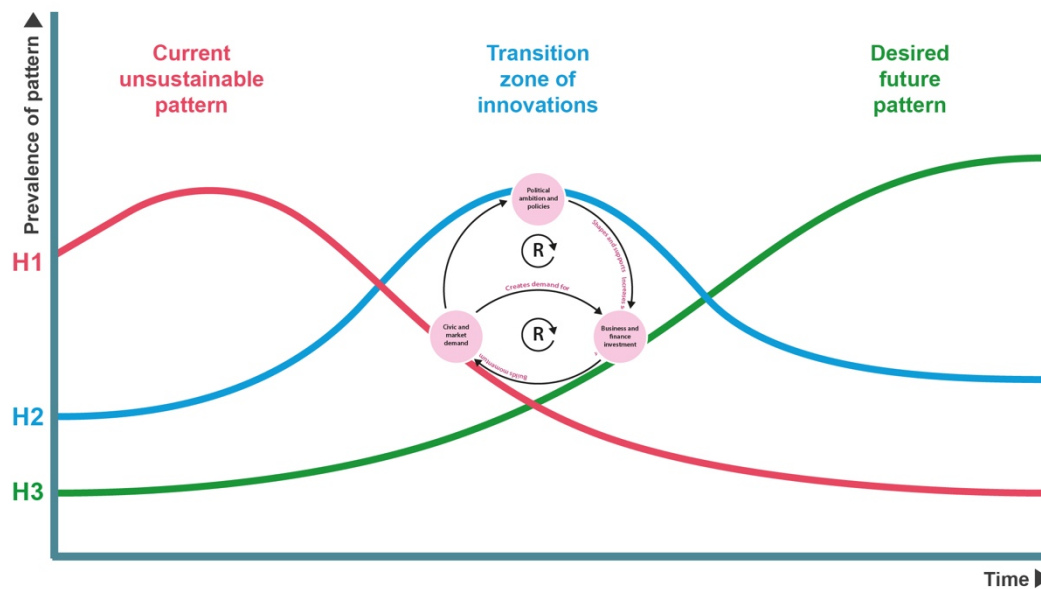


Figure 2. Shows the Ambition Loop Framework as a tool in the second horizon of the Three Horizons framework as used in this case study for Yorkshire food system transformation.

Underpinning this study is then a complex adaptive systems ontology which brings to the fore the importance of dynamic interconnections between components, actors through which multiple, diverse outcomes emerge across time and space (Preiser et al. 2018). To develop the Ambition Loop, we also applied two epistemological perspectives. First, we took a prospective, creative, future-oriented approach (Laszlo 2021) where the future is brought into the present (Otto Scharmer and Kaeufer 2010). Without imagining a different future, no radical transformation of the present is possible (Hodgson 2017). Such an idea of a different future is important to provide direction and ambition (Carmen et al. 2024). Prospection is thus key to synergic action as the development of an Ambition Loop is about showing a desired pathway of change.

Second, to develop our understanding of the food system of interest, we applied a subjectivist approach that recognises diverse perspectives and meanings (Yu 2020). A qualitative inductive research strategy was therefore applied to be more open to alternative ideas and meanings from the data (Ramos et al. 2007; Corbin and Strauss 2024). Whilst different subjective views were sought to understand the complex nature of the system under investigation, the processes of dialogue, combined with conceptual explorations to consolidate the work, led to a single representation of the ambition loop. Thus, the research process was an iterative and co-creative process.

3.4.3. Method and materials

An ambition loop was created through a multi-stage process (figure 4), using data from the three horizons process, particularly the five action domains in horizon two, as described in the case study section.

Stage 1: Exploring mutualistic relationships between action domains

The first step after identifying five key action domains was to conduct a two-day in-person workshop with 30 FixOurFood researchers and food system stakeholders in December 2022 as shown by figure 4. The workshop explored the transformative potential of previously identified action domains, enabling conditions needed to support them, and how the action domains can mutually work together in terms of what each domain might offer or need in return from which systemic action could take effect. Some of the outcomes of this work has been presented elsewhere (Buckton et al. 2024). For this study, data from the workshop was analysed in further depth.

Stage 2: Allocating action domains to the three distinct arenas of action within the framework

From the five action domains, three were allocated to the three arenas of action of the Framework as shown by figure 4. This included the action domain ‘Support schools and young people as drivers of long-term change’ being allocated to the role of ‘civic and market demand’; ‘Policy support for environmentally beneficial farming’ allocated to the role of ‘political ambition and policy’; and ‘Enhance supply chain connectivity and innovation’ allocated to business and finance investment. This allocation was made as it was considered to provide the greatest momentum of action (i.e. potential for ambition). The two other domains - ‘Empowering citizens to reshape demand’ and ‘Providing trusted, accessible knowledge’ – were also considered important and integrated across the three arenas in developing the Ambition Loop.

Stage 3: Identifying reinforcing patterns

The reinforcing patterns within the Ambition Loop were identified by participants of the two day in person workshop, with each reinforcing loop named using conceptual system model conventions (Sterman 2000).

Stage 4: Identifying actions that support the reinforcing loop

Data from the earlier workshop with descriptions of what action domains could offer, or request from, other action domains, were further analysed, sense-checked and validated with six previous workshop participants by going through the reinforcing loops and ensuring it was rightly interpreted as shown by figure 4. Data were then mapped onto the reinforcing loops as actions that would be needed to support a particular reinforcing loop.

Step 5: Identifying key policies that support the action domains

Potential policies were identified from the Three Horizons results (Buckton et al. 2024) that would be needed to support or enhance each action domain.

Following these five key steps, the Food system ambition loop was created through multiple iterations and sense-checking as shown by figure 4.

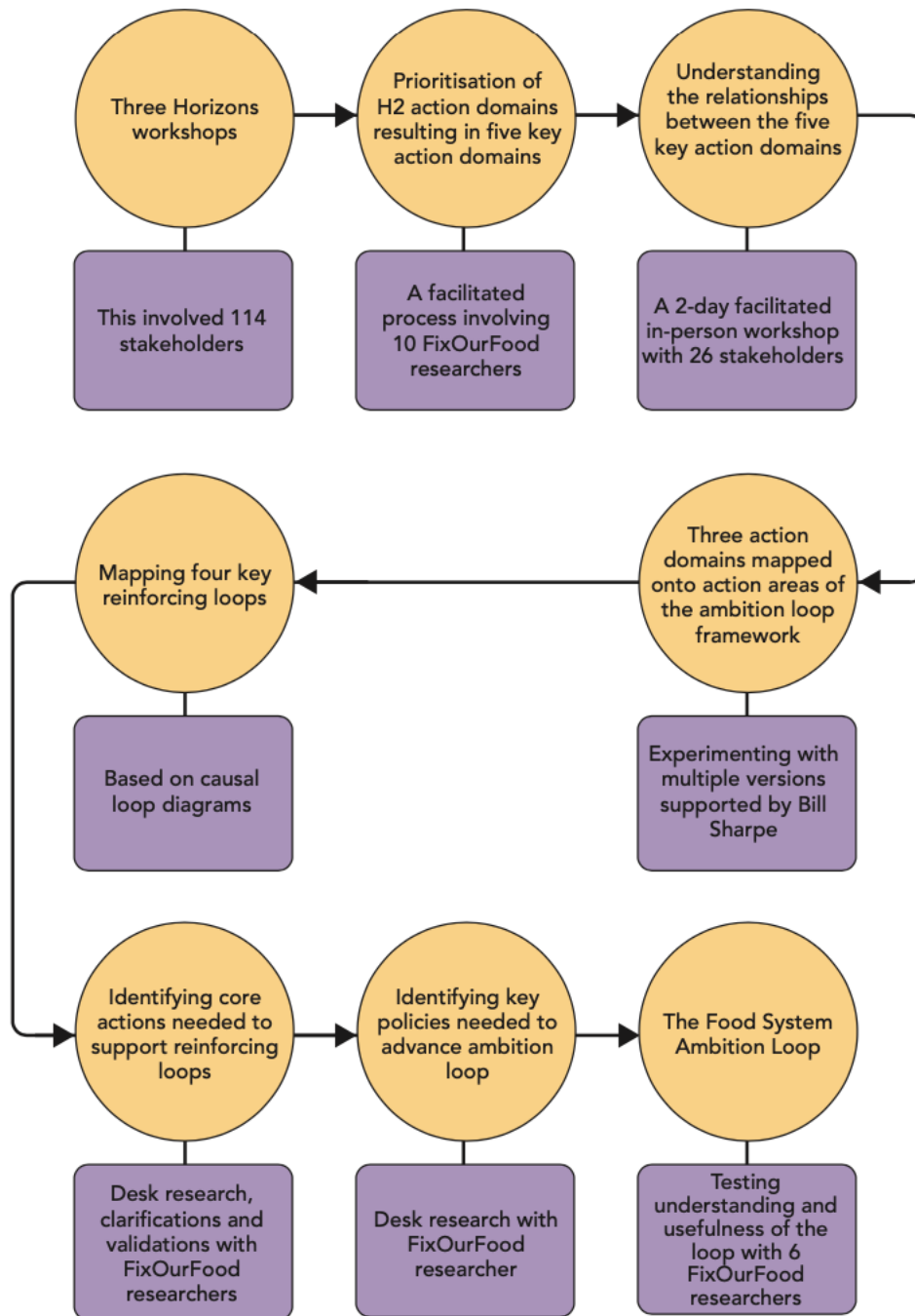


Figure 3. Process map showing key stages in creating the ambition loop for Yorkshire food system

3.5. Results

The ‘Food System Ambition Loop’ developed (Figure 4) includes: (1) action domains; (2) four positive reinforcing loops; (3) core actions needed to support and enhance reinforcing

effects; and (4) policies needed to support the action domains. Each aspect is explained in turn.

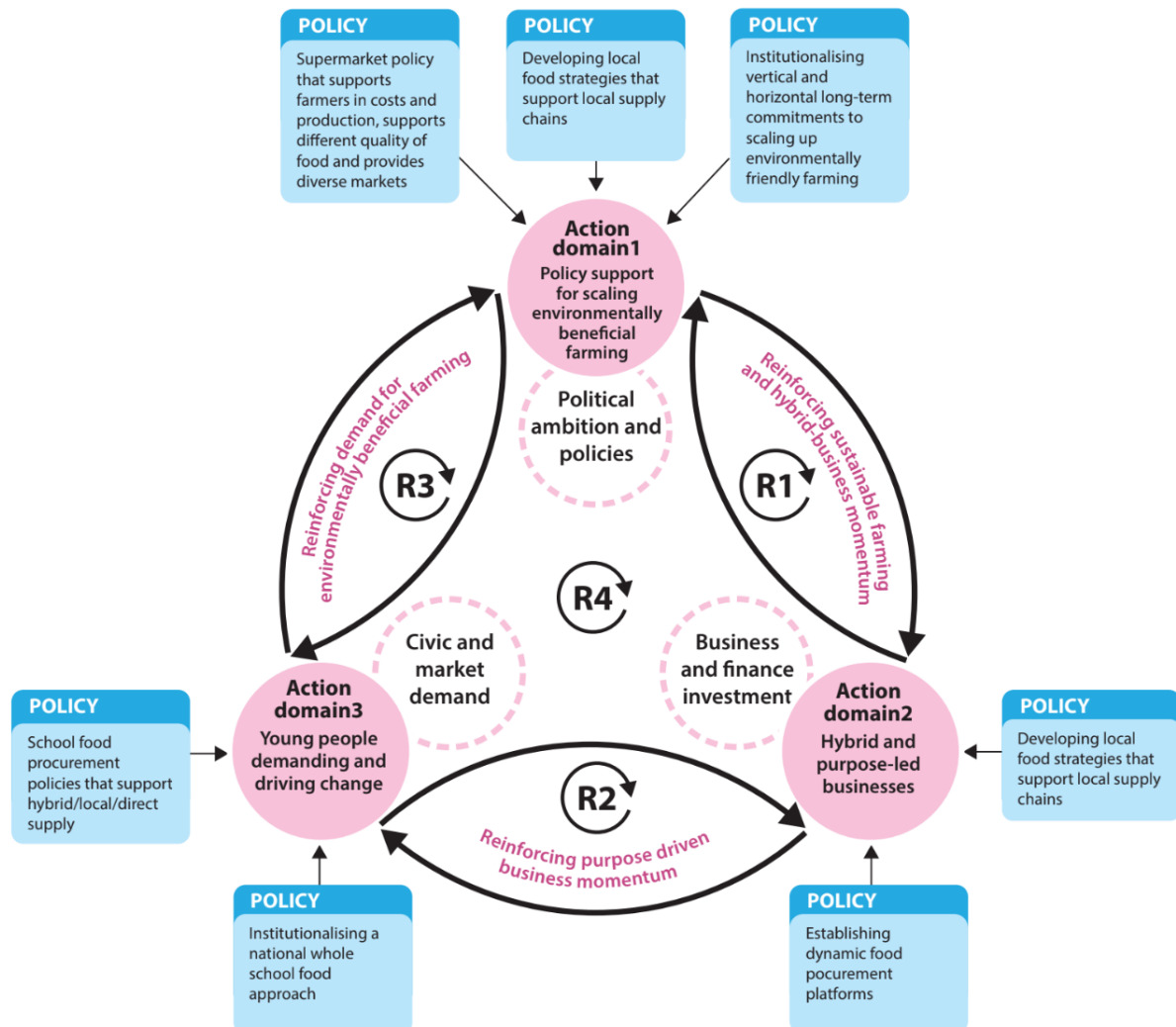


Figure 4. The Food System Ambition Loop is based on the Ambition loops framework with three distinct arenas of policy, businesses and consumers where actors operate. The pink circles show the three action domains that were mapped onto the three categories of actors of the ambition loops framework. The blue boxes show policies needed to support each action domain. Overall, the Food System ambition loop shows a positive reinforcing loop highlighting interconnections between action domains and required policy necessary for transformation of the Yorkshire food system.

3.5.1. Reinforcing loops

The three core arenas of the Ambition Loop (Figure 4) included: (1) Policy support for environmentally beneficial farming’ – where ‘political ambition and policies’ was considered particularly important; (2) ‘Enhance supply chain connectivity and innovation’ was associated with a strong need for ‘business and finance investments’; and (3) ‘Support schools and young people as drivers of long-term change’ was associated with ‘civic and market demand’. To drive ambition, a focus on these key arenas was then considered to be

possible by attending to four key reinforcing loops of the interaction were identified (Figure 3). The reinforcing loops highlight how ambition and change can take place when different sets of actors come together to reinforce their activities.

The first loop, **‘Reinforcing sustainable farming and hybrid-business momentum’ (R1)**, shows how scaling environmentally beneficial farming and enhancing supply chain connectivity and innovation support each other. Increased environmentally beneficial farming can lead to the availability of more sustainable food, making it easier for businesses to reduce costs and increase accessibility to consumers. As businesses adopt more purpose-led models and generate socio-environmental impacts, more sustainable food can be procured from farmers, strengthening local connectivity and shortening supply chains. This enhances the market for farmers to sell local produce, empowering producers to farm more sustainably.

The second loop, **‘Reinforcing purpose-driven business momentum’ (R2)**, highlights how, as supply chain connectivity and innovation towards more sustainable forms of businesses can be supported by work within schools and for young people, who can be drivers of long-term change. As the number of sustainability focused businesses increases, they can not only meet demand from young people for sustainable food but also encourage alternative business models and new job opportunities that is also beneficial for the environment, instilling inspiration. Inspired young people, with their demand for sustainable food, become supportive of purpose-led and sustainable businesses influencing the scaling of these businesses. Businesses are further able to inspire and support young people's demand for sustainable food, thus business and demand reinforce each other.

The third reinforcing loop, **‘Reinforcing demand for environmentally beneficial farming’ (R3)**, comprises action domain 3, ‘support schools and young people as drivers of long-term change’ and action domain 1 ‘Policy support for environmentally beneficial farming’. As the number of young people demanding healthy and sustainable food increases, it also increases the likelihood of farmers shifting towards more environmentally beneficial farming practices, resulting in the availability of more sustainable produce. Scaling environmentally beneficial farming positively reinforces the empowerment of young people by providing sustainable food in addition to educational opportunities and new routes into work (e.g. to be a farmer). Further, scaling up environmentally beneficial farming raises awareness among young people to value healthy, nutritious and sustainable food that also

benefit the environment. For these reasons, young people can further demand support to scale environmentally beneficial farming, continuously reinforcing each other.

The fourth loop is the overall loop (**R4**), ‘**Synergizing policy, investments and demand for Food system transformation**’ which consists of action domains 1, 2 and 3. The extent of scaling environmentally beneficial farming enhances and creates opportunities for purpose-led businesses to bridge the gap between farmer-business relationships. These businesses providing sustainable food further inspire young people to demand sustainable food, thereby reinforcing the need for sustainable farming and purpose-led businesses. Consumers, strongly supported by young people demanding change for sustainable food, demand support for the scaling of environmentally beneficial farming practices, leading to the scaling up of environmentally beneficial farming. This increases the potential availability of more sustainable produce, which in turn supports hybrid and purpose-led businesses to procure more sustainable food from farmers.

The overall loop (Figure 4, R4) – which connects across all three core areas - is further supported by the remaining action domains not directly included in the Ambition Loop: **Empowering food citizens to reshape demand** for sustainable food is critical in supporting loop **R1, R2 and R3** (Figure 4). When empowered, citizens can influence decisions on how food is produced, distributed, consumed and reducing food waste, it influences the extent of environmentally beneficial farming, supporting farmers to shift to more sustainable farming practices. It supports the scaling up of hybrid and purpose-led businesses due to increased demand driven by shifts in fundamental values of food from consumers such as choosing to buy local, more plant-based food, reducing food waste, caring for the well-being of the planet.

The overall loop is further supported by the action domain of ‘**Providing trusted, accessible knowledge support for standards and incentives**’. Empowering food citizens by providing transparent information of our food system (e.g. where food comes from, food product information) helps make informed choices in where they buy from and what they eat, also supporting the action domain of ‘support schools and young people as drivers of long-term change’. Political support for scaling environmentally beneficial farming requires evidence and data to make informed policy decisions that support not only the environment but also the profitability for farmers. Providing standardised data and measurements thus becomes

critical to the policy support for scaling environmentally beneficial farming. Furthermore, this action domain also affects the extent to which hybrid and purpose-led businesses can develop transparent supply chains, supporting consumer awareness.

The overall reinforcing loop suggests a critical point about how it can influence change in the Yorkshire food system. The ambition loop brings awareness to current relationships between actors and points to potential new relationships. It further supports actors in seeing different connections within the system that may not have been visible before.

3.5.2. Supporting the influence of one action domain on another

While the individual action domains and reinforcing loops have potential to create change, they do not in themselves guarantee transformation. Reinforcing loops usually require strengthening to help steward change. Table 3 details actions mapped by participants during the initial workshop that were considered important to support the beneficial impact of one action domain on another. For example, to reinforce policy support for environmental beneficial farming (R1), mainstreaming regenerative farming approaches was considered important. This would be further supported by increasing profit margins for farm businesses and improving farmer-policy maker relationships. As supply for environmental beneficial produce increases, it would positively impact uptake by purpose-led businesses, - especially if dynamic food procurement platforms and shortened supply chains were present – and further enhance potential for purpose-led businesses. This can be further supported by creation of farmer-business sharing networks and more equitable partnerships. This strengthens the sustainable farming policy loop (Figure 4, R1).

To reinforce business investments in purpose-driven business models (Figure 4, R2), for example, providing transparency about the source of food to consumers, particularly the younger generation, was identified as critical to enable informed decision making of food choices. Providing affordable, nutritious and accessible food increases demand, which in turn supports expansion of purpose-driven businesses. Purpose-led businesses can also provide new routes into work such that the younger generation are inspired to take on meaningful business roles that serve community and the planet. This can be enabled by engaging the youth in supply chain innovations and by creating greater community awareness of sustainable food and business models. As demand for sustainable food increases, it creates

better markets for purpose-led businesses which may increase business investments in the uptake of such business models.

To reinforce demand for environmentally beneficial farming (Figure 4, R3), education in schools to empower young people about sustainable farming was identified as critical to enhance policies to support scaling of environmentally beneficial farming. Farmers can support learning of young people by providing educational farm visits, supporting mental health and best practise among their peers. Such actions would enhance demand for local and sustainable food, further reinforcing policy support for scaling of environmentally beneficial farming.

