Regenerative Farming and Sustainable Diets

Human, Animal and Planetary Health

Edited by Joyce D'Silva and Carol McKenna

EARTHSCAN FOOD AND AGRICULTURE

earthscan from Routledge

Regenerative Farming and Sustainable Diets

"This must read book emphasises the importance of regenerative farming, agroforestry and permaculture. These methods of farming work with rather than against nature, restore biodiversity, and help to slow down climate change. They can become truly sustainable and feed us for generations to come."

Jane Goodall, *PhD, DBE, Founder – the Jane Goodall Institute & UN Messenger of Peace*

This book makes the case for an urgent move away from industrial agriculture towards regenerative farming and the promotion of plant-based diets.

How we produce, distribute and consume food are critical issues for the health and well-being of humans, animals and the environment. In order to develop a sustainable food system, this book argues for a radical change in farming and food consumption. Containing contributions from world-renowned experts, this book promotes regenerative farming as the means to preserve planetary health, establish sustainable, healthy and secure diets and safeguard the welfare of animals. Chapters discuss broad ranging issues from climate change and biodiversity conservation to animal sentience and intensive farming, and the role of financial markets and food businesses. This book concludes with chapters discussing the routes in policy and practice to transforming the food system and achieving real-world change.

This book is a must read for students, scholars and policymakers interested in establishing sustainable farming and food systems, for human health, animal welfare and environmental protection.

Joyce D'Silva is Ambassador Emeritus for Compassion in World Farming and its former CEO. She has Honorary Doctorates from the Universities of Keele and Winchester. She is the author of *Animal Welfare in World Religion: Teaching and Practice* (Routledge 2023), rated a "powerful book" (Christiana Figueres) and "profoundly thought-provoking" (Joanna Lumley).

Carol McKenna is Special Advisor to Compassion in World Farming's Global CEO. Her role includes leading projects such as the Extinction and Regeneration Conference on which this book is based (www.extinctionconference.com). She is a Trustee of the Eating Better Alliance (www.eating-better.org) and co-editor of *Farming, Food and Nature: Respecting Animals, People and the Environment* (Routledge 2018).

Earthscan Food and Agriculture

Peasants, Capitalism, and Imperialism in an Age of Politico-Ecological Crisis
Mark Tilzey and Fraser Sugden

Genome Editing and Global Food Security
Molecular Engineering Technologies for Sustainable Agriculture
Zeba Khan, Durre Shahwar, and Yasmin Heikal

University Engagement with Farming Communities in Africa
Community Action Research Platforms
Edited by Anthony Egeru, Megan Lindow, and Kay Muir Leresche

Globalisation and Livelihood Transformations in the Indonesian Seaweed Industry
Edited by Zannie Langford

Principles of Sustainable Aquaculture
Promoting Social, Economic and Environmental Resilience, 2nd edition
Stuart W. Bunting

The Spatial Organization of Urban Agriculture in the Global South
Food Security and Sustainable Cities
Ada Górna

Digital Communication for Agricultural and Rural Development
Participatory Practices in a Post-COVID Age
Edited by Ataharul Chowdhury and Gordon Gow

Regenerative Farming and Sustainable Diets
Human, Animal and Planetary Health
Edited by Joyce D'Silva and Carol McKenna

For more information about this series, please visit: https://www.routledge.com/Earthscan-Food-and-Agriculture/book-series/ECEFA

Regenerative Farming and Sustainable Diets

Human, Animal and Planetary Health

Edited by
Joyce D'Silva and Carol McKenna

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

earthscan
from Routledge

Designed cover image: Getty images

First published 2025
by Routledge
4 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
605 Third Avenue, New York, NY 10158

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-032-68435-2 (hbk)
ISBN: 978-1-032-68432-1 (pbk)
ISBN: 978-1-032-68436-9 (ebk)

DOI: 10.4324/9781032684369

Typeset in Times New Roman
by codeMantra

Contents

Figures

Tables

Acknowledgements

The editors would like to thank the organisations who partnered with Compassion in World Farming (Compassion) for our May 2023 conference, *Extinction or Regeneration: Transforming Food Systems for Human, Animal and Planetary Health*, which provided the inspiration for this book. Our partners were IPES-Food, the Jane Goodall Institute (UK), Birdlife International, FaithInvest, The European Environmental Bureau, Brighter Green, Eating Better, the Safina Center, the Institute of Development Studies, the University of Winchester and the Good Food Fund.

Most of the authors in this book were speakers at that ground-breaking conference. Where we felt there were important issues missing, we invited other experts to write a chapter. We are almost overwhelmed by the quality of the contributions we have received and sincerely thank the authors, all of whom contributed freely to this book.

We would like to thank Compassion for providing funding for Open Access publication of the book, so its knowledge and wisdom can be shared and used as widely as possible. We thank Michaela Miller for her highly skilful editing support on certain chapters, and we thank Paul Taylor for helpful administrative assistance. We thank Hannah Ferguson at Routledge for her help and support with the whole book venture and Rosie Anderson at Routledge for her support.

Our gold star of thanks goes to our Compassion colleague Wendy Smith, without whom this book might never have been brought together or made its way to the publishers.

Joyce D'Silva and Carol McKenna, editors

Contributors

Noemi Altobelli is Community Manager of the Conscious Food Systems Alliance (CoFSA). She holds a degree in International Law. Prior to joining CoFSA, Noemi worked with NGOs, supporting Livelihood and Climate Resilience projects in The Gambia and Solomon Islands. She teaches yoga and meditation and is a musician and storyteller.

Molly Anderson is the William R. Kenan Jr. Professor of Food Studies at Middlebury College, where she directs the Food Studies Academic Program and teaches classes on hunger, food sovereignty, agroecology, and food power and justice. She is a member of the International Panel of Experts on Sustainable Food Systems.

James Bailey is Executive Director of Waitrose where he has redrawn their Agriculture Strategy, focusing on transparency of the supply chain, a net zero UK farming supply base by 2035, reduction in waste on farms and in the wider supply chain, and maintaining the highest standards of animal welfare.

Professor Tim Benton led the Environment and Society Programme at Chatham House, was a global agenda steward of the World Economic Forum and an author of the IPCC's Special Report on Food, Land and Climate (2019) and the UK's Climate Change Risk Assessment. He is a Research Professor at Leeds University.

Benjamin Leon Bodirsky is a Senior Researcher in the Land-Use group of the Potsdam Institute for Climate Impact Research. He works on quantitative future projections of the global food system and is a developer of the land system modelling framework MAgPIE.

Natasha Boyland is a Senior Research & Policy Advisor at Compassion in World Farming, part of a team aiming to improve aquatic animal welfare through advocacy, campaigning and food business engagement. Natasha's PhD focused on farmed animals' social behaviour. Her MSc research investigated the communication networks of European fiddler crabs.

Fabia Bromovsky is Strategic Advisor and Global Farm Metric Director at the Sustainable Food Trust. Fabia chairs the GFM coalition working group and her work has taken the Global Farm Metric to the next stage of consensus and adoption.

Donald M. Broom is Emeritus Professor of Animal Welfare at Cambridge University. He has chaired EU and other international scientific committees, has been a member of four UK government committees and has won many awards. His 400 refereed papers and 12 books concern animal behaviour, welfare, stress, sentience, sustainability, morality and religion.

Jakob Fritzbøger Christensen is Political Director of GRØN, the Foundation for Sustainable Development. He has worked extensively with transformation of the global food system and is the writer and producer of the popular, international documentary "10 Billion Mouths".

Jennifer Clapp is a Professor in the School of Environment, Resources and Sustainability at the University of Waterloo, member of the International Panel of Experts on Sustainable Food Systems and member of the Scientific Advisory Committee of the UN Food Systems Coordination Hub.

Chantal Wei-Ying Clément is the Deputy Director of IPES-Food. She holds a PhD in Political Science from Carleton University, where she was a researcher and lecturer on the politics of food, community food security and local food system governance.

Michael S. Crawford is a Postdoctoral Researcher at the Potsdam Institute for Climate Impact Research, where he co-develops the MAgPIE land system model within the Land-Use Management group.

Olivier De Schutter is a Co-Chair of IPES-Food and UN Special Rapporteur on extreme poverty and human rights. A Professor at UC Louvain, he was between 2008 and 2014 the UN Special Rapporteur on the right to food.

Henry Dimbleby is a Co-Founder of Leon restaurants, the Sustainable Restaurant Association and the charity Chefs in Schools. He authored two independent reviews for government: *The School Food Plan* and *The National Food Strategy*. The latter was reworked as the book, *Ravenous: How to Get Ourselves and Our Planet into Shape*.

Rune-Christoffer Dragsdahl is Secretary-General of the Vegetarian Society of Denmark, which helped achieve a landmark deal between the Government and Parliament, which resulted in 675 million DKK for initiatives to develop the plant-based sector in Denmark, including an agreement that Denmark should have a National Action Plan for Plant-Based Foods.

Shenggen Fan is Chair Professor at the College of Economics and Management at China Agricultural University. He was the Director General of the International Food Policy Research Institute 2009–2019. He is known for his work on transition economies and rural development. He is a Commissioner of the Food System Economics Commission.

Xiaolong Feng is an Associate Professor at the Academy of Global Food Economics and Policy, College of Economics and Management, China Agricultural University, Beijing.

David Finlay is a dairy farmer who experienced a fundamental belief system change from adhering to intensive animal production to trailblazing organic, compassionate farming. His cows are 100% pasture-fed and antibiotic-free, calves and mothers stay together much longer and his agroecological methods enable biodiversity to flourish on his farm.

Stefanos Fotiou is the Director of the FAO Office of Sustainable Development Goals, and Director of UN Food Systems Coordination Hub at FAO. In these roles, Stefanos provides strategic leadership and oversees coordination mechanism to support countries on SDGs' acceleration and integration. He holds a PhD in Natural Resource Economics and has 30 years of experience in the United Nations system, private sector and research organisations.

Reginaldo Haslett-Marroquin is a Co-Founder and CEO, Tree-Range® Farms and Founder/Chair, the Regenerative Agriculture Alliance. He was a consultant for the UNDP's Bureau for Latin America and was an advisor to the World Council of Indigenous Peoples. Regi operates a 65-acre farm where he does R&D on regenerative poultry production systems.

Nick Jacobs is the Director of the secretariat of the International Panel of Experts on Sustainable Food Systems. He previously worked as support to Dr. Olivier De Schutter, as a journalist for *Agra Europe*, providing coverage of EU agriculture and trade policy and blogged on EU politics for *EU Observer*.

Dr. Lyla June Johnston (Lyla June) is an Indigenous musician, author and community organiser of Diné (Navajo), Tsétsêhéstâhese (Cheyenne) and European lineages. Her doctorate focused on the ways in which pre-colonial Indigenous Nations shaped large regions of Turtle Island (the Americas) to produce abundant food systems for humans and non-humans.

Tracey Jones has been the Global Director of Food Business at Compassion in World Farming since 2013, overseeing its evolution and expansion, working with the world's leading food companies across Europe, the US and APAC/LATAM. Previously, Tracey was a researcher on applied farm animal welfare for 20 years.

Dr. Amir Kassam is a Visiting Professor at the University of Reading. He moderates the Global Platform on Conservation Agriculture Community of Practice. Amir is an agroecologist with a career in international agriculture research and development. He was awarded an OBE for services to tropical agriculture and rural development.

Dr. Laila Kassam is a Founder and Director of Animal Think Tank. She is the co-editor of the book *Rethinking Food and Agriculture: New Ways Forward* which envisions a just and sustainable food system. Laila previously worked in international development for 15 years and has a PhD in Development Economics.

Dr. Shireen Kassam is a Consultant Haematologist and Certified Lifestyle Medicine Physician. She founded Plant-Based Health Professionals UK, which provides education on healthy plant-based diets. Her first book is *Eating Plant-Based, Scientific Answers to Your Nutrition Questions* and she co-edited the textbook *Plant-Based Nutrition in Clinical Practice*.

Richard Kipling is the Head of Research at Sustainable Food Trust and played a key role in the design of harmonised, holistic frameworks for sustainability. He has extensive expertise in high nature value and climate friendly livestock farming. Previously, Richard was a lecturer in Sustainable Systems at Aberystwyth University.

Andrew Knight is a Veterinary Professor of Animal Welfare affiliated with Australia's Griffith University, a European, British and American veterinary specialist in Animal Welfare and a Fellow of the Royal College of Veterinary Surgeons. His many publications, websites and social media videos on animal welfare issues have attracted numerous awards.

Rattan Lal is Distinguished University Professor of Soil Science and Founding Director of the CFAES Rattan Lal Center for Carbon Management and Sequestration, Ohio State University. He was awarded the GCHERA World Agriculture Prize and Glinka World Soil Prize (2018), World Food Prize (2020) and India's Padma Shri Award (2021).

Elena Lara has a degree in Biology, a PhD in Marine Biology and an MSc in Animal Law. Currently, she is studying for an MSc in Planetary Health, alongside working for the international animal welfare environmentalist NGO, Compassion in World Farming, as a senior research and public affairs advisor.

Melissa Leach was the Director of the Institute of Development Studies (IDS) at the University of Sussex. She was the lead author of the World Social Science Report *Challenging Inequalities* and is a member of the International Panel of Experts on Sustainable Food Systems. She is a Fellow of the British Academy.

Thomas Legrand is Lead Technical Advisor for the UNDP-convened Conscious Food Systems Alliance (CoFSA), a movement of food, agriculture and consciousness practitioners which supports people from across food and agriculture systems to cultivate the inner capacities that activate systemic change and regeneration. He is the author of *Politics of Being* (2022).

Debbora Leip is a Doctoral Researcher in the Land-Use group of the Potsdam Institute for Climate Impact Research. She works with the global land system modelling framework MAgPIE, focusing on agricultural labour in future scenarios of the global food system.

Dr. André Leu is International Director of Regeneration International, which promotes food, farming and land-use systems that regenerate and stabilise climate systems and the health of the planet and people. He was formerly the President of IFOAM-Organics International, the global umbrella and change agent for the organic sector.

Emily Lewis-Brown leads the Global Farm Metric trials programme for the Sustainable Food Trust. She works to deliver research and advocacy that improves the well-being of people, the planet and animals, including for WWF, at UNFAO negotiations, and as advisor to the UN Patron of the Ocean.

Dr. Steven Lord, a global expert in food system and economic modelling for sustainability, risk and resilience, is Senior Researcher in the Food Systems Transformation Group of the University of Oxford. Current work includes cost modelling of global food system externalities and machine learning to predict food insecurity.

Prof. Hermann Lotze-Campen is the Department Head for Climate Resilience at the Potsdam Institute for Climate Impact Research (PIK) and a Professor of Sustainable Land Use and Climate Change at HU Berlin. He is working on global land-use modelling, climate impacts and economic damages and land-based climate change mitigation.

Philip Lymbery is the Global CEO of Compassion in Farming International, President of Eurogroup for Animals and Board member of World Federation for Animals. He is a former United Nations Food Systems Champion. An award-winning author, his latest book is *Sixty Harvests Left: How to Reach a Nature-Friendly Future* (Bloomsbury, 2022).

Janet Maro is a leading Tanzanian social entrepreneur and agroecologist. In 2011, she founded Sustainable Agriculture Tanzania (SAT), an umbrella organisation that is the main centre for organic and sustainable agriculture in Tanzania. The SAT Farmer Training Centre has trained more than 8,000 people on Sustainable Land Management (SLM).

Lesley Mitchell is Policy Director for the Sustainable Food Trust, developing policy evidence and advocacy for regenerative food and agriculture. Lesley is a specialist in systems change, with previous roles including leading Forum for the Future's global food systems practice and the head of International Farming Policy at World Animal Protection.

Dr. Rathana Peou Norbert-Munns is a Policy Expert at the Office of Sustainable Development Goals, FAO. An award-winning futurist (APF-IF 2022) and experienced researcher and practitioner on climate change, agriculture and food security, Rathana has extensive experience in design, implementation, capacity building and analysis within the practice of foresight planning for sustainable food systems.

Cóilín Nunan is Scientific Advisor to the Alliance to Save Our Antibiotics, an alliance of 67 organisations that campaigns against the overuse of antibiotics in livestock farming. He has co-authored numerous reports on antibiotic resistance and antibiotic residues, highlighting the human-health impact of excessive antibiotic use in intensive livestock farming.

Katherine Richardson is Professor in Biological Oceanography in the Section for Biodiversity, Globe Institute, Faculty of Health and Medical Sciences and Leader at the University of Copenhagen's Sustainability Science Centre. She is a core researcher in an international research team who identify "Planetary Boundaries" and co-authored *Earth Beyond Six of Nine Planetary Boundaries*, 2023.

Carl Safina is an ecologist and holds the Endowed Chair for Nature and Humanity at Stony Brook University. He is the founder of the not-for-profit Safina Center. His books include *Becoming Wild: How Animal Cultures Raise Families, Create Beauty and Achieve Peace* and *Alfie & Me: What Owls Know, What Humans Believe*.

Dr. Vandana Shiva is a physicist and environmental campaigner. She dedicates her life to protecting biodiversity and founded Navdanya to protect the diversity of living resources and promote organic farming and fair trade. *Forbes Magazine* identified Dr. Shiva as one of the top seven most powerful women on the globe.

Laura Strangeway is Head of Food System Transition in Compassion in World Farming's Food Business team. She has over 20 years' experience working in the food industry including food production, marketing and sustainability in manufacturing and retail roles. She is currently responsible for developing strategy, tools and resources to build the business case for change on the need to reduce our reliance on ASF and move towards regenerative farming.

Peter Stevenson OBE is Chief Policy Advisor for Compassion in World Farming. He is the lead author of the FAO study reviewing animal welfare legislation in the beef, pork and poultry industries. He has written reports on the detrimental impact of industrial farming on human health, biodiversity, deforestation, soils and water.

Seth Watkins owns Pinhook Farm, which is home to a herd of Angus cattle, several hives of honey bees, some chickens and a flock of Katahdin sheep. Seth strives to build a system that works with nature, by prioritising stewardship over production. Seth was a United Nations Food Systems Champion.

John Webster is Professor Emeritus at the University of Bristol, where he established the centre for the study of animal welfare and behaviour. He propounded the "Five Freedoms", internationally recognised as standards defining good welfare. His most recent book (2022) is *Animal Welfare: Understanding Sentient Minds and Why It Matters*.

Ruud Zanders is a Founding Partner of Kipster, a revolutionary poultry farm producing higher welfare eggs and meat with minimal pressure on the environment. Ruud dreams of the time when we no longer use animals at all in our food system. Until then, we must cause as little suffering as possible.

Introduction

Extinction or Regeneration? Humanity has the choice

Joyce D'Silva and Carol McKenna

There is more than enough food in the world to feed everyone. Yet, more than 780 million people are going hungry whilst nearly one-third of all food produced is lost or wasted. More than three billion people cannot afford healthy diets. Two billion are overweight or obese heightening their risk of diseases.

"In a world of plenty it is outrageous to still have hunger", said the Secretary-General of the United Nations, António Guterres, at the 2023 opening of the United Nations Food Systems Stocktake Summit. Our current food system is broken and results from decades of wrong choices.

The impacts of the food system go well beyond human health and food poverty. Forests and precious ecological grasslands are being laid waste for cattle grazing or growing soya and corn destined for animal feed. Soils are degraded from monoculture cropping and heavy use of chemical fertilisers and pesticides. Rivers, lakes and oceans are poisoned with run-off from these chemicals and with wastes from industrially farmed animals. It seems we are intent on destroying the planetary life support systems on which we depend.

The impact on animal lives is devastating too. Wild creatures lose their habitats as their homes are destroyed. Animals farmed for food are condemned to live in prison-like structures, where their every natural instinct is thwarted. They cannot graze or forage, they cannot rear their young (who are removed); they are kept in barren metal cages or on hard floors. Many have their bodies mutilated, often without anaesthesia or pain relief. Millions of aquatic animals also suffer from confinement or cruel fishing methods.

Add to this the impacts of climate change, especially on small-scale farmers in Africa, Asia and Latin America, and the impacts of the broken food system itself on climate change and we have a doomsday-like scenario.

This is why we need change – and urgent change. To build momentum for change and to inspire greater cross-sectoral collaboration, Compassion convened the 2023 Extinction or Regeneration conference together with IPES-Food and other partners.[1] The conference provided a platform for some of the world's best thinkers from a breadth of countries, cultures and areas of expertise to share solutions.

This book brings together much of the insights and knowledge shared at the conference and expands upon it, highlighting pathways to a global food system that works for people, planet and animals.

Many of the chapters look honestly at the damage being caused by our food systems and the barriers to change that need to be tackled. They also look forward to a better world. A world in which all people everywhere have access to sufficient affordable, nourishing food produced within the safe operating space of all nine planetary boundaries whilst protecting wild and

DOI: 10.4324/9781032684369-1

domestic animals and restoring soils, oceans, forests and biodiversity. Radical reform is needed to achieve this.

There is still time to change – but not much! The next few years will be decisive if we are to stop eating our way to extinction.

We hope you will find our book challenging but inspiring. We hope you will put its content to use and share it widely.

We are hugely grateful to all our chapter authors for encouraging the food system transformation that is so urgently needed.

Note

1 Other valued conference partners were the Jane Goodall Institute (UK), Birdlife International, FaithInvest, The European Environmental Bureau, Brighter Green, Eating Better, the Safina Center, the Institute of Development Studies, the University of Winchester and the Good Food Fund. The conference presentations are available online via www.extinctionconference.com.

Part 1

The urgency of food systems change

1 Why our children's future depends on a Global Agreement on food, climate and animal welfare

Philip Lymbery

The choice now facing humanity is extinction or regeneration. Looked at through the lens of the four seasons, our society is currently living through summer, an endless party, a time of limitless consumption as if the planet has no boundaries. Yet, the browning leaves of autumn are starting to show as anxiety grows over the climate and nature crises. Carry on as we are, and we face a perpetual winter. COVID-19 gave us a collective taste of that perpetual winter. It showed how society is vulnerable, fragile, not to be taken for granted. But how do we get to a new spring?

Well, the great news is there are beautiful, life-affirming, compassionate solutions already at hand that can take us to that never-ending spring.

Focal points

But we need to move quickly. If we are to have any chance at all of addressing pressing planetary emergencies of climate and the collapse of nature or achieving the Sustainable Development Goals (SDGs) of the United Nations (UN), we will have to focus on where we can have the most impact.

So, let's ask ourselves, then, what is the biggest land user on the planet? It's food. What is responsible for a third of greenhouse gas emissions? It's food. What accounts for 70% of all fresh water use in the world? It's food.

What this tells us is that the answer to addressing the climate and biodiversity crises, water conservation issues, and meeting our SDG targets lies with transforming our food system.

This will mean moving away from industrial animal agriculture to one that is based on nature-friendly, regenerative approaches to farming for food.

When it comes to food, animal welfare and the environment, society is starting to get a much greater appreciation of how things are intertwined. There is a growing recognition of the principle of "One Health, One Welfare": that the future health of people relies on the wellbeing of animals and a thriving ecosystem. That we are all in it together.

Joining the dots with an open mind quickly gets us to the point where we can see that being cruel to animals harms us all.

This was brought home to me when out walking the fields near the farm hamlet that is my home in the south of England.

Walking on the moon

It was early morning, and a tractor was pulling a plough. Back and forth it went, ploughing its lonely furrow. Behind the tractor, dust clouds spiralled and caught the sun, creating an aura.

DOI: 10.4324/9781032684369-3

A timeless symbol of the season. Only, something was missing: there were no screeching gulls following the plough in search of worms.

I took a closer look. The tractor was ploughing across a footpath, giving me a bird's eye view of the newly upturned soil. As I stared down, do you know what I saw? – nothing. There were no worms, beetles, or bugs desperate to get back into their world turned upside down. The soil was lifeless. It was like sand. We could have been walking on the moon.

That field should have had millions of worms in every hectare, in every patch the size of a football pitch. In each hectare, there should have been 13,000 species of life with a collective weight of an elephant: five tonnes (Griffiths et al. 2019).

But instead, there was nothing.

The field was planted with maize (corn), a crop commonly used as animal feed. Treated with chemical pesticides and artificial fertilisers, the soil had degenerated and was washing into the river.

It reminded me of seeing flowing green oceans of maize (corn) in the American Midwest of Nebraska, much of which was destined for the feed troughs of factory farmed chickens, pigs and cattle. I remember seeing feedlots. Hundreds of cows and calves stood in barren pens, not a blade of grass in sight. Despite the hot summer sun, they had no shade. I watched as they jostled in the searing heat, trying to get some respite by lying in each other's shadow.

It was a potent example of the factory farming regime that now ravages the planet.

Industrial revolution

Industrial agriculture is a recent phenomenon. It was but a single human lifetime ago when we started removing animals from the land to be caged, crammed and confined. Vast acreages of cropland elsewhere were then devoted to growing their feed. Factory farming was born.

Far from making food, factory farming wastes it because animals are particularly poor at converting crops into meat, milk and eggs. In the process, most of the food value in terms of calories and protein is wasted. In this way, we squander enough food to feed four billion people (Cassidy et al. 2013).

What has become obvious is that the way that we produce and consume food has changed beyond all recognition. Food systems have become ever more industrialised and dominated by animal-sourced foods. This change has brought us to the point where industrial animal agriculture is the biggest driver of wildlife declines worldwide and the greatest cause of animal cruelty.

At the same time, industrial agriculture is undermining the very thing we need to produce food in the future: soil. Which is why the UN has rightly warned that if we carry on as we are, we have just 60 harvests left in the world's soil. No soil, no food. Game over.

The choice before us, then, is extinction or regeneration, which was the theme of the major conference that inspired this book. The event brought together thought-leaders, academics, farming practitioners and those working on the front line of new and regenerative solutions to discuss what future-saving food system transformation needs to look like.

Food system transformation

It built on the groundbreaking work of the UN Food Systems Summit in 2021, a gathering of world leaders billed as a "People's Summit". This brought together a wide diversity of voices globally, including young people, women, food producers, Indigenous Peoples, civil society, researchers, the private sector, finance and governments.

The Summit's stated aim was to focus on transforming food systems to drive our recovery from COVID-19 and get us back on track to achieve all 17 SDGs by 2030. It was compelling stuff.

UN Secretary-General, António Guterres, who convened the Summit, framed the problem saying, "We are waging a war against nature - and reaping the bitter harvest. Ruined crops, dwindling incomes and failing food systems… The war on the planet must end, and food systems can help us build that peace" (UN 2021).

The challenge to world leaders was well and truly made. Governmental leaders called for global action to feed everyone whilst tackling the growing challenges of health, climate and biodiversity loss.

The statistics are sobering: more than 780 million people are going hungry whilst nearly one-third of all food produced is lost or wasted. More than three billion cannot afford healthy diets. Two billion are overweight or obese.

Yet we live in a world where nearly half our major cereal crops go into the feed hoppers of confined chickens, pigs and cattle. Industrial animal agriculture, or "factory farming" – the grain-feeding of confined animals – is the biggest single source of food loss, squandering enough grain to sustain half of humanity alive today. The result: animals suffer whilst people starve.

Recent food shortages are rightly blamed on the Russian conflict in Ukraine, a major wheat-exporting nation to the world. However, in truth, the root of the problem is that too much of our grain is geared towards feeding industrially reared farmed animals. For example, the UK and EU combined feed three times the equivalent of Ukraine's global wheat exports annually to the animals in their industrial farms (Lymbery 2022).

At the same time, reliance on industrial animal agriculture fuels malnutrition and sickness from unbalanced diets. Eating too much red and processed meat for example is associated with increased risk of cancer, heart disease and type 2 diabetes. In addition, the number of hungry and malnourished people in the world continues to grow.

In a heating world of more people and less resources, world attention has increasingly started to turn towards food as central to deciding the future of humanity.

Changing the narrative

The UN Food Systems Summit has undoubtedly achieved a crucial change in the global narrative: away from business as usual with a few tweaks to one of needing food systems *transformation*.

Looking back on my time attending that Summit, it felt like a new era dawning. That at the highest policy levels, there was a recognition that things can't go on as they are.

For those working in this field for decades, the change in narrative was striking. Thirty years ago, the dominant paradigm was that things have "never been better" and that anyone raising issues like hunger, wildlife declines or animal cruelty were hopeless idealists or annoyingly radical. Brick walls to change were as high as they were deep. All that we felt could be aspired to back then were incremental changes to make things less bad. Aspirations of feeding everyone well, of reversing wildlife declines, or of decent lives for farmed animals were seen as hopelessly extreme. Fundamental change was but a pipedream.

Scroll forward to the 2021 UN Food Systems Summit and the topline rhetoric had changed to that of food system transformation. A procession of national leaders queued up to recite reasons for food system change. But the emphasis was on things like aiming for the provision of school meals for every child, zero food waste and agricultural innovation. Profoundly good and much-needed changes. Yet, gravitating towards opportunities that could be described as lowest hanging fruit.

We are now at the halfway point for delivering on the globally agreed 2030 SDGs. Most of them are offtrack or going backwards. Getting the world back on track will take a radical overhaul of our food systems.

Blind spot

The reality is that without moving away from industrial animal agriculture, or "factory farming", most SDGs will remain seriously out of reach. As will addressing the growing crises of climate, nature and pollution.

A genuine grasp of the need for this fundamental shift has largely remained a universal governmental blind spot, until very recently.

Time ticking

Scientists are clear that we have less than a decade left to cut emissions to keep global warming within 1.5°C of temperature rise deemed "safe".

Climate change will hit developing countries and people on low incomes disproportionately hard. It will also affect animals, not only leading to extinctions but also greater suffering caused by flooding, drought and wildfire disasters like those seen in Australia, Pakistan and the Amazon.

As for nature, if we carry on as we have done for the last half a century, the world is on course for almost total obliteration of our wildlife by 2040 (WWF 2022). At the same time, tropical forests, vital as the lungs of the Earth, are under enormous pressure, not least through expansion of industrial agriculture. By 2040, current rates of deforestation look set to erase an area of forest the size of half the EU. Added to which, the very thing that stores so much atmospheric carbon and water, as well as producing most of our food – the soil – is disappearing, with industrial agriculture a major cause. By 2040, in a world with more than a billion more mouths to feed, there could be a third less soil, with devastating implications for food production, food security and global stability. All of which ups the prospect of mass migration, of societal unrest and of world-ending conflict.

Decisive decade

The 2020s have been described as the "decisive decade" on climate change. The available evidence shows that without ending industrial animal agriculture and associated high-meat diets, it will be followed by the "desperate decade" of the 2030s where government leaders scramble belatedly to do what they should have done today. Urgent action is needed to stave off a planetary tailspin and the "deadly decades" that would follow.

What the data tells us is that shifting to regenerative farming and diets much less dependent on animal products needs to happen now, with the utmost urgency. Leaving it beyond 2040 will be too late.

Elephant in the room

Outside the UN Food Systems Summit, transforming food systems has barely got a mention.

UN Climate Change conferences (or COPs) have taken place every year for nearly three decades, yet the fact that the issue of food has hardly figured at previous gatherings has rendered them a copout. Their failure to address this elephant in the room has left the world on a perilous course. As things stand, our over-consumption of meat alone could trigger catastrophic climate change.

As already noted, a third of greenhouse gas emissions globally are caused by food and the way we produce it (IPCC 2019). The majority of this comes from agriculture and deforestation to make way for new farmland. The livestock sector alone produces more greenhouse gases than the direct emissions of the world's planes, trains and cars combined.

The latest science from the UN's Intergovernmental Panel on Climate Change (IPCC) suggests that greenhouse gas emissions need to be cut by 43% by 2030 (UN 2022). This is critical to limit temperature rise to 1.5°C by the end of this century. Failing to hit this target will unleash some of the worst impacts of climate change, including more frequent and severe droughts, heatwaves and rainfall. Extinctions, crop failures and widespread suffering are likely to result.

Thankfully, the UN's 28th Conference of the Parties (COP28) in Dubai in December 2023 saw a breakthrough.

COP28 opened with a Presidency Declaration on food systems, farming and climate (COP28.com 2023). Described as a "landmark" statement of intent, over 150 countries signed on, including the UK, EU and the US. It affirms that tackling climate change means that food consumption and production "must urgently adapt and transform". It forms a commitment to integrate food and farming into future climate negotiations. It also sets its sights on 2030 and the culmination of the world's SDGs, making the connection that tackling food and climate together are essential if targets are to be met.

COP28's food declaration is a welcome development, and one that has been nearly thirty years in the making. Success will be defined by the level of ambition that now transpires.

Big change coming

Stefanos Fotiou of the UN Food and Agriculture Organization (FAO), charged with taking forward the outcomes of the recent UN Food Systems Summit, saw it as a development second only in significance to the Paris Agreement itself. That was where the world agreed to the original climate treaty.

Fotiou took to X (formerly Twitter) saying, "it is important to stress the need for urgent transformative climate action now. Key to this, in addition to fossil fuels phase out, is the reduction of emissions from agrifood systems". (See Chapter 3 by Stefanos Fotiou and his colleague Rathana Peou Norbert-Munns.

Also significant at that time (2023) was the release of a report by the UN Environment Programme (UNEP) looking at plant-based, cell-based and fermentation-based alternatives to conventional animal products in addressing the adverse impacts of animal agriculture. According to the report, these show "strong potential for reduced environmental impacts compared to many conventional animal products… [and] have the potential to drastically reduce harm to animals" (UNEP 2023).

I've always believed that the first step to big change is recognition of the problem.

Now, after thirty years of absence, food systems are officially recognised as a key driver of climate change. Getting the world off fossil-fuel addicted factory farming, with its fertilisers, cages and live animal transport, together with reducing consumption of conventional animal products, is a must-do for a climate-friendly world.

To be sure, the one thing we can guarantee is that big change is inevitable, that we simply cannot go on as we are.

Beyond sustainability

In a world with more mouths to feed and shrinking planetary resources – land, water and climate stability – sustainability won't be enough. Being able to do tomorrow what we do today simply won't cut it.

Instead, we need solutions that are regenerative – working with nature in ways that put back into our natural bank account: rebuilding soils, water and wildlife biodiversity whilst producing nutritious food in ways that ensure all animals can flourish in high welfare farms.

Towards a new spring

Which is why we need those beautiful, life-affirming, compassionate solutions mentioned at the beginning of this chapter – which can be summed up in three "R"s: Regeneration, Rethinking Protein and Rewilding, not least of the soil.

Regeneration

Regeneration of the countryside through high-welfare, nature-friendly or regenerative farming that involves restoring animals to the land as rotational grazers or foragers where they can express their natural behaviours – running, flapping their wings, grazing – making for happier animals with better health too. Regenerative farming cuts reliance on chemical pesticides, fertilisers and antibiotics, reducing costs to farmers and creating a varied landscape bursting with wildflowers that lure back pollinating insects like bumblebees, as well as providing seeds and insects for birds and other wildlife.

Rethinking protein

Rethinking protein by reducing our consumption of meat and milk from animals. Combining regenerative farming with a serious reduction in the number of farmed animals can create food systems that are genuinely sustainable. Based on scientific assessments within the EAT-Lancet Planetary Health Diet, we can see that saving the planet will require drastic reductions in consumption of animal-sourced foods.

Evidence shows that by the middle of the century, our consumption of animal products globally must be reduced by more than half (Willett et al. 2019; Loken et al. 2020). In high-consuming regions such as the West, deeper cuts will be needed. For example, the UK and EU would need reductions of two-thirds, whilst in the US, a reduction of four-fifths is required.

By rethinking protein, meat from farmed animals would come only from higher welfare, nature-friendly regenerative farms. Consumption of animal-sourced foods would be reduced through replacement with plant-based and other alternative proteins. These could include cultivated meat from stem cells grown in a bioreactor, and precision fermentation – the production of protein from the action of programmed microbes. These alternatives, together with eating more fruit, vegetables and legumes, holds the key to more planet-friendly, balanced diets.

Rewilding the soil

The third "R" in our planet-saving repertoire would be Rewilding the soil. This can best be achieved by returning animals to the land and keeping them regeneratively – as part of mixed rotational farms. Where they can turbo-boost soil fertility by feeding that elephant's weight of biodiversity that should be under our feet. Farmed animals living their best lives. Experiencing the joy of life. Huge amounts of carbon could be locked up in healthy soil. Much more water would be conserved for crops. And a vast array of biodiversity would be restored to thriving farmland.

New day dawning

We urgently need a new dawn for people, animals and the planet; the big question is, how do we get there, and fast?

The answer is by truly embracing those beautiful, life-affirming, compassionate solutions represented by the three "R"s.

Transformation of food systems needs to be a central theme in global conversations on climate, water, biodiversity and achieving the SDGs. Every time governments meet to discuss climate, or food security, or biodiversity, or the SDGs, or global development, there should be a concerted focus on addressing that elephant in the room – industrial animal agriculture.

In this way, we can create the much-needed single-minded clarity that means ending the war on the planet and building peace through nature-friendly food systems. It means embracing food systems that are truly nature-based, inclusive, livelihood sustaining and carbon capturing. It means making decent, nutritious, planet- and animal-welfare-friendly food a basic human right, not just a privilege for those who can afford it. It means moving to a regenerative food future.

Key actions

So, who needs to be involved and how?

The answer lies in us all playing our part: governments, business, finance, the UN and civil society working in partnership to transform the food system.

It lies in governments creating policy environments for change, using directives, incentives and subsidies to steer food and farming away from cages and confinement towards this new nature-friendly era. The opportunities for greening food production are enormous – take subsidies: globally, governments provide US$700 billion a year in farm subsidies, more than US$1m per minute, much of which currently drives industrial farming, the climate crisis and destruction of wildlife. That money could be far better spent redirecting it towards regenerative farming and reducing demand for meat.

It lies in food companies setting measurable targets for the reduction of animal-sourced foods, shunning those from the factory farm altogether. Cage-free commitments are a key prerequisite to humane and sustainable food.