Table 1. Actions needed to support reinforcing loops within the Food System Ambition Loop, derived from the ‘offers and request’ workshop that explored the transformative potential of the five action domains

Reinforcing loops	Support needed to enhance reinforcing loop	Explanation
1. Reinforcing policy support for environmental beneficial farming	Mainstreaming regenerative farming approaches	Helps scaling of regenerative farming, also helping shorten supply chains
	Improving farmer- policy maker relationships	It provides an opportunity for new policies that will help farmers in scaling regenerative farming. Farmers can also help policy makers with data that is needed to make effective policies enhancing local connectivity of production and consumption
	Dynamic food procurement platforms	Opens diverse markets for farmers, shortening supply chains and also helping to promote purpose led businesses
	Increase profit margins for farm businesses	Farmers can cover costs for regenerative farming, costs to run trials and to support a stable livelihood thereby increasing likelihood for regenerative farming
	Introducing Knowledge sharing platforms	Can reduce knowledge gaps in research, researchers and farmers working together to scale regenerative farming
	Uptake of purpose-led business models	Supports businesses in achieving socio-environmental impacts by supporting regenerative farming
	Farmer- business sharing networks	Existing farmer sharing networks can extend to include businesses to strengthen relationships between businesses and farmers
	More equitable partnerships between farmers and businesses	Farmers and businesses such as supermarkets share costs of regenerative farming helping scale regenerative farming
2. Reinforcing business investments for purpose-driven business models	Raising awareness of different business models	Businesses showing positive impacts on the environment and society can inspire the younger generation to also be inspiring agents of change thereby demanding the scaling out of such businesses
	Providing better food procurement	Businesses becoming examples of providing regenerative farming produce to procurers at a fair and cheaper price
	New routes into work	Businesses show the younger generation different routes into work throughout the supply chain
	Affordable, accessible and nutritious food	Businesses can keep costs down for healthy, tasty and sustainable food, therefore, healthy and sustainable food is accessible by all income groups
	Producing with low carbon footprint	Investing in low carbon products throughout the value chain
	Transparency of source of food	Businesses become transparent where they source their food from so that consumers are better informed to decide who they buy from
	Future workforce	Empowered young people becoming leaders for change
	Acceptance of different food products and quality	Reduces food waste and acceptance of different food products and quality can impact what is offered by businesses
	Procure from hybrid, local and direct supply chains	Young people demanding regeneratively produced food means that institutions such as universities and schools are empowered to produce from local suppliers supporting local farmers and businesses
	Creative engagement for supply chain innovation	Young people can greatly shape how and what they eat and therefore becoming innovators for their future
	School budget spent on good food	Schools can be a vehicle for change where they empower their students by providing healthy, tasty and sustainable food
3. Reinforcing consumer demand for environmentally friendly farming	Greater community awareness	Schools can also play a role in raising community awareness by engagement with parents and the wider community wherever schools are located
	Education and support of environmentally friendly farming and food security education in early years	Education in schools can empower young people to make better choices of their food therefore young people are empowered to demand regenerative food helping the scaling of regenerative farming approaches
	Demand a fair price for farmers products	Demanding a fairer price for farmers means that farmers have the resources to invest and scale environmental beneficial farming
	Demand direct supply and food that benefits the environment	Demanding direct supply means that businesses can prioritise local suppliers shortening supply chains
	Providing educational farm visits, demonstrating benefits of better practise	Can inspire young people to become farmers and appreciation for the immense effort that goes into food growing
	Mental health provision	Farms can become places for mental health provision, showing the younger generation the multiple benefits of running a farm
	Provision of sustainable food	Scaling of environmentally beneficial farming means more availability of sustainable food

3.5.3. Policy to support each action domain

While the action domains individually hold potential for supporting change, political leadership will be necessary to support each individual action domain (Table 2). Six key policies were identified by workshop participants as essential in supporting and scaling three key action domains. These spanned from developing local food strategies, enhancing commitments to environmentally beneficial farming, developing dynamic food platforms, and establishing more whole school based approaches to food (Table 2). Some of these policies and actions are already being developed, with considerable interest, for example, in the creative development of new kinds of procurement platforms.

Table 2. Policy required to strengthen action domains

Action domains	Required policy support	Explanation
1. Policy support for scaling environmentally beneficial farming	Developing local food strategies that support local supply chains	Local food strategies can promote local supply chains, promoting direct sales from farmers and also reducing carbon emissions
	Institutionalising vertical and horizontal long-term commitments to scaling up environmentally friendly farming	Supporting farmers with costs of environmentally friendly farming approaches is critical for producing sustainable food and keeping costs low to improve accessibility for sustainable and healthy food
	Policy that provides farmers diverse markets, distributing cost of sustainable food production with supermarket	This would encourage farmers to produce more environmentally beneficial food, while also supporting their livelihoods
2. Enhance supply chain innovation and connectivity	Establishing Dynamic Food Procurement Platforms	Promotes diverse markets and local supply of food
3. Support schools and young people as drivers of long-term change	Developing local food strategies that support local supply chains	Local food strategies can help connect farmers and purpose-led businesses to localise supply chains
	School food procurement policies that support hybrid/local/direct supply of food	This policy support can enable schools to procure directly from farmers, shortening supply chains and providing healthy and sustainable food
	Nationally embedding the ‘whole school approach’ to school food	A national whole school approach to school food can enable all schools to provide healthy and sustainable food to young pupils, empowering their choices for sustainable food

3.6. Discussion

This paper introduces the Ambition Loop Framework and findings from applying this framework in a case study of the Yorkshire food system transformation programme, critically examining its usefulness as an approach to taking synergic action to support transformative change. In this section, we first discuss implications for supporting transformation of Yorkshire's food system by drawing on the Food System Ambition Loop. We then discuss the wider implications and limitations of using the framework, and finally suggest directions for further research.

3.6.1. Supporting synergic action for transformation of the Yorkshire food system

The 'Food System Ambition Loop' (Figure 4) points to three key ways to support synergic action for transformation of the Yorkshire food system. First, alignment of all three action domains, which represents majorly different areas of society i.e. business, policy and civil society, is key. Alignment here refers to how the action domains and its related processes work in similar ways in the Yorkshire food system. Alignment of action domains means alignment of vision, values and goals held by actors within the Yorkshire food system. Focus on understanding how and where actors are already aligning and looking for opportunities to increase coherence will be critical. For example in Yorkshire, farmers and schools are already beginning to align their approach for supporting environmentally beneficial farming produce that not only supports farm biodiversity but also connects young people with land and their food source (FixOurFood 2022). There are also examples of local to regional alignment in goals, such as achieving nutrition which show opportunities for developing greater coherence among actors striving for food system change across scales (Buckton et al. 2024). However, greater alignment will also be needed between various actors within the three action domains to support transformation.

The second important way to support synergic action for Yorkshire food system transformation is the integration of various approaches to change, concurrently strengthening existing and building new relationships, which is also key to alignment of the three action domains of the Food system ambition loop. Table 3 presented multiple actions that will be needed to support and strengthen connections between action domains such as mainstreaming

regenerative farming approaches to improving business models. There are examples from wider literature that also highlight the need for better farmer-business relationships (Schoneveld 2022), farmer- consumer relationships (Goss and Bush 2023) and farmer-policy maker relationships (Wei and Ruan 2022) that will help enhance scaling of environmentally beneficial farming to move towards more sustainable food systems. Currently, in the Yorkshire food system there are various networks and organizations such as Deliciously Yorkshire, Yorkshire Grain Alliance, Yorkshire Food farming and Rural network that try and support coherence through sharing of knowledge and practices and to strengthen the ability to adopt more holistic perspectives. They are examples of initiatives that aim to connect actors from different parts of the food system in Yorkshire to better enable alignment of action.

The Ambition Loop Framework further helped understand key strategic areas and their relationship to each other, created by the FixOurFood Commission in recognising the value to cross-sector relationships. It comprises of key influential food system change actors from production through to waste, with the aim of continuing action towards transformation of the Yorkshire food system (FixOurFood 2024). The commission have developed a set of strategic action areas for driving food system change which also broadly align with the results of the Food Ambition Loop (FixOurFood 2024). These include developing whole school approaches for understanding food, leveraging funding and political support for regenerative farming, developing infrastructure to support a circular economy and supporting the establishment of a local public procurement platform (FixOurFood 2024). Through this vision, they intend to connect with wider food system actors. This is just one example of how to create institutional spaces that builds capacities for actors to act in more systematic ways.

The third way to support synergic action for Yorkshire food system transformation is working with the critical role of policies and political leadership to stimulate transformation. To enhance each of the action domains, policy support is necessary which is more likely if policies and policy communities also involve a focus on synergies (Resnick and Swinnen 2023; Carmen et al. 2023). The Food System Ambition Loop helps to see existing policy synergies. For example, policies are not only needed to help increase business investments in procuring environmentally beneficial produce but also to enable farmers to invest in scaling environmentally beneficial farming and support food education to increase demand. Policy synergies are therefore critical and can be supported by creating collaborative platforms

within policy formulation processes in and by fostering systems thinking among policy actors (Carmen et al. 2023). The Food System Ambition Loop therefore highlights the important role of policy actors in supporting the ambition of a transformed Yorkshire food system and can support this in practice.

3.6.2. Wider implications and limitations of the framework

The application of the Ambition Loop Framework demonstrates how it can be used to align action and actors, particularly in relation to the three distinct arenas of the framework.

Critiques of transformative change and transition studies highlight the lack of attention on actors and their agency (Avelino and Wittmayer 2016; de Haan and Rotmans 2018). This is important as actors (either individually or collectively) can mobilise resources and energies to influence the direction of change in socio-technical systems (de Haan and Rotmans 2018).

Therefore, the strength of the framework is its approach to systemic action, focused on actors that drive action.

The framework thus presents an opportunity to be sensitive to the agency of actors to act and intervene in a system. In this study, while the framework did not map key actors per se, and was dependent on the way previous research had been conducted, it did explore critical interconnections, reinforcing loops and action between core domains of action. This helps identify and align action and actors. In our case, the Ambition Loop has the potential to guide future research, policy and action by highlighting focal areas for more in-depth mapping of actors most likely to be able to affect change. Future studies may be able to more directly begin to examine actors in initial stages of their research to maximise momentum and get commitment for systemic change.

The framework further provides an entry point for strengthening systems thinking and holistic engagement to work with complex adaptive systems. First, due to its simplicity it lowers barriers to participation and engagement in using systems approaches to change. This creates opportunities to introduce systems concepts such as causal loops or influence diagrams in simpler language. Second, it encourages multi-disciplinary collaboration, represented through the three arenas of action in the framework, which further creates protentional for deeper systems mapping. Third, the framework provides a foundation to map actors and existing relationships, which can be further extended to various systems

approaches such as stakeholder mapping and social network analysis among others. The framework, helps actors situate themselves in the broader system and understand how they are interrelated and may be supported by others (Fischer and Newig 2016; Huber 2022) in a more simpler way, lowering barrier to participation.

The work also emphasises the importance of an exploratory and participatory process where diverse actors engage in dialogue and begin to understand how they are connected to other actors. Such an approach was key in our previous, and in this work to help collectives understand and begin to re-perceive the system of interest. Co-creative processes are therefore essential in considering different perspectives and are a powerful tool for fostering conversations (Hoever et al. 2012; Massari et al. 2023). In our study, the framework provided a way of organising actions and for harnessing the potential for synergies.

The framework may, by some, be perceived to have some limitations. For example, it does not include negative feedbacks, delays, or stocks and flows which are commonly included in conceptual systems modelling (Sterman 2000). Yet this would be a misunderstanding of the prospective nature of the Ambition Loop. The goal of developing the loop is to orientate key strategic actors to help determine how best to get audacious action, albeit structured around understanding opportunities for beneficial reinforcing action. It is not meant to be a perfect model of the world, but rather to outline relatively simply opportunity, potential and help support re-perception. Other frameworks can also be included to enhance such perception and strategic action (Meadows 1999; Hodgson 2012; Adams 2020). In our work, the Ambition Loop was – for example - also developed in conjunction with Three Horizons practice (Sharpe et al. 2016).

Another potential limitation of the framework for this study, was that the three domains of the food system ambition loop overlapped with the three entry points or sub-systems taken by the FixOurFood programme as a way into the Yorkshire food system. However, this is not a limitation of the framework itself but how the study used data from the extensive three horizons workshop conducted with stakeholders of the Yorkshire food system. Therefore, the three action domains of the food ambition loop reflects the ongoing momentum of action found within the Yorkshire food system as shared by the actors who engaged with FixOurFood. The food ambition loop can then serve to bring together and align actors who

are already engaged in action in building better relationships in supporting Yorkshire food system transformation.

In summary, the Ambition Loop Framework and its development is meant to help actors coalesce and guide coherent and synergic action. Its power lies in its simplicity. As this study demonstrates, the final Food System Ambition Loop was derived from extensive exploration of the complex Yorkshire food system. The framework helped distil key information from the complex system that can be more easily understood by different actors.

3.6.3. Implications for synergic action

The framework fits within the view of synergy as process and whole, as described in the background section. Synergy as process emphasises the importance of co-creative and iterative processes to build quality relationships (Om et al, in review) which is essential for creating ambition loops. The framework also highlights the need for a holistic understanding of our systems relating to synergy viewed as a whole, and presents three distinct categories of actors that are relevant for large-scale systems change. However, it does not particularly deepen our conceptual understanding of synergy but more importantly, the framework helps us understand where to look for synergies and how to go about delivering synergic action. Furthermore, in applying this framework, it has the potential to enhance understanding of synergy viewed as process and whole which may provide further insights into the concept of synergies.

The framework is useful in bringing awareness to the wider system and looking for key dynamics within the system of interest. From this study, we can learn that for synergic action to take place, a greater understanding of the wider system will be key. This is critical to enable key strategic actors to better understand how synergic action as outcomes that are greater than the sum of separate parts are possible by developing a more holistic picture of how they are interconnected and part of a bigger system (Sáez de Cámara et al. 2021; Fourat et al. 2024). From this understanding, actors can potentially locate new actors that align with their values and goals for better outcomes. Wider understanding of the system will also help locate weak and negative dynamics and strengthen positive ones, enabling actors to engage and enhance synergic action. Further research on what constitutes synergic action will be needed although this study has provided a starting point for synergic ways of intervening in

the system by introducing the framework. The framework highlights the importance of using methods to facilitate conversations and aid understanding of one's interconnectedness in a system to enhance and identify opportunities for synergic action.

3.7. Conclusion

This study introduced an approach, the 'Ambition Loop Framework', and critically examines its usefulness in taking synergic action to support transformative change using a case study of Yorkshire food system transformation. As a result, the Food System Ambition Loop was developed through a co-creative and participatory process which is the main finding of this study. While further research is needed to explore how the framework can be used in conjunction with other complementary systems frameworks, methods and tools, this study highlights the importance of cohering policy, businesses and consumer demand to support Yorkshire food system transformation. The framework offers a way to harness synergies and guide coherent action as a critical way to plan and act towards system transformation.

Chapter 4

Chapter 3 answered research question 2 of what practical frameworks will help enhance strategic synergic action. It thus developed and applied a novel framework, the Ambition Loop Framework, to Yorkshire food system transformation. It resulted in the food system ambition loop, that shows how policy for environmental beneficial farming, hybrid and purpose-led businesses and young people can cohere synergistically to support Yorkshire food system transformation. The findings have implications for the Yorkshire food system in relation to aligning key actors, integrating various approaches to change and the role of policies and political leadership to support its transformation. The framework itself has implications for how it can be used to align actors in a more systemic way using co-creative processes and encouraging holistic engagement. However, whilst this chapter provided a framework as an approach to synergic action, there is a gap in understanding the conditions needed to deliver synergic action.

Given the need to understand necessary conditions needed to deliver synergic action, chapter 4 addresses research question 3, how is synergy currently delivered and what are the key enablers for synergic action to support transformative change? The following chapter thus looks at understanding and learning from expert practitioners in the Yorkshire food system.

This chapter has been published in the scientific journal to sustainability

Om, E.S., Fazey, I., Eyre, L., Tyfield, D., Cooper, M., Carmen, E., Jackson, D., Fearnley, J., Ritter, L., Newman, R., Cousquer, S. (Published) *Sustainability*

4. How to support synergic action for transformation: Insights from expert practitioners and the importance of intentionality

Om, E.S., Fazey, I., Eyre, L., Tyfield, D., Cooper, M., Carmen, E., Jackson, D., Fearnley, J., Ritter, L., Newman, R., Cousquer, S. (Submitted). *Environmental Science and Policy*

Abstract

A global poly-crisis of climate change, biodiversity loss, dwindling natural resources, geopolitical instability among other complex challenges are on the rise. Societal transformations are therefore imminent, whether intended or unintended. The key question is how to steward and facilitate such changes where fragmentation and siloed ways of working persist. The concept of synergies and notion of synergic action could help overcome fragmented efforts to steering transformative changes. However, there exists a critical research gap in understanding the conditions needed to enable synergic action. This paper thus explores how synergic action is currently undertaken and the key essentials needed to deliver synergic action. The study uses a case study of the Yorkshire food system transformation to learn from its exemplar practitioners. The study used semi-structured interviews and thematic analysis process to reach our two key findings. First, we highlight the three types of synergic action: 1) Non-systemic synergic action, 2) Non-systemic synergic action with multiple outcomes, and 3) Systemic synergic action. Differentiating types of synergic action can help identify where synergic action is already underway and guide more explicit efforts towards transformative change. The second key finding is the five essentials for synergic action which are: 1) Leadership for synergic action; 2) Networking, partnerships and collaborations; 3) Care and understanding; 4) A systems approach; and 5) Intentionality for synergic action. This study brings to the fore, the importance of intentionality without which the first four essentials are less likely to coalesce. This is important to inform reflection and learning of practitioners of systemic change about

how they are currently and could be working more synergistically in the future driven by clear intentionality.

Keywords: Fragmentation; Siloes; Capabilities; Collaboration; Systems approach; Leadership

4.1 Introduction

We are facing a poly-crisis: that of climate change, biodiversity loss, sea-level rise, poverty, hunger, and pandemics, among many other crises (Lawrence et al. 2024). There is increasing recognition for the need for societal transformations to more sustainable and regenerative futures (O'Brien 2018; Buckton et al. 2023). Bringing this about in practice requires interconnected ways of working (Redman and Wiek 2021; McNamara and Bambra 2025). Yet fragmented and siloed ways of working and reductionist approaches to change persist, limiting the potential to steer transformative types of change (Swanson et al. 2012). Holistic and systemic approaches are vital (Vogel and O'Brien 2022). One approach holding promise to support holistic ways of working with transformation is through fostering synergic action.

We define synergic action as any *deliberate* actions that, when brought together, lead to outcomes greater than the sum of the individual actions. The notion of synergic action is rooted in the concept of synergies, where interaction or cooperation of parts, elements or individuals (living or non-living) leads to outcomes greater than the sum of the effect of the individual parts (Corning 1998). Synergic action has the protentional to focus actions and resources in a more effective way. While there have been conceptual advances about what constitutes synergy (Om et al.), very little is still understood about how synergic action is currently carried out in practice and the conditions needed for such practice to be effective.

The aim of the study is therefore to understand what synergic action looks like in practice for those working towards system change and the conditions needed for synergic action to be effective. To do this, we draw on insights from expert practitioners actively working towards systemic change by using a case study of Yorkshire food system transformation, embedded in the UKRI funded FixOurFood programme. We first explore the background to synergy, synergic action and broad enablers for change and then outline the research methodology. We

then present our key findings, followed by a discussion on the implications of the research for supporting transformational change.

4.2. Background

There are ongoing efforts for change in multiple systems (e.g. transforming health and energy systems) and emerging conceptual and empirical research that looks at understanding how such fundamental and large-scale change can be actualized (Swanson et al. 2012; Gielen et al. 2019). Many now recognize that a systems approach is key to support such large-scale change (Burch et al. 2014; Fazey et al. 2018; Voulvoulis et al. 2022). This has led to a plethora of systems methods, frameworks and processes for identifying problems and developing strategies for action. Methods include systems mapping, the three horizons framework, and leverage points among others (Bentz et al. 2022), as well as those for identifying and enhancing synergies (Swanson et al. 2012; Ison 2017; Voulvoulis et al. 2022). Whilst this approach is progressive, much of this research focuses on analyses of ‘what is’ and fails to examine how systemic change might be pursued in practice. There is therefore a need for both conceptual and practical understandings that help inform ways of thinking and acting to support systems change.

There are two important aspects relating to the practice of guiding systemic change which to date, received limited attention in the literature. The first is finding the right kind of operational concepts suitable for supporting systemic change. Thus, synergy as a concept is helpful for working with systems change in practice, particularly for four key reasons. The concept explicitly points towards going beyond the idea of additive summation and the need for creative ways of working that bring together specific parts and relationships to generate more superior outcomes and functionality (Corning 2003; Seamon 2024). Second, through its application it emphasizes a need for coherence of action and key resources (FAO 2022; Om et al.). Third, it can be used to encourage collaboration between silos by providing a cohering concept. An example is identifying synergies between various interventions and across policy objectives to enhance collective action (Carmen et al. 2023; Edwards et al. 2024; Li et al. 2024). Fourth, it provides a positive framing for change by encouraging engagement and inspiration for collective action compared to approaches focusing primarily on identification of challenges. The concept therefore usefully provides a gateway into systems thinking and holistic action with a positive and inspiring orientation that actively invites the search for creative ways of working.

Given its relevance to practice, it is then perhaps not surprising that the concept of synergy has then been applied across many disciplines such as ecology, psychology, organizational studies, business management, and medicine (Biavatti 2009; Corning 2017; Cooper 2019b; Tripathy et al. 2020). This has led to diverse ways in which synergy is understood, with each having implications for the practice of synergic action. When synergy is, for example, understood as ‘a whole’ - and where it cannot be approached by disaggregating different actions - it invites practitioners to find new ways of understanding and perceiving challenges and the system in which they seek to intervene (Om et al. In review). This can then lead to new ways of understanding problems and the identification of new possibilities and creative solutions. Overall, how synergy is practiced depends on the way the concept is understood.

The second aspect often receiving limited attention when approaching system change is the lack of understanding of how to apply concepts in practice. Systems concepts such as leverage points, systems dynamics and reinforcing loops are often difficult to apply practically (Skyttner 2006). The dominant patterns of existing systems such as governance approaches, profit-driven mindsets among others, often complicates and challenges the way in which systems concepts are successfully applied for systemic change (Fillion et al. 2015). The concept of synergy has the potential to orient actors towards more effective ways of working that can deliver outcomes that are greater than the summation of parts.

The key question is, what are actors actually doing on the ground that makes synergic action for transformative change possible? Although numerous endeavors focus on using systems approaches to understand current challenges, or focus on what needs to be transformed, there is much less focus on how actors are actively working in synergic ways to support systemic action for change. Yet this is important for supporting and expanding such efforts in the future. We therefore aim to answer this question by looking at exemplar practitioners of the Yorkshire food system as a case study.

4.3. Methodology, methods and materials

4.3.1. Approach

Ontologically, we recognize that systems are complex and highly inter-related (O'Brien 2018; Linnér and Wibeck 2021; McNamara and Bambra 2025). The study is also founded on constructionism, based on Bryman (2015), where meanings are socially constructed and shaped by constant interactions and relationships. Furthermore, particular perspectives of synergy were applied where outcomes are shaped by synergic processes and holistic understanding of the system [9].

Our epistemology is loosely based on grounded theory where the theory emerges from the data and usually does not have a pre-conceived questions that can influence what emerges from the data (Diano and S. Calbi 2024; Corbin and Strauss 2024). This led to an inductive research strategy to examine how strategic actors are currently engaging in synergic action.

Therefore, the overall the approach that was taken was that one that recognized the need for exploration that looked for aspects of synergy whilst also not influencing what we would find, allowing space for new insights to be identified.

4.3.2. Case study

Our global food system may no longer be considered 'fit for purpose', evidenced by unsustainable agriculture, fragile supply chains, unhealthy diets, nutrition related diseases and major contributions to global greenhouse gas emissions (Okpala 2020), signaling an urgent need for transformation. These issues are further exacerbated by global events such as war, pandemics and climate change that greatly disrupt global supply chains, causing increases in food prices and highlighting the interdependent nature of systems (Hasegawa et al. 2021; Ben Hassen and El Bilali 2022).

This study uses transformation of the food system in the county of Yorkshire in the UK as a case study to explore how actors within the Yorkshire food system are approaching synergic action and understanding the key conditions needed for synergic action to support transformation. The case study is embedded into the FixOurFood programme, funded by United Kingdom Research and Innovation (UKRI), which aims to transform the Yorkshire food system to a regenerative system (Doherty et al. 2022). The transformation of the Yorkshire food system is relevant within the current food system paradigm of global food crisis.

Yorkshire, England's largest county, includes major cities such as Leeds, Bradford and Sheffield. It has one of the UK's largest concentrations of food and drinks businesses (Doherty et al. 2022) and is home to 13-17% of UK crop production and 10-14% of UK livestock consisting of multiple farming systems (Herbert 2023). More than 20% of Yorkshire's population was reported to experience food insecurity in 2022 in addition to high mono-culture farming leading to less resilient farms (Herbert 2023). Current land management practices, production and consumption patterns are leading to biodiversity degradation and GHG emissions. There is an urgent need to transform the Yorkshire food system such that everyone has healthy and sustainable food where farms are sustainable, profitable and resilient to climate change (Herbert 2023).

4.3.3 Methods and materials

4.3.3.1. Data collection

The primary data collection method was semi-structured interviews which allowed in-depth exploration, and space to follow trajectories of the interviewees' experience and subconscious work patterns (Magaldi and Berler 2020). The sampling technique employed was opportunity sampling to maximize participation and ensure diversity (Panatsa and Malandrakis 2024). This sampling approach also suited the exploratory nature of the study.

Interviewees were stakeholders of the Yorkshire food system who were already engaged with the FixOurFood programme. Interviewees were chosen to cover a diversity of professions within the Yorkshire food system and the focus of the programme on systems approach to change increased the likelihood for diversity of participants. Diversity was further insured by conducting interviews in three rounds. Each round assessed the roles of participants which allowed inclusion of participants with varying roles in further rounds. These included: community leads, representatives of regional food groups and religious centers, researchers, educators, health professionals such as nutritionists and civil servants working in public health, local businesses, and farmers as shown by table 1. This resulted in 22 semi-structured in-depth online interviews, each lasting an hour. All interviews were conducted within a period of 6 months from January to June, 2023.

An interview guide was developed, and written consent was gained prior to the interview for audio recording and use of data in the research process. The word ‘synergy’ was deliberately not used in the interview to allow space to understand unconscious working patterns of change makers when dealing with complex systems, in addition to avoiding confusion of the definition. A range of topics were explored with interviewees, such as examples that led to multiple benefits when combining different forms of actions, enablers and challenges of successful partnerships; and the most important, action for facilitating transformations for the Yorkshire food system. A conversational interview style was adopted to foster an atmosphere of active engagement, beginning with warm up questions (Baumbusch 2010).

Table 1. Interviewee and their roles within the Yorkshire food system

Interviewee identifier	Interviewee role	Key focus of their work
S1	Chair	Local and sustainable food
S2	Vice chair	Enables connectivity across food, farming and rural communities
S3	North York Moors National Park Authority	Helping farmers transition from the basic payment system
S4	Education Co-ordinator	Support schools to set up their own social enterprise and food education
S5	Communications manager	Communication with government for better outcomes for farmers and land owners
S6	Policy team	Local nature recovery strategy
S7	Director	Support food access, bringing together partners, sharing good practise and resources
S8	PCN Dietician	Support clinicians in GP surgeries, provide training to carehomes, community response teams and therapy teams
S9	Consultant	Work with NGO's, charities and local council to help understand policy practise issues on childhood nutrition
S10	Chair	Brings together food partnerships from towns and cities across the UK for sustainable food
S11	Head of Science, Evidence & Research	Food risk assessment, research and evidence
S12	Public health manager	Health and wellbeing for children and local communities
S13	Managing director	Supporting early stage business growth
S14	Managing director	Business owner, focused on food manufacturing technologies

S15	Consultant/ farmer	Promotes regenerative agriculture
S16	Public health senior officer	Healthy nutrition and lifestyle with a strong focus on children's food standards
S17	Senior role in diocese	Leads on the ecological agenda and is part of the environmental working group for net zero. Also focused on rural and urban life and the impacts of food
S18	Business development manager	Regional food group that supports businesses and individuals involved in food and drink in Yorkshire

4.3.3.2. Data analysis

A transcription software Otter.ai was used to transcribe all interviews after which all transcripts were printed for a paper-based approach to coding that allowed ease of access and flexibility for coding and developing memos (Saldana 2025). All paper-based coding was then transferred to an electronic document. Thematic analysis was used in the first part of the analysis to inductively elicit themes relating to enablers for synergic action. This was an iterative process that involved “immersion in the data, reading, reflecting, questioning, imagining, wondering, writing, retreating, returning” (Braun and Clarke 2021). Analytical memos were used to explore, reflect and refine emerging themes and insight. This led to identification the five essentials for synergic action.

Concurrently, the second part of the analysis included the exploration of examples that lead to multiple benefits when combining different forms of actions. This was important to identify the types of synergic action and understand how actors were taking synergic action on the ground. The analysis was done in three key steps. Examples were first extracted from the transcripts from all interviewees. Second, examples were grouped together, inductively developing a set of categories. This categories reflected three forms of synergy: a) Actors acting towards the same outcomes, b) Actors achieved one goal which lead to other multiple benefits and c) Actors with systems knowledge that mobilized other actors and resources. Third, the three categories were then named resulting in the three types of synergic action.

4.4. Results

The inductive analysis resulted in two key findings. The first key finding shows the different patterns of how synergic action was implicitly approached by actors of the Yorkshire food

system. The second key finding presents the key essentials needed for effective delivery of synergic action.

4.4.1 Types of synergic action

Three types of synergic action were identified. These are; 1) Type 1, non-systemic synergic action, 2) Type 2, non-systemic synergic action for multiple outcomes, 3) Type 3, systemic synergic action. The following section explains each of these in turn.

4.4.1.1. Type 1: Non-systemic synergic action

This type of synergic action refers to actions where two or more actors come together in a synergic relationship to achieve a common goal. This is illustrated by Figure 5 where ‘actor A’ and ‘actor B’ come together to reach their goal of ‘outcome C’. An example is a non-profit organisation such as Rethink Food (actor A) working with a business such as ASDA (actor B), to deliver synergic outcomes of setting up new social enterprises in schools and reducing food waste. Interviewee P4 stated, *“the Asda project they physically get a market stall that's on wheels as well so they get this weekly delivery of food surplus food from Rethink or another organisation and that's a mixture of ambient products such as tins, pasta, rice, cereals, bread, but also they get fresh produce as well”* (P4). Various examples of this type of synergic action are shown by Table 5.

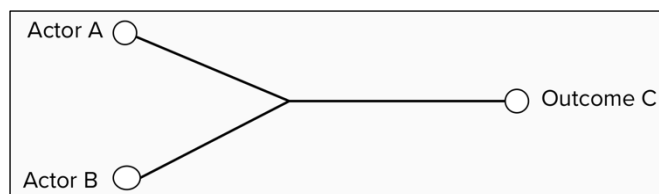


Figure 1. Illustrates Type 1 synergic action, non-systemic synergic action, where two or more actors come together to achieve a common goal

Table 2. Examples of type 1 synergic action in the Yorkshire food system.

Actors	Synergic outcome	Quotes
Cathedrals working with food banks	Feeding communities and disadvantaged people	<i>“So we're at the Cathedral do quite a lot as being a sort of centre where people with food can bring it so we act as a sort of collection point. And then we disperse that to local food banks” (P19)</i>
Food education organizations working with bakery chains	Helping highly deprived areas and enabling quality education on healthy eating, planet	<i>“it's all about healthy eating, and the impact on the planet, it's a combination of everything through a systems approach, and that's actually they're funding it to go out to their Greg's Foundation funded breakfast clubs” (P4)</i>
Dieticians working with schools	Working with schools to reduce anxiety, improved mental health or better sleep	<i>“some new programs for early years, sort of reading programs and people sort of preschool families, to support them with healthy eating messages for their children, and then hopefully the work that I'm doing in the school will reinforce that and then eventually we'll be moving into senior school” (P8)</i>
Consultants working with NGOs and charities	Focus on childhood nutrition	<i>“we work with NGOs and charities and local councils, help and look at policy and practice issues around childhood nutrition and getting better food on children's plates.” (P9)</i>
Supermarkets working with farmers	Celebrates British farmers and local food	<i>“you've got Morrison's, who were quite actively plugged into the supply chain, and makes great advertising PR out of only sourcing British grown produce locally reared meat and that sort of thing, and high standards. So it celebrates British farmers, which is a good start, because moving away from or reducing the number of food imports into the country” (P5)</i>

4.4.1.2. Type 2: Non-systemic synergic action with multiple outcomes

This pattern of synergic action refers to two or more actors coming together for a common goal, but the initial effort for synergic action not only leads to ‘outcome C’ as shown by Figure 6, ‘outcome C’ also leads to further recognised outcomes, either intended or unintended.

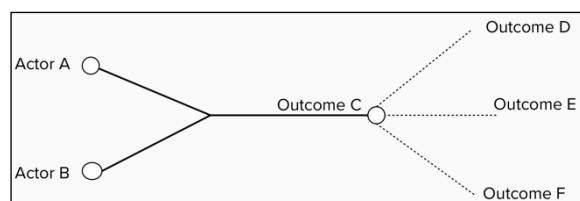


Figure 2. Illustrates type 2 synergic action, non-systemic synergic action with multiple outcomes

The Incredible Edible project is one such example where a group of people, actors A and B, came together to manage unused plots of small land to grow food (Outcome C), which led to multiple outcomes connecting communities, growing food that brought people closer to their source of food and becoming a global movement among many others. Table 3 illustrates further examples of multiple outcomes achieved by multi-actor interventions.

Table 3. Illustrates examples of type 2 synergic action

Multi actor- Interventions	Synergic outcomes
Village hall weeks	Primary objective is to feed people but there are added outcomes of increased community spirit, cultural integration etc
Farming in Protected Landscape grant scheme	Funding to support farmers, leading to positive outcomes of building and strengthening farming communities, networking, delivery of public goods
Local nature recovery strategy	Balancing nature and food production, linking towns and cities, nature recovery
Regenerative farming	Improving organic carbon in the soil and maintaining biodiversity on the farm leads to healthy land, nutritious food, profit, mental wellbeing etc

4.4.1.3. Type 3: Systemic synergic action

This type of synergic action refers to actors who understand key players in the system, including who have more agency, resources and power to support a goal, and then bring

relevant actors together (Figure 7). Although all interviewees had the knowledge that a systems approach to change is necessary, we found that certain actors tended to wear various ‘hats’ and network extensively. The multiplicity of roles by one actor enabled them to understand key actors in the system that if brought together could lead to better synergic outcomes. For example, interviewee P2 had roles across Yorkshire Food Farming and Rural Network, North Yorkshire Local Enterprise Partnership board and Grow Yorkshire project enabling the interviewee to deliver better synergic outcomes in supporting farmers and the agriculture sector. Such actors from various parts of the Yorkshire food system were identified to better catalyse synergic action (see Table 7).

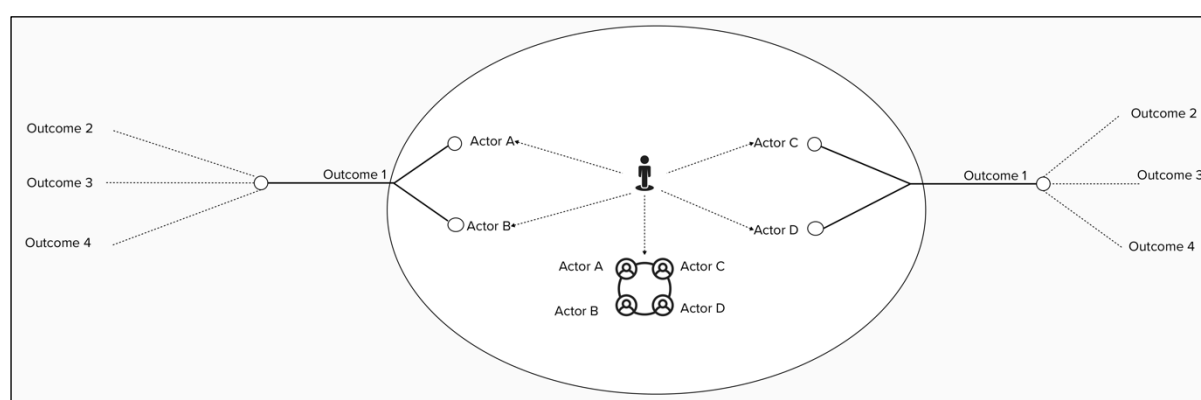


Figure 3. Illustrates type 3 synergic action, where certain actors have a better understanding of the system and facilitate the bringing together of relevant actors and resources for change

Table 4. Actors in the Yorkshire food system that has the potential to catalyze synergic action.

Actors	Synergic outcomes	Example quotes
Religious leaders	Encouraging communal eating, helping homeless individuals, reducing food waste, supporting framers, engaging regionally	“The cathedrals connects with community, so very important that we are working with other partners to come together” (P19) “I think another way in which churches are wedded in is I say we have chaplains and we have connection on the ground with farming communities and other people because of a lot of stuff which people never see” (P17)
Researchers	Cohering diverse actors together, co-creation of processes with stakeholders, knowledge exchange	“I think stakeholder engagement is key. And I think in terms of the university as a sort of anchor institution within that food system. I think they have a huge responsibility” (P13)
Food advocacy workers	Cohering diverse actors, educating young people, encourage local and seasonal food	“So if anybody says to me, what do you think is your USP or what do you bring to the table? That I would say it's about the synergies is that I sit on quite a lot of different groups. And I can network people or put people in touch with people and all of those things together” (P2)
Farmers	Engagement with other knowledge institutions, sharing of best practice	“we are seeing more farming groups coming together. So and those farming groups are bringing in people who are not necessarily farmers, talk about the systems and we're prepared to access more information and advice on how to better or how they may access different options to the way in which they can farm” (P3)
Educators	Education in schools about the source of food, nutrition, sustainable food	“I do think there needs to be more information about, about where your food comes from, from a very young age, and, and, and how much it costs to produce. I think information

		<i>about the fact that you go and buy a chicken for four quid, you need to know how much that costs to produce” (P3)</i>
		<i>“it’s children and schools, we’ve got to start with how young people work” (P2)</i>
Local councilors	Food strategies, voicing the need for healthy and affordable food	<i>“political will again, if you knew that there was a leader of a council or a particular MP that would bang your drum for you, then you you’re hanging your hat on that” (P9)</i>

The three types of synergic action show how synergic action is implicitly carried out in the Yorkshire Food system. This has implications for learning how to intentionally implement synergic action in the future.

4..4.2. Essentials for synergic action

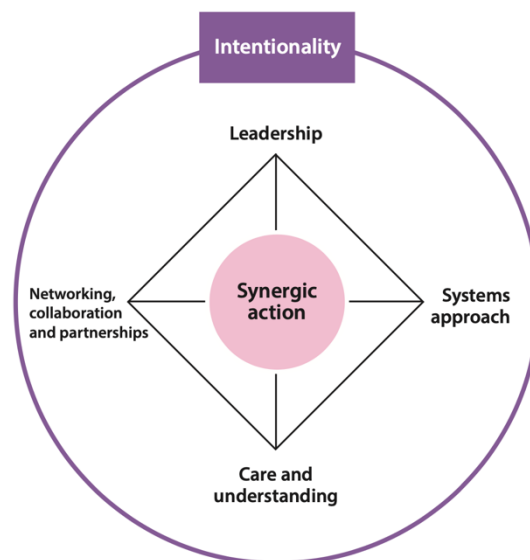


Figure 4. The five essentials for synergic action. The inner ‘diamond’ shows the first four essentials for synergic action. The circle outside the diamond represents the overall importance and the need for intentionality for synergic action. The circle also represents the intention needed to bring the first four essentials together.

Our second key finding highlights the five key essentials needed for synergic action that together have the potential to drive synergic action. The five essentials as shown by figure 4 are: (1) Leadership for synergic action; (2) Networking, partnerships and collaborations; 3) Care and understanding; (4) A systems approach; 5) Intentionality for synergic action. In this section we broadly describe each essential.

4.4.2.1. Leadership for synergic action

Particular forms of leadership are needed for synergic action. Interviewees highlighted the need for trusted leaders who have wide reach, influence and have the commitment for change. Leaders who were also respected and trusted in the community were identified as important, *“you have got to have a leader who is respected and kind of commands a bit of gravitas”* (P9). The credibility and influence of these leaders was identified as crucial for bringing people together to initiate action and foster conversations, *“conversations are happening by people who are trusted speakers”* (P17).

Further, interviewees emphasised the ability of leaders to encourage and engage diverse people and perspectives, creating spaces for people to gather and foster creative collaboration. Interviewees also saw leadership as supporting creation of multidisciplinary roles that allowed for experimentation without constraints, therefore taking a *“multidisciplinary team approach”* (P8). Such teams might then have the capacity to adopt agile methods and experimentative approaches to change. Credible, respected and trusted leaders thus helped instil confidence and promoted growth in creative ideas in communities and those who worked towards change. For instance, a newly created role of a primary care network (PCN) dietician is working for a collective of GP surgeries, for leading more effective resource use and patient journeys. Interviewee (P8) states, *“what I’m doing at the moment is I’m scoping out my role, and to find out what the population needs, how I can support the clinicians in the GP surgeries and how I can use my time most effectively”*. The new role gave multiple opportunities to explore what is needed.

Furthermore, interviewees highlighted the importance of leaders as the driving force of creating and carrying a shared vision forward for collective action. They emphasised leaders who were explicit about their agendas and explained *“why it’s important”* (P21), and particularly valued leaders who had *“clear and articulated”* (P20) agendas and were able to persuade others. It further included sending the right messages and framing conversations. This underlined the importance of leaders having clarity on how change is going to happen to therefore enable others to have confidence in a shared vision and collective agendas. Additionally, leaders who were systems thinkers were also highlighted to be crucial.

4.4.2.2. Effective networking, partnerships and collaboration

The second essential for synergic action was a co-creative and participatory processes to support effective networking and the creation of successful collaborations. Interviewees highlighted that a diversity of engagement strategies are needed to encourage conversation and learn about solutions and barriers to change across different scales. Interviewees further emphasised the need to design processes that gave stakeholders more voice and power to influence change. This was emphasised in using networking as a strategy to enhance power for certain groups creating opportunities for them to *“impact the rules of the game”* (P22). This included designing workshops and processes that gave a platform to engage and hear the voices of the marginalised. For instance, in the process of developing the Sheffield local food action plan, interviewee P22 said, *“we went really out of our way to make sure that marginalised voices were included in this process. We included travel funds, et cetera, to ensure that people could participate from all areas of the city and from all backgrounds”*.