It lies in the financial sector ensuring that funding is only available to support the transition towards welfare-friendly and nature-positive practices.

It lies in policymakers recognising that big change is inevitable. In recognising that we no longer have the luxury of asking, can we afford to change? – the fact is, we cannot afford not to.

Leadership is therefore needed at the highest level through an overarching UN Global Agreement to transform food systems. Food's central role in the success of existing conventions, not least on climate and biodiversity needs to be recognised and addressed through a unifying Convention. One that shifts towards regenerative food and farming and away from industrial animal agriculture. To one that sees animal welfare as an essential part of sustainable food systems and thereby a future for us all.

The choice before us remains extinction or regeneration. There is still time to act. But we are beyond the eleventh hour. We have just seven harvests left to save the SDGs. We have just sixty harvests left in our soils to save the future for our children. For people, animals and the planet, the clock is ticking. There is no time to lose. What we do now will define the next one thousand years.

Author's note

Philip Lymbery is Global Chief Executive of Compassion in World Farming, author of *Sixty Harvests Left: How to Reach a Nature-friendly Future* (Bloomsbury 2022), and a regular columnist in *The Scotsman*. This chapter is adapted from the book and subsequent columns and is an expanded version of Lymbery's opening speech to the conference, *Extinction or Regeneration: Transforming food systems for human, animal and planetary health,* in May 2023.

References

Cassidy E S, West P C, Gerber J S and Foley J A, 2013. Redefining agricultural yields: From tonnes to people nourished per hectare. *Environ. Res. Lett*. 8: 034015 (8pp). http://dx.doi.org/ 10.1088/1748-9326/8/3/034015

COP28.com, 2023, 1 December. COP28 presidency puts food systems transformation on global climate agenda.www.cop28.com/en/news/2023/12/COP28-UAE-Presidency-puts-food-systems-transformation

Griffiths B, McDonald C and Lawrie M-J, 2019. Soil biodiversity and soil health. Farm Advisory Service, Scotland. Technical Note 721. www.fas.scot/downloads/tn721-soil-biodiversity-and-soil-health/

IPCC, 2019. Climate change and land. https://www.ipcc.ch/srccl/

Loken B et al., 2020. Diets for a better future. EAT. https://eatforum.org/content/uploads/2020/07/Diets-for-a-Better-Future_G20_National-Dietary-Guidelines.pdf

Lymbery L, 2022, 23 May. Ukraine War: 'Apocalyptic' global food crisis is being exacerbated by factory farming of grain-fed animals. www.scotsman.com/news/opinion/columnists/ukraine-war-apocalyptic-global-food-crisis-is-being-exacerbated-by-factory-farming-of-grain-fed-animals-philip-lymbery-3702707

UN (United Nations), 2021. Food's a human right, not just 'a commodity to be traded': Guterres. https://news.un.org/en/story/2021/09/1100942

UN (United Nations), 2022. Climate plans remain insufficient: More ambitious action needed now. https://unfccc.int/news/climate-plans-remain-insufficient-more-ambitious-action-needed-now

UNEP (United Nations Environment Programme), 2023. What's cooking? An assessment of potential impacts of selected novel alternatives to conventional animal products. https://www.unep.org/resources/whats-cooking-assessment-potential-impacts-selected-novel-alternatives-conventional

Willett W et al., 2019. Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet* 393(10170): 447–492. http://dx.doi.org/ 10.1016/S0140-6736(18)31788-4. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext

WWF, 2022. *Living Planet Report 2022 – Building a Nature-Positive Society*. Almond R. E. A., Grooten M., Juffe Bignoli D. and Petersen T. (Eds). Gland, Switzerland: WWF. https://www.wwf.org.uk/sites/default/files/2023-05/WWF-Living-Planet-Report-2022.pdf

2 Addressing power and poverty in a crisis-prone food system

Olivier De Schutter, Chantal Wei-Ying Clément and Nick Jacobs

Over the past three years, the glaring vulnerabilities and inequalities in our global food system have been thrust into sharp relief. Ongoing supply chain disruptions, food price spikes and an explosion of hunger have disproportionately impacted vulnerable and marginalised populations around the world. From the COVID-19 pandemic to the Ukraine war, climate shocks to protracted conflicts, a series of compounding crises have unveiled the troubling reality behind our food systems: control over resources, markets and decision-making is concentrated in the hands of a few, leaving vulnerable communities at the mercy of a crisis-prone system (IPES-Food 2020; IPES-Food et al. 2021).

The inequity embedded in our global food system, however, is not the result of happenstance; it is the outcome of a logic over a century in the making that has favoured productivism and a profit-driven growth model over social justice and sustainability, allowing unprecedented power to accrue to a handful of dominant actors. This industrial food system model is now clearly faltering under the weight of contemporary challenges. Calls for food system reform are gaining ground, particularly as climate challenges come to the fore, but reforms will only succeed if we address questions of power head on.

This chapter aims to shed light on power and the mechanisms that drive inequality within our food systems. After a brief reminder of how the modern food system emerged, we consider three ways that perpetuate ongoing power imbalances and exacerbate food systems' vulnerability in the face of shocks, namely: market concentration and price distortion, persistent livelihoods pressures and marginalisation of small farmers and economic disparities resulting from the global trading system and debt. Finally, we explore how agroecology could serve as the blueprint we need to break away from the current food system, redistribute power away from dominant actors and set us on a sustainable course.

A crumbling legacy: Origins and impacts of the modern food system

The origins of the modern food system stretch as far back as the 19th century, when industrialised countries reshaped food chains through colonisation, industrialisation and global integration. However, the logic underpinning food systems today derives largely from choices made in the post-World War II period. In the 1960s and early 1970s, rapid population growth – almost double today's rate – threatened a major crisis. Stagnating yields in many developing regions, aggravated by limited import capabilities, compounded the threat of insufficient food for a booming population and convinced policymakers that the answer was to produce more food.

This mindset would drive agricultural policies for the next 50 years. Whilst the specific responses would differ from region to region, the general approach was similar all over: thanks to a combination of technological advances, private funds and public policies – including subsidies

DOI: 10.4324/9781032684369-4

to farmers and research funding – outputs were raised and prices driven down. The Common Agricultural Policy of the European Union (EU) and the US reforms under US Department of Agriculture (USDA) Secretary, Earl Butz, in the 1960s epitomised this ethos, encouraging mass production of staple commodities and guaranteeing compensation for surplus production. Similar approaches were rolled out in the Global South and particularly in South Asia, where the risks associated with overpopulation were considered to be highest and concerns about pro-communist sentiment – in a context of massive rural poverty – were considered the most acute. The "Green Revolution" spread across India, the Philippines and Mexico aimed to increase agricultural output through technology transfer, high-yield crop varieties, expansion of irrigated land and intensifying chemical fertiliser use. Around the world, governments and international organisations learned to narrowly prioritise productivity and understand hunger as a *quantitative* problem that science and technology would always be able to solve.

The logic of industrialisation, specialisation and mechanisation transformed food and farming systems. This revolution succeeded spectacularly in meeting the productivity goals it set out to achieve: whilst population growth began to slow in the late 1960s, the total output per hectare of agricultural land would continue to grow steadily for 50 years at an average of 2.1% per year (Fuglie et al. 2012). In addition, technological advances and new breeding techniques allowed for greater food production without significantly expanding areas under cultivation: whilst the world population nearly doubled between 1961 and 2001, the amount of land cultivated to feed this growing population only increased by 12% (Alston and Pardey 2014).

However, these successes have begun to unravel, with recent crises exposing the inherent weaknesses of industrial systems particularly in terms of ensuring social equity. Below, we identify three ways in which food systems have generated and continue to generate inequities and power imbalances – three key weaknesses that must be urgently addressed:

Market concentration and price distortion

The Green Revolution and the industrialisation of the global food system put a premium on input-responsive crops with universal applications, as well as global food commodity trade and distribution. In this context, leading firms have been able to accumulate huge market shares and profits, exacerbating long-standing trends of market concentration in the agrifood sector. Today, following unprecedented mergers and corporate integration, a small number of companies have been able to expand their influence across the entire supply chain, from food production to retail. For example, only four companies – ADM, Bunge, Cargill and Dreyfus – control an estimated 70%–90% of the world grain market (Clapp and Howard 2023). Just four companies (Syngenta Group, Bayer, BASF and Corteva) control over 50% of the seed industry and over 60% of global agrochemical sales; and only six companies control over 50% of the global market for farm machinery (ETC Group 2022).

It has been made clear that the excessive market power of leading firms contributed to recent price inflation, with corporate price gouging identified as a leading cause of food price spikes in the US during the COVID-19 pandemic (Weber and Wasner 2023). Another recent analysis – corroborated by members of the US Federal Reserve and the European Central Bank (Inman 2023)[1] – confirmed that corporate profiteering played a major role in increasing global food prices in recent years. Further, fertiliser companies reported a 36% increase in profits in 2022, whilst leading grain companies saw record earnings, highlighting the risks of excessive market power at these highly consolidated nodes of the chain (Clapp and Howard 2023).

Concentration of power reduces competition and gives farmers little control to negotiate fair prices and conditions (IPES-Food 2017). It also affects consumers by limiting their choices and exacerbating food price inflation, with devastating consequences for the world's poorest, who spend up to two-thirds of their incomes on food (World Bank 2019). Over the past three years, food prices have skyrocketed, particularly in the wake of the Russian invasion of Ukraine, with some countries experiencing food price inflation above 100% (Baffes and Mekonnen 2023) and an additional 122 million people around the world being driven to hunger since 2019 (FAO 2023).

In addition, recent crises have shown that power is not only found in the hands of a few agrifood corporations but also in those of financial actors outside the food system with the ability to capitalise on market unpredictability.[2] For example, hedge funds were reported to have made an estimated two billion USD in profit from trading grain and soy following the invasion of Ukraine in 2022 (Harvey 2023). Such sudden influxes of investment into commodity futures markets risks major fluctuations in food prices without any accountability of real availability and demand (Clapp 2023), making it incredibly difficult for farmers to plan production and anticipate their earnings, whilst leaving consumers at the mercy of price volatility.

Persistent livelihood pressures and marginalisation of small farmers

The industrialisation of our food systems set in motion a process of marginalising smallholder farmers that remains one of the major global drivers of social inequity today. Production increases between 1960 and 2000 went hand in hand with regional specialisation in a relatively narrow range of products; this process, encouraged by policy incentives and the growth of international trade in agriculture, led to the rapid expansion of monocultures.

Monocultures reward economies of scale and favour the largest landholders, who are better positioned to achieve efficiency gains under this model. This model also increases farmer dependency on multinational corporations for inputs, for example by prioritising seed traits that require specific pesticides or fertilisers produced by the same company. Whilst these inputs initially allowed for increased productivity, escalating input costs strain farmers' finances, forcing them into dependency and overwhelming debt. The need to continuously re-invest in inputs exacerbates farmers' vulnerability to market fluctuations and strains their livelihoods. Indeed, since 2019, farm debt has increased exponentially around the world, driving an increase in farmer suicides at an alarming rate (CDC 2023; NCRB 2023).

In parallel, farmers in the Global South have been exposed to unfair competition with other regions. Overproduction in the highly subsidised farming sectors of the Global North has put downward pressure on global agricultural prices, relegating many small farmers to subsistence agriculture and accelerating rural outmigration (Stein 2011; FAO 2016). To date, those remaining in rural areas make up over 80% of the world's extreme poor, the majority of whom continue to rely on agricultural work to sustain their livelihoods (UN 2023). Further, because of male outmigration from rural areas, small-scale farming has become largely dependent on family labour and women. Yet the mobility and time constraints women face, as well as discrimination in access to land, inputs and farm extension services, further restrict their and their families' livelihoods (De Schutter 2013).

Today, farmers – and particularly smallholders in the Global South – remain in a highly precarious position. Boom-bust cycles continue to undermine farmer livelihoods, with food producers squeezed by ever-more powerful input providers and corporate buyers and unable to profit even on the price upswing (IPES-Food 2023a). Indeed, following the Ukraine war, the global input price index reached an all-time high due to rising energy prices, with an average monthly growth rate three times higher than the rise in food prices over the same period (Schmidhuber and Qiao 2022). This spike raised major concerns that farmers would be unable to purchase the necessary inputs to produce food for the coming years, further threatening farmers' livelihoods, consumer prices and global food security.

Further, whilst new investment has flooded into the sector post-2007, it has failed to reach smallholders and has often been channelled into large-scale land acquisitions that threaten their access to land and resources. In particular, investments frequently prioritise export-oriented cash crops or biofuel production over domestic food needs, leading to dispossession of land, loss of livelihoods for smallholders and the resilience of affected communities (IPES-Food 2023a, 2022a). Land inequality is becoming an ever-more pressing issue, with less than 1% of farms operating over 70% of the world's farmland by 2010 (Lowder et al. 2021).

Lastly, whilst the negative environmental impacts of the industrialisation of food systems have been increasingly recognised,[3] it is worth noting that they have disproportionate and devastating impacts on the world's poorest and those most reliant on agriculture for their livelihoods. Indeed, small-scale farmers, fishers and food workers in the Global South are being hit first and worst by the effects of climate change, due to increased weather-related shocks and already limited access to resources and financial support. And as climate change increases risk, farmers face even greater barriers to access credit and resources. As a result, many are being forced into losing scenarios. For example, small-scale cacao producers in the rainforests of Brazil have experienced major drops in productivity in recent years due to climate change and deforestation. To avoid starvation, they are being pushed into selling timber and driving further deforestation to make room for cattle farming, despite the environmental threats they know such industries cause to their communities (Mahony 2023). Others do not have the option to remain on their lands: many rural and Indigenous communities are being displaced due to land grabs or escalating rents. Often, these communities are resettled onto marginal lands that lack the resources to cope with environmental stresses – exacerbating poverty and marginalisation.

Trade, debt and global economic disparities

Another legacy of the Green Revolution is import/export dependencies, which have left countries in the Global South vulnerable to market fluctuations, external economic shocks and rising debt, thereby perpetuating economic disparities and power imbalances between world regions. The dominance of the industrial agricultural model and its focus on export-oriented, high-yield crops has turned many developing countries into net food importers, displacing traditional diets and food crops despite their environmental resilience and nutritional benefits (IPES-Food 2016). When the prices of agricultural products suddenly increased in 2007, most of the world's "Least Developed Countries" (LDCs) realised they had failed to invest in their own farmers to satisfy local needs, having shifted the bulk of their production to a narrow range of commodities for export.

The growing reliance of developing countries on staple food imports – including the dumping of heavily subsidised foods – has made it particularly difficult for smallholder farmers to make a living and has created a reliance on cheap food imports as a de facto social policy, i.e., a substitute for improved wages for workers in the non-agricultural sectors and the establishment of social protection floors. Those risks have been amplified in the face of rising shocks and increasingly volatile food prices, becoming a recipe for social and political instability and creating a cycle that many countries struggle to escape from (IPES-Food 2022a).

Further, the recent spike in food and input costs has helped to precipitate a debt crisis in many middle- and low-income countries (IPES-Food 2023a). In 2023, low-income countries not only faced the highest levels of debt repayments since the 1990s but also near-empty public purses following the COVID-19 pandemic and economic disruptions following the Ukraine war (Chuku et al. 2023). Many countries have found themselves caught in a vicious cycle, compelled to continue importing staple foods at sky-high costs to feed their populations and increasingly reliant on export-oriented cash cropping to generate the required foreign currency reserves to service their debts and continue importing food and other essentials.

--

The assessment above is by no means an exhaustive list of the impacts of today's global food system. Nevertheless, these trends reflect the failure of the productionist approach to benefit communities or prioritise sustainability. Although hunger and poverty alleviation were central goals of the industrialisation of food systems, broader concerns about power and social equity were never the main concern. As shown above, globalised food chains favour large agribusinesses and retailers, consolidating power and worsening inequities. Structural biases undermine small farmers' access to these chains, perpetuating dependency and exploitation particularly in low-income countries. In 2021, UN agencies found that almost 90% of agricultural subsidies harmed public health, the climate and drove inequality (FAO et al. 2021). For decades, these concerns have been critically overlooked and under-prioritised and can no longer be ignored.

The promise of agroecology

Recent crises have shed light on a system in which the incentives of a narrow set of actors hold the greatest sway over the shape and function of our food systems. To break away, a transformation towards food system sustainability requires no less than a bold paradigm shift that decentralises and diversifies food systems, redistributes power and prioritises social equity rather than reinforces today's disparities.

The crises of recent years provide an opportunity for this shift, although they are also being used by powerful actors to reinforce the status quo. In the wake of the Ukraine war, public and private actors urged governments to ramp up production to keep feeding the world, often to the detriment of environmental and social regulations (IPES-Food 2022a). For example, the European Commission deferred two legislative proposals to regulate pesticides and improve nature restoration targets and allowed Member States to grow food on land previously designated as "ecological focus areas". Former President of Brazil, Jair Bolsonaro, argued an increase in fertiliser prices was ground to lift a ban on mining on Indigenous lands in the Amazon. More recently, UK ministers scrapped a proposal to tackle food waste citing the current cost of living crisis as a reason to defer the law, despite the government's own assessment finding that even a 0.25% reduction in food waste would balance out any costs to implement it (Uba 2023).

Relatedly, "climate-smart agriculture" or "nature-positive production" approaches are increasingly being touted by public and private actors alike in national debates and international fora, including the climate and biodiversity COPs, as *the* solutions to tackle climate change. However, these approaches tend to perpetuate a technocentric and productionist logic by favouring large-scale industrial approaches over locally adapted or community-driven solutions. They risk further sidelining smallholder farmers and Indigenous practices by neglecting socio-economic disparities and only addressing the symptoms rather than the underlying causes that lock in unsustainability in food systems (IPES-Food 2022b).

In contrast, agroecology offers a holistic paradigm shift, and a pathway beyond the harmful legacy of industrialisation. Agroecology has been defined as an integrated approach that applies ecological and social concepts to the study, design and management of sustainable agroecosystems (Altieri 1995; Gliessman 2007). It is not a new concept, but one that has been practiced by Indigenous peoples and smallholder farmers for centuries, explored in scientific literature since the 1920s and taken up by grassroots movements as the benchmark for sustainable development around the world (FAO 2018). Agroecology is highly knowledge-intensive, based on techniques that are not delivered top-down but developed based on farmers' knowledge and community experimentation. As opposed to the concentration of knowledge and power at the heart of the industrial food system, agroecology enhances autonomy and resilience through a system in which communities and small-scale farmers shape their own systems and equip one another with the tools and capacity to adapt to changing conditions.

A wide panoply of techniques has been developed and successfully tested across world regions based on this perspective, including integrated nutrient management, agroforestry, water harvesting and crop-livestock integration, amongst others (Pretty 2008). Such resource-conserving, low-external-input techniques have a huge, yet still largely untapped, potential to address the combined challenges of ensuring production, encouraging rural development, preserving ecosystems and mitigating climate change. Through diversification in the field and through local adaptation, agroecology has proven more resilient than conventional systems, offering marginalised groups greater security against external market fluctuations or environmental shocks (Sinclair et al. 2019).