Findings indicated that participatory processes were enhanced by local and place-based collaboration. Interviewees emphasised the importance of taking more local approaches for collaboration and partnerships which may result in *“supportive local partners that understand the benefit of the work and ultimately want to protect it”* (P13). Some examples of successes included the ‘Incredible Edible project’, ‘village hall weeks’ and various food banks run by local communities. Creating a community spirit through regular local events supported by a local facilitator was seen as important, *“by bringing people together on a regular basis, basically monthly, we strengthen the sort of community working and cooperation within the city”* (P19).

The community spirit, collaborations and partnerships were thought to be strengthened by having transparency and integrity with partners. Communication over a period of time and ensuring consistency and quality of work were identified as enabling successful partnerships. Interviewees emphasised the importance of being honest and upfront about one's values, *“we try and be upfront about our values and our politics and things like that. So rather than pretend that we are objective, or impartial about these things, you know, we wear on our sleeve”* (P22). It therefore helped clarify that all are operating from the same understanding of what the goal is and its particular processes. On the contrary, it can also deter actors from working with actors that do not align with their values and can therefore seek out alternative

actors to work with. Thus, building relationships and credibility through collaboration was critical to enable effective partnerships.

4.4.2.3. Care and understanding

Interviewees emphasised the importance of care and understanding towards one another as the third essential for synergic action. For example, the value of listening to different viewpoints and particular needs to enhance care and understanding, *“you’d have to listen more than you talk”*, (P18). It was about *“listening to all the competing, sort of convictions and requirements”* (P19). Interviewees further highlighted listening without being immediately reactive, *“we really think it’s important to listen to other organisations and reflect on that and we’re not immediately reactive”* (P4). Moreover, interviewees stressed the significance of helping people feel their value and *“recognising how everybody contributes”* (P12) which was important so that *“they feel that it’s worth their while”* (P20). Deep listening and valuing individuals was then enhanced by responding with empathy and respect.

Responding with empathy and respect was identified as complimenting deep listening values. Interviewees highlighted that showing respect and care for others’ opinions and circumstances as important to foster collaboration and strong partnerships. For example, *“figuring out how to engage with farmers at a human level to undergo a major shift in mindset is required”* (P21). An important aspect here was responding with care and helping others respond, *“there’s still the need to respond and effectively respond in a charitable way to human need”* (P19). Further, interviewees highlighted dealing with tensions with much empathy and care which included understanding barriers for different groups. Additionally, understanding the limits of *“willingness to change”* (P18) and creating positive environments to facilitate challenging conversations was cited as crucial by interviewees to enable synergic action.

Personal inquiry for change was also identified as crucial for demonstrating care and understanding. Interviewees highlighted the importance of questioning our own values and *“principles by which we make a decision”* (P19). Further, acknowledging and perceiving the subjective nature of change and how that influences processes and outcomes was highlighted as crucial. For instance in creating the Sheffield local food action plan interviewee P22

acknowledged that *“I have my politics and values and things like that. And inevitably, those shaped the process, as did all my co-authors on the plan, and we try and be upfront about our values and our politics and things like that”*. Interviewees further recognised the importance of deeper inquiry within individuals in relation to the role they play in larger communities, a recognition of the need for deeper evaluation of our relationship to others as well as the planet.

4.4.2.4. A systems approach to change

A systems approach to change was highlighted as a fourth key essential for synergic action. Interviewees emphasised the need to *“look at a problem holistically”* (P2) exemplified by the ‘healthy weight healthy lives strategy’ to tackle obesity, which was further emphasised by the need for a *“holistic approach to incorporate all the different players”* (P5). Understanding *“interdependency and relationality”* (P17) was identified as critical to move away from the problem of *“atomistic individualism”* (P17) and silo ways of working.

Furthermore, identifying gaps in information and using current knowledge to support a systems approach was identified as important. Having knowledge about the current state of affairs such as how land is currently managed was highlighted as important to get a holistic picture of the system. Interviewee P22 states, *“there's a lack of transparency in terms of who owns land”*. Interviewees highlighted that having organisations that could connect people, such as Deliciously Yorkshire, universities, religious centres were critical in building networks and gaining knowledge about the system. This was seen as supporting a systems approach to change through fostering holistic understanding of the system and inclusion of diverse actors to strategize for potential interventions. Thus a systems approach to change, guided by holistic thinking, filling gaps in information, was considered a crucial enabler of synergic action.

4.4.2.5. Intentionality for synergic action

Underlying the first four essentials was a fifth key essential: the intentionality for synergic action where intention is understood as ‘an attitude that drives behaviour’ that sustains, guides and co-ordinates behaviour (Livingston 2005). Although all interviewees

acknowledged the need for a systems and holistic approach to change to support transformation of the Yorkshire food system, very few interviewees were found to be explicitly trying to do synergic action. Intention for synergic action generally tended to be overlooked in most studies and was also overlooked by most interviewees in this study. However, few interviewees tended to fall within type 3 synergic action (systemic synergy) which was not common. These interviewees had a deeper understanding of the system and were intentional in their efforts to bring actors together for collective action and actively pursued synergic outcomes.

Intentionality for synergic action made a difference to synergic outcomes in two ways. First, actors were able to bring various actors together to achieve multiple goals for the food system, as shown by pattern 3 of synergic action in figure 3. Interviewees further emphasised the importance of their unique roles. For example, P9 emphasised, *“I work as a consultant so you have to pay people like me to try and coalesce people around a problem and move them”*. Second, other actors in the food system greatly benefited from these intentional actors such that they were able to direct relevant actors towards each other. Interviewee P2 mentions her active role, *“I sit on quite a lot of different groups. And I can network people or put people in touch with people and all of those things together”*. Interviewee P18 states *“So one of the key cornerstones is around... collaboration and around community and around kind of helping, spread, spread, best practice or helping individuals understand how they can network better really”*. These actors understood the importance and value of someone like themselves that was able to see connections within different parts of the system using systems approaches and *intentionally* outcomes greater than the sum of the parts by bring people together for change.

4.5. Discussion

The study aimed to understand how synergic action was carried out in practice and key conditions needed to enable synergic action using a case study of Yorkshire food system transformation. We thus identified three types of synergic action and five key essentials that together increase the potential for synergic action.

4.5.1. Types of synergic action

The three types of synergic action have implications for how interventions are approached for systemic change in the Yorkshire food system. It brings awareness to actors on how they are already implicitly doing synergic action and therefore enhances potential for deliberate synergic action. Type 1 and 2 are dominant patterns of how actors currently engage in systemic change. However, type 3 provides a different way of thinking and doing for systemic change. In sustainability transition literatures, type 3 actors are often called systemic transition intermediaries (Kanda et al. 2020; den Boer et al. 2023). The role of the intermediaries are to connect and link individuals, groups, organisations and institutions and their related resources to create a momentum for change (den Boer et al. 2023). Although type 1 and 2 have their own merits in doing synergic action, type 3 provides a much more systemic approach to change and therefore enhances the likelihood of a much more effective synergic action. Therefore, it is imperative to develop individual and collective capabilities to shift from type 1 to type 3 synergic action to drive large scale systems change. This includes developing leadership skills, systems thinking and facilitation capabilities among others. Type 3 synergic action thus helps actors orient towards application of the concept of synergy into practice for supporting widespread, fundamental change. This application of synergy into practice is supported by the five essentials for synergic action.

4.5.2. Essentials for synergic action

The five key essentials show the importance of how each essential reinforces each other and how they are held together by an intentionality for synergic action as shown by figure 4. The first four essentials for synergic action (the inner ‘diamond’ of figure 4) have often been discussed as broad enablers for change in climate discourses and sustainability transitions (Pereira et al. 2018; Scoones et al. 2020; Vogel and O’Brien 2022; Concilio et al. 2023). Enablers of change such as leadership (Grin et al. 2018; Jacobs et al. 2020; Strasser et al. 2022), understanding power (Avelino and Wittmayer 2016; Temper et al. 2018; Feindt and Weiland 2018) transcending current thinking, worldviews and beliefs among others (Fazey et al. 2018; Bentz et al. 2022) are already part of the mainstream narrative. There are also emerging new ways of organizing and working with people and knowledge for collective action (Machalaba et al. 2015; Naito et al. 2022; Schipfer et al. 2024). For example, ‘organizational process work’

is used for better collaboration for change within organizations (Karp 2005). Further, it is no longer about one person leading the masses but about creating networks and collective action for change (Strasser et al. 2022; Bowser et al. 2024). Our study, however, presents a fifth essential, *intentionality* (represented by the circle outside the 'diamond' in figure 4), as critical in bringing together the first four essentials for synergic action. Without the intention for synergic action and the deliberate integration of the four essentials i.e. leadership, a systems approach, care and understanding, networks, partnerships and collaborations, individual enablers tended to only provide a narrow focus of action. Further, understanding how the essentials relate to each other is also crucial to enable synergic action which is discussed in the following.

Particular kinds of leadership and systems approaches to change are key for systemic change. A key role leaders have is to set intentions for their group (Bien and Sassen 2020). Setting intentions guide action and norms of how a group collaborates, which is critical for synergic action. It further influences the type of partners for collaboration that will lead to outcomes that are greater than the sum of their individual parts. Effective leadership can then be supported by taking a systems approach to change. Systems approaches raise greater understanding of interactions within the system, reducing blind spots and to identify negative patterns (Arnold and Wade 2015). It therefore enables leaders to be more effective in understanding the problem and more deliberate in their approach to working with others outside their domain. It further enables leaders and other actors to collectively be more aware of blind spots and negative patterns and become more resilient to uncertain outcomes.

Taking a systems approach is also key for multi-stakeholder engagement where diverse perspectives and voices are heard and can further support the creation of new patterns of relationships through new collaboration and partnerships. The same actors and the same actions cannot keep solving entrenched challenges, so networking and forming new partnerships are essential to foster new synergies. Networking further creates room for spontaneous synergy, enabling unique partnerships to form and new innovations to take place (Rohe and Chlebna 2022). Thus, a systems approach to change supports collaboration and partnerships and successful collaborations have the potential to create momentum for systemic change.

Furthermore, successful collaboration and partnerships seem to be based on deep trust and respect for one another and enhances the potential to build long-term relationships (Alhassan

et al. 2021; O'Dwyer et al. 2023). For collective action, deeply considering differences of others and finding a pathway of action, appears critical (Moriggi et al. 2020; Lenka and Khatua 2025). Therefore, showing deep care and understanding, towards others with the same goals, and also to those with contrasting goals, strengthens and enhances collaborative efforts. Care and understanding further help reinforce positive leadership and to build trust. However, without the intention for change and such integration of the essentials, the potential to deliver synergic action will remain limited. These findings provide an important focus for the development of capabilities for synergic action, with implications likely to be generalizable beyond the case study examined in this research.

4.5.3. Intentionality for synergic action

A key, and novel finding, was the importance of intentionality for enabling synergic action to support systemic transformations. This included intentionality as being a core characteristic that held the other four essentials together, which was key to enabling support for more complex synergic approaches. Research on intentionality in the fields of sustainability transitions and transformations is limited. Emerging literature in sustainability transitions and transformations highlight the need for 'systems-level intentionality' where future visioning, transdisciplinary collaboration, policy coherence, other forms of governance models and maintaining transformational intent among others are critical if intentional change is desired (O'Brien and Sygna 2013; Abson et al. 2017; Fazey and Leicester 2022; Bosone et al. 2024). There are also few literatures that highlight the importance of intentionality for collective climate action (Sabherwal and Shreedhar 2022; Pennacchioni 2025). Further, intention is also a critical component of design research in sustainability to encourage sustainable behavior choices through intentional design (Lilley and Wilson 2017; Visciola 2022).

Intentionality, however, is widely and deeply discussed in the field of psychology. The theory of planned behavior posits that 'behavior is an outcome of individual beliefs', with intention as the most important factor driving behavior (Armitage and Conner 2001; Paul et al. 2023). Intention is also emphasized as a key phase in therapy to achieve personal growth and goals (Cooper 2019b). Research in behavioral change further shows that setting intentions helps progress through different stages of changes (Brandstätter et al. 2003; Armitage 2006).

To apply these psychological findings to the field of sustainability transitions and transformations is not to say that actors working towards systemic change are not already intentional in achieving synergies. Instead, actors are naturally inclined to seek actors that can create win-win situations, albeit often implicitly. The problem with implicit synergic action is that it makes assumptions as to what might be good or needed for one another. For example, in couples therapy, it is found that explicit and intentional communication delivers better results (Gottman and Gottman 2015). This does not mean that implicit assumptions of what might be good for one's partner do not, also, lead to positive results; but that intentionality can enhance the magnitude or scale of synergic outcomes. The more complex a situation is, the more deliberate and intentional processes have been found to be most helpful (Page et al. 2016).

In our case study, actors that demonstrated the third type of synergic action were deliberate in their approach to change and had an immediate positive impact in identifying and bringing different actors of the Yorkshire food system together. In systemic change processes, intentionality has the potential to deliberately enhance clarity of vision and direction, creating shared understanding among stakeholders and fostering effective collaboration (Voulvoulis et al. 2022; Bosone et al. 2024). Setting clear intentions also creates a benchmark for evaluation and associated iterative learning during the process and therefore prepares actors to adapt to changes within the system (Marra 2025). Intentionality is therefore crucial to supporting systemic transformations. Thus, if there is intention for synergic action, one can start asking the following questions: In what ways can we organize? What resources can we bring in and share? Who are the right people? What is our shared purpose and vision? What is our individual purpose? What approach do we take? Intentionality for synergic action has great potential in making explicit clear goals and processes to support systemic change.

This study thus highlights that careful and deliberate action with explicit intention is needed for synergic action to emerge. Although intentionality is already apparent in systemic change, it is about how we begin to shift intentions and towards intentional synergic action. While the five essentials are unlikely to be the only requirements, they – and the way they reinforce one another – do seem critical for delivery of synergic action to support transformation. Thus, the practice of synergic action is rooted in intentionality and how this supports integration of the other four essentials. The practice of synergic action therefore entails fostering intention and primarily building the capabilities for leadership, systems thinking, successful partnerships and skills that cultivate care and understanding for others.

4.5.4. Limitations and further research

There are two key limitations to this study. First, whilst this study engaged with actors who were actively engaged with the FixOurFood programme that provided insightful findings, it is also a limitation of this study. Engaging actors outside the programme might be useful for future studies as it could either confirm our findings or further enhance our understanding of synergic action by providing scope for future studies. Second, although the food system case study provided valuable insights, it will be useful to study other complex systems for a more comprehensive understanding of synergic action.

There is scope for further research in the following areas. First, greater understanding is needed of what kinds of leadership will be most helpful, what kinds of capabilities and competencies are needed, and what methods and processes can most effectively deliver synergic action. Second, more research is needed to understand better how actors involved in Type 3 synergic processes relate and intervene and how the essentials can more effectively support such relations and interactions. Additionally, there is also a need to examine if and how actors shifted from type 1 to type 3 synergic action. Third, there is a need to delve deeper into the aspects of intention, and how more explicit intentionality for synergic action can be enhanced and supported. Finally, greater understanding is needed on barriers and enabling conditions to support actors to engage with synergic action. Actors may be genuinely aiming for systems change, but may be hampered when this is not the norm or the approach is poorly understood within the institutions they may be working through. Therefore, it will be important to further address institutional resistance and resource constraints among others limiting synergic action.

4.6. Conclusion

The aim of the study was to understand what synergy action looked like on the ground and the key conditions needed to deliver synergic action. This study found the three types of synergic action and the five key essentials needed to deliver synergic action. To support

synergic action building capabilities that integrate the five essentials and also enabling type 3 synergic action will be critical. Further, intentionality for synergic action will be key to really hold together the essentials and enhance potential for synergic action. The first four essentials have broadly been suggested elsewhere in different system change related studies. This study explicitly links these to the pursuit of synergic action. However, the fifth essential, intentionality for synergic action, is the key contribution of this study. We foreground intentionality for synergic action as crucial in aligning and holding together the first four essentials for synergic action. We therefore draw particular attention to the fifth essential for synergic action without which synergic action is much less likely to unfold.

Whilst there is wide consensus for the need of systemic approaches to change and the importance of identifying synergies, there are very few who deliver synergic action in practise to support systemic change. Thus, this study has provided essentials that will better enable the practise of synergic action for system transformation. Our findings will have implications for practitioners of systems change in orienting their intentions and actions towards deliberate synergic action.

Chapter 5

Chapter 4 answered research question 3, providing key insights on the three types of synergic action that is already practised on the ground. This has implications for actors who are already doing synergic action and provides a learning opportunity to enhance their practice. It further presented the five essentials for synergic action without which potential for synergic action remains limited. The chapters core contribution brings to the fore the need for intentionality for synergic action. Intentionality for synergic action will also support integration of the key essentials i.e. leadership, partnerships and collaboration, care and understanding, systems approach to change.

Chapter 5 provides a synthesis of key findings from all previous chapters and draws out key research insights to answer the overarching research question of how to enable synergic action to support transformation for sustainable futures. It further outlines the need for future research and practise.

5. Synthesis

5.1 Research aims

The thesis aimed to understand how we can enable synergic action to support sustainable transformations using a case study of Yorkshire food system transformation. This included addressing the following key questions:

1. How is synergy currently understood in the context of transformational change?
(*Chapter 2*)
2. What practical frameworks will help enhance strategic synergic action? (*Chapter 3*)
3. How is synergic action currently applied in practice and what are the key enablers for synergic action to support transformation change? (*Chapter 4*)

To answer these research questions, an inductive research strategy and diverse qualitative methods were used. This included a narrative literature review in *Chapter 2* to understand how the concept of synergy was understood, presenting a framework of synergy and drawing out implications for actors engaging in transformative change. *Chapter 3* used primary data from workshops with stakeholders of Yorkshire food system from the FixOurFood programme which was used to develop and apply a framework to drive synergic action. *Chapter 4* used primary data, collected through semi-structured interviews to understand key conditions needed to deliver synergic action. Analysis was iterative and reflexive. Each study however varied in analytical approach, involving thematic analysis, various heuristics and tools, such analytical memo writing.

5.2 Key Findings from Individual Chapters

Chapter 2 was primarily conceptual and answered the first research question: *How is synergy currently understood in the context of transformational change?* It involved a qualitative synthesis of literature from 14 diverse disciplines and presented two key findings. The value of the work is in the way it advanced conceptual understanding of synergy by providing a framework of the different ways synergy can be understood, with each having implications for the way different actors may intervene in a system.

The research found that synergy can have different attributes in relation to its magnitude, how it occurs at different temporal and spatial scales, and that synergy can be both desirable (positive) or undesirable (negative). It also found the three views of synergy: As an outcome; a process; or as perceived wholes. Depending on how synergy was viewed, the pathway of action for change - the processes and strategies including how research is undertaken – could be different. For example, understanding synergies as a process promotes more co-creative and participatory processes and a focus on building quality relationships. Thus, understanding synergy as an outcome is useful in informing future actions while understanding synergy as a process and perceived whole has greater potential to maximise efficient use of resources, engender greater connectivity, enhance creativity and inform strategic planning for enhancing governance conditions and policy impact. Therefore, how synergy is understood has implications for how change is approached. As such, to enhance practical utility, a practitioner seeking to invoke the concept needs to carefully consider what they mean by the concept of synergy.

Chapter 3 asked *What practical frameworks can enhance strategic synergic action?* This chapter, which was both conceptual and practical, used a case study of Yorkshire food system transformation to introduce a novel approach, the Ambition Loop Framework, to engage with synergic action. The framework was introduced as an actor-based tool to cohere actors and action for change and focuses on three distinct arenas of action i.e. policy, business and consumers. The framework is thus an example of synergy as process that can support processes and action for change. The chapter made both a conceptual and a practical contribution by exploring how a novel framework for the application of the principles of synergy could help actors and practitioners think in a more holistic way and support synergic action.

The Food system ambition loop developed in the research provided important insights about how food system transformation in Yorkshire might be supported. This included highlighting the need for greater alignment, coherence and harnessing of synergies between environmental beneficial farming (policy arena), enhancing supply chain connectivity and innovation (business arena) and supporting schools and young people as drivers of long-term change (consumer arena). The findings further highlighted the importance of strengthening existing relationships and building new ones, and the important role of policies and political

leadership in stimulating transformation. The framework is a simple yet powerful tool to foster systems thinking, critical dialogue and guide transformative action in a more synergic way.

Chapter 4 asked: *How is synergic action currently delivered in the Yorkshire Food System and what are the key enablers for synergic action to support transformative change?* The work involved understanding what synergic action looked like for exemplar practitioners who are doing systems change work in the Yorkshire food system, and what is needed for more effective synergic action to emerge. Semi-structured interviews were conducted with 22 diverse stakeholders of the Yorkshire food system and an inductive thematic analysis was used to analyse the data. The work advances understanding of effective practice by highlighting how actors are already doing synergic action and gives direction to building capabilities to enhance systemic action and change.

There were two main findings. First, three types of synergic action were identified that were implicitly being employed by practitioners: a) Type 1: Non-systemic synergy; b) Type 2: Non-systemic synergy with multiple outcomes; c) Type 3: Systemic synergic action. Second, five key essentials were identified that together enhanced the potential for synergic action. This included: (i) the need for leaders to drive audacious visions, engage diverse perspectives, and create spaces to foster creative collaboration; (ii) Networking, partnerships and collaborations focused on place based collaborations; (iii) Care and understanding for each other and ability to listen to different viewpoints and show respect for others; (iv) A holistic approach to change, including gaining a view of the ‘whole’, such as by addressing data gaps; and (v) Intentionality for synergic action. This latter aspect was considered particularly important as it provided the foundation for the emergence of the other four essentials.

5.3. Research limitations

This study answered three key research questions that resulted in important findings to enable synergic action to support transformations however, there are three key limitations among others. The first limitation is that in order to explore how synergy was understood, the study covered 16 disciplines. Although the study could have included a broader range of

disciplines, achieving a deeper understanding of synergy required a balance between the coverage of disciplines and the depth of analysis. The second limitation is that the Ambition Loop Framework has not been tested in a practical implementation context although this study provided a strategic pathway for action. As social change is a complex process, there will inevitably be new learnings in the implementation process. Further, complexity of social change includes the different dynamics and perspectives, the framework however does not address conflict and resistance to change which was beyond the scope of the study. This study interviewed participants who were already engaged in systems change in various ways particularly in relation to the FixOurFood programme. The programme attracted particular actors that were interested in systems change and therefore has implications for how the findings of this study has relevance for actors that are new to systems approaches to change . Thus, the third limitation lies in interviewing people who were already actively engaged in change initiatives but not necessarily using a systems approach to change. However, for this study, choosing participants already engaged in systems change helped understand how to enable synergic action in a complex system.

5.4. Integrated Findings - How can we enable synergic action to support sustainable transformations?

Overall, this thesis aimed to understand how synergic action can be enabled to support transformations and system change. By integrating the core findings, a key set of essentials and principles emerge about how synergic action might be enhanced and supported more effectively in practice.

5.4.1. Foster Type 3 Synergic Action, systemic synergic action

If systemic action is desired, then the findings highlight that some approaches to synergic action are more likely to have systemic effect than others. That is, many actors within a system may be implicitly working already in some way on systems change. Yet there are different qualities of synergic action – with some more focused on system change than others.

If one wishes to support synergic action, then it is helpful to focus on type 3 synergic action i.e. systemic synergic action (Type 3 in Chapter 4, Figure 7). Whilst type 1 and type 2 synergic action may enhance efficiency and improve effectiveness of action, enabling type 3

synergic action will be critical to support transformative change. Actors falling within type 3 synergic action took a more holistic view of the system with the result that they were much more focused on cohering and aligning actors and resources from across different parts of the system. To approach change and action in this way, however, actors also need to be able to re-perceive the system in a more holistic way in which change is desired.

5.4.2. Take a whole systems approach

To encourage engagement with type 3 synergic action and to deliver synergic action to support transformative change, viewing systems in a more holistic way and taking a more holistic approach will be necessary. Most actors are familiar with reductionist approaches of problem solving i.e. looking at separate parts of the system to understand the problem of a whole system (Arnold and Wade 2015). Although this approach has been effective in many ways, a whole systems approach that integrates different parts of the system, is needed to deal with complex issues.

A whole systems approach, however, requires that the intervenor or change makers see the system holistically. Here, re-perceiving the system is key. Doing so helps actors challenge their dominant mental models, beliefs and habitual ways of doing, allowing for new insights and ways of relating to the system in which they are embedded (Chapter 2). Re-perception can then be supported by use of tools such as the world model that directs attention to 12 key elements in a system necessary for its viability (Hodgson 2012). Heuristics such as the Three Horizons framework and the Ambition Loop framework also provide a more holistic lens that helps actors see the system differently. Applying such processes requires engaging beyond surface level assumptions. It also requires careful consideration not just of the inter-relatedness of aspects of a system, but how this can re-shape our understanding of change itself. Many aspects of Chapter 3 included the development of deeper insights among actors, for example.

5.4.3. Intentionality for synergic action

To genuinely support synergic action, intentionality is crucial (Chapter 4). Without the explicit intentionality for synergic action, real synergic action cannot be delivered. The power of intention is about having the capacity to activate a deeper level of human will (Scharmer

and Kaufer 2017). Such intentionality influences the quality of results (Scharmer and Kaufer 2017). Thus, intentionality for synergic action affects leadership approaches, strategies, goals, who we collaborate with and the processes for how change takes place. Importantly, our research found that intentionality is key to focusing on more holistic forms of synergic action (Chapter 4) and that it drives greater reflexivity and finding new ways forward (Chapter 2 and 4). Such intentionality to take a more synergic approach is also necessary for mobilising and redirecting limited resources – human or otherwise – in new ways (Chapter 4).

5.4.4. Building capabilities

Intentionality on its own, however, is not enough. Many other aspects need development and nurturing if actors are to be able to engage more effectively with synergic action. This includes certain forms of leadership, partnerships and fostering care (Chapter 4). As such, building capabilities within actors that can work across and integrate all essentials for synergic action (Chapter 4) will be important. This in turn needs the capabilities for reflexive learning and engaging in complexity, including the ability to suspend judgement and habitual ways of doing (Scharmer and Kaufer 2017). Thus, building such a wide range of new capabilities will be crucial to deliver synergic action.

5.4.5. Amplifying action research and co-creative research

Action-oriented forms of research and co-creative learning – such as that employed in this thesis (Chapter 3) is also needed to support synergic action. Action-oriented modes of research often involve researchers taking a more participatory approach for learning from action, problem solving and co-creation with diverse stakeholders (Kemmis et al. 2013; Croeser et al. 2024). It is different to traditional modes of research where observers claim to stand from the outside looking in. Such approaches, while having value, tend not to encourage the kinds of co-learning needed to advance – practically and conceptually – integrated and synergic ways of working (Fazey et al., 2018). Action-oriented research, however, enhance potential for innovation, learning from action, with ‘research’ in this work aiding deeper reflection and deliberation. Additionally, awareness based action research (Scharmer and Kaufer 2017) such as that employed in Chapter 3, takes it a step further by engaging change makers to develop tools and methods to understand connections and help support re-perception and how actions and actors relate to the whole (Scharmer and Kaufer 2017; Scharmer et al. 2021). The combination of action and research – which support re-perception and also allow for learning from doing – is then key to enhancing synergic action.

5.4.6. Summary

In summary, to support synergic action for transformation there are five important inter-related findings: Type 3 synergic action as a particular approach to change combined with a whole systems approach and re-perception for action to be effective. To do this, intentionality for synergic action is critical. To support all of this, active development of many other capabilities and reflexive learning and action-oriented research is required.

5.5. Methodological advances

5.5.1. Novel application of research methods

This thesis contributed to the advancement of research methods in two main ways. First, it developed and applied the Ambition loop framework. Second, it involved the use of appreciative inquiry and different combinations of qualitative data collection and analytical methods and tools that resulted in findings of the types of synergic action and five key essentials needed for synergic action.

Ambition Loops

Developing and applying the ambition loop framework was novel and contributed to advancing research methods for three key reasons. The process involved in-person workshops with multiple stakeholders of the Yorkshire food system to explore reinforcing relationships between different actors of the system, whilst keeping the vision of a regenerative food system alive. There were two key aspects of the approach that were novel or helped advance methodologies for studying synergic action.

First, the approach helped move away from restrictive and extractive traditional research methods that ‘harvest’ knowledge from practitioners. Instead, the approach actively supported the development of practitioner’s own understanding of how to navigate complexity and, as the work progressed, enabled engagement with tacit or implicit knowledge of the stakeholders which can be difficult to make explicit. It supported the kinds of sense-making needed to wrestle with complexity and find new ways of perceiving and understanding food system transformation from a synergic action lens.

Second, the ambition loop framework was combined with Three Horizons practice that was seeking to develop how system change can be most effectively supported. In particular, the Ambition Loop was focused on the transitional – second Horizon – phase. It added depth to the understanding of how a system of transition using existing actors and action can be most effectively cohered to generate systemic change outcomes. While the need for such cohering had already been established (Buckton et al. 2024), the details of how this might be achieved had not been codified. Thus, the Ambition Loop approach enabled the combination of participatory and action-oriented approaches that added depth to understandings and action for system change.

Appreciative Inquiry

The second aspect of the research that had elements of novelty was the use of Appreciative Inquiry (Armstrong et al. 2020). While this research highlighted a need for synergic action (Chapter 2), there was limited understanding on how actors are implicitly applying it in practice. Appreciative inquiry with a form of interviewing and data analysis was used to elicit understanding of synergic action was applied (Chapter 4). Appreciative inquiry helped understand what was working well and identify ‘generative potential’, strengths and goal orientations (Cooperrider et al. 2008; Armstrong et al. 2020). Interviews, for example, were designed to understand what enabled particular successes and effective collaboration that led to synergic outcomes. The term ‘synergy’ itself was deliberately not mentioned to draw out the way actors were *implicitly* engaging with synergic action. This helped us understand the unconscious working patterns of actors which resulted in the three types of synergic action and the five essentials for synergic action. In contrast, conventional research methodologies typically focus on post hoc analysis of interview content, seeking to uncover implicit meanings after data collection. This study, however, intentionally sought to explore actors’ implicit actions from the outset of the research process, helping develop a good understandings of the different patterns and qualities of synergic action they were engaging with.

The key message here is that if we want to deliver synergic action, we will need to start applying existing methods in new ways in addition to developing new methods of research and learning. The research methods used in this study aided conceptual understandings of

synergy, helped create a framework for practice and understand how to enable synergic action. Without these methodological advances outlined in this section, it would not have been possible to arrive at key conclusions of how to enable synergic action to support transformations for sustainable futures as presented in this study.

5.6. Future research

This research provides key conceptual and methodological contribution towards understanding synergy and its application in practise to support transformative change. However, this study further points to future research needs. First, there is a need to understand how we can foster and embody the five essentials needed to enable synergic action, focused on building capabilities. Second, there is a need to deeply understand more actors who fall within type 3 synergic action in how they approach systemic change as this study only identified the three types of synergic action. It might require research methods such as taking a positive deviance approach that identifies particular individuals or groups that achieve better outcomes given the same constraints as others (Baxter et al., 2015; O'Malley et al., 2021). Third, there is a need to test the Ambition Loop framework in a practical implementation context, assessing its usefulness in building synergic relationships and addressing conflict and resistance to support transformative change. Finally, there is a need to understand go beyond developing individual capabilities to developing institutional structures and capabilities to enable synergic action for system transformation.

5.7. Conclusion

The aim of this research was to understand how to enable synergic action to support sustainable transformations. If we are to take transformation and systemic change seriously, then actors will need to make a much more explicit shift towards engaging with synergic action. Much of the existing literature conceptualizes synergy primarily as a multi-benefit outcome, rather than as a deliberate approach for driving systemic change. Instead, to support synergic action, transformative change needs to be conceptualised as emerging from type 3 forms of synergic action in combination with a whole systems approach and driven with explicit and strong intention. This then also needs to be supported by advancement of particular capabilities and by reflexive and action-oriented research. Further research is also needed to tease out further detail and establish how, in systemic terms that go beyond

individual capabilities, synergic action might be enabled, such as how institutions can embody intentionality and action that support transformation.

6. References

- Abson DJ, Fischer J, Leventon J, et al (2017) Leverage points for sustainability transformation. *Ambio* 46:30–39. <https://doi.org/10.1007/s13280-016-0800-y>
- Adams D (2020) Gaining Perspective with the Wheel of Wisdom. In: H3Uni. <https://www.h3uni.org/facilitation-guide/gaining-perspective-with-the-wheel-of-wisdom/>. Accessed 27 Feb 2024
- Akinyi, D. P., Ng’ang’a, S. K. and Girvetz, E. H. (2021). Trade-offs and synergies of climate change adaptation strategies among smallholder farmers in sub-Saharan Africa: A systematic review. *Regional Sustainability*, 2 (2), p.130–143.
- Akkas, M. A., Chakma, A. and Hossain, M. I. (2015). Employee-management cooperation: The key to employee productivity. *Journal of US-China Public Administration*, 12 (2), p.81–88.
- Al Maamzi, J. J. and Tawfik, T. (2022). The effectiveness of agile management on traditional projects within public organizations. *IOP Conference Series: Materials Science and Engineering*, 1218 (1), IOP Publishing, p.012037. [Accessed 13 May 2022].
- Al Qudaiby B, Khan MR (2013) Financial Synergy in Mergers and Acquisitions in Saudi Arabia. *Finante - provocările viitorului (Finance - Challenges of the Future)* 1:181–192
- Al Qudaiby, B. and Khan, M. R. (2013). Financial Synergy in Mergers and Acquisitions in Saudi Arabia. *Finante - provocările viitorului (Finance - Challenges of the Future)*, 1 (15), University of Craiova, Faculty of Economics and Business Administration, p.181–192.
- Alhassan JAK, Gauvin L, Judge A, et al (2021) Improving health through multisectoral collaboration: enablers and barriers. *Can J Public Health* 112:1059–1068. <https://doi.org/10.17269/s41997-021-00534-3>
- Ambition Loop (2024). In: Ambition Loop. <https://www.ambitionloop.earth>. Accessed 9 Jan 2025
- Andrews, L. (2017). How can we demonstrate the public value of evidence-based policy making when government ministers declare that the people ‘have had enough of experts’? *Palgrave communications*, 3 (1), Springer Science and Business Media LLC. [Online]. Available at: [doi:10.1057/s41599-017-0013-4](https://doi.org/10.1057/s41599-017-0013-4).

Angelard C, Bever JD (2013) Symbionts, Genetics of. In: Maloy S, Hughes K (eds) Brenner's Encyclopedia of Genetics (Second Edition). Academic Press, San Diego, pp 595–597

Ansari S, Schouten M, Verwaal E (2006) Unlocking synergies between business units: internal value creation at Royal Vopak. *Strateg change* 15:353–360. <https://doi.org/10.1002/jsc.775>

Armitage CJ (2006) Evidence that implementation intentions promote transitions between the stages of change. *J Consult Clin Psychol* 74:141–151. <https://doi.org/10.1037/0022-006X.74.1.141>

Armitage CJ, Conner M (2001) Efficacy of the Theory of Planned Behaviour: a meta-analytic review. *Br J Soc Psychol* 40:471–499. <https://doi.org/10.1348/014466601164939>

Armstrong AJ, Holmes CM, Henning D (2020) A changing world, again. How Appreciative Inquiry can guide our growth. *Soc Sci Humanit Open* 2:100038. <https://doi.org/10.1016/j.ssaho.2020.100038>

Arnold RD, Wade JP (2015) A definition of systems thinking: A systems approach. *Procedia Comput Sci* 44:669–678. <https://doi.org/10.1016/j.procs.2015.03.050>

Audet, R. (2014). The double hermeneutic of sustainability transitions. *Environmental innovation and societal transitions*, 11, Elsevier BV, p.46–49. [Accessed 14 November 2024].

Aufvenne, P., Egner, H. and Von, E. K. (2014). On climate change research, the crisis of science and second-order science. *Constructivist Foundations*, 10 (1), p.120–129.

Avelino F, Wittmayer JM (2016) Shifting power relations in sustainability transitions: A multi-actor perspective. *J Environ Policy Plann* 18:628–649. <https://doi.org/10.1080/1523908x.2015.1112259>

Axelsson J (2022) What systems engineers should know about emergence. *INCOSE Int Symp* 32:1070–1084. <https://doi.org/10.1002/iis2.12982>

Axon S, Morrissey J (2020) Just energy transitions? Social inequities, vulnerabilities and unintended consequences. *Build Cities* 1:393–411. <https://doi.org/10.5334/bc.14>

Badampudi, D., Wohlin, C. and Petersen, K. (2015). Experiences from using snowballing and database searches in systematic literature studies. In: *Proceedings of the 19th International Conference on Evaluation and Assessment in Software Engineering*. EASE '15 17. 27 April 2015. New York, NY, USA: Association for Computing Machinery. p.1–10. [Accessed 16 July 2024].

Baffoe, G. et al. (2021). Urban-rural linkages: effective solutions for achieving sustainable development in Ghana from an SDG interlinkage perspective. *Sustainability Science*, p.1–22.

Baldi, F. and Trigeorgis, L. (2009). Assessing the value of growth option synergies from business combinations and testing for goodwill impairment: A real options perspective. *Journal of applied corporate finance*, 21 (4), Wiley, p.115–124.

- Bandari R, Moallemi EA, Lester RE, et al (2022) Prioritising Sustainable Development Goals, characterising interactions, and identifying solutions for local sustainability. *Environ Sci Policy* 127:325–336. <https://doi.org/10.1016/j.envsci.2021.09.016>
- Bauer F, Friesl M (2022) Synergy evaluation in mergers and acquisitions: An attention-based view. *J Manag Stud*. <https://doi.org/10.1111/joms.12804>
- Baumbusch J (2010) Semi-structured interviewing in practice-close research. *J Spec Pediatr Nurs* 15:255–258. <https://doi.org/10.1111/j.1744-6155.2010.00243.x>
- Baxter, R. et al. (2015). What methods are used to apply positive deviance within healthcare organisations? A systematic review. *Quality & safety in health care*, 25, qualitysafety.bmj.com, p.190–201.
- Ben Hassen T, El Bilali H (2022) Impacts of the Russia-Ukraine War on Global Food Security: Towards More Sustainable and Resilient Food Systems? *Foods* 11:. <https://doi.org/10.3390/foods11152301>
- Bentz J, O'Brien K, Scoville-Simonds M (2022) Beyond “blah blah blah”: exploring the “how” of transformation. *Sustain Sci* 17:497–506. <https://doi.org/10.1007/s11625-022-01123-0>
- Bhunoo R, Poppy GM (2020) A national approach for transformation of the UK food system. *Nature Food* 1:6–8. <https://doi.org/10.1038/s43016-019-0019-8>
- Biavatti MW (2009) Synergy: an old wisdom, a new paradigm for pharmacotherapy. *Braz J Pharm Sci* 45:371–378. <https://doi.org/10.1590/s1984-82502009000300002>
- Bibri, S. E. (2018). Backcasting in futures studies: a synthesized scholarly and planning approach to strategic smart sustainable city development. *European journal of futures research*, 6 (1), Springer Science and Business Media LLC. [Online]. Available at: [doi:10.1186/s40309-018-0142-z](https://doi.org/10.1186/s40309-018-0142-z).
- Bien C, Sassen R (2020) Sensemaking of a sustainability transition by higher education institution leaders. *J Clean Prod* 256:120299. <https://doi.org/10.1016/j.jclepro.2020.120299>
- Bingham AJ (2023) From data management to actionable findings: A five-phase process of qualitative data analysis. *Int J Qual Methods* 22:. <https://doi.org/10.1177/16094069231183620>
- Bohm, D. (2005). *Wholeness and the implicate order*. London, England: Routledge. [Online]. Available at: [doi:10.4324/9780203995150](https://doi.org/10.4324/9780203995150).
- Bortoft H (1996) *The Wholeness of Nature: Goethe's Way Toward a Science of Conscious Participation in Nature*. Lindisfarne Press
- Bosone L, Thiriot S, Chevrier M, et al (2024) Visioning sustainable futures: Exposure to positive visions increases individual and collective intention to act for a decarbonated world. *Glob Environ Psychol* 2:1–28. <https://doi.org/10.5964/gep.11105>

Bowser G, Ho SS, Ziebell A, Lazendic-Galloway J (2024) Networking and collaborating: the role of partnerships across sectors to achieve educational goals in sustainability. *Sustain Earth* 7:1–8. <https://doi.org/10.1186/s42055-024-00080-z>

Brandstätter V, Heimbeck D, Malzacher J, Frese M (2003) Goals need implementation intentions: The model of action phases tested in the applied setting of continuing education. *Eur J Work Org Psychol* 12:37–59. <https://doi.org/10.1080/13594320344000011>

Braun V, Clarke V (2021) One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qual Res Psychol* 18:328–352. <https://doi.org/10.1080/14780887.2020.1769238>

Bridle S, Parsons K, Poppy G, et al (2025) Key action areas for transforming the UK food system: insights from the Transforming UK Food Systems (TUKFS) Programme project portfolio. *Philos Trans R Soc Lond B Biol Sci* 380:20240166. <https://doi.org/10.1098/rstb.2024.0166>

Broillet, A., Barchilon, M. and Kampf, C. E. (2012). Visualizing an iterative, dynamic model for improving leadership-employee communication in the organizational change process. In: *2012 IEEE International Professional Communication Conference*. October 2012. IEEE. p.1–7. [Accessed 31 October 2024].