Agroecology challenges the dominance of large agribusinesses and their influence across the entire supply chain by cutting our intermediaries, promoting local markets, direct sales and more cooperative distribution channels and networks. It has been shown to improve the incomes of small-scale farmers and rural communities by limiting reliance on external inputs (Baum and Mechsner 2023). It puts agriculture on the path of true sustainability by delinking food production from the reliance on fossil energy and by increasing carbon sinks (see for example, Aubert et al. 2020). Lastly, agroecology's focus on local crops and breeds plays a crucial role in diversifying diets and providing communities with fairer access to nutritious, culturally adapted foods (see IPES-Food 2018).

Agroecology is not a pipe dream, but an achievable approach. Despite the challenges of recent years, we have witnessed a myriad of success stories of farmers building resilience in the face of adversity, of communities defending their food security through solidarity initiatives, and governments resisting corporate power to crack down on junk food and put new social and environmental protections into law (see also, IPES-Food and ETC Group 2021; IPES-Food 2023b) – all crucial steps of an agroecological transformation. In 2018, the Food and Agriculture Organization of the United Nations' (FAO) *10 Elements of Agroecology* represented a strong attempt to "operationalise" agroecology, distilling it into ten mutually reinforcing principles meant to support the planning, management and evaluation of agroecological transition (FAO 2018).

Indeed, agroecology is a comprehensive approach whose principles will need to be translated through robust but achievable shifts in practice, policy and thinking across the entire food system: it will mean incentivising agroecological practices through subsidies, redirecting research and development budgets, providing technical assistance for transition and fostering collaborative platforms for sharing traditional and innovative farming knowledge. It will mean prioritising social equity across the food system through new modes of social production, strengthening labour rights and addressing the dependencies in the Global South, who have been forced into colonial patterns of extraction and domination. It will also mean transforming governance structures by breaking down concentration in agrifood chains through stricter competition policy and antitrust laws, cracking down on false solutions and quick "techno-fixes" for agriculture and building out new forms of citizen participation. Such actions could steer agriculture towards resilience, enhanced resource efficiency and greater environmental sustainability within food systems.

In 2021, over 1,000 organisations and experts called for governments, corporations and civil society to adopt the principles of agroecology as the unifying framework for food systems transformation (IPES-Food et al. 2021). The call to action warned against dominant actors proposing "greenwashed" or weakly defined solutions to maintain the status quo or only address one part of the food system. Amidst the challenging reality of recent years, agroecology holds promise in reshaping a broken system. It envisions a future where food production is not a source of inequality but a catalyst for social justice, environmental stewardship and resilience in the face of crises.

Conclusion

Whilst recent crises may not have been predictable, many of their devastating impacts were certainly preventable. The concentrated control over resources, distribution and decision-making by a select few has disproportionately affected marginalised populations, amplifying hunger and inequalities. As we navigate the complexities of a food system on the brink, we underscore the urgency to address power imbalances, confront inequality and alleviate poverty through transformative change.

However, any meaningful transformation hinges on confronting the central issue of power within our food systems. The productionist priorities of cheap food, cheap energy and infinite growth have become empty promises, creating unprecedented space for new thinking to emerge.

By freeing ourselves from the stranglehold of the industrial food system, we can forge a path towards a more equitable and resilient future. Agroecology stands as a testament to this possibility, calling us to realign our approach, policies and actions towards sustainability. This call to action is not just for governments and policymakers but for communities, businesses and individuals to collectively reimagine a food system that values equity, resilience and nourishment for all.

Notes

1 Corporate profiteering in times of crisis is nothing new. In the early 1970s, poor harvests combined with the first oil crisis suddenly drove food and fertiliser prices – and profits – upwards. Similar profiteering occurred during the food price crisis of 2008, when low crop yields due to climate shocks and higher energy prices sparked a growing demand for biofuels and futures market speculation (Clapp 2023).

2 A link between financial actors and agricultural commodity trade has existed for centuries, but financialisation in the agrifood sector has grown significantly in recent decades due to a slackening in regulation and the expansion of neoliberalism under the WTO. The increasing role of financial actors became a major contributing factor to the food crisis of 2008, when instability in financial markets pushed investors to rapidly move into commodity-driven investments to seek higher and more stable returns. The sudden influx of investment increased basic food commodity prices between 100% and 200% between 2006 and 2008 (WRI 2008).

3 Over the last two decades, however, yield increases for major crops in industrial agricultural systems have plateaued – with further decreases in yields predicted as the effects of climate change take hold (IPES-Food 2016; Zhu et al. 2022). Intensive use of chemical inputs in industrial agriculture has led to soil degradation, loss of biodiversity, and water pollution. In addition, industrial food systems have become increasingly vulnerable to and a leading cause of climate change and are responsible for one third of greenhouse gas emissions and 15% of global fossil fuel use (IPES-Food 2023b).

References

Alston J M and Pardey P G, 2014. Agriculture in the global economy. *Journal of Economic Perspectives* 28(1):121–146.

Altieri M A, 1995. *Agroecology: The Science of Sustainable Agriculture*. 2nd ed. Boulder, CO: Westview Press.

Aubert P M, Schwoob M H and Poux X, 2019. Agroecology and carbon neutrality in Europe by 2050: What are the issues? Findings from the TYFA modelling exercise-Study No. 02, April 2019.

Baffes J and Mekonnen D, 2023. Falling food prices, yet much higher than pre-covid. *World Bank Blogs*. https://blogs.worldbank.org/opendata/falling-food-prices-yet-much-higher-pre-covid

Baum D and Mechsner S, 2023. Jobs perspectives in agroecology: more employment, better income. *GIZ*. https://www.snrd-africa.net/wp-content/uploads/2023/07/Factsheet_Agroecology_Employment_Promotion_EN.pdf

CDC (Centers for Disease Control and Prevention), 2023. Suicide in rural America. *Government of the United States*. https://www.cdc.gov/rural-health/php/public-health-strategy/suicide-in-rural-america-prevention-strategies.html

Chuku C, Chabert G, Chamon M et al., 2023. Another systemic debt crisis in low-income countries can be prevented – if we act now. *Centre for Economic Policy Research (CEPR)*. https://cepr.org/voxeu/columns/another-systemic-debt-crisis-low-income-countries-can-be-prevented-if-we-act-now

Clapp J, 2023. Concentration and crises: Exploring the deep roots of vulnerability in the global industrial food system. *The Journal of Peasant Studies* 50(1):1–25.

Clapp J and Howard P, 2023. The hunger profiteers. *Project Syndicate*. 8 August 2023. https://www.project-syndicate.org/commentary/agribusiness-market-concentration-food-insecurity-profiteering-by-jennifer-clapp-and-phil-howard-2023-08

De Schutter O, 2013. *Gender Equality and Food Security. Women's Empowerment as a Tool against Hunger*. Manila: Asian Development Bank – United Nations Food and Agriculture Organization (FAO).

ETC Group, 2022. Food Barons 2022: Crisis profiteering, digitalization and shifting power. https://www.etcgroup.org/sites/www.etcgroup.org/files/files/food-barons-2022-full_sectors-final_16_sept.pdf

FAO (Food and Agriculture Organization of the United Nations), 2016. Migration, agriculture and rural development: Addressing the root causes of migration and harnessing its potential for development. Rome.

FAO, 2018. The 10 elements of agroecology: Guiding the transition to sustainable food systems and agricultural systems. https://www.fao.org/3/i9037en/i9037en.pdf

FAO, 2023. The State of Food Security and Nutrition in the World 2023. https://www.fao.org/documents/card/en/c/cc3017en

FAO, UNDP and UNEP, 2021. A multi-billion-dollar opportunity – Repurposing agricultural support to transform food systems. https://doi.org/10.4060/cb6562en

Fuglie K O, Sun Ling Wang and Eldon Ball V (Eds.), 2012. *Productivity Growth in Agriculture: An International Perspective*. Oxfordshire: CAB International.

Gliessman S R, 2007. *Agroecology: The Ecology of Sustainable Food Systems*. New York: CRC Press.

Harvey F, 2023, 14 April. Top 10 hedge funds made £1.5bn profit from Ukraine war food price spike. *The Guardian*. https://www.theguardian.com/world/2023/apr/14/hedge-funds-profit-ukraine-war-food-price-surge

Inman P, 2023, 7 December. Greedflation: Corporate profiteering 'significantly' boosted global prices, study shows. *The Guardian*. https://www.theguardian.com/business/2023/dec/07/greedflation-corporate-profiteering-boosted-global-prices-study

IPES-Food, 2016. From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agroecological systems. https://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf

IPES-Food, 2017. Too big to feed: Exploring the impacts of mega-mergers, concentration, concentration of power in the agri-food sector. https://www.ipes-food.org/_img/upload/files/Concentration_FullReport.pdf

IPES-Food, 2018. Breaking away from industrial food and farming systems: Seven case studies of agroecological transition. https://ipes-food.org/_img/upload/files/CS2_web.pdf

IPES-Food, 2020. COVID-19 and the crisis in food systems: Symptoms, causes, and potential solutions. https://www.ipes-food.org/pages/covid19

IPES-Food, IFOAM Organics International, Agroecology Europe, FiBL and Regeneration International, 2021. A unifying framework for food systems transformation. A call for governments, private companies & civil society to adopt 13 key principles. https://www.ipes-food.org/_img/upload/files/sfsENhq.pdf

IPES-Food, 2022a. Another perfect storm? How the failure to reform food systems has allowed the war in Ukraine to spark a third global food price crisis in 15 years, and what can be done to prevent the next one. https://ipes-food.org/_img/upload/files/AnotherPerfectStorm.pdf

IPES-Food, 2022b. Smoke and Mirrors: Examining competing framings of food system sustainability: Agroecology, regenerative agriculture, and nature-based solutions. https://ipes-food.org/_img/upload/files/SmokeAndMirrors.pdf

IPES-Food, 2023a. Breaking the cycle of unsustainable food systems, hunger, and debt. https://www.ipes-food.org/_img/upload/files/DebtFoodCrisis.pdf

IPES-Food, 2023b. From plate to planet: How local governments are driving action on climate change through food. https://www.ipes-food.org/_img/upload/files/PlatetoPlanetEN.pdf

IPES-Food and ETC Group, 2021. A long food movement: Transforming food systems by 2045. https://www.ipes-food.org/_img/upload/files/LongFoodMovementEN.pdf

Lowder S K, Sánchez M V and Bertini R, 2021. Which farms feed the world and has farmland become more concentrated? *World Development* 142:105455.

Mahony C, 2023. Farmers impoverished by climate change make 'lose-lose' choices. https://www.bayes.city.ac.uk/news-and-events/news/2023/december/farmers-impoverished-by-climate-change-make-lose-lose-choices

NCRB (National Crime Record Bureau), 2022. Accidental Deaths and Suicides in India (ADSI) 2022 report. Government of India. https://ncrb.gov.in/accidental-deaths-suicides-in-india-adsi.html

Pretty J, 2008. Agricultural sustainability: Concepts, principles and evidence. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 363(1491):447–465. http://dx.doi.org/10.1098/rstb.2007.2163

Schmidhuber J and Qiao B, 2022. High input prices protract high food prices, creating a double burden for import-dependent countries. *FAO Food Outlook*. June 2022. https://www.fao.org/3/cb9427en/cb9427en_special_feature_2.pdf

Sinclair F, Wezel A, Mbow C et al., 2019. The contributions of agroecological approaches to realizing climate-resilient agriculture. *The Global Center for Adaptation*. https://gca.org/reports/the-contributions-of-agroecological-approaches-to-realizing-climate-resilient-agriculture/

Stein H, 2011. World Bank agricultural policies, poverty and income inequality in Sub-Saharan Africa. *Cambridge Journal of Regions, Economy and Society* 12:79–90.

Uba E, 2023, 17 August. Ministers criticised for scrapping new food waste laws in England. *The Guardian*. https://www.theguardian.com/environment/2023/aug/17/ministers-criticised-for-scrapping-new-food-waste-laws-for-england

UN, 2023. Extreme poverty in developing countries inextricably linked to global food insecurity crisis, senior officials tell second committee. *General Assembly Second Committee Meeting*. 78th Session. GA/EF/3590. https://press.un.org/en/2023/gaef3590.doc.htm

Weber I M and Wasner E, 2023. Sellers' inflation, profits and conflict: Why can large firms hike prices in an emergency? *Review of Keynesian Economics* 11(2):183–213. https://doi.org/10.4337/roke.2023.02.05

World Bank, 2019. Food price shocks: Channels and implications. *Commodity Market Outlook*, April 2019. https://thedocs.worldbank.org/en/doc/974291555528031558-0050022019/original/CMOApril2019SpecialFocus.pdf

WRI (World Resources Institute), 2008. Rattling supply chains: The effect of environmental trends on input costs for the fast-moving consumer goods industry. http://pdf.wri.org/rattling_supply_chains.pdf

Zhu P, Burney J, Chang J et al., 2022. Warming reduces global agricultural production by decreasing cropping frequency and yields. *Nature Climate Change* 12(11):1016–1023.

3 Accelerating the SDGs

The opportunity of agrifood systems transformation

Stefanos Fotiou and Rathana Peou Norbert-Munns

Feeding the SDGs: How sustainable agrifood systems drive the 2030 agenda

> In the pursuit of sustainable development, we must remember that the path forward is not solely paved with economic growth, but with the courage to redefine progress in ways that nourish our planet and its people.

Introduction

Agrifood systems are currently under an unprecedented number of threats, risks and uncertainties. These include population growth pressure – a projected population of 8.6 billion to be fed by 2030 (UN 2015a) – dietary changes, environmental degradation and pressure on natural resources. Conflicts paired with climate change are also major threats to feeding our planet's people. Such risk combinations mean we are facing an unparalleled time in human history where the convergence of the global pandemic, multiple conflicts and climate change crisis are creating compounded challenges. This risks the undoing of years of progress in sustainable development and exacerbates inequalities and vulnerabilities across the world.

Unfortunately, the point of no return has been reached in some fields such as biodiversity protection. Overall, biodiversity has declined by 28% around the world since 1970 and in low-income countries the loss is particularly important – it has reached 60% (WWF 2020).

But do such losses really point to the ultimate failure of our food system?

Despite record-high global food production per person, malnutrition and food crises persist. Our current food system – a mix of local, global and unsustainable practices – is deeply linked to biodiversity, health and equity concerns. Transitioning to sustainable agrifood systems demands significant changes across the board, from production to waste management. This transition will require all Sustainable Development Goals (SDGs) to be achieved by 2030. However, the world is not on track to do so. The lack of progress is global and developing countries and the world's poorest people are bearing the brunt.

This chapter demonstrates that our food system is not just part of the problem, but an essential part of the solution to some of the world's most pressing challenges. It has the potential to accelerate us towards the SDG deadline.

We will start by asking the questions: why has sustainable development been so elusive and why are the SDGs still far from being realised? We will then examine the emergence of a new sustainability paradigm which recentres food system activities and outcomes. Finally, we will reinforce the need to shift to sustainable agrifood systems by providing concrete example of policies and actions driven by the UN.

DOI: 10.4324/9781032684369-5

Enlarging horizons – beyond economic growth as a development paradigm

This section attempts to answer the question: "Why is sustainable development not happening?" Three concepts from classical physics – momentum, inertia and friction – are used.

How the "momentum of growth" shaped today's economy and the development paradigm

Over the last 70 years of development, the world has experienced remarkable economic growth and technological advancements. These have led to significant reductions in extreme poverty. They have also improved education and healthcare access, and increased life expectancy in many areas.

However, we've also faced persistent challenges such as rising income inequality, environmental degradation and economic disparities within and amongst countries. Part of this failure should be attributed to the persistent use of economic models that are based in the General Equilibrium Theory as well as other doctrines of the neoclassical economics.

With this dogmatic focus on growth as the only measure of development, the "momentum of growth" has resulted in policies that have created negative environmental and social externalities. These are affecting people and the planet in ways that offset the potential positive economic impacts of growth.

These policy approach failures have led to the emergence of sustainable development as a response to the understanding that economic growth alone is not enough to foster true development. However, most policies are still designed based on a single objective: GDP growth.

Rethinking the development paradigms of the 21st century: The obstacle of inertia

Isaac Newton's first law of motion, known as inertia, states: "An object at rest tends to stay at rest, and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force" (Newton 1687).

By interpreting this law in the context of economic and social dynamics, we can argue that: "Individuals and businesses have a tendency to maintain their routines, even if these routines are not optimal, unless influenced or disrupted by external factors or forces".

In this social interpretation, external influences like cultural shifts, policy changes, or technological advancements act as "unbalanced forces". These challenge the inertia in economic and social systems and drive potential change. Despite sustainable development emerging as a transformative force over the past 50 years, the expected change hasn't occurred for two reasons.

Sustainable development has been treated by economists as an add-on to equilibrium-based models, but a shift to dynamic systems-based models is essential. Achieving such a transformation demands broad collaboration, continuous adaptation and the use of innovative approaches to influence the system.

As the economist Steven Keen (Keen 2001) rightly pointed out

> The fallacy that dynamic processes must be modelled as if the system is in continuous equilibrium is probably the most important reason for the intellectual failure of neoclassical economics. Mathematics, science and engineering developed tools long ago to model outside of equilibrium processes. This dynamic approach to thinking about the economy should become second nature to economists.

This first reason why sustainable development hasn't happened is clearly linked to the momentum of growth issue that we addressed above.

Overcoming friction in shifting paradigms

The second reason for this is related to the concept of friction. Shifting development towards sustainable paradigms necessitates a critical examination of the existing dynamics, drivers and systems that can hinder such a transition. One central notion is that traditional measures of economic progress, like GDP growth, often overlook underlying societal and environmental failures.

These failures include inequality and public health disparities and the inability to change. Market forces and vested interests, which prioritise short-term gains, frequently guide decision-making and perpetuate unsustainable practices. This creates a significant friction in the transition, where resistance to innovative ideas and solutions can impede development pathways. Established interests deeply rooted in the current status quo system, combined with significant power imbalances, create obstacles to change, acting as pull factors that limit the transition away from business-as-usual. A deeper understanding of these root causes would help tackle these challenges effectively.

The solution of the 2030 Agenda and the SDGs

In 2015, the adoption of the SDGs marked a crucial milestone in global efforts to achieve sustainable development. They provided a dynamic framework that can overcome the problems created by momentum, inertia and friction. The 17 SDGs cover economic, social and environmental dimensions and provide a roadmap for a fairer, more inclusive and sustainable world.

Whilst there is progress in some areas, there's still much work to be done. Particular focuses must include combating poverty, hunger and inequality and addressing environmental crises like climate change and biodiversity loss. Dealing with the vulnerabilities and risks as exposed by the COVID-19 pandemic is also critical. As noted by the United Nations (UN 2023):

> The world reached the midpoint in the implementation of the 2030 Agenda and its 17 Sustainable Development Goals (SDGs) in 2023. Systemic risks due to climate change and other related environmental crises, conflicts and war are threatening all efforts and gains made to date to achieve a sustainable, resilient, and just world for all. These emergencies highlight the need, more than ever, to focus attention and action on the implementation of the SDGs and to fully leverage science, engineering, technology, and innovation to ensure we are back on track.

Shifting priorities – putting SDGs above the momentum of growth

Whilst we have the solution of the 2030 Agenda, the neoclassical economic approach that talks about growth, profits and cost has somehow prevailed over the design of policies to implement the SDGs. Perhaps one of the most urgent and challenging notion to confront on our way to implementing the 2030 Agenda is the perception that achieving the SDGs comes at a significant monetary cost.

However, in the pursuit of sustainable development, one must remember that the path forward is not solely paved with economic growth. It must also be paved with the courage to redefine progress in ways that nourish our planet and its people.

The monetary resources needed to achieve the SDGs need to be thought of as a redistribution process and should be viewed as future investments, rather than costs. True transformation prioritises SDG targets over financial concerns, fostering a narrative of opportunity.

The nexus of choice, regulations and SDG impacts

Individual and business choices, influenced by cultural, social and economic factors, are crucial for food system transformation. Understanding these dynamics is vital for sustainable change.

It is clear that market mechanisms have not inherently guided us towards making sustainable choices, including those relating to food. Markets mostly prioritise short-term profit over long-term sustainability. The way that the markets work in the agrifood systems creates externalities (or hidden costs) that amounted up to 12.7 trillion Purchasing Power Parity (PPP) dollars in 2020. Therefore, regulatory interventions become indispensable in aligning market forces with sustainability goals. Such regulations can encompass incentives for sustainable agricultural practices, the establishment of eco-labelling standards, application of the "polluters pays" principle and limitations on environmentally harmful practices.

In addition, certain strategies can be instrumental in guiding consumers towards sustainable options and entering a new era of responsible consumption. These include improved product labelling, incentivising healthy and sustainable choices and creating environments that make such choices convenient.

One critical aspect of regulation requiring careful consideration is the potential for regulations to disproportionately affect people who are usually left behind, such as small-scale farmers and low-income citizens. Some regulations may necessitate costly upgrades or compliance measures that are challenging for small-scale agricultural operations to meet, potentially endangering their livelihoods.

Therefore, there is a pressing need for a more equitable approach to regulation. This should consider the capacity of small farmers to adapt to new standards and provide them with the necessary support, technical assistance and financial incentives to transition towards more sustainable practices.

There is also an increasing need for stronger regulations applicable to large corporations with the power to impose choices and create, via their operations, enormous negative social and environmental externalities.

National food systems transformation visions and plans presented to the UN as "pathways" contain multifaceted perspectives and actions. This demonstrates a growing understanding of the complex interplay between consumer choices, regulatory mechanisms and equitable policies in the pursuit of SDGs.

Collaborative solutions and approaches to accelerate the SDGS

The UN Food Systems Summit of 2021 (UNFSS) marked a milestone in the efforts to accelerate the SDGs through the transformation of agrifood systems. Summit preparation created a dynamic space for governments, science and other food system stakeholders. It enabled them to work together to identify collaborative solutions to make our agrifood systems more sustainable.

The following priorities are those which countries have identified as a first set of transformative actions that could accelerate the SDGs:

- Incorporating agrifood systems strategies into all national policies for sustainable development, ensuring no one is left behind;

- Establishing agrifood systems governance that engages all sectors and stakeholders for a comprehensive approach;
- Investing in research, data, innovation and technology capabilities;
- Promoting inclusive participatory design and implementation at the local level;
- Engaging businesses to shape sustainable agrifood systems and enhance accountability; and
- Ensuring access to short and long-term financial support, including investments, budget support and debt restructuring.

Food system transformation as SDG accelerators

Food system changes can drive broader transformations that affect many SDGs. Whilst the global movement for agrifood system shift is in its early stages, there are signs of progress needing rapid acceleration (UNFSS 2023).

Where do we stand on our efforts to transform agrifood systems?

In July 2023, the United Nations Food Systems Summit +2 (UNFSS+2) in Rome assessed global progress towards more sustainable agrifood systems. More than 100 countries showcased their initiatives, reflecting commitment at both national and international levels:

- Two-thirds of the countries have integrated the transformation vision of their national pathway into national strategies and/or sectoral plans.
- A quarter of countries report that food systems issues are now being reflected in national laws and regulations. Increased importance is being given to the right to food, food loss and waste, school meals, food fortification and the application of labour codes for food systems workers.
- Around two-thirds report the setup, or strengthening, of platforms for governing national food systems. 70% have adapted governance processes to take account of the food systems approach.
- One-third report that food systems work is being decentralised and advanced in sub-national jurisdictions and/or administrations, usually with dedicated coordination mechanisms.
- Nearly 50% are continuing food systems dialogues linked to implementation at national and sub-national levels to refine their pathways.
- Engagement with stakeholders most often prioritises those involved in food production, processing, trade, distribution and retail.
- Women's organisations are often engaged. However, youth and Indigenous Peoples networks are not systematically involved.
- In 40% of countries, efforts are underway to assess financing gaps and 36% have established investment strategies to mobilise public and/or private financial resources.
- Nearly two-thirds of countries indicate that information systems are being upgraded by refining the relevance and quality of available data and strengthening systems for data collection, analysis and presentation.
- Most governments report that there is close engagement with scientific groups for developing information systems and for the development of the capabilities of personnel.
- More than two-thirds of national reports indicate that actions have been taken to facilitate access to knowledge, science, evidence and technology.

Acknowledging shortcomings and identifying bottlenecks

The analysis of the voluntary reports also reveals areas that need urgent attention as they are pointing to shortcomings of, and bottlenecks to, the transformation process (UNFSS 2023). The following points describe the bottlenecks:

- Putting plans into action requires time, resource and effort, yet garnering political support for crisis management and transformation is challenging.
- Implementing plans is challenging, especially amid policy disputes or resource shortages.
- Adequate funding is essential for fostering sustainable changes in food systems.
- A shortage of skilled experts hampers the push for food system transformation.
- Infrastructure gaps in many developing countries are causing food losses, restricted market access and waste.

The way forward

There is still a massive amount of work to be done on transforming agrifood systems for SDG acceleration. The UN Secretary General Call to Action of the UNFSS+2 points out several items that need to be addressed including the following:

- Incorporating food systems strategies into all national policies for sustainable development, for people's livelihoods, nutrition and health, for economic growth, climate action and nature, and to address post-harvest losses, leaving no one behind.
- Establishing food systems governance that engages all sectors and stakeholders for a whole-of-society approach, combining the short and long terms.
- Investing in research, data, innovation and technology, including stronger connections to science, experience and expertise. To make food system transformation effective, it's important to involve a diverse range of people in both planning and execution. This means including women, youth and Indigenous communities in local decisions. Key strategies include sharing knowledge, working across different sectors, building partnerships with various stakeholders, tailoring actions to specific local contexts, enhancing and diversifying production methods and ensuring everyone involved is held accountable for their actions.
- Promoting increased engagement of businesses. Collaborations between government and businesses are key in shaping how food systems operate. They are important in establishing and strengthening accountability.
- Ensuring access to short and long-term concessional finance, investments, budget support and debt restructuring.

Conclusion

The challenges and crises of the recent years have cast a harsh light on the vulnerabilities of our global agrifood systems and put us off track to fulfil the SDGs by 2030. However, they have also kindled a deeper understanding of the urgent need to transform these systems in ways that are inclusive and sustainable. As the world moves forward, concerted and coordinated action is essential to achieve the full potential of agrifood systems that prioritise the right to food and deliver on the SDGs to the benefit of us all.

We have a plan, the "2030 Agenda" (UN 2015b). We have concrete objectives and a blueprint to achieve a sustainable future for people and planet through the SDGs and their targets.

We have also identified the potential of agrifood systems transformation to the most important SDGs acceleration; and countries have their plans to make this transformation happen.

Diligence and persistence are required to uphold the sustainable development principles set out in Rio in 1992 and to make meaningful progress. The conclusion of this chapter is: let us stay optimistic!

References

Keen S, 2001. *Debunking Economics: The Naked Emperor of the Social Sciences*. 1st ed. London: Zed Books.

Newton I, 1687. *Philosophiæ Naturalis Principia Mathematica*. 1st ed. London: Joseph Streater.

UN, 2015a. *Population 2030, Demographic Challenges and Opportunites for Sustainable Development Planning*. New York: UN. www.un.org/en/development/desa/population/publications/pdf/trends/Population2030.pdf

UN, 2015b. Transforming our world: The 2030 agenda for sustainable development. https://sdgs.un.org/2030agenda

UN, 2023. *Progress towards the Sustainable Development Goals: Towards a Rescue Plan for People and Planet*. New York: UN. https://sdg.iisd.org/news/un-secretary-generals-report-outlines-rescue-plan-for-people-and-planet/

UNFSS, 2023. Making food systems work for people and planet. *UNFSS+2*. https://knowledge4policy.ec.europa.eu/publication/making-food-systems-work-people-planet-report-secretary-general-un-food-systems-summit_en

WWF, 2020. *Living Planet Report 2020*. Gland, Switzerland: WWF. www.wwf.org.uk/sites/default/files/2020-09/LPR20_Full_report.pdf

Bibliography

Smith A, 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell.

4 Food systems futures and how to achieve them

Tim Benton

A food system that is harming our health and our planet

Do we need to grow more food to feed a growing global population that, through international development, is also getting richer? For some time, the predominant discourse, politically and economically has answered this question with a “yes, of course”.

The decades-long drive to produce more and more food has already come at huge environmental cost. Our global production system is now largely dependent on the production of a small number of crops – wheat, maize, rice, barley, soybean, oil palm, sugar and potatoes – in a small number of producing regions. As demand has risen – partly because of a growing global population but mainly owing to increased meat consumption and the associated increase in demand for animal feed – so too has the use of chemical inputs such as fertiliser, pesticides and herbicides to maximise yields on existing cropland. At the same time, rainforest, savannah and peatlands have been cleared to make space for the expansion of cropland and livestock grazing. Nature has suffered as a result.

Food production is therefore a central cause of declining biodiversity, deforestation, water and air pollution and land degradation. As cropland and pasture expands, habitats and food sources are lost and species are threatened. The space available for nature shrinks; today, half of all habitable land is taken up with crop production or livestock rearing. Chemicals applied to crops degrade soils and find their way into water systems, damaging marine ecosystems; chemicals used in aquaculture do the same. Food production, and especially livestock farming, contributes about a third of all human-driven greenhouse gas emissions (GHGs), making it one of the main drivers of climate change.

And yet, despite this huge productivity growth since the Green Revolution, the world is far from feeding people in way that enhances health and well-being through nutrition. Poor diets are now responsible for more deaths around the world than any other risk factor (11 million people in 2017) (Afshin et al. 2019). One in five deaths globally are associated with inadequate diets – diets which are too low in whole grains, fruit, nuts and seeds and/or too high in unhealthy fats, sugars and red and processed meat (Swinburn et al. 2019). Nearly half of all deaths in children under five are caused by deficiencies in essential nutrients. Poor diets are also responsible for 20% of all disability-adjusted life years. Alarmingly, across Europe approximately the same number of people now die each year of dietary-related ill health as died at the peak of COVID-19.

The challenge of providing healthy diets is not an absolute lack of calories at the global level, but more a story of growing too much of some things and too little of others, leading to inequitable distribution and affordability. The current mismatch between what is grown and optimal diets globally means that if everyone were to try to access all the foods needed for high quality,

DOI: 10.4324/9781032684369-6

nutrient-rich diets (e.g., fruits and vegetables, or fish, nuts, or pulses), they would not be able to do so. For example, we only produce about a third of the fruit and vegetables that would be needed, and we overproduce grains for human consumption (Bahadur et al. 2018). However, we produce about the right amount of proteins; these include meat, fish, lentils, pulses, beans and other plant proteins.

This imbalance – over-production of starchy grains, oils and sugars and under-production of fruits and vegetables – means that the key foods for a healthy diet are expensive so that an estimated three billion people cannot afford a nutritious diet – a result both of the high costs of nutritious food and of pervasive income inequalities. The diversion of crop calories to produce cheap and processed meat and highly processed foods has encouraged – for many – diets that are high in fat, salt and sugar but low in nutritional value. These diets that are contributing to overweight, obesity and diet-related diseases including cardiovascular disease and type 2 diabetes (Swinburn et al. 2019).

Vicious circles of environmental harm and worsening diets

The failings of our food system are increasingly apparent: in addition to contributing to a growing global disease burden, our current patterns of production and consumption are undermining reliable access to affordable food both today and for generations to come. The ecosystems being degraded by intensive farming and land conversion are vital to our planet's natural defences against climate change, helping to absorb carbon emissions, regulate the surface temperature of the earth and protect against damage to natural and human infrastructure from weather and climate extremes. Nature's ecological processes – processes that we are disrupting through the polluting of land and water with chemical inputs and through the clearance and degradation of land – are essential to sustaining the quality of water, air and soil on which we depend. The more we degrade these ecosystems, the more we require additional land freed up by their destruction; the more we disrupt these ecological processes, the more we rely on the very inputs that pollute them.

Today's global food system is the product of deliberate policy decisions (Benton and Bailey 2019). Governments have long sought to boost agricultural productivity, both as an engine of wider economic development and to push down the cost of food and enable more economic consumption. Vast amounts of public money have been channelled into agricultural subsidies, value chain infrastructure and research and development to incentivise and shape food production. The pursuit of liberalised trade and globalisation have spurred ever increasing specialisation in international food value chains, furthering the concentration of production amongst a handful of crops and producers and incentivising more intensive production supported by chemical inputs. The virtual exclusion of agriculture from climate policy has spared the sector from financial and policy pressure to transition to more sustainable practices.

The historical pursuit of ever cheaper food and ever more productive farming has trapped us in a vicious cycle of increasingly unsustainable production and unhealthy diets (Benton et al. 2021). Whilst the environmental cost of producing food is very high, the cost of food itself has declined – except for notable periods of price spikes, including those we are experiencing in 2023–2024. Cheap staple crops have contributed to cheap processed goods and, in high-income economies, to cheap meat.

Animal-sourced foods account for 66% of GHGs, 78% of land use and provide 18% of calories. Across the UK and the European Union (EU) more than 60% of grain is now grown for livestock feed (Benton et al. 2022). This enormous figure shows there is great potential for changing the industrial livestock system through the amount of land that could be used for other purposes. Low prices have stimulated greater demand and incentivised the further expansion of cropland and pasture and the continued intensive use of chemical inputs. Neither producers of more nutritious foods – fruit, vegetables, nuts and seeds, legumes – nor of goods produced through organic methods have benefitted from anything approaching the same level of financial support; the cost of these goods is thus relatively high and prohibitively so for many. When household budgets are tight, it is these foods that are the first to be sacrificed in place of more available and cheaper calories.

Our current industrial food systems are therefore unsustainable in multiple ways, driving climate change and ecological disruption. They convert native habitats and ecosystems to farmland and monocultural landscapes, leaving little space for nature. They also pollute our world with pesticides, fertilisers and manure. And, for an increasing proportion of the world's population, they do not supply an adequate diet to support long-term health (Benton et al. 2021).

Transforming our food system: To what?

It's clear that to transform our food system to make it truly sustainable and feed our populations well, we need to rebalance production. Going beyond how we should be growing food, we need also to consider what we should be growing. We must go beyond the current discourse of politics and industry that the vision for sustainable agriculture is about growing more and more, whilst trying to reduce its environmental impact.

Anyone sampling the political and industrial discourse on food security and the future of food will be familiar with a range of projections that food supply is estimated to increase by a certain percentage by a certain date (van Dijk et al. 2021). These projections are sometimes then taken as "fact". Perhaps the most famous was the 2008 estimate – ultimately derived from an FAO (UN Food and Agriculture Organization) report – announced by the FAO DG Jacques Diouf, "Global food production must be doubled to feed a world population currently standing at 6 billion and expected to rise to 9 billion by 2050" (quote from Soil Association 2010). This "doubling of food production by 2050" notion quickly became deeply embedded as a requirement to immediately invest in the intensification of food production. As the Soil Association at the time highlighted, this projection makes a range of assumptions (some robust, some less so) and should not have been taken as a "fact".

This begs the broader question, what is our vision for the future of food systems? Is it a necessity to radically increase food supply to feed the world, or do we have a choice? To address this question, my colleague Helen Harwatt and I recently looked at the two main visions for the future of food, and how to define sustainable agriculture within them (Benton and Harwatt 2022). Our analysis was on the narratives that support the two contrasting visions for the future.

Vision 1 – Sustainable intensification and land sparing

In this vision, the growth in demand for food is assumed inevitable, and so, to protect nature, we put a fence round it (and spare land), and the land used by agriculture therefore has to meet demand growth through intensification. To continue growing ever more food per hectare requires significant technological development, but efforts should be made to make the required intensification sustainable (which is often assumed to be captured by efficiency measures per hectare or kilo of product). This vision is the predominant "business as usual" vision.

This narrative is based on five key assumptions:

- Demand is exogenous to the food system, set by population size and wealth, and will therefore increase as population size and wealth increases;

- Growing market demand *requires* productivity growth to raise supply. In this vision, markets are given primacy, and modifying demand by changing the way markets work is deemed undesirable;
- Given the primacy given to markets, dietary change is deemed to be the preserve of the individual consumer (if they want change, they can). Policy to reflect public health or public goods in shaping diets is described as "nanny statism" or "red tape";
- Given demand will grow, and intensification is needed, the degree to which intensification (yields per hectare) can increase and be made sustainable (by reducing the environmental impact, primarily through efficiency gains) is large and is limited only by the investments made in research and technology;
- Finally, by raising yields through sustainable intensification, and allowing the markets to balance supply and demand, there will be a point where the market pressures on land conversion decline because agricultural land provides the supply. Thus, land sparing for nature is enabled.

It is important to recognise that this set of assumptions is underpinned by a belief that markets should be the main tool to deliver food supply. They are thus more ideological, rather than evidence based. Each of the assumptions can be critiqued. For example, currently, the market rewards production of very high volumes of unhealthy foods in unsustainable ways, and incentivises food waste because, for many people, food is economically rational to waste. Making the market "work" to deliver public goods (public health, sustainability) through changing the incentives (policy, regulation, subsidies, etc.) is certainly theoretically (if not politically) possible. One can imagine a world where the business model of the food system is inverted so it produces less, in better ways, to provide healthier diets. Changing dietary composition at scale could be a very significant way to reduce the demand for primary produce (Kozicka et al. 2023).

In short, whenever anybody says: "We have to grow more food to feed the world", they're implicitly making the assumptions outlined above: that the market takes primacy, and market failure should be ignored in the name of profit.

Vision 2 – Enabling a sustainable food system through dietary change

This vision for the future is the counterpoint of the first. By changing the way the market works by intervening on both the demand and supply sides – through changing taxes, subsidies, regulations and so on. In particular, on the supply side, changing the incentives and disincentives for intensive, commodity-led agriculture, and on the demand side, changing the incentives and disincentives to eat more fruit, vegetables, plant proteins, whole grains and fewer animal-sourced foods. Encouraging such change in diets would allow aggregate demand for food to drop, enabling farmers to use climate- and nature-positive methods such as agroecology. They would produce less food but food that is based more on its quality (both nutritionally and environmentally). If demand falls sufficiently, the need to convert land into agriculture might also decrease, allowing both land sparing and land sharing.