Bryman A (2015) *Social research methods*, Fifth edition. Oxford University Press, Oxford, England

Buckminster Fuller R (1982) *Synergetics: Explorations in the Geometry of Thinking*. Estate of R. Buckminster Fuller

Buckton SJ, Fazey I, Doherty B, et al (2024) Transformative action towards regenerative food systems: A large-scale case study. *PLOS Sustain Transform* 3:e0000134. <https://doi.org/10.1371/journal.pstr.0000134>

Buckton SJ, Fazey I, Sharpe B, et al (2023) The Regenerative Lens: A conceptual framework for regenerative social-ecological systems. *One Earth* 6:824–842. <https://doi.org/10.1016/j.oneear.2023.06.006>

Burch S, Shaw A, Dale A, Robinson J (2014) Triggering transformative change: a development path approach to climate change response in communities. *Clim Policy* 14:467–487. <https://doi.org/10.1080/14693062.2014.876342>

Burt, G. (2010). Revisiting and extending our understanding of Pierre Wack's the gentle art of re-perceiving. *Technological forecasting and social change*, 77 (9), Elsevier BV, p.1476–1484.

Calla S, Lécuyer L, Butler JRA, Young JC (2024) What makes a change agent in environmental conflict transformation? Evidence from rural France. *Biodivers Conserv* 33:667–683. <https://doi.org/10.1007/s10531-023-02765-x>

Carmen E, Fazey I, Bergseng AM, Om ES (2023) Building policy synergies: A case of community resilience, climate change and community empowerment policies in Scotland. *Environ Sci Policy* 150:103579. <https://doi.org/10.1016/j.envsci.2023.103579>

Carmen E, Ibrahim A, Blackstock K, Waylen K (2024) A transformations framework for mainstreaming a nature-based solutions approach. *Nature-Based Solutions* 6:100199. <https://doi.org/10.1016/j.nbsj.2024.100199>

Carmen, E., Fazey, I. and Friend, R. M. (2024). Community-based sustainability initiatives: the quality of relationships matter? *Sustainability Science*. [Online]. Available at: doi:10.1007/s11625-024-01492-8.

Castell AM (1999) Synergy matters, 1999th edn. Kluwer Academic/Plenum, New York, NY

Chandran, U. et al. (2017). Network pharmacology. *Innovative Approaches in Drug Discovery*, Elsevier, p.127.

Chulvi, V. et al. (2012). Comparison of the degree of creativity in the design outcomes using different design methods. *Journal of engineering design*, 23 (4), Informa UK Limited, p.241–269.

Concilio G, Bianchi I, Tosoni I (2023) Signals of sustainability transition: Sensing enabling factors through cultural initiatives. *City Territ Arch* 10:. <https://doi.org/10.1186/s40410-022-00187-w>

Cooper M (2019a) Integrating counselling & psychotherapy. SAGE Publications, London, England

Cooperrider D, Whitney DD, Stavros J (2008) The appreciative inquiry handbook, 2nd edn. Berrett-Koehler

Corbin J, Strauss A (2024) Basics of Qualitative Research. In: SAGE Publications Inc. <https://us.sagepub.com/en-us/nam/basics-of-qualitative-research/book235578>. Accessed 16 Feb 2024

Corning P (2003) Nature's Magic: Synergy in Evolution and the Fate of Humankind. Cambridge University Press

Corning P (2017) Synergistic selection: How cooperation has shaped evolution and the rise of humankind. World Scientific Publishing Co Pte Ltd

Corning PA (1998) “The synergism hypothesis”: On the concept of synergy and its role in the evolution of complex systems. *Journal of Social and Evolutionary Systems* 21:133–172. [https://doi.org/10.1016/S1061-7361\(00\)80003-X](https://doi.org/10.1016/S1061-7361(00)80003-X)

Corning PA (2012) The re-emergence of emergence, and the causal role of synergy in emergent evolution. *Synthese* 185:295–317. <https://doi.org/10.1007/s11229-010-9726-2>

Corning, P. A. (2021). “How” vs. “Why” questions in symbiogenesis, and the causal role of synergy. *Bio Systems*, 205, p.104417.

Coscieme L, Mortensen LF, Donohue I (2021) Enhance environmental policy coherence to meet the Sustainable Development Goals. *J Clean Prod* 296:126502. <https://doi.org/10.1016/j.jclepro.2021.126502>

Cremades, R. et al. (2019). Ten principles to integrate the water-energy-land nexus with climate services for co-producing local and regional integrated assessments. *The Science of the total environment*, 693, p.133662.

Croeser T, Clement S, Fernandez M, et al (2024) Action research for transformative change. *Sustain Sci* 19:665–670. <https://doi.org/10.1007/s11625-023-01458-2>

Crutzen, P. J. (2006). The “Anthropocene.” In: Ehlers, E. and Krafft, T. (Eds). *Earth System Science in the Anthropocene*. Berlin, Heidelberg: Springer Berlin Heidelberg. p.13–18.

Dabaieh, M. et al. (2024). Climate change adaptation at the margins. The case of Cairo, Egypt. *Cities*, 154, 105390. [Online].

de Haan FJ, Rotmans J (2018) A proposed theoretical framework for actors in transformative change. *Technol Forecast Soc Change* 128:275–286. <https://doi.org/10.1016/j.techfore.2017.12.017>

de Lima Bezerra F, Favacho CH, de Souza RN, De Souza C (2014) Towards Supporting Systematic Mappings Studies: An Automatic Snowballing Approach. In: XXIX Simpósio Brasileiro de Banco de Dados. unknown

DEFRA (2024) United Kingdom food security report 2024: Theme 2: UK food supply sources. In: Gov.uk. <https://www.gov.uk/government/statistics/united-kingdom-food-security-report-2024/united-kingdom-food-security-report-2024-theme-2-uk-food-supply-sources>. Accessed 13 Jan 2025

Delacote, P. and Angelsen, A. (2015). Reducing Deforestation and Forest Degradation: Leakage or Synergy? *Land Economics*, 91 (3), p.501–515. [Online]. Available at: doi:10.3368/le.91.3.501.

den Boer ACL, van der Valk AJJ, Regeer BJ, Broerse JEW (2023) Food policy networks and their potential to stimulate systemic intermediation for food system transformation. *Cities* 135:104239. <https://doi.org/10.1016/j.cities.2023.104239>

DESA (2024) The Sustainable Development Goals Report 2024. <https://unstats.un.org/sdgs/report/2024/>

Diano FM Jr, S. Calbi J (2024) School leadership in the 21st century: A grounded theory. *Kuey*. <https://doi.org/10.53555/kuey.v30i6.3228>

Dickerson A, Drew D, Joseph N, et al (2018) The Ambition Loop, How business and government can advance policies that fast track zero-carbon economic growth. In: The Ambition Loop. <https://ambitionloop.org>

Doherty B, Bryant M, Denby K, et al (2022) Transformations to regenerative food systems—An outline of the FixOurFood project. *Nutr Bull* 47:106–114. <https://doi.org/10.1111/nbu.12536>

Duffy, R. J. and Cook, J. J. (2019). Overcoming bureaucratic silos? Environmental policy integration in the Obama administration. *Environmental politics*, 28 (7), Routledge, p.1192–1213.

- Duguma, L. A. et al. (2014). A systematic analysis of enabling conditions for synergy between climate change mitigation and adaptation measures in developing countries. *Environmental science & policy*, 42, Elsevier BV, p.138–148. [Accessed 11 September 2024].
- Edwards F, Sonnino R, López Cifuentes M (2024) Connecting the dots: Integrating food policies towards food system transformation. *Environ Sci Policy* 156:103735. <https://doi.org/10.1016/j.envsci.2024.103735>
- England MI, Dougill AJ, Stringer LC, et al (2018) Climate change adaptation and cross-sectoral policy coherence in southern Africa. *Reg Environ Change* 18:2059–2071. <https://doi.org/10.1007/s10113-018-1283-0>
- Espejo R (2002) Seeing Systems: Overcoming Organisational Fragmentation. In: *Synergy Matters*. unknown, pp 1–6
- Fanzo J, Haddad L, Schneider KR, et al (2021) Viewpoint: Rigorous monitoring is necessary to guide food system transformation in the countdown to the 2030 global goals. *Food Policy* 104:102163. <https://doi.org/10.1016/j.foodpol.2021.102163>
- FAO (2022) Synergies: building synergies enhances key functions across food systems, supporting production and multiple ecosystem services. <https://www.fao.org/agroecology/knowledge/10-elements/synergies/en/>. Accessed 29 Jan 2022
- Fazey I, Leicester G (2022) Archetypes of system transition and transformation: Six lessons for stewarding change. *Energy Research & Social Science* 91:102646. <https://doi.org/10.1016/j.erss.2022.102646>
- Fazey I, Schöpke N, Caniglia G, et al (2018) Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Research & Social Science* 40:54–70. <https://doi.org/10.1016/j.erss.2017.11.026>
- Fazey, I. et al. (2018b). Transformation in a changing climate: a research agenda. *Climate and Development*, 10 (3), Taylor & Francis, p.197–217.
- Fazey, I. et al. (2021a). Social dynamics of community resilience building in the face of climate change: the case of three Scottish communities. *Sustainability Science*. [Online]. Available at: [doi:10.1007/s11625-021-00950-x](https://doi.org/10.1007/s11625-021-00950-x).
- Fazey, I. et al. (2021b). Three emergencies of climate change: The case of Louisiana’s coast. *Environmental science & policy*, 124, Elsevier, p.45–54. [Accessed 25 January 2023].
- Feindt PH, Weiland S (2018) Reflexive governance: exploring the concept and assessing its critical potential for sustainable development. Introduction to the special issue. *J Environ Policy Plann* 20:661–674. <https://doi.org/10.1080/1523908X.2018.1532562>
- Fernandez, D. J. and Fernandez, J. D. (2008). Agile Project Management —Agilism versus Traditional Approaches. *Journal of Computer Information Systems*, 49 (2), Taylor & Francis, p.10–17.

Fielding, J. L. and Fielding, N. (2008). Synergy and synthesis: integrating qualitative and quantitative data. *The sage handbook of social research methods*. Los Angeles: Sage, torrossa.com, p.555–571.

Fillion G, Koffi V, Ekionea J-PB (2015) Peter senge's learning organization: A critical view and the addition of some new concepts to actualize theory and practice. *Journal of Organizational Culture, Communications and Conflict* 19:73

Fiorentino, R. and Garzella, S. (2015). Synergy management pitfalls in mergers and acquisitions. *Management Decision*, 53 (7), Emerald Group Publishing Limited, p.1469–1503.

Fischer L-B, Newig J (2016) Importance of actors and agency in sustainability transitions: A systematic exploration of the literature. *Sustainability* 8:476.
<https://doi.org/10.3390/su8050476>

Fisher, J. and Rucki, K. (2017). Re-conceptualizing the science of sustainability: A dynamical systems approach to understanding the nexus of conflict, development and the environment. *Sustainable development*, 25 (4), Wiley, p.267–275.

FixOurFood (2022) Transforming food culture in Yorkshire's schools and early years settings: Summary report of the co-creative Three Horizons process.
<https://fixourfood.org/wp-content/uploads/2022/11/Transforming-Yorkshires-school-food-culture.pdf>. Accessed 21 Jan 2025

FixOurFood (2024) FixOurFood Commission. In: Fix Our Food.
<https://fixourfood.org/commission/>. Accessed 21 Jan 2025

Folke C, Polasky S, Rockström J, et al (2021) Our future in the Anthropocene biosphere. *Ambio* 50:834–869. <https://doi.org/10.1007/s13280-021-01544-8>

Food, Farming and Countryside Commission. (2024). The false economy of big food. [Online]. Available at: <https://ffcc.co.uk/publications/the-false-economy-of-big-food>

Foran, T. et al. (2014). Taking complexity in food systems seriously: An interdisciplinary analysis. *World development*, 61, Elsevier BV, p.85–101.

Forsberg, C. W. (2009). Sustainability by combining nuclear, fossil, and renewable energy sources. *Progress in Nuclear Energy*, 51 (1), p.192–200.

Fourat E, Blanchart E, Cué Rio M, et al (2024) Holistic approaches to assess the sustainability of food systems in low- and middle-income countries: A scoping review. *PLOS Sustain Transform* 3:e0000117. <https://doi.org/10.1371/journal.pstr.0000117>

Fuso Nerini, F. et al. (2017). Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nature Energy*, 3 (1), Nature Publishing Group, p.10–15. [Accessed 12 January 2022].

Garzella, S. and Fiorentino, R. (2017). M&A Success and Failure: The Role of Synergy Management. In: Garzella, S. and Fiorentino, R. (Eds). *Synergy Value and Strategic*

Management: Inside the Black Box of Mergers and Acquisitions. Cham: Springer International Publishing. p.9–34.

Gielen D, Boshell F, Saygin D, et al (2019) The role of renewable energy in the global energy transformation. *Energy Strategy Reviews* 24:38–50.
<https://doi.org/10.1016/j.esr.2019.01.006>

Goss, D. and Bush, L. (2023). *Regenerative-Farming-Report_Sept-23.pdf*. [Online]. Available at: https://demos.co.uk/wp-content/uploads/2023/09/Regenerative-Farming-Report_Sept-23.pdf.

Gottman JS, Gottman JM (2015) 10 principles for doing effective couples therapy (Norton series on interpersonal neurobiology). W. W. Norton & Company

Grin J, Hassink J, Karadzic V, Moors E (2018) Transformative Leadership and Contextual Change. *Sustainability*. <https://doi.org/10.3390/SU10072159>

Hamza, T., Sghaier, A. and Thraya, M. F. (2016). How do Takeovers Create Synergies? Evidence from France. *Studies in Business and Economics*, 11 (1), Walter de Gruyter GmbH. [Online]. Available at: [doi:10.1515/sbe-2016-0005](https://doi.org/10.1515/sbe-2016-0005)

Hasegawa T, Sakurai G, Fujimori S, et al (2021) Extreme climate events increase risk of global food insecurity and adaptation needs. *Nat Food* 2:587–595.
<https://doi.org/10.1038/s43016-021-00335-4>

Hasnain S, Ingram J, Zurek M (2020) Mapping the UK Food System – a report for the UKRI Transforming UK Food Systems Programme. Environmental Change Institute, University of Oxford, Oxford ISBN 978-1-874370-81-9

Herbert S (2023) Sustainable Food Systems. <https://doi.org/10.48785/100/168>

Hodgson A (2012) A transdisciplinary world model. *Syst Res Behav Sci* 29:517–526.
<https://doi.org/10.1002/sres.2154>

Hodgson A (2017) Reperceiving the Future. *World Futures Review* 9:208–224.
<https://doi.org/10.1177/1946756717729511>

Hodgson A (2019) *Systems Thinking for a Turbulent World: A Search for New Perspectives*. Routledge

Hodgson A (2024) Biosphere game. In: Ali Hodgson.
<https://www.alihodgson.co.uk/biosphere-game>. Accessed 5 Feb 2025

Hodgson T (2020) Synergy with the world mandala. In: H3Uni.
<https://www.h3uni.org/facilitation-guide/synergy-with-the-world-mandala/>. Accessed 17 Dec 2024

Hodgson, A. (2009). Decision integrity and second order cybernetics. In: *Cybernetics and Systems Theory in Management*. IGI Global. p.52–74.

Hodgson, A. (2024). Studying the future in the present moment. In: *Handbook of Futures Studies*. Edward Elgar Publishing. p.66–79. [Accessed 19 August 2024].

Hoenink JC, Garrott K, Jones NRV, et al (2024) Changes in UK price disparities between healthy and less healthy foods over 10 years: An updated analysis with insights in the context of inflationary increases in the cost-of-living from 2021. *Appetite* 197:107290. <https://doi.org/10.1016/j.appet.2024.107290>

Hoever IJ, van Knippenberg D, van Ginkel WP, Barkema HG (2012) Fostering team creativity: perspective taking as key to unlocking diversity's potential. *J Appl Psychol* 97:982–996. <https://doi.org/10.1037/a0029159>

Hoff, H. (2011). *Understanding the Nexus. Background Paper for the Bonn2011 Conference: The Water, Energy and Food Security Nexus. Stockholm Environment Institute, Stockholm*. [Online]. Available at: <https://www.sei.org/publications/understanding-the-nexus/>

Holden LM (2005) Complex adaptive systems: concept analysis. *J Adv Nurs* 52:651–657. <https://doi.org/10.1111/j.1365-2648.2005.03638.x>

Holland JH (2014) *Complexity: A Very Short Introduction*. OUP Oxford

Holtström, J. and Anderson, H. (2021). Exploring and extending the synergy concept – a study of three acquisitions. *Journal of Business & Industrial Marketing*, 36 (13), p.28–41. [Online]. Available at: [doi:10.1108/jbim-09-2020-0420](https://doi.org/10.1108/jbim-09-2020-0420).

Horcea-Milcu A-I Abson DJ, Apetrei CI, Duse IA, et al (2019) Values transformational sustainability science: four perspectives change

Huber M (2022) How the qualities of actor-issue interdependencies influence collaboration patterns. *Ecol Soc* 27:. <https://doi.org/10.5751/es-13536-270406>

Hughes S, Yordi S, Besco L (2020) The role of pilot projects in urban climate change policy innovation. *Policy Stud J* 48:271–297. <https://doi.org/10.1111/psj.12288>

Hunt L, Pettinger C, Wagstaff C (2023) A critical exploration of the diets of UK disadvantaged communities to inform food systems transformation: a scoping review of qualitative literature using a social practice theory lens. *BMC Public Health* 23:1970. <https://doi.org/10.1186/s12889-023-16804-3>

Iida, M. et al. (2024). A network-based trans-omics approach for predicting synergistic drug combinations. *Communications medicine*, 4 (1), Springer Science and Business Media LLC, p.154.

Ingram J, Zurek M (2018) Food Systems Approaches for the Future. In: *Agriculture & Food Systems to 2050*. World Scientific, pp 547–567

Inman EN, Inman PJ (2023) Tackling environmental problems: Are people and the environment antithetical? *Environ Nat Resour Res* 13:19. <https://doi.org/10.5539/enrr.v13n1p19>

Ison R (2017) The juggler: A way to understand systems practice. In: *Systems Practice: How to Act*. Springer London, London, pp 59–85

Jacobs G, Kiniger-Passigli D, Henderson H, Ramanathan J (2020) Catalytic strategies for socially transformative leadership: Leadership principles, strategies and examples. *Cadmus* 4:6–45

Jaffe, K. and Febres, G. (2016). Defining synergy thermodynamically using quantitative measurements of entropy and free energy: Defining Synergy Thermodynamically using Quantitative Measurements. *Complexity*, 21 (S2), Hindawi Publishing Corporation. [Online]. Available at: doi:10.1002/cplx.21800.

Jagtap S, Trollman H, Trollman F, et al (2022) The Russia-Ukraine Conflict: Its Implications for the Global Food Supply Chains. *Foods* 11:.. <https://doi.org/10.3390/foods11142098>

Jagustović R, Papachristos G, Zougmore RB, et al (2021) Better before worse trajectories in food systems? An investigation of synergies and trade-offs through climate-smart agriculture and system dynamics. *Agric Syst* 190:103131. <https://doi.org/10.1016/j.agsy.2021.103131>

Jagustović R, Zougmore RB, Kessler A, et al (2019) Contribution of systems thinking and complex adaptive system attributes to sustainable food production: Example from a climate-smart village. *Agric Syst* 171:65–75. <https://doi.org/10.1016/j.agsy.2018.12.008>

Jalali S, Wohlin C (2012) Systematic literature studies: database searches vs. backward snowballing. In: Proceedings of the ACM-IEEE international symposium on Empirical software engineering and measurement. ACM, New York, NY, USA, pp 29–38

Jamil U, Pearce JM (2025) Regenerative agrivoltaics: Integrating photovoltaics and regenerative agriculture for sustainable food and energy systems. *Sustainability*. <https://doi.org/10.3390/su17114799>

Jasanoff, S. (2004). Science and citizenship: a new synergy. *Science & public policy*, 31 (2), Oxford University Press (OUP), p.90–94.

Jasińska, M. (2020). Synergy - an enhancement of learning organisations undergoing a change. *Entrepreneurship and Sustainability Issues*, 7, jssidoi.org, p.1902–1920.

Jelti F, Allouhi A, Aoul KAT (2023) Transition paths towards a sustainable transportation system: A literature review. *Sustainability*. <https://doi.org/10.3390/su152115457>

Junjie M, Yingxin M (2022) The discussions of positivism and interpretivism. *Glob Acad J Humanit Soc Sci* 4:10–14

Kalsie, A. and Nagpal, A. (2017). Identification of Financial Synergy: A Case Study of Merger of UltraTech Cement with Samruddhi Cement. *International Journal of Management Research*, 8 (2), p.42–60.

Kanda W, Kuisma M, Kivimaa P, Hjelm O (2020) Conceptualising the systemic activities of intermediaries in sustainability transitions. *Environ Innov Soc Transit* 36:449–465. <https://doi.org/10.1016/j.eist.2020.01.002>

Karp T (2005) An action theory of transformative processes. *J Chang Manag* 5:153–175. <https://doi.org/10.1080/14697010500124134>

Karsidi, R. et al. (2017). The importance of synergy and organisation culture to accelerate university in the global environment: a case study. *International Journal of Trade and Global Markets*, 10 (4), inderscienceonline.com, p.314.