This Vision for a sustainable food system is based on these five assumptions, which, like Vision 1, are less based on evidence than ideological framing:

- The current unsustainability of farming is a form of market failure that can be corrected, and governments have social licence to intervene in markets to correct market failure;

- Demand can be changed and should be shaped by social needs through structural change in markets underpinned by legislative and regulatory measures (trade policy, taxes, subsidies, environmental protection, changing food environments, education, etc.);
- A healthy diet is also a more sustainable one: particularly through changing dietary composition reducing the consumption of land-intensive animal-sourced foods, to a greater diversity of fruit, vegetables and whole grains. Given the land footprint of animal agriculture is large, accounting for nearly 80% of agriculture's total land print, changing demand for meat can potentially free up significant land;
- "Agroecological" approaches can supply sufficient nutrients to "feed the world" if consumption patterns change at sufficient scale. Whilst the geographical context varies (e.g., in Sub-Saharan Africa, mineral fertiliser might still be needed (Falconnier et al. 2023), and what exactly is defined as "agroecological" is contested, the conceptual approach is to work more with nature, circularly;
- Sufficient research on "agroecological" approaches – much neglected by industrial and public funding streams – can create innovations that allow productive, sustainable yields, in mixed, heterogenous farming systems. Such research can provide sustainable farming that is more sustainable than sustainable intensification's vision of maximising productivity whilst increasing environmental efficiency, predominantly in monocultural systems.

Proponents of Vision 1 often dismiss these assumptions as "ideological", whilst not recognising their own views are equally ideological. Vision 1's underpinning ideology is liberalised markets generating wealth without intervention. Vision 2's underpinning ideology is that markets need to better support social and environmental needs, to provide long-term sustainability, justice and equity.

Who chooses the vision?

"The future is already here - it's just not very evenly distributed", said the novelist William Gibson (Wikiquote 2023). So, if you search the internet about the future of farming and food, you'll get a range of different views – today's cutting edge extrapolated forwards. These include large-scale farming, autonomous vehicles, robots, drones and vertical farming such as the recently developed 26-storey pig farm in China – the world's largest. But they also include visions of organic and agroecological diverse farming, circular and mixed farming bristling with technology and ecological intensification and pest control. Diets in the future might be engineered, 3D-printed, ultra-processed or whole foods cooked at home. Given these visions are essentially choices, it begs the question who decides which one is to be supported and developed?

The future is, of course, shaped within its complex system, by a whole range of different actors interacting together. Discourse often suggests that different constituencies hold most power to effect change, and depending on the debate, it might be said that "It's down to consumers to change the behaviour of the market…" or "It's down to the market players to change the behaviour of the market…" or "It's down to politicians to change the behaviour of the market…"

In reality, it is all the above that will drive change. Politicians will not change the role of the market until they have the political licence to do so by citizens accepting or wanting (but not resisting) change. Whilst citizens as consumers can play some role in shaping the market, this role is often limited by individual choices being constrained by the environments in which people live. So, whilst citizens as consumers may potentially play some role in changing markets, the vote of citizens is what may – or may not – licence the politics of transformative change through changing the legislative and regulatory basis of the way markets work. The incentives for incumbent business are such that often “business as usual” is a better option than change, and if change is required, it is often incremental. Businesses can then block or enhance change, depending on the degree to which politicians are able to push, and citizens to pull, for change to happen.

The interactions between different constituencies of food system actors – politicians, people and market actors, but also other groups like farmers, investors – are themselves dynamic and can change over time. Crucially, they can also be critically influenced by events.

In the last 20 years or so, there have been many world-changing events – whether the drumbeat of climate impacts, growing in frequency and intensity, new or old pests and diseases (Ebola, COVID, locusts, armyworm, SARS, MERS), war, conflict and terrorism (9/11 to the invasion of Ukraine), geopolitical disruptions and events (North Korea, growing tensions between the west and China, trade wars). As we look ahead, the disruptions that we’re going to see are going to get bigger and bigger, partly because we are not tackling the environmental crisis. In time, maybe in 2024 with El Niño’s heightened warming impacts on the world, the lived experience of people around the world may start to open a political space to demand change. Just because today, the politics look entrenched does not mean than they will not change and change potentially quickly.

At present, the power of big business makes it difficult to imagine driving food system transformation to deliver real change to improve lives, livelihoods, people and the planet. The political space for change in the structure of the markets – changing subsidies, taxes, trade, regulations and so on, is not apparent. Whilst in-depth conversations with citizens reveal they want change (e.g., FFCC 2023), as a whole, food systems change is not resonating, so neither politicians or markets will change radically. But, if the pattern of the last decade or so continues to drive geopolitical tensions and disruptions, inevitably some of the changes may make it easier for the political space to open and to adopt one or other of the Visions outlined above. For example, a world becoming more regionalised, and less globalised, would require growing more locally to secure of our supply of food. A greater degree of local production would also require more diverse farming systems, where, to ensure we meet nutritional needs, agricultural policy is also driven by public health policy. Were such a multipolar, deglobalising world to occur, it might lead to policies that support Vision 2 rather than Vision 1.

So, can we achieve a better future?

A truly sustainable future depends on all our actions and on the ability for events to help us by giving us opportunities for real radical system change. We need a real perturbation to the system that will allow citizens to change the current political calculus that leaving health, welfare and sustainability to the markets to deliver will work. Making food system change, for people and the planet, a vote-winner will allow politicians to change the “rules of the game” in ways they currently do not see an opportunity to do. If leadership is there, it would be possible to radically change the market structure and head more towards Vision 2 than Vision 1.

Opportunities for such change will come. It’s inevitable. Unless the system changes, the system will eventually break. Consequently, it is perfectly possible to imagine a future where we eat less meat and more healthily in general; where the food is produced in sustainable farming systems and where farmers make a profit, and where food is not – at a household level – more expensive. It’s not going to be easy but citizens and consumers need to be ready to try driving the system through both their ability to adapt their consumption habits and, perhaps more importantly, through voting for change.

References

Afshin A et al., 2019. Health effects of dietary risks in 195 countries, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 393:1958–1972. https://doi.org/10.1016/S0140-6736(19)30041-8

Bahadur K C K et al., 2018. When too much isn't enough: Does current food production meet global nutritional needs? *PLoS One*, 13(10):16. https://doi.org/10.1371/journal.pone.0205683

Benton T G and Bailey R, 2019. The paradox of productivity: Agricultural productivity promotes food system inefficiency. *Global Sustainability*, 04/29(2):e6. https://doi.org/10.1017/sus.2019.3

Benton T G et al., 2021. Food system impacts on biodiversity loss. London. https://www.chathamhouse.org/2021/02/food-system-impacts-biodiversity-loss

Benton T G et al., 2022. The Ukraine war and threats to food and energy security: Cascading risks from rising prices and supply disruptions. London. https://doi.org/10.55317/9781784135225

Benton T G and Harwatt H, 2022. Sustainable Agriculture and Food Systems: Comparing contrasting and contested versions. London. https://doi.org/10.55317/9781784135263

van Dijk M et al., 2021. A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. *Nature Food*, 2(7):494–501. https://doi.org/10.1038/s43016-021-00322-9

Falconnier G N et al., 2023. The input reduction principle of agroecology is wrong when it comes to mineral fertilizer use in sub-Saharan Africa. *Outlook on Agriculture*, 52(3):311–326. https://doi.org/10.1177/00307270231199795

FFCC, 2023. So what do we really want from food? Starting a national conversation about food. Bristol: Food, Farming and Countryside Commission. https://ffcc.co.uk/so-what-do-we-really-want-from-food

Kozicka M et al., 2023. Feeding climate and biodiversity goals with novel plant-based meat and milk alternatives. *Nature Communications*, 14(1):5316. https://doi.org/10.1038/s41467-023-40899-2

Soil Association, 2010. Telling Porkies: The big fat lie about doubling food production. Bristol. https://www.soilassociation.org/media/4906/policy_telling_porkies.pdf

Swinburn B A et al., 2019. The global syndemic of obesity, undernutrition, and climate change: *The Lancet* commission report. *The Lancet*, 393(10173):791–846. https://doi.org/10.1016/S0140-6736(18)32822-8

Wikiquote, 2023. William Gibson. https://en.wikiquote.org/wiki/William_Gibson

5 Preventing and preparing for pandemics

Why food systems must transform

Melissa Leach

A key and truly existential reason for food system transformation lies in preventing and preparing for pandemics. In the wake of the COVID-19 pandemic – which not only had devastating health impacts but also brought societies and economies to their knees – this is a top priority for scientists, policymakers and publics around the world. Indeed during 2024, the world is expected to have a new pandemic accord. This legally binding agreement, to be adopted by the World Health Organisation's 194 member countries, will seek to shore up the world's defences against new pathogens (World Economic Forum 2023).

The recommendations that are dominating this latest round of policy concern to prevent, prepare for and respond better to pandemics echo longstanding approaches. These focus on technical and biomedical measures for improved threat detection and surveillance, data sharing, health system strengthening and research and development for diagnostics, vaccines and therapeutics, whilst also seeking to strengthen global governance and co-ordination, political leadership and financing (IPPPR 2021; WHO 2023). However, these fail to deal adequately with the increasing risks of disease emergence and spread, and the related vulnerabilities and crises in social, political, environmental and economic systems. As evidence from COVID-19 and earlier epidemics shows, to secure health in the face of uncertain disease threats requires a fresh framework in which social, economic and political issues are as central to the pandemic preparedness agenda as biological ones (IDS 2023a).

This chapter highlights the centrality of food systems in such an agenda for "pandemic preparedness for the real world". It traces some of the ways that our current food systems contribute to disease outbreaks which then spread to become pandemics with devastating and inequitable impacts. I focus first on how food production and marketing involving animals can enhance risks of disease emergence and transmission, and the importance of understanding and addressing these links to preventing pandemics. I then turn more briefly to the roles of food systems in shaping the impacts of epidemics and pandemics. The chapter thus argues that to head off future pandemic threats and protect the societal health and well-being of populations when they do occur, food system transformation is vital. The approaches we adopt must better integrate the various dimensions of preparedness and response and have care, equity and justice at their hearts.

Food systems and pandemic prevention

Almost all recent infectious disease outbreaks and pandemics have originated in wild animals, often via domesticated livestock or poultry (Jones et al. 2008). This is the case for COVID-19, along with HIV, H5N1 (avian flu), H1N1 (swine flu), Nipah, Ebola Virus Disease and others. Viruses and other pathogens circulate constantly both in the wild and sometimes in human

DOI: 10.4324/9781032684369-7

populations and so-called "zoonotic spillovers", where they transfer between animals and to humans, occur frequently, but often go unnoticed. It is only under certain circumstances, such as with SARS-CoV-2, where transmission is easy, and mortalities low enough to allow significant viral spread but high enough to be a concern, that a new disease gets noticed. It is dramatic outbreaks affecting populations, particularly in rich, Northern countries, that tend to drive global health policies and attention (see also Leach et al. 2021).

There is still much to learn about the dynamics and drivers of zoonotic spillover and of "take-off" into a noticeable outbreak amongst humans, as well as many uncertainties, contestations and debates over the evidence and its implications. But it is clear that food systems are deeply implicated in such dynamics. Responding to zoonotic diseases requires understanding of the complex interrelationships between humans, animals and ecologies in changing food production and marketing systems. It also requires attention to the wider structural political and economic conditions that shape these dynamics.

A first set of dynamics involves spillover and transmission from wildlife, where vulnerabilities to zoonotic disease can arise from increased human–wildlife interaction, exacerbated by habitat destruction. Food systems can be part of the picture, for instance where commercial agriculture and large-scale land investments destroy and fragment wildlife habitats such as forests, and push people to encroach for their livelihoods on what remains, coming into more frequent contact with animals and their viruses.

The so-called "efficiencies" of global food production and trade are also argued to have paved the way for increasingly uniform farming systems and impoverished landscapes without the disease "firebreaks" of biodiversity (WHO/CBD 2015). For instance, this is argued to be the case for Ebola Virus Disease outbreaks in Africa (Rulli et al. 2017), with the origins of the 2014–2016 Ebola epidemic that killed more than 11,000 people traced to a spillover encounter between a small child and a virus-carrying bat in a village in the forest region of the Republic of Guinea (Baize et al. 2014). But some of these links are contested by local experience and so we must beware of simple, one-way narratives. For example, in this region of Guinea, villagers' own accounts and more detailed evidence of human–ecological interactions suggests people's long-cohabitation with bats and the multi-way viral spillover between them. This now seems to have offered some protection to their populations against COVID-19, as well – and suggests that the origins of this particular Ebola outbreak must be sought elsewhere, probably in human–human transmission from a survivor from an earlier outbreak (Fairhead et al. 2021). As this example illustrates, understanding complex, local dynamics between food systems and zoonoses is crucial.

A second zoonosis route is directly from animals, especially in industrial animal production. In industrial farming, confinements of high numbers of farmed animals with narrow genetic diversity in small spaces leave animals far more susceptible to viral infections. It also supports the conditions for those viruses to evolve into more infectious types. Spillover to people – such as livestock production and abattoir workers – becomes a risk, often exacerbated by poor, unsanitary labour conditions. The political economic structures and dynamics of food systems, with their pressures for efficient mass production of animal protein in the context of shifts in diet and demand, are central in shaping these risks. For example, there have been recurrent outbreaks of H5N1 avian flu since the early 2000s and by mid-2023 avian flu was affecting more than 35 countries. It has resulted in more than 860 human cases since 2003 and more than half of the people infected have died. Behind this already worrying situation lurks the high chance of a further viral mutation, which could lead to a new human-to-human flu pandemic of potentially existential proportions.

The rising frequency of H5N1 spillover is linked to the growing intensity of poultry production, in a context in which chicken numbers and density across the world are growing. Currently, 70% of all bird biomass on the planet is now chickens – and commercial units and mass feeding operations are growing at the expense of smaller backyard systems where people and chickens have lived together for generations. Outbreaks can be traced especially to the growth of medium scale, industrial units with limited biosecurity in fast-growing southeast Asian nations with growing demand for poultry meat (Scoones 2010). The outbreak of H1N1 swine flu in 2009 is attributable to the industrial production of pork, across the southern US and Mexico, led by some large, well-connected agribusiness firms (Forster 2012). In both cases, changing livestock production and food systems, and the circuits of capital involved, intersected with particular context-specific farming practices and human–animal relations to shape disease risk. Whilst some recent analyses argue generally that risks of spillover are lower in industrial livestock units (as compared with small-scale, "backyard" systems), mainly because of their stronger biosafety practices (Bartlett et al. 2022), such conclusions need to be qualified by a wider framing that takes into account the social and political economic dimensions of food systems in diverse contexts (Wallace 2016).

In a third route, we see wildlife, domestic and farmed animals and humans all interacting in intense interfaces where spillover can affect and implicate all three. Food markets are the key sites where this can happen as exemplified by the SARS pandemic in 2003. SARS originated in a bat virus that then transmitted to a civet cat in a food market and then to humans. The scenario was repeated for COVID-19 in the Wuhan wet markets of China via a still uncertain intermediate host. Yet, whilst zoonotic disease spillover likelihood is increased in farmers' markets that contain multiple wild animals in close proximity and unsanitary conditions, we must again ask broader questions about food market systems and their social and political economic dimensions. We need to explore how risky conditions emerge: what are the politics of regulation in such places; who makes use of such markets; how are animals hunted and captured, for whom, and so on? It may be that the "cause" is not the "wet market" itself but the wider food system dynamics shaping it, for instance as structural economic drivers push hunters and trappers to go further to gain access to resources, as land is expropriated for other uses (Wallace et al. 2016). Simple closure of food markets as the way to prevent pandemics may be misplaced without addressing these wider food system dynamics. As was pointed out when this was advocated in the context of COVID-19, the results can be both ineffective in public health terms and damaging to the lives and livelihoods of small-scale farmers and traders (Lynteris and Fearnley 2020).

A fourth set of dynamics involves anti-microbial resistance (AMR), described by WHO and others as the "overlooked pandemic". It contributes to treatment failures, the consequent increased human vulnerability to a wide range of bacterial infections, and to their spread and their impact. The most recent figures suggest that AMR will cause more than ten million deaths per year by 2050 – more deaths than from cancer and diabetes combined. Amongst the key drivers of AMR are the routine use and overuse of antibiotics to promote growth and prevent diseases in intensified livestock units.

Alarming levels of AMR are reported in all countries and at all income levels, but it disproportionately affects poor individuals. This is partly because people living in poverty have so much less access to more expensive antibiotic treatments when cheaper antibiotics – the first line of defence – fail. Yet blanket bans on antibiotic use in livestock production can also have unequal impacts, undermining the livelihoods of small-scale producers too. Thus it is important that transitions to lower, more regulated antibiotic use are socially just, supporting and compensating those who would otherwise lose out. An understanding of food systems is important to understand AMR risks and possible responses.

As all these examples highlight, it is not just the immediate interfaces between humans and animals and their viruses and pathogens that matter for pandemic prevention. It is also the wider social, ecological and political economic drivers that shape them, and which are part and parcel of our global food systems – from land investments, labour conditions and trade patterns, and the trade, economic and financial models underpinning them. These wider aspects of our global food systems, which are structural and involve power, need to be better understood and addressed as part of pandemic prevention agendas.

Food systems and pandemic impacts

What about when an outbreak takes off and spreads to become a pandemic? Global maps tell only part of the story, and again it is a food system story. Who gets sick and why in a pandemic depends on social differences, inequalities and their structural drivers – something seen clearly in the West African Ebola epidemic of 2014–2016 where the magnitude and impacts, especially on poor and marginalised people, reflected histories of resource dispossession and under-investment in food and health systems that can be seen as forms of "structural violence" (Wilkinson and Leach 2015). The COVID-19 pandemic revealed sharply how past health and nutrition inequities, linked to race and poverty, shaped co-morbidities that left some more vulnerable to severe disease and death than others. Food system conditions sometimes amplified spread, whether amongst crowded workers in factories and meat plants or as hungry people necessarily flouted stay-at-home orders (Leach et al. 2021).

COVID-19 also revealed how disease control efforts, sometimes more than disease itself, amplified hunger and food insecurity – as employment, informal work and mobility were curtailed. The World Food Programme estimated that more than 345 million people faced high levels of food insecurity in 2023, a rise of 200 million people compared to pre-COVID-19 pandemic levels (WFP 2023). Meanwhile, evidence collected by Oxfam led it to term SARS-CoV-2, aptly, "the hunger virus" (Oxfam 2020). Evidence collected by partners in the COVID Collective global platform in 39 countries across the world reveal the inequalities across class, gender, race and place associated with these effects, as well as the ways food systems are implicated in these (COVID Collective 2023). For instance, food workers both in rural areas and in industrialised animal production and processing units were some of those to suffer most from COVID-19 and policies. This was due to movement restrictions and health risks from working in unsanitary conditions, threatening both their livelihoods and wider economic and food system sustainability (IPES-Food 2020). In rural African settings in Sierra Leone and Uganda, COVID-19 lockdowns, movement restrictions and border closures interacted with food system conditions in ways that added to the "intersecting precarities" faced by poorer farmers and women, who were no longer able to reach their farms and gardens and market their produce (MacGregor et al. 2022).