- Kemmis S, McTaggart R, Nixon R (2013) *The action research planner*, 4th edn. Springer, Singapore, Singapore
- Kerber, S. W. et al. (2021). Understanding the nexus of energy, environment and conflict: An overview. *Renewable and Sustainable Energy Reviews*, 151 (111473), Elsevier BV, p.111473.
- Khalili NR, Duecker S, Ashton W, Chavez F (2015) From cleaner production to sustainable development: the role of academia. *J Clean Prod* 96:30–43.
<https://doi.org/10.1016/j.jclepro.2014.01.099>
- Kläy, A., Zimmermann, A. B. and Schneider, F. (2015). Rethinking science for sustainable development: Reflexive interaction for a paradigm transformation. *Futures*, 65, Elsevier BV, p.72–85.
- Koskela I-M, Paloniemi R (2023) Learning and agency for sustainability transformations: building on Bandura's theory of human agency. *Environ Educ Res* 29:164–178.
<https://doi.org/10.1080/13504622.2022.2102153>
- Krishna Kumar, T. (2024). Dynamic interactions: The synergy between Organizational Behaviour and HRM. *Educational Administration Theory and Practice journal*, 30 (4), p.9987–9992.
- Kujala J, Sachs S, Leinonen H, et al (2022) Stakeholder Engagement: Past, Present, and Future. *Business & Society* 61:1136–1196. <https://doi.org/10.1177/00076503211066595>
- Kumah E, Ankomah SE, Fusheini A, et al (2020) Frameworks for health systems performance assessment: how comprehensive is Ghana's holistic assessment tool? *Glob Health Res Policy* 5:10. <https://doi.org/10.1186/s41256-020-00139-2>
- Lalmi, A., Fernandes, G. and Boudemagh, S. S. (2022). Synergy between Traditional, Agile and Lean management approaches in construction projects: bibliometric analysis. *Procedia computer science*, 196, Elsevier BV, p.732–739.
- Lambin, E. F. et al. (2014). Effectiveness and synergies of policy instruments for land use governance in tropical regions. *Global environmental change: human and policy dimensions*, 28, p.129–140.
- Lang T (2009) Reshaping the food system for ecological public health. *J Hunger Environ Nutr* 4:315–335. <https://doi.org/10.1080/19320240903321227>
- Lanhoso F, Coelho DA (2021) Emergence fostered by systemic analysis—Seeding innovation for sustainable development. *Sustain Dev* 29:768–779.
<https://doi.org/10.1002/sd.2173>
- Law, R. et al. (2022). Interpersonal Psychotherapy and Mentalizing-Synergies in Clinical Practice. *American journal of psychotherapy*, 75 (1), p.44–50.
- Lawrence M, Homer-Dixon T, Janzwood S, et al (2024) Global polycrisis: the causal mechanisms of crisis entanglement. *Global Sustainability* 7:e6.
<https://doi.org/10.1017/sus.2024.1>

Leino H, Puumala E (2021) What can co-creation do for the citizens? Applying co-creation for the promotion of participation in cities. *Environment and Planning C: Politics and Space* 39:781–799. <https://doi.org/10.1177/2399654420957337>

Leiren MD, Jacobsen JKS (2018) Silos as barriers to public sector climate adaptation and preparedness: insights from road closures in Norway. *Local Government Studies* 44:492–511. <https://doi.org/10.1080/03003930.2018.1465933>

Lenka P, Khatua D (2025) Women’s leadership in accelerating sustainable development : Care based approach for transformative change. *Problemy Ekorozwoju*. <https://doi.org/10.35784/preko.6605>

Li J, Li J, Guo K, et al (2024) Policy spillovers from climate actions to energy poverty: international evidence. *Humanit Soc Sci Commun* 11:1–12. <https://doi.org/10.1057/s41599-024-03614-0>

Li, S. et al. (2021). Prediction of synergistic drug combinations for Prostate cancer by transcriptomic and network characteristics. *Frontiers in pharmacology*, 12, Frontiers Media SA, p.634097.

Lilley D, Wilson GT (2017) Design for sustainable behaviour. In: *Routledge Handbook of Sustainable Product Design*. Routledge, New York : Routledge, 2017., pp 127–144

Linnér B-O, Wibeck V (2021) Drivers of sustainability transformations: leverage points, contexts and conjunctures. *Sustain Sci* 16:889–900. <https://doi.org/10.1007/s11625-021-00957-4>

Liu J, Hull V, Godfray HCJ, et al (2018) Nexus approaches to global sustainable development. *Nat Sustain* 1:466–476. <https://doi.org/10.1038/s41893-018-0135-8>

Liu J, Mooney H, Hull V, et al (2015) Sustainability. Systems integration for global sustainability. *Science* 347:1258832. <https://doi.org/10.1126/science.1258832>

Livingston P (2005) Chapter 1 WHAT ARE INTENTIONS? In: *Art and Intention*. Oxford University Press Oxford, pp 1–30

Loukianova, A., Nikulin, E. and Vedernikov, A. (2017). Valuing synergies in strategic mergers and acquisitions using the real options approach. *Investment Management and Financial Innovations*, (14, № 1 (contin.)), Business Perspectives, Publishing Company, p.236–247.

Machalaba C, Romanelli C, Stoett P, et al (2015) Climate Change and Health: Transcending Silos to Find Solutions. *Ann Glob Health* 81:445–458. <https://doi.org/10.1016/j.aogh.2015.08.002>

Magaldi D, Berler M (2020) Semi-structured Interviews. In: Zeigler-Hill V, Shackelford TK (eds) *Encyclopedia of Personality and Individual Differences*. Springer International Publishing, Cham, pp 4825–4830

Manago, B., Sell, J. and Goar, C. (2019). Groups, inequality, and synergy. *Social forces; a scientific medium of social study and interpretation*, 97 (3), Oxford University Press (OUP), p.1365–1388. [Accessed 5 July 2024].

Mansoor Z, Williams MJ (2018) Systems approaches to Public Service Delivery: Lessons from health, education, and infrastructure

Marciniak G, Urbach D, Schneider F, et al (2024) Leveraging capacity for transformative sustainability science: a theory of change from the Future Earth Pathways Initiative. *Glob Sustain* 7:e21. <https://doi.org/10.1017/sus.2024.19>

Marra M (2025) Bridging the gaps in sustainability assessment: A systematic literature review, 2014-2023. *Eval Program Plann* 110:102557. <https://doi.org/10.1016/j.evalprogplan.2025.102557>

Massari S, Galli F, Mattioni D, Chiffolleau Y (2023) Co-creativity in Living Labs: fostering creativity in co-creation processes to transform food systems. *J Sci Commun* 22:A03. <https://doi.org/10.22323/2.22030203>

Massari, S. et al. (2023). Co-creativity in Living Labs: fostering creativity in co-creation processes to transform food systems. *Journal of Science Communication*, 22 (03), Sissa Medialab Srl, p.A03. [Accessed 21 January 2025].

Masud S, Khan A (2024) Policy implementation barriers in climate change adaptation: The case of Pakistan. *Environ Pol Gov* 34:42–52. <https://doi.org/10.1002/eet.2054>

Mayne, R. et al. (2018). Using evidence to influence policy: Oxfam's experience. *Palgrave communications*, 4 (1), Springer Science and Business Media LLC. [Online]. Available at: [doi:10.1057/s41599-018-0176-7](https://doi.org/10.1057/s41599-018-0176-7).

McNamara C, Bambra C (2025) The global polycrisis and health inequalities. *Int J Soc Determinants Health Health Serv* 27551938251317470. <https://doi.org/10.1177/27551938251317472>

McQueen M, Abou-Zeid G, MacArthur J, Clifton K (2021) Transportation transformation: Is micromobility making a macro impact on sustainability? *J Plan Lit* 36:46–61. <https://doi.org/10.1177/0885412220972696>

Meadows DH (1999) Leverage points: Places to intervene in a system

Micsinszki, S. K. et al. (2022). Creative processes in co-designing a co-design hub: towards system change in health and social services in collaboration with structurally vulnerable populations. *Evidence & policy: a journal of research, debate and practice*, 18 (2), Bristol University Press, p.291–310.

Midgley, G. (2008). Systems thinking, complexity and the philosophy of science. *Emergence: Complexity and Organization*, 10 (4), p.55–73. [Accessed 31 October 2024].

Mishra AK, Dash PK, Mishra A, Sharma S (2024) Regenerative agriculture: A multifaceted approach to one health and soil restoration. In: *Key Drivers and Indicators of Soil Health Management*. Springer Nature Singapore, Singapore, pp 1–32

Moriggi A, Soini K, Franklin A, Roep D (2020) A care-based approach to transformative change: ethically-informed practices, relational response-ability & emotional awareness. *Ethics Policy Environ* 1–18. <https://doi.org/10.1080/21550085.2020.1848186>

- Mukherjee, P. K., Banerjee, S. and Kar, A. (2018). Exploring synergy in ayurveda and traditional Indian systems of medicine. *Synergy*, 7, p.30–33.
- Mumford, M. D., Medeiros, K. E. and Partlow, P. J. (2012). Creative thinking: Processes, strategies, and knowledge. *The journal of creative behavior*, 46 (1), Wiley, p.30–47.
- Naito R, Zhao J, Chan KMA (2022) An integrative framework for transformative social change: a case in global wildlife trade. *Sustain Sci* 17:171–189. <https://doi.org/10.1007/s11625-021-01081-z>
- Nam S-J, Hwang H (2019) What makes consumers respond to creating shared value strategy? Considering consumers as stakeholders in sustainable development. *Corp Soc Responsibility Environ Manage* 26:388–395. <https://doi.org/10.1002/csr.1690>.
- Neset T-SS, Cordell D (2012) Global phosphorus scarcity: identifying synergies for a sustainable future. *J Sci Food Agric* 92:2–6. <https://doi.org/10.1002/jsfa.4650>
- Nesheim MC, Oria M, Yih PT, et al (2015) *The U.S. Food and Agriculture System as a Complex Adaptive System*. National Academies Press (US)
- Nimptsch U (2020) Evaluating the consequences of health policy decisions. *Isr. J. Health Policy Res.* 9:19
- Nobles, J. et al. (2022). Ripple effects mapping: capturing the wider impacts of systems change efforts in public health. *BMC medical research methodology*, 22 (1), Springer Science and Business Media LLC, p.72.
- Normann R (2001) *Reframing Business: When the Map Changes the Landscape*. John Wiley & Sons
- Normann, R. (2001). *Reframing Business: When the Map Changes the Landscape*. John Wiley & Sons.
- O’Brien K (2012) Global environmental change II: From adaptation to deliberate transformation. *Prog Hum Geogr* 36:667–676. <https://doi.org/10.1177/0309132511425767>
- O’Brien K (2018) Is the 1.5°C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability* 31:153–160. <https://doi.org/10.1016/j.cosust.2018.04.010>
- O’Brien K, Garibaldi LA, Agrawal A, et al (2025) *IPBES Transformative Change Assessment: Summary for policymakers*
- O’Brien K, Sygna L (2013) Responding to climate change: The three spheres of transformation. http://www.europarc.org/wp-content/uploads/2020/05/OBrien-and-Sygna_2013_Responding-to-climate-change-Three-spheres-of-transformation.pdf. Accessed 25 Jan 2023
- O’Connor T (2020) Emergent Properties. <https://plato.stanford.edu/entries/properties-emergent/>. Accessed 20 Aug 2025

- O'Dwyer M, Filieri R, O'Malley L (2023) Establishing successful university–industry collaborations: barriers and enablers deconstructed. *J Technol Transf* 48:900–931. <https://doi.org/10.1007/s10961-022-09932-2>
- O'Malley, R. et al. (2021). A systematic review of the use of positive deviance approaches in primary care. *Family practice*, academic.oup.com. [Online]. Available at: [doi:10.1093/fampra/cmab152](https://doi.org/10.1093/fampra/cmab152).
- Ogden, L. et al. (2013). Global assemblages, resilience, and Earth Stewardship in the Anthropocene. *Frontiers in ecology and the environment*, 11 (7), Wiley, p.341–347.
- Ogola RJO, Ouko KO (2021) Synergies and trade-offs of selected climate smart agriculture practices in Irish potato farming, Kenya. *Cogent Food & Agriculture* 7:1948257. <https://doi.org/10.1080/23311932.2021.1948257>
- Okpala COR (2020) Toward sustaining global food systems for the future. *Front Sustain Food Syst* 4:. <https://doi.org/10.3389/fsufs.2020.00003>
- Olkhovaya, T. A. et al. (2016). A synergy-based approach through developing cross-disciplinary module. *International electronic journal of mathematics education*, 11 (3), Modestum Publishing LTD, p.467–474. [Accessed 28 October 2021].
- Om ES, Fazey I, Newman R, et al Synergies: Understandings in a Complex World. *Sustainability sci.* (In review)
- Otto Scharmer C, Kaeufer K (2010) In front of the blank canvas: Sensing emerging futures. *J Bus Strategy* 31:21–29. <https://doi.org/10.1108/02756661011055159>
- Oyinlola, M. et al. (2018). Bottle house: A case study of transdisciplinary research for tackling global challenges. *Habitat international*, 79, Elsevier BV, p.18–29. [Accessed 21 June 2024].
- Page GG, Wise RM, Lindenfeld L, et al (2016) Co-designing transformation research: lessons learned from research on deliberate practices for transformation. *Curr Opin Environ Sustain* 20:86–92. <https://doi.org/10.1016/j.cosust.2016.09.001>
- Pakeltienē R, Ragauskaitē A (2017) Creative synergy as a potential factor for the development of social innovations. *Latvia University of Agriculture*
- Panatsa VM, Malandrakis G (2024) Greek primary school students' moral judgments and motives about sustainable food consumption. *Cleaner and Responsible Consumption* 12:100173. <https://doi.org/10.1016/j.clrc.2024.100173>
- Papargyropoulou E, Bridge G, Woodcock S, et al (2024) Impact of food hubs on food security and sustainability: Food hubs perspectives from Leeds, UK. *Food Policy* 128:102705. <https://doi.org/10.1016/j.foodpol.2024.102705>
- Parsons K, Hawkes C (2019) Connecting food systems for co-benefits: How can food systems combine diet-related health with environmental and economic policy goals? *European Observatory on Health Systems and Policies*, Copenhagen (Denmark)

Paul B, Kirubakaran R, Isaac R, et al (2023) A systematic review of the theory of planned behaviour interventions for chronic diseases in low health-literacy settings. *J Glob Health* 13:04079

Paul B, Kirubakaran R, Isaac R, et al (2023) A systematic review of the theory of planned behaviour interventions for chronic diseases in low health-literacy settings. *J Glob Health* 13:04079. <https://doi.org/10.7189/jogh.13.04079>

Pearson PJG, Watson J (2023) The unfolding low-carbon transition in the UK electricity system. *Proc Natl Acad Sci U S A* 120:e2206235120. <https://doi.org/10.1073/pnas.2206235120>

Pennacchioni G (2025) Harnessing collective intentionality for climate action: An institutional perspective on sustainability. *Topoi (Dordr)* 44:197–208. <https://doi.org/10.1007/s11245-024-10087-y>

Pereira L, Karpouzoglou T, Frantzeskaki N, Olsson P (2018) Designing transformative spaces for sustainability in social-ecological systems. *Ecology and Society* 23:.. <https://doi.org/10.5751/ES-10607-230432>

Persaud A (2005) Enhancing synergistic innovative capability in multinational corporations: An empirical investigation. *J Prod Innov Manage* 22:412–429. <https://doi.org/10.1111/j.1540-5885.2005.00138.x>

Peterseim, J. H. et al. (2014). Concentrating solar power hybrid plants – Enabling cost effective synergies. *Renewable Energy*, 67, p.178–185.

Power MS (2019) Seeking justice:how to understand and end food poverty in York. In: York Food Justice Alliance. <https://eprints.whiterose.ac.uk/id/eprint/151502/>. Accessed 29 Sept 2025

Preiser R, Biggs R, De Vos A, Folke C (2018) Social-ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches. *Ecol Soc* 23:.. <https://doi.org/10.5751/es-10558-230446>

Preuß UK (2001) The rule-making and policy actors in the transition and the issue of the strategy of transformation. *Stud East Eur Thought* 53:183–195. <https://doi.org/10.1023/a:1011206817748>

Quan J, Li H, Wang X (2023) Cooperation dynamics in public goods games with evolving cognitive bias. *Management System Engineering* 2:.. <https://doi.org/10.1007/s44176-023-00025-4>

Ramos H, Bryman A, Teevan JJ (2007) Social research methods, Canadian edition. *Can Sociol* 32:129. <https://doi.org/10.2307/20460620>

Ratnapalan S, Lang D (2020) Health care organizations as complex adaptive systems. *Health Care Manag (Frederick)* 39:18–23. <https://doi.org/10.1097/HCM.0000000000000284>

Redman A, Wiek A (2021) Competencies for advancing transformations towards sustainability. *Front Educ* 6:.. <https://doi.org/10.3389/educ.2021.785163>

Renaud, F. G. et al. (2022). Synergies and trade-offs between sustainable development goals and targets: innovative approaches and new perspectives. *Sustainability science*, 17 (4), Springer Science and Business Media LLC, p.1317–1322.

Resnick D, Swinnen J (2023) The Political Economy of Food System Transformation: Pathways to Progress in a Polarized World. Oxford University Press

Revez, A. et al. (2022). Mapping emergent public engagement in societal transitions: a scoping review. *Energy, sustainability and society*, 12 (1), Springer Science and Business Media LLC, p.2. [Accessed 30 October 2024].

Riedy C, Waddock S (2022) Imagining transformation: Change agent narratives of sustainable futures. *Futures* 142:103010. <https://doi.org/10.1016/j.futures.2022.103010>

Rockström J, Edenhofer O, Gaertner J, DeClerck F (2020) Planet-proofing the global food system. *Nature Food* 1:3–5. <https://doi.org/10.1038/s43016-019-0010-4>

Rockström J, Gupta J, Qin D, et al (2023) Safe and just Earth system boundaries. *Nature* 619:102–111. <https://doi.org/10.1038/s41586-023-06083-8>

Rohe S, Chlebna C (2022) The evolving role of networking organizations in advanced sustainability transitions. *Technol Forecast Soc Change* 183:121916. <https://doi.org/10.1016/j.techfore.2022.121916>

Roos M (2024) The economy as a complex adaptive system. In: *Classroom Companion: Economics*. Springer International Publishing, Cham, pp 147–182

Rosenzweig C, Tubiello FN (2007) Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change* 12:855–873. <https://doi.org/10.1007/s11027-007-9103-8>

Rothengatter W (2025) Planning of transport systems under increasing complexity—looking into nature. *J Sustain Res* 7:. <https://doi.org/10.20900/jsr20250023>

Ruben R, Cavatassi R, Lipper L, et al (2021) Towards food systems transformation-five paradigm shifts for healthy, inclusive and sustainable food systems. *Food Secur* 13:1423–1430. <https://doi.org/10.1007/s12571-021-01221-4>

Sabherwal A, Shreedhar G (2022) Stories of intentional action mobilise climate policy support and action intentions. *Sci Rep* 12:1179. <https://doi.org/10.1038/s41598-021-04392-4>

Sáez de Cámara E, Fernández I, Castillo-Eguskita N (2021) A holistic approach to integrate and evaluate Sustainable Development in Higher Education. The case study of the University of the Basque Country. *Sustainability* 13:392. <https://doi.org/10.3390/su13010392>

Saldana J (2025) The coding manual for qualitative researchers, 4th edn. SAGE Publications, London, England

Scharmer O (2018) The Essentials of Theory U: Core Principles and Applications. Berrett-Koehler Publishers

Scharmer O, Kaufer K (2017) Awareness-based action research: Catching social reality creation in flight. In: The SAGE Handbook of Action Research. SAGE Publications Ltd, 1 Oliver's Yard, 55 City Road London EC1Y 1SP, pp 199–210

Scharmer O, Pomeroy E, Kaufer K (2021) Awareness-based action research: Making systems sense and see themselves. The SAGE handbook of participatory research and enquiry 633–648

Schipfer F, Burli P, Fritsche U, et al (2024) The circular bioeconomy: a driver for system integration. *Energy Sustain Soc* 14:. <https://doi.org/10.1186/s13705-024-00461-4>

Schipfer, F. et al. (2024). The circular bioeconomy: a driver for system integration. *Energy, sustainability and society*, 14 (1), Springer Science and Business Media LLC. [Online]. Available at: [doi:10.1186/s13705-024-00461-4](https://doi.org/10.1186/s13705-024-00461-4).

Schoneveld GC (2022) Transforming food systems through inclusive agribusiness. *World Dev* 158:105970. <https://doi.org/10.1016/j.worlddev.2022.105970>

Scoones I, Stirling A, Abrol D, et al (2020) Transformations to sustainability: combining structural, systemic and enabling approaches. *Current Opinion in Environmental Sustainability* 42:65–75. <https://doi.org/10.1016/j.cosust.2019.12.004>

Seamon D (2024) Holism and the Gurdjieff Work. *Altern Spirit Relig Rev* 15:26–51. <https://doi.org/10.5840/asrr2024131107>

Serrao-Neumann, S. et al. (2015). One human settlement: A transdisciplinary approach to climate change adaptation research. *Futures*, 65, Elsevier BV, p.97–109.