In the context of these wider social, economic and food impacts of both the COVID-19 pandemic itself and of control measures, many governments stepped up with enhanced social protection, safety net and food-distribution measures. However, in many cases they were unable to do this effectively, or their interventions were inadequate. In such circumstances, voluntary efforts – from food banks to neighbourhood food-distribution measures – very often filled gaps. Whilst the community action, care and compassion shown in such examples are laudable, the fact that they were needed shows how vulnerable our food systems are. Both nationally and globally, as argued by the International Panel of Experts on Sustainable Food Systems (IPES-Food 2020) the pandemic brutally exposed the low resilience and flexibility of food systems, and their extreme vulnerability to shocks.

"One Health", equity and food system transformation

In the wake of the COVID-19 pandemic, there has been renewed attention to "One Health" as a framework for addressing the scientific and policy challenges of pandemic prevention, preparedness and response. Recent definitions describe One Health as "Working towards a world better able to prevent, predict, detect and respond to health threats and improve the health of humans, animals, plants and the environment whilst contributing to sustainable development" (Adisasmito et al. 2022). The "tripartite" of United Nations organisations that originally proposed the framework in the early 2000s – the World Health Organisation (WHO), the Food and Agriculture Organisation (FAO) and the World Organisation for Animal Health (WOAH) – has been joined by the United Nations Environment Programme (UNEP), bringing a stronger emphasis on ecological dimensions.

One Health approaches emphasise the integration of human, animal and environmental health, along with integration across sectors and disciplines, and across society – local and global, rural and urban and inclusive involvement of different social groups. A One Health approach offers key opportunities to push the collaboration, co-ordination and capacity needed for global health security, or pandemic prevention and preparedness, more generally. There are opportunities now to interconnect an understanding of food systems, and food systems transformation, far more fully and explicitly with One Health thinking and action, and this will be essential if approaches to pandemics are to succeed.

The question of equity is key. It is easy for One Health to remain at the level of global and national commitments, neglecting diverse local contexts and needs. It is easy too to promote approaches that seem to solve the pandemic threat problem by changing human–animal–ecological interfaces, but actually damage people's livelihoods and food security. When a farmer's market is closed because it is seen to present a zoonotic spillover risk, what happens to the small-scale traders and consumers dependent on it? When separating people from "viral bats" and their habitats becomes a new justification for top-down, "fortress"-style forest conservation, what about those whose socio-cultural lives and food supplies depend on that forest? Blanket bans on the use of anti-microbials in livestock systems might seem to be an obvious way to curtail AMR, but what about the producers who will lose their animals and livelihoods to disease? So as a series in the journal *The Lancet* recognises, health equity needs ecological equity and both are important for One Health (The Lancet 2023). I argue that it is imperative to integrate concerns with food equity too. In addressing how pathways to equitable food systems might be identified and built (IDS 2023b), there is a need actively to identify synergies and avoid trade-offs, with pandemic prevention and response.

A realistic approach to One Health in the context of pandemic threats therefore requires concerns with food, health and ecological equity to be integrated and balanced, in ways that suit local needs and contexts and acknowledge the wider structural and political economic conditions shaping them. To take just one example that points in these directions, we can look to the work of the collaborative One Health Poultry Hub in Bangladesh, where poultry production is vital to people's livelihoods and food security but avian influenza a constant threat. Supporting the implementation of Bangladesh's 3rd Avian and Pandemic Influenza Preparedness and Response Plan (NAPIP), the hub worked with farmers and traders to address the realities that were encouraging them to take short-term risky decisions, such as selling sick chickens and using markets with poor biosafety measures. By providing better support with credit, information and veterinary expertise it proved possible to overcome key structural constraints and sensitively to support practices that improved both chicken and human health (One Health Poultry Hub 2023).

Across our food systems, there are many other examples where positive synergies can unfold – from those that might look to alternative protein and livelihoods, to local agrifood approaches that work with not against non-human natures, to their scaling up into wider principles and movements such as agroecology, food sovereignty and more. Examples are blossoming across the world, often led by social movements and working with the knowledge and perspectives of small-scale food workers, local communities, Indigenous people and citizens' everyday experiences. They need much greater recognition and support.

Pandemic threats and crises should be an opportunity to speed up the transformation of food systems – towards ones that help prevent pandemics, are resilient when they do occur, and that enhance food equity. This will not be easy, because the features of food systems that work against these features are also deeply enmeshed with politics and power and challenging these will be essential. This needs transformation in knowledge, to be more interdisciplinary and diverse across the natural and social sciences, and in integrating local understandings and experiences. It requires transformation in underpinning values too, foregrounding care over short-term profit in markets, and equity over and above the concentration of power and resources amongst elites. Such transformation in values also extends to a fundamentally different approach to the natural world, from human exceptionalism to a more reciprocal view in which we are concerned about the welfare of non-human animals and the environment as well as humans. This is an approach in which we emphasise care and justice not just between people, but with non-human natures and ecologies too. In this way, we might hope to move towards food systems that genuinely help prevent and mitigate pandemics, whilst also fostering wider approaches to securing human, animal and ecological life and health that appreciate their deep interdependence.

References

Adisasmito W B, Almuhairi S, Behravesh C B et al, 2022. One Health: A new definition for a sustainable and healthy future. *PLoS Pathogens*, 18(6):e1010537.

Baize S, Pannetier D, Oestereich L et al., 2014. Emergence of Zaire Ebola virus disease in Guinea. *New England Journal of Medicine*, 371:1418–25. https://doi.org/10.1056/NEJMoa1404505

Bartlett H, Holmes M A, Petrovan S O et al., 2022. Understanding the relative risks of zoonosis emergence under contrasting approaches to meeting livestock product demand. *The Royal Society Open Science*, 9:211573. https://doi.org/10.1098/rsos.211573

COVID Collective, 2023. *The Covid Collective: Social Science Research for Covid-19 Action*. Brighton: Institute of Development Studies. www.covid-collective.net/

Fairhead J, Leach M and Millimouno D, 2021. Spillover or endemic? Reconsidering the origins of Ebola Virus disease outbreaks by revisiting local accounts in light of new evidence from Guinea. *BMJ Global Health*, 6(4):e005783. https://doi.org/10.1136/bmjgh-2021-005783.

Forster P, 2012. *To Pandemic or Not? Reconfiguring Global Responses to Influenza*. STEPS Working Paper 51. Brighton: STEPS Centre.

IDS, 2023a. *Pandemic Preparedness for the Real World: Why We Must Invest in Equitable, Ethical and Effective Approaches to Help Prepare for the Next Pandemic*. Brighton: Institute of Development Studies. https://doi.org/10.19088/CC.2023.002

IDS, 2023b. *Pathways to Equitable Food Systems*. Brighton: Institute of Development Studies. https://doi.org/10.19088/IDS.2023.024

IPES-Food, 2020. *COVID-19 and the Crisis in Food Systems: Symptoms, Causes, and Potential Solutions*. Brussels: IPES-Food.

IPPPR, 2021. *Covid-19: Make it the Last Pandemic*. Independent Panel for Pandemic Preparedness and Response.

Jones K E et al., 2008. Global trends in emerging infectious diseases. *Nature*, 451:990–993.

Leach M, MacGregor H, Scoones I and Wilkinson A, 2021. Post-pandemic transformations: How and why COVID-19 requires us to rethink development. *World Development*, 138. https://doi.org/10.1016/j.worlddev.2020.105233

Lynteris C and Fearnley L, 2020. Why shutting down Chinese 'wet markets' could be a terrible mistake. *The Conversation*. https://theconversation.com/why-shutting-down-chinese-wet-markets-could-be-aterrible-mistake-130625

MacGregor H, Leach M and Pandemic Preparedness Project Team, 2022. Negotiating intersecting precarities: COVID-19, pandemic preparedness and response in Africa. *Medical Anthropology*, 41:1.

One Health Poultry Hub, 2023. Poultry in Bangladesh. https://www.onehealthpoultry.org/where-we-work/bangladesh/poultry-in-bangladesh/

Oxfam, 2020. The Hunger Virus: How Covid-19 is fuelling hunger in a hungry world. *Media Briefing*. https://bit.ly/3vp7ZPs

Rulli M, Santini M, Hayman D et al., 2017. The nexus between forest fragmentation in Africa and Ebola virus disease outbreaks. *Scientific Reports*, 7:41613.

Scoones I, 2010. *Avian Influenza: Science, Policy and Politics*. Abingdon and New York: Earthscan.

The Lancet, 2023. One Health: A call for ecological equity. *The Lancet*, 401:10372.

Wallace R et al., 2016. *Big Farms Make Big Flu: Dispatches on Influenza, Agribusiness, and the Nature of Science*. New York: NYU Press.

Wilkinson A and Leach M, 2015. Briefing: Ebola–myths, realities, and structural violence. *African Affairs*, 114(454):136–148.

World Economic Forum, 2023. WHO Pandemic Treaty: What is it and how will it save lives in the future? https://www.weforum.org/agenda/2023/05/who-pandemic-treaty-what-how-work/

World Food Programme (WFP), 2023. A global hunger crisis. https://www.wfp.org/global-hunger-crisis

World Health Organization (WHO), 2023. Pandemic prevention, preparedness and response accord. https://www.who.int/news-room/questions-and-answers/item/pandemic-prevention--preparedness-and-response-accord

World Health Organization and Secretariat of the Convention on Biological Diversity (WHO/CBD), 2015. Connecting global priorities: Biodiversity and human health.

Part 2

Planetary health

6 The global food system can and must be transformed to respect planetary boundaries

Katherine Richardson and Jakob Fritzbøger Christensen

2015 marked a milestone in the way we approach the management of our relationship with the world around us – as well as in the context within which we must see our food production. When the 193 countries of the United Nations (UN) adopted the 17 Sustainable Development Goals, the global community adopted a new understanding of and approach to sustainable societal development. Gone were the days of the *Millennium Goals*, where UN member states focused on solving global issues such as poverty, hunger, child mortality and environmental degradation one at a time and in isolation from one another. Instead, a new realisation spread through the singular transformative Agenda 2030: all the challenges we face when aiming for a sustainable development for humanity are interrelated and we will not be able to handle any one challenge without respecting these interactions and adopting a systemic approach. It is in this context that humanity now and forever more must meet its nutritional demands.

This new understanding of, and political consensus surrounding, sustainable development emerged from the relatively new discipline of Earth system science (Steffen et al. 2020). With the Amsterdam Declaration (Pronk 2002) on the Earth system, it became widely recognised that the "Earth system behaves as a single, self-regulating system comprised of physical, chemical, biological and human components". This framing is important as it emphasises humans are a part of nature – not elevated above it. As a component part of the Earth system, human activities have begun to operate as a "quasi-geological" force that can change the overall environmental conditions on Earth.

At the level of individual ecosystems (i.e., lakes, coral reefs, grasslands), we intuitively recognise that both non-human forces and human activities can cause a state change of the ecosystem as a whole (clear to turbid lakes, pristine coral reefs to reefs covered by algae; grasslands to shrub lands, etc.). The Amsterdam Declaration essentially acknowledged that it is not only the condition of ecosystems that human activities can dramatically, and potentially irreversibly, change but also the entire Earth system. In this sense, Earth system science essentially regards the earth as an ecosystem in and of itself.

This understanding of the Earth as a self-regulating system began at around the same time that Compassion in World Farming started and when Apollo astronauts took photos of the Earth from space. For the first time, it became abundantly clear to the scientist and non-scientist alike that the Earth is a solitary entity in space, i.e., is not connected to any other celestial body. What this means, of course, is that the natural resources we take from the Earth and upon which we depend for survival are finite. Once they are depleted, they will not be replenished. Currently, we are approximately eight billion people on Earth and UN projections indicate that the global human population will reach nine to ten billion by 2050 and possibly even higher by 2100.

The challenge this poses with respect to the global food system, i.e., how we produce and use food products, is enormous. Already today, the global production, distribution and consumption

DOI: 10.4324/9781032684369-9

of food combine to produce about a third of global greenhouse gas emissions whilst a third of the food produced is lost or wasted and 800 million people go undernourished (GSDR 2019). One out of every six people is suffering from malnutrition and only about half of those aren't getting enough to eat. The rest are getting too much, or the wrong, food and a global obesity epidemic is raging.

At the same time, agriculture occupies half of the world's habitable land (Ritchie 2019). An area the size of North, Central and South America combined is used for grazing and producing feed crops for meat and dairy production (Ritchie and Roser 2019). 70% of all freshwater withdrawals are currently used for agriculture and 85% of these withdrawals are consumed in irrigated agriculture (FAO 2021). How can the food system provide healthy nourishment for nine to ten billion people in 2050 and restore rather than exhaust the Earth's natural resources?

Addressing these difficult but critical questions requires a political will to more equitably share the Earth's resources, but it also requires a more thorough understanding and estimate of the magnitude of these resources. Before we can even begin to consider how to equitably share the Earth's natural resources, we need to know how much is available for our use. One approach for quantifying the Earth's resources available for human use is the *planetary boundaries framework* (Rockström et al. 2009a,b; Steffen et al. 2015; Richardson et al. 2023). Briefly, this framework is based on the observation that Earth has, throughout its history, experienced numerous different "states", i.e. periods with different global environmental conditions and where temperatures have been both warmer and colder than they are today.

During the past ~12,000 years, however, the climate conditions have been relatively warm and stable compared to the last million years. This period in Earth's history is called the Holocene. Whilst humans have been a part of the Earth system for the past ~200,000 years, it is only within the Holocene that everything we associate with modern civilisations (agriculture, written language, etc.) has developed. We know, then, that humanity can thrive in Holocene-like conditions. We do not know for certain that it can thrive under other than Holocene-like states. It would, therefore, be very unwise for humanity to perturb critical Earth system processes to the point that there is an increase in the risk of the Earth transitioning to a different state.

In developing the planetary boundaries framework, the authors identify nine global processes that all are critical for maintaining the Earth system in its current state. All are also heavily impacted by human activities (Figure 6.1). By studying the variability of these processes throughout the Earth's history, the framework proposes limits or "boundaries" for human perturbation. When these boundaries are exceeded, scientific evidence suggests that there is increased risk that this human perturbation can lead to a change in the overall environmental conditions on Earth. These "boundaries" are not to be confused with absolute thresholds or tipping points but, rather, can be compared to the measurement of blood pressure. When blood pressure is > 120/80, it is not inevitable that a cardiac event will occur, but the risk of an event is increased. Therefore, we attempt to reduce blood pressure. This analogy fits quite well when we consider the historical development of human influence on the Earth's ozone layer. The planetary boundaries analyses show that, in the 1990s, human impacts on the ozone layer were close to or on the wrong side of the boundary. Today, thanks to actions agreed in the Montreal Protocol, human impacts on the ozone layer have been brought to within the planetary boundary.

Campbell et al. (2017) considered the effects of agriculture, including livestock farming, to the human perturbation of the global processes included in the planetary boundaries framework using an earlier version of the framework (Steffen et al. 2015). Agriculture makes a significant contribution to the climate boundary but the impacts of agriculture on the climate system are, in themselves, not enough to bring human perturbation beyond the planetary boundary.

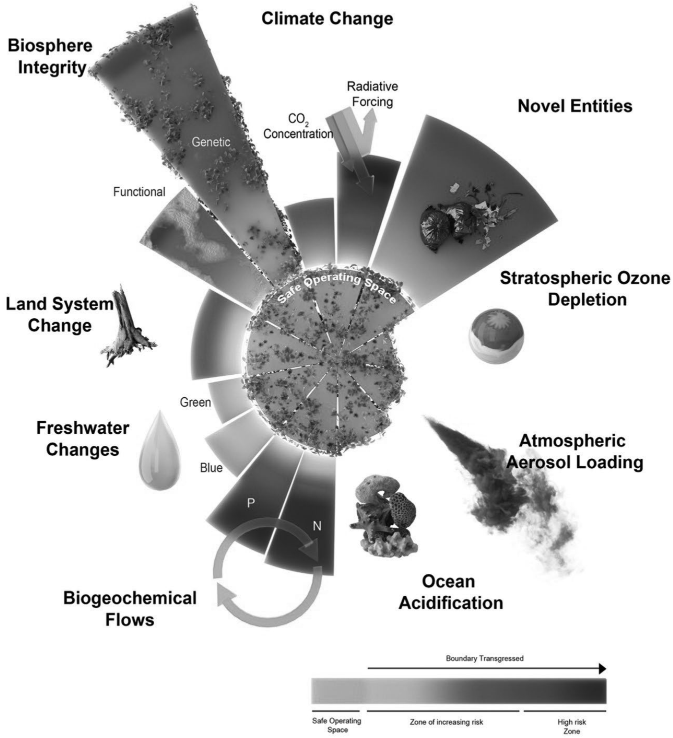

Figure 6.1 The status of the nine planetary boundaries (after Richardson et al. 2023). The planetary boundaries are combined to create the perimeter of the circle in the centre, i.e., the *safe operating space* for humanities activities. Six of the nine boundaries are now argued to be transgressed. Increasing intensity of shade indicates increasing risk of human activities triggering a drastic and potentially irreversible change in the overall environmental conditions on Earth. Note that three of the boundaries' processes (biosphere integrity, land use, and freshwater change) relate to anthropogenic activities that remove something from the Earth system, e.g., the removal of natural vegetation to allow agricultural activities. The remaining six relate to the introduction of waste products from human activities, e.g., greenhouse gases, reactive nitrogen and phosphorus, aerosols, and synthetic chemicals.

For several of the other boundaries, biosphere integrity ("biodiversity"), freshwater change, land use change, and the release of reactive nitrogen and phosphorus to the environment, Campbell et al. (2017) found that the impacts of agriculture on their own cause the boundaries to be transgressed. It becomes clear, then, that to meet the nutritional demands of nine to ten billion people without running the risk of inadvertently transitioning the Earth system to a new state will require substantial changes in the global food system.

Whilst the scale of the challenge seems enormous, our ability to measure it also gives us the tool to imagine what a sustainable food system could look like. Multiple scenarios have been developed that meet the nutritional demands of ten billion people without destroying the environment. The World Resources Institute has calculated how agriculture's annual greenhouse gas emissions can be reduced from 15 Gt CO_2e (carbon dioxide equivalent) in a baseline scenario for 2050 to 4 Gt CO_2e (Searchinger et al. 2019). The reduction requires only that we cut the consumption of red meat by 30% compared to the baseline (this still represents an increase of 32% compared to 2010 levels due to population growth). However, this scenario also assumes technological innovation exceeding that of the "Green Revolution" in the middle of the 20th century, e.g., a 67% increase in beef production per hectare, a 58% growth in dairy output per hectare, and cutting food loss and waste by half.