Shahid S (2024) Complex challenges and multidisciplinary solutions: A strategic approach. *JPEHSS* 2:50–63

Sharpe B, Hodgson A, Leicester G, et al (2016) Three horizons: A pathways practice for transformation. *Ecol Soc* 21:. <https://doi.org/10.5751/ES-08388-210247>

Sharpe, B. (2020). Hexagon mapping. *H3Uni*, H3Uni.org. [Online]. Available at: <https://www.h3uni.org/facilitation-guide/hexagon-mapping/> [Accessed 12 November 2024].

Shrivastava, M. and Ramamohan Rao, T. V. (2014). Organisational synergies, dissonance and spinoffs. *International Journal of Economics and Business Research*, Inderscience Publishers. [Online]. Available at: [doi:10.1504/IJEBR.2015.066012](https://doi.org/10.1504/IJEBR.2015.066012) [Accessed 5 July 2024].

Skyttner L (2006) General systems theory: Problems, perspectives, practice (2nd edition): Problems, perspectives, practice. World Scientific Publishing, Singapore, Singapore

Snyder H (2019) Literature review as a research methodology: An overview and guidelines. *J Bus Res* 104:333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>

Sterman J (2000) Business Dynamics: Systems Thinking and Modeling for a Complex World. Irwin/McGraw-Hill

Strasser T, de Kraker J, Kemp R (2022) Network leadership for transformative capacity development: roles, practices and challenges. *Global Sustainability* 5:e11. <https://doi.org/10.1017/sus.2022.6>

Stroh, D. P. (2015). *Systems Thinking For Social Change: A Practical Guide to Solving Complex Problems, Avoiding Unintended Consequences, and Achieving Lasting Results*. Chelsea Green Publishing.

Suckling J, Hoolohan C, Soutar I, Druckman A (2021) Unintended consequences: Unknowable and Unavoidable, or Knowable and unforgivable? *Front Clim* 3:737929. <https://doi.org/10.3389/fclim.2021.737929>

Swanson RC, Cattaneo A, Bradley E, et al (2012) Rethinking health systems strengthening: key systems thinking tools and strategies for transformational change. *Health Policy Plan* 27 Suppl 4:iv54-61. <https://doi.org/10.1093/heapol/czs090>

Swarnakar S, Chowhan P, Paul S, Chakraborty AP (2024) Exploring the nexus of food and medicine: Boundaries, synergies, unraveling the role of food in shaping future health. In: *Traditional Foods: The Reinvented Superfoods*. Springer Nature Switzerland, Cham, pp 551–569

Tälle M, Wiréhn L, Ellström D, et al (2019) Synergies and Trade-Offs for Sustainable Food Production in Sweden: An Integrated Approach. *Sustain Sci Pract Policy* 11:601. <https://doi.org/10.3390/su11030601>

Tantalo, C. and Priem, R. L. (2016). Value creation through stakeholder synergy: Stakeholder Synergy. *Strategic management journal*, 37 (2), Wiley, p.314–329. [Accessed 1 July 2024].

Temper L, Walter M, Rodriguez I, et al (2018) A perspective on radical transformations to sustainability: resistances, movements and alternatives. *Sustain Sci* 13:747–764. <https://doi.org/10.1007/s11625-018-0543-8>

Tett, G. (2011). Silos and silences: The role of fragmentation in the recent financial crisis. In: *Forecasting, Warning and Responding to Transnational Risks*. London: Palgrave Macmillan UK. p.208–216. [Accessed 30 October 2024].

Tomai M, Ramani SV, Papachristos G (2024) How can we design policy better? Frameworks and approaches for sustainability transitions. *Sustainability* 16:690. <https://doi.org/10.3390/su16020690>

Topps, G. and Busia, K. (2005). The concept of synergy: time for a new paradigm? *Australian Journal of Medical Herbalism*, 17 (2), p.45–54. [Accessed 11 September 2024].

Torraco RJ (2005) Writing integrative literature reviews: Guidelines and examples. *Hum Resour Dev Rev* 4:356–367. <https://doi.org/10.1177/1534484305278283>

Townsend JR, Kirby TO, Sapp PA, et al (2023) Nutrient synergy: definition, evidence, and future directions. *Front Nutr* 10:1279925. <https://doi.org/10.3389/fnut.2023.1279925>

Treuherz, S., Yap, C. & Rowson, S. (2023) *ShefFood's Local Food Action Plan for Sheffield 2023-2030*. Sheffield, UK: ShefFood-FixOurFood. <https://openaccess.city.ac.uk/id/eprint/30927/7/Local>. Accessed 24 Mar 2025

Tripathy N, Mishra N, Gupta I (2020) Effect of synergy success and efficiency gains through mergers and acquisitions on research and development. *Int J Public Sect Perform Manag* 1:1. <https://doi.org/10.1504/ijpspm.2020.10036233>

Tschakert P, Tuana N, Westskog H, et al (2016) T CHANGE : the role of values and visioning in transformation science. *Curr Opin Environ Sustain* 20:21–25. <https://doi.org/10.1016/j.cosust.2016.04.003>

UKRI (2022) Transforming UK Food Systems. In: Transforming UK Food Systems. <https://ukfoodsystems.ukri.org>. Accessed 24 Mar 2025

Egharter E (2023) Cultivating a resilient food future: FixOurFood’s collaboration with the Yorkshire Grain Alliance. In: Fix Our Food. <https://fixourfood.org/cultivating-a-resilient-food-future-fixourfoods-collaboration-with-the-yorkshire-grain-alliance/>. Accessed 2 Oct 2025

Umpleby, S. A. (2014). Second-order Science: Logic, Strategies, Methods. *Constructivist Foundations*, 10 (1), unknown, p.16–23. [Accessed 7 March 2022].

Upton, J., Janeka, I. and Ferraro, N. (2014). The whole is more than the sum of its parts: Aristotle, metaphysical: Aristotle, metaphysical. *The journal of craniofacial surgery*, 25 (1), Ovid Technologies (Wolters Kluwer Health), p.59–63. [Accessed 11 September 2024].

van Dinther, M., Dochy, F. and Segers, M. (2011). Factors affecting students’ self-efficacy in higher education. *Educational research review*, 6 (2), Elsevier BV, p.95–108. [Accessed 1 July 2024].

Visciola M (2022) Intentional Behavioral Design. In: Sustainable Innovation. Springer International Publishing, Cham, pp 95–107

Vogel C, O’Brien K (2022) Getting to the heart of transformation. *Sustainability Sci* 17:653–659. <https://doi.org/10.1007/s11625-021-01016-8>

Voulvoulis N, Giakoumis T, Hunt C, et al (2022) Systems thinking as a paradigm shift for sustainability transformation. *Glob Environ Change* 75:102544. <https://doi.org/10.1016/j.gloenvcha.2022.102544>

Waddock S (2025) Advancing eco-social strategic management: a whole systems lens. *Sustain Sci*. <https://doi.org/10.1007/s11625-025-01723-6>

Waddock S, Steckler E (2016) Visionaries and wayfinders: Deliberate and emergent pathways to vision in social entrepreneurship. *J Bus Ethics* 133:719–734. <https://doi.org/10.1007/s10551-014-2451-x>

Wainaina, P., Tongruksawattana, S. and Qaim, M. (2018). Synergies between Different Types of Agricultural Technologies in the Kenyan Small Farm Sector. *The journal of development studies*, 54 (11), Routledge, p.1974–1990.

Wamsler C, Osberg G, Osika W, et al (2021) Linking internal and external transformation for sustainability and climate action: Towards a new research and policy agenda. *Glob Environ Change* 71:102373

- Wang, J., Abdullayeva, S. and Hoang, D. S. (2024). Diversification and company sales efficiency: Synergy influence on business valuation. *Managerial and decision economics: MDE*, 45 (2), Wiley, p.940–951.
- Wei X, Ruan J (2022) Influences of government policies and farmers' cognition on farmers' participation willingness and behaviors in E-commerce interest linkage mechanisms during farmer–enterprise games. *Agriculture* 12:1625. <https://doi.org/10.3390/agriculture12101625>
- Weymes, E. (2002). Relationships not leadership sustain successful organisations. *Journal of Change Management*, 3 (4), Routledge, p.319–331.
- White, H. (2019). The twenty-first century experimenting society: the four waves of the evidence revolution. *Palgrave communications*, 5 (1), Springer Science and Business Media LLC. [Online]. Available at: doi:10.1057/s41599-019-0253-6.
- Winter MD (2020) Reshaping health care governance using pilot projects as public policy implementation instruments: The case of integrated care pilot projects for chronic patients in Belgium. *irpp* 2:317–341. <https://doi.org/10.4000/irpp.1422>
- Wittmayer JM, Avelino F, van Steenberghe F, Loorbach D (2017) Actor roles in transition: Insights from sociological perspectives. *Environmental Innovation and Societal Transitions* 24:45–56. <https://doi.org/10.1016/j.eist.2016.10.003>
- Wohlin C (2014) Guidelines for snowballing in systematic literature studies and a replication in software engineering. In: *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering*. ACM, New York, NY, USA
- Xiao, Y. and Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. *Journal of Planning Education and Research*, 39 (1), SAGE Publications Inc, p.93–112.
- Yang Y, Zhang Z, Li S, et al (2014) Synergy effects of herb extracts: pharmacokinetics and pharmacodynamic basis. *Fitoterapia* 92:133–147. <https://doi.org/10.1016/j.fitote.2013.10.010>
- Yildirim S (2022) The Consumer Role for Sustainable Development: How Consumers Contribute Sustainable Development Goals. In: *Research Anthology on Measuring and Achieving Sustainable Development Goals*. IGI Global, pp 872–888
- Deliciously Yorkshire (2025) Deliciously Yorkshire - supporting Yorkshire Food & Drink producers. In: *Deliciously Yorkshire*. <https://deliciouslyyorkshire.co.uk>. Accessed 2 Oct 2025
- Yu F-LT (2020) Subjectivism and interpretative methodology in theory and practice. Anthem Press, London, England
- Zhang, J., Li, S. and Wang, Y. (2023). Shaping a Smart Transportation System for Sustainable Value Co-Creation. *Information Systems Frontiers*, 25 (1), p.365–380.
- Zhou, Y. et al. (2024). Improving full-chain process synergy of multi-energy complementary distributed energy system in cascade storage and initiative management strategies. *Energy conversion and management*, 322 (119120), Elsevier BV, p.119120.

Zurek M, Hebinck A, Selomane O (2021) Looking across diverse food system futures: Implications for climate change and the environment. Q Open 1:.
<https://doi.org/10.1093/qopen/qaaa001>

7. Appendix

**University of York
York Graduate Research School
Research Degree Thesis Statement of Authorship**

Note that where a paper has multiple authors, the statement of authorship can focus on the key contributing/corresponding authors.

Candidate name	Eugyen Suzanne Om
Department	Department of Environment and Geography
Thesis title	How can we enable synergic action to support sustainable transformations?

Chapter 2

Title of the work (paper/chapter)	Synergies: Understanding in a complex world	
Publication status	Published	
	Accepted for publication	
	Submitted for publication	YES
	Unpublished and unsubmitted	
Citation details (if applicable)	Om, E.S., Fazey I, Newman, R., Hodgson, A., Cooper, M., Carmen, E., Baffoe, G., Eyre, L., Cordero, J.P. (In review). Synergies: Understandings in a Complex World. <i>Sustainability sci</i>	

Description of the candidate's contribution to the work*	Primary researcher, who designed and undertook this research. It includes conceptualisation, design of methodology, gathering data, analysis and writing.
Approximate percentage contribution of the candidate to the work (<i>if possible to describe in this way</i>)	90%

Signature of the candidate	
Date (DD/MM/YY)	25th March, 2025

Co-author contributions

By signing this Statement of Authorship, each co-author agrees that:

- (i) the candidate has accurately represented their contribution to the work;**
- (ii) if required, permission is granted for the candidate to include the work in their thesis (note that this is separate from copyright considerations).**

Name of co-author	Professor <u>Ioan Fazey</u>
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York ioan.fazey@york.ac.uk
Description of the co-author's contribution to the work*	Provided main supervision, providing oversight in research planning and execution. Further supported conceptual development (concept of synergy) and review and editing of multiple drafts of this chapter
Signature of the co-author	Ioan Fazey
Date (DD/MM/YY)	22/04/25

Name of co-author	Dr. Rebecca Newman
Contact details of co-author	Dr. Rebecca Newman, Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom rebecca.newman@york.ac.uk
Description of the co-author's contribution to the work*	Provided review and editing of multiple drafts of this chapter
Signature of the co-author	
Date (DD/MM/YY)	23/04/2025

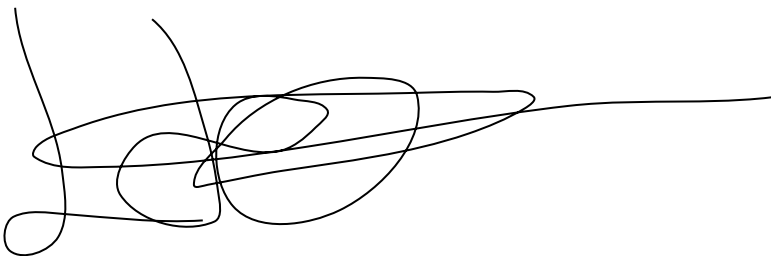
Name of co-author	Dr. Anthony Hodgson
Contact details of co-author	Dr. Anthony Hodgson, H3uni, Glenrothes, KY7 5NA, UK anthony.hodgson@h3uni.org
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and later helped with edits to the paper.
Signature of the co-author	
Date (DD/MM/YY)	22/04/2025

Name of co-author	Professor Mick Cooper
Contact details of co-author	School of Psychology, University of Roehampton, London SW15 4JD, UK mick.cooper@roehampton.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and later helped with review and edit of multiple drafts of the paper
Signature of the co-author	
Date (DD/MM/YY)	16/04/2025

Name of co-author	Dr. Esther Carmen
Contact details of co-author	Social, Economic and Geographical Sciences, The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, UK Esther.Carmen@hutton.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and later helped with review and edit of multiple drafts of the paper

Signature of the co-author	Esther Carmen
Date (DD/MM/YY)	16/04/2025

Name of co-author	Dr. Gideon Baffoe
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom gideon.baffoe@york.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and feedback on analysis of data
Signature of the co-author	
Date (DD/MM/YY)	24/04/2025

Name of co-author	Mr. Lee Eyre
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom le749@york.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	22/04/2025

Name of co-author	Dr. Juan P. Cordero
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom juanpablo.cordero@york.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	22/4/2025

Chapter 3

Title of the work (paper/chapter)	Synergic action and system transformation: The Ambition Loop Framework	
Publication status	Published	
	Accepted for publication	
	Submitted for publication	YES
	Unpublished and unsubmitted	
Citation details (if applicable)	Om, E.S., Sharpe, B., Fazey, I., Eyre, L., Newman, R., Carmen, E., Cisse, A. (Submitted). Synergic action and system transformation: The Ambition Loop Framework. <i>Sustainability Science</i>	

Description of the candidate's contribution to the work*	Primary researcher, who designed and undertook this research. It includes conceptualisation, design of methodology, gathering data, analysis and writing.
Approximate percentage contribution of the candidate to the work (<i>if possible to describe in this way</i>)	90%
Signature of the candidate	
Date (DD/MM/YY)	25th March, 2025

Name of co-author	Professor Ioan Fazey
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York ioan.fazey@york.ac.uk
Description of the co-author's contribution to the work*	Provided main supervision, providing oversight in research planning and execution. Further provided guidance and structure of paper and review and editing of multiple drafts of this chapter
Signature of the co-author	Ioan Fazey
Date (DD/MM/YY)	22/4/25

Name of co-author	Bill Sharpe
Contact details of co-author	International Futures Forum, The Boathouse, Silversands, Hawkraig Road, Aberdour, Fife KY3 0TZ, UK
Description of the co-author's contribution to the work*	Was instrumental in introducing and testing the Ambition Loop framework and editing of later drafts of the paper.
Signature of the co-author	Bill Sharpe
Date (DD/MM/YY)	23/04/2025

Name of co-author	Lee Eyre
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom le749@york.ac.uk
Description of the co-author's contribution to the work*	Provided support in analysis of data and helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	22/04/2025

Name of co-author	Dr. Rebecca Newman
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom rebecca.newman@york.ac.uk
Description of the co-author's contribution to the work*	Provided review and editing of multiple drafts of this chapter
Signature of the co-author	
Date (DD/MM/YY)	23/04/2025

Name of co-author	Dr. Esther Carman
Contact details of co-author	Social, Economic and Geographical Sciences, The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, UK Esther.Carmen@hutton.ac.uk
Description of the co-author's contribution to the work*	Provided guidance on structure and method of the research and later helped with review and edit of multiple drafts of the paper

Signature of the co-author	Esther Carmen
Date (DD/MM/YY)	16/04/2025

Name of co-author	Avelile Cishe
Contact details of co-author	Ambition Loop, Neveria 4774 apt 801, Las Condes - Santiago, Chile avelile.cishe@ambitionloop.earth
Description of the co-author's contribution to the work*	Helped with review and edit of multiple drafts of the paper
Signature of the co-author	Avelile Cishe
Date (DD/MM/YY)	24/04/25

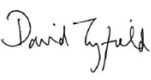
Chapter 4

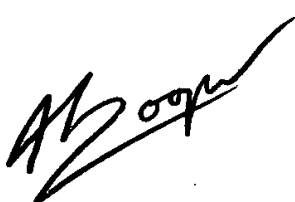
Title of the work (paper/chapter)	How to support synergic action for transformation: Insights from expert practitioners	
Publication status	Published	
	Accepted for publication	
	Submitted for publication	YES
	Unpublished and unsubmitted	
Citation details (if applicable)	Om, E.S., Fazey, I., Eyre, L., Tyfield, D., Cooper, M., Carmen, E., Jackson, D., Fearnley, J., Ritter, L., Newman, R., Cousquer, S. (Submitted). <i>Environmental Science and Policy</i>	

Description of the candidate's contribution to the work*	Primary researcher, who designed and undertook this research. It includes conceptualisation, design of
---	--

	methodology, gathering data, analysis and writing.
Approximate percentage contribution of the candidate to the work (<i>if possible to describe in this way</i>)	90%
Signature of the candidate	
Date (DD/MM/YY)	25th March, 2025

Name of co-author	Professor Ioan Fazey
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York ioan.fazey@york.ac.uk
Description of the co-author's contribution to the work*	Provided main supervision, providing oversight in research planning and execution. Further provided guidance and structure of paper and review and editing of multiple drafts of this chapter
Signature of the co-author	Ioan Fazey
Date (DD/MM/YY)	22/4/25

Name of co-author	Professor David Tyfield
Contact details of co-author	d.tyfield@lancaster.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support, guidance on structure of paper and narrative and review of later drafts
Signature of the co-author	
Date (DD/MM/YY)	29/05/25

Name of co-author	Professor Mick Cooper
Contact details of co-author	mick.cooper@roehampton.ac.uk
Description of the co-author's contribution to the work*	Provided conceptual support and review of later drafts
Signature of the co-author	
Date (DD/MM/YY)	16/04/25

Name of co-author	Dr. Esther Carmen
Contact details of co-author	Esther.Carmen@hutton.ac.uk
Description of the co-author's contribution to the work*	Contributed with review and edit of multiple drafts of the paper including guidance on methodology
Signature of the co-author	Esther Carmen
Date (DD/MM/YY)	16/04/25

Name of co-author	Declan J. Jackson
Contact details of co-author	declan.jackson@york.ac.uk
Description of the co-author's contribution to the work*	Helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	16/04/25

Name of co-author	James Fearnley
Contact details of co-author	jqt517@york.ac.uk
Description of the co-author's contribution to the work*	Helped with review and edits of later drafts to the paper
Signature of the co-author	James Fearnley
Date (DD/MM/YY)	25/04/25

Name of co-author	Rebecca Newman
Contact details of co-author	rebecca.newman@york.ac.uk
Description of the co-author's contribution to the work*	Helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	23/04/2025

Name of co-author	Luea Ritter
Contact details of co-author	luea@collectivetransitions.com
Description of the co-author's contribution to the work*	Helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	22/04/2025

Name of co-author	Dr Stefan Cousquer
Contact details of co-author	Hult Ashridge Executive Education, Hult International Business School, Ashridge House, Berkhamsted, Hertfordshire HP4 1NS, United Kingdom. Stefan.Cousquer@ashridge.hult.edu
Description of the co-author's contribution to the work*	Provided conceptual support in the early inception of the research and helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	16/04/25

Name of co-author	Lee Eyre
Contact details of co-author	Department of Environment and Geography, Wentworth Way, University of York, Heslington, York, YO10 5NG, United Kingdom le749@york.ac.uk
Description of the co-author's contribution to the work*	Provided support in analysis of data and helped with review and edits of later drafts to the paper
Signature of the co-author	
Date (DD/MM/YY)	22/04/2025

*The description of the candidate and co-authors contribution to the work may be framed in a manner appropriate to the area of research but should always include reference to key elements (e.g. for laboratory-based research this might include formulation of ideas, design of methodology, experimental work, data analysis and presentation, writing). Candidates and co-authors may find it helpful to consider the [CRediT \(Contributor Roles Taxonomy\)](#) approach to recognising individual author contributions.