The organisation EAT and the journal *The Lancet* have published an alternative scenario with basis in the planetary boundaries (Willett et al. 2019). That study shows how similar reductions in greenhouse gas emissions can be reached without further innovation if all people change to a diet of more fish, vegetables, legumes, wholegrains, and nuts, with a red meat intake comparable to that in North Africa and the Middle East today. To keep Earth within most of the planetary boundaries, however, requires that these dietary changes are combined with the halving of food loss and waste, that the efficiency of food production increases to 90% of the theoretical optimum, and 50% of phosphorous is recycled.

The important thing about all of these scenarios, however, is not the precise pathways they employ to reach a sustainable food system but, rather, that they show us several possible and plausible combinations of actions that can theoretically lead to a global food system that can meet the nutritional needs of ten billion whilst still respecting limits to the environmental damage caused in connection with the production of our food.

Thus, these different scenarios give us confidence that transformation to a sustainable food system is possible. They also show us, however, that no single "solution" will deliver a sustainable food system. Likewise, technological innovation on its own will not transform our food production in a manner that respects planetary boundaries. Behavioural changes on the part of both the producer and consumer of food are also necessary.

Feeding ten billion people requires that planetary boundaries be respected. These can only be respected when we ensure that our nutritional demands are met with a minimum of associated environmental cost. History has shown us that without intervention the global food system does not evolve with a focus on minimising environmental effects. We have the tools, however we need to catalyse the change to a global food system into one that rewards resource use efficiency and reduces the emission of waste products (greenhouse gases, reactive nitrogen and phosphorus, pesticides, and antibiotics) to the open environment. Productivity increases (greater nutritional value per unit area) should be economically rewarded and the "polluter pays" principle implies that release of all waste to the environment should be associated with monetary costs. Thus, we can use our economic, financial, and governance systems to incentivise the structural and behavioural changes necessary to create a sustainable food system.

Our production and use of food are linked in a complex adaptive system. Complex adaptive systems rarely evolve via large steps or singular "solutions". Almost always, we see that it is the combination of many small changes and adjustments that drive the evolution of complex systems. Our understanding of the functioning of the Earth system and of the effects our food system has on the global environment, demonstrate clearly that the nutritional needs of ten billion people cannot be met without transformation in the way we produce and use our food. We know what needs to be done, and we have most – if not all – of the tools we need to catalyse the necessary transformation. There are no excuses for waiting to change the way we produce and use food.

Acknowledgement

This chapter represents an update of an earlier work (Richardson K, 2018. Livestock and the boundaries of our planet, in: D'Silva J and McKenna C (Eds.), *Farming, Food and Nature: Respecting Animals, People and the Environment*. Routledge) and may contain similar textual passages.

References

Campbell B et al., 2017. Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, 22:4, article 8.

FAO (Food and Agriculture Organization of the United Nations), 2021. The State of the World's Land and Water Resources for Food and Agriculture – Systems at Breaking Point. Synthesis Report 2021.

GSDR, 2019. Independent Group of Scientists appointed by the Secretary-General, Global Sustainable Development Report 2019: The Future Is Now – Science for Achieving Sustainable Development. New York: United Nations.

Pronk J, 2002. The Amsterdam declaration on global change. In: Steffen W, Jäger J, Carson D J and Bradshaw C (Eds.), *Challenges of a Changing Earth. Global Change - The IGBP Series*. Berlin, Heidelberg: Springer.

Richardson K, Steffen W, Lucht W et al., 2023. Earth beyond 6 of 9 planetary boundaries. *Science Advances*, 9:37.

Ritchie H, 2019. Half of the world's habitable land is used for agriculture. https://ourworldindata.org/global-land-for-agriculture

Ritchie H and Roser M, 2019. Land use. https://ourworldindata.org/land-use

Rockström J et al., 2009a. A safe operation space for humanity. *Nature*, 461:472–475.

Rockström J et al., 2009b. Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*, 14:2, article 32.

Searchinger T et al., 2019. Creating a sustainable food future. *World Resources Institute*. https://www.wri.org/research/creating-sustainable-food-future

Steffen W et al., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science*, 347:6223.

Steffen W et al., 2020. The emergence and evolution of Earth System Science. *Nature Reviews. Earth & Environment*, 1:54–63. https://doi.org/10.1016/S0140-6736(18)31788-4

Willett W et al., 2019. Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet*, 393(10170):447–492. http://dx.doi.org/10.1016/S0140–6736(18)31788-4

7 Regenerative management of agroecosystem soils to minimise extinction risks and for climate and food security

Rattan Lal

Introduction

Many once-thriving civilisations perished because they took the finite soil and other natural resources (water, biodiversity, air) for granted. Examples of these civilisations include:

1 Mesopotamian in present day Iraq circa 1700 BC (4,000 years ago), wiped out by dust storms (Watanabe et al. 2019);
2 Harappan in northwest India circa 1700 BC, demolished by severe drought in the catchment of river Ghaggar (mythical river Saraswati) after 3500 BC (Tripathi et al. 2004);
3 Mycenaean in present day Greece in 1200 BC;
4 Mayan in present day Mexico, ended by an intense drought in the 9th century AD (Bencks 2021); and
5 Norse society in Greenland about 1400 AD, ended by plummeting temperatures and poor land management along with raids by pirates (Gilder and Pal 2015).

Thus, soil and environmental degradation caused the demise of these and other once mighty civilisations. What lessons can the "Carbon Civilisation" (circa 1750 to 2050) (Lal 2007) learn from the collapse of these historic empires to safeguard its future? The era of the Carbon Civilisation, coinciding with the Anthropocene[1] (Crutzen 2006), is faced with the soil crisis. Yet healthy soils are critical to continuation of the human race.

The Carbon Civilisation has thus far followed the path of conquering nature and developing science-based agricultural systems. However, there are emerging problems which cannot be ignored such as climate change, soil degradation and severe pollution (air, water, sound, light) and mass extinction (Sayari et al. 2014).

Based on the study of the fate of four river valley civilisations, which originally had free-ranging large animals including elephants, Doughty et al. (2013) hypothesised that

> decreased soil fertility (caused by extinction of large animals) may have reduced food yields and driven early agriculture from the outer regions away from rivers towards the more fertile flood plains. Thus, yield and populations in outer regions would have decreased, constraining the potential growth of these civilisations.

There is strong evidence about the presence of elephants in the ancient Nile valley which were hunted and distributed to Egypt and the Greco-Roman world (Lobban and Liedekerke 2000). Indeed, there exists a well-documented collapse of past civilisations whose cultural pattern of behaviour can be described as "self-organised extinction". It is widely argued that the Carbon Civilisation represents the sixth major extinction event (Chen 2005).

DOI: 10.4324/9781032684369-10

Thus, there is a need to rethink humanity's (the Carbon Civilisation's) attitude towards nature and its sustainability. This chapter provides an objective review of extinction or regeneration, in eco-socialism and "Hospice Earth" so that it can continue to nurture humanity in perpetuity (Barkdull and Harris 2015).

Global issues of the 21st century

Global issues of the 21st Century include the following:

1. population of 8.12 billion (B) in 2024, increasing at 1.14% per year (7.65 million (M) per month);
2. per capita arable land area of 0.186 hectares (ha) decreasing to less than 0.07 ha for many densely populated countries in 2025;
3. soil degradation affecting 30% of Earth's land area and aggravated by tropical deforestation of around 7.6 M ha per annum, equal to the land area of Sri Lanka;
4. renewable fresh water supply of less than 1000 m^3 for 30 countries, which by 2050 will affect 58 countries and 4 B people;
5. atmospheric carbon dioxide (CO_2) concentration of 424 parts per million (ppm) in 2023, increasing at 0.5% (around 2 ppm) per year;
6. energy use of 637.8 quads (10^{15} BTU) or 672.9 EJ in 2023, increasing at 1.4%/per year, projected to be 736 quads by 2040;
7. 38% of land under agriculture –5.2 B ha, of which 3.7 B ha are used for raising of livestock;
8. a food-insecure population of 824 M in early 2023 and increasing because of wars and political unrest;
9. rapid urbanisation with an encroachment of around 4 M ha of prime agricultural land; and
10. the upper limit of emission of fossil fuel carbon of 290 Pg (Gt) between 2024 and 2050 so that atmospheric CO_2 concentration does not exceed 560 ppm (double than that of the pre-industrial era).

Biodiversity plays a critical role in moderating the concentration of CO_2 in the atmosphere. Thus, biodiversity is important in the ecosystem's capacity to control CO_2 in the atmosphere as the primary reason not only of the "greenhouse effect" but also of the "greenhouse catastrophe" (Rozanov 1998). The Carbon Civilisation has set in motion the sixth mass extinction.

The rapid increase in agricultural production since the 1960s, because of the seed-centric Green Revolution, is the result of massive inputs. These include fertilisers (nitrogen (N), phosphorous (P), potassium (K)), pesticides, energy use in ploughing and farm operations and irrigation of around 350 M ha on around 20% of the world's cropland area.

Between 1961 and 2023, global population increased 2.46 times from 3.1 B to 8.12 B, global cereal production increased 3.3 times from 880 M tonnes (t) to 3.0 Bt, and per capita cereal production increased 32% from 284 kg to 376 kg. The increased food availability saved hundreds of millions from starvation. The use of N fertiliser increased by 9.2 times, P fertiliser by 5 times, K fertiliser by 4.8 times, pesticide use by 5.2 times and irrigated land use by 2.4 times (from 144 to 350 M ha). Global pesticide application in 2019 was estimated at 4.19 Mt, and water use by agriculture at 2 quadrillion (10^{15}) gallons or about 3,150 km^3.

Despite heavy use of inputs, there is also a serious problem of soil degradation by erosion through hydric (water) and aeolian (wind) processes, salinisation (excess water-soluble salts in soil), acidification (harmful build-up of acids), alkalisation, elemental imbalance, depletion of soil organic carbon (SOC) content and stock and decline in activity and species diversity of soil biota (soil life).

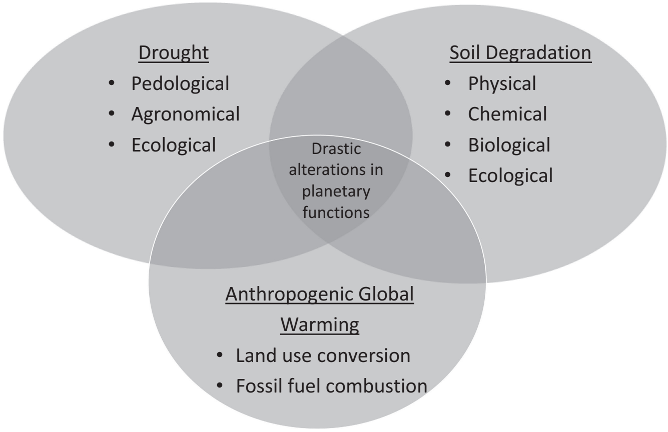

Figure 7.1 The mutually reinforcing processes leading to drastic alterations in planetary functions.

By 2020, one-third of ice-free land had been degraded by human activities (IPBES 2018; IPCC 2019). Depletion of soil organic carbon from global agricultural land is estimated at ~135 Pg C (Lal 2018). The mutually reinforcing degradation processes outlined in Figure 7.1 must be avoided to minimise risks of drastic alterations in planetary processes.

Land use change from natural to agricultural ecosystems and intensification of agriculture (fertiliser use, ploughing, irrigation, drainage of peat lands, raising of livestock and grazing) have aggravated greenhouse gas emissions (GHGs) and the attendant global warming.

Raising of livestock and cultivation of rice paddies have contributed to methane (CH_4) emissions, and use of nitrogenous fertilisers and leguminous cover crops to emissions of nitrous oxide (N_2O), both of which have a high global warming potential (GWP).

The 2022 global average amount of GHGs in the atmosphere was 417.9 ppm for carbon dioxide (CO_2) (150% increase since pre-industrial levels), 1923 ppb of CH_4 (264% increase since pre-industrial levels) and 335.8 ppb of N_2O (124% increase since the pre-industrial level of 271.1 ppb) (WMO 2023). The absolute (and relative) annual increase of these GHGs is estimated at 2.2 ppm (0.53%) of CO_2, 16 ppb (0.84%) for CH_4 and 1.4 ppb (0.42% for N_2O). The average absolute increase for the past decade ending in 2022 was 2.46 ppm/yr for CO_2, 10.2 ppb/yr for CH_4 and 1.05 ppb/yr for N_2O (WMO 2023). The atmospheric concentration of CO_2 was recorded at 424 ppm in May 2023.

Consequently, the Earth's surface temperatures have warmed by about 1.1°C (1.9°F) since 1850. Since 1975, the observed rate of warming is 0.15°C to 0.20°C per decade (WMO 2023).

Resources used for agriculture

Through rapid expansion of land area under agriculture, by the conversion of natural to agro-ecosystems, humans have been culprit and victim of the ecological crisis (Figure 7.2). For example, almost 38% of the Earth's ice-free land area is used for agriculture. Furthermore, 75% of agricultural land (3.73 B ha) is used for raising animals, and 1.5 B ha is used for cultivation of food crops. Irrigation of agricultural land is a major use of water, and 70% of water withdrawal is used for irrigation. One-third of all anthropogenic (human-related) GHG emissions are attributed to global food systems, of which agriculture (food production) is one of the primary emitters.

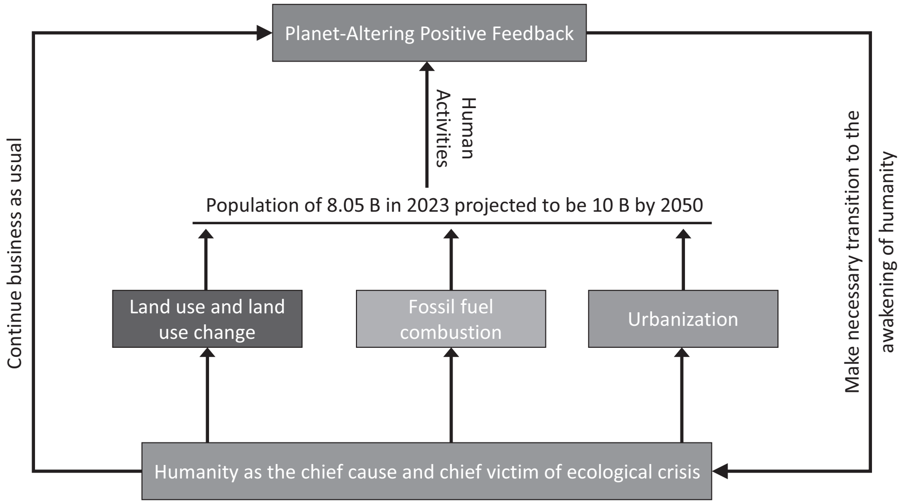

Figure 7.2 Humanity as the cause and victim of ecological crisis.

Despite vast use of natural resources and input, about 1 B people (out of 8.05 B total population in 2023) are prone to hunger and around 2 B people are prone to hidden hunger or malnutrition. The carbon footprint (CFP) is the fastest growing component of the humanity's environmental footprint (EFP) and must be reduced by living in harmony with nature (during the early 2020s, the CFP is 54% of the overall EFP (Lal 2022c). Indeed, the way food is produced and consumed, affects health of soil, plants, animals, people and the planetary processes (Lal 2020a).

Through agriculture and other activities, humans are changing the atmosphere, the hydrosphere and cryosphere (water and ice), the lithosphere (Earth's crust) and the biosphere (Rasmussen 2023). These effects are evident from climate volatility and air pollution, water scarcity and eutrophication (pollution of water, sometimes so severe that "dead zones" result), large eco-social uncertainty, mass extinction and other natural disasters. Thus, there is a need for rethinking and reforming human responsibility for protecting and restoring planetary processes especially those of the pedosphere (soil). We need to consider alternative strategies to address the ecological crisis that humanity is gripped in (Guga 2021), with the focus on a more sustainable future. The strategy is to "produce more from less", use biofertilisers and biopesticides and enhance soil health to creating disease-suppressive soils, thus reducing the need for pesticides.

Alternative strategies for a vision of a sustainable future

It is argued that global catastrophe risks aggravated by anthropogenic activities may include climate change, natural pandemics, near Earth objects, space weather (solar flares, solar particles), stellar explosions (X-ray bursts), volcanic eruptions, etc. Several of these natural events may have high on-going probability, with severe consequences to humanity, and should not be dismissed (Baum 2023).

Indeed, human-induced global warming (climate change) is already a climate emergency (Bingaman 2022). Earth's mean temperature has already increased by 1.1°C above pre-industrial levels, and unless non-carbon fuel sources are developed soon, the world is on track to a total increase of 2.6°C to 3.9°C with disastrous consequences (Raven 2022).

Gardner and Bullock (2021) suggested a paradigm shift from biodiversity conservation to survival ecology with the focus on safeguarding a planetary system in which humans and other species can thrive. The concept of "survival ecology" acknowledges unavoidable change. It looks to the future, not the past, and embraces the philosophy of non-violent disobedience.

Human civilisation is dependent on plants, and how they grow in soil or the so called "geoderma". Yet, modern civilisation is rather disconnected from plants (Stroud et al. 2022), and from soil, which is the habitat of all life on earth. Properly managed plants can play a critical role in human wellbeing. All plants depend on the supply of green water, the water available to plants in the root zone. Soil's green water capacity is adversely affected by soil degradation (erosion, depletion of soil organic carbon stock, salinisation). Similar to the well-known climate emergency (Gardner and Bullock 2021), the deteriorating state of the Earth's water supply is also a cause of concern, and a major contribution to the "extinction anxiety" (Reding 2021).

Adopting negative emission technologies

Carbon (C), an important element on Earth, is the basis of life by being the basis of energy sources that are critical to the Carbon Civilisation (Lal 2007). Its storage and mobilisation throughout the Earth from core to crust forms the foundation of humanity. Large scale perturbations of the carbon cycle can lead to mass extinctions. It is thus critical for the scientific community to understand the global carbon cycle (Suarez et al. 2019), with particular attention to the role of soil and its management (Lal 2004).

Industrialisation based on fossil energy has intensified global warming and calls for urgency to achieve negative emissions development. "Carbon neutrality" (Zou et al. 2021) is not good enough to address the climate crisis and the related syndromes accelerating the downward spiral. Of course, achieving "carbon neutrality" is the first step towards the goal of negative emission development. Policy makers must consider "resilient environmental governance" and promote the transition from Carbon Civilisation to non-carbon humanity such as that based on hydrogen (Lal 2007) or "Ecological Civilisation" (Robinson 2020).

Priority should be given to sustainable development through effective protection of biodiversity and its habitat. Rather than ecosystem services (ESs), the concept of "Nature's Contributions to People" (NCP) has been proposed (Li et al. 2019). But the central focus must be on avoiding the sixth mass extinction.

Carbon storage in the terrestrial biosphere, an important regulator of Earth's climate, has been facilitated by the evolution of woody plants about 400 million years ago (Fazan et al. 2020). Amongst more than 374,000 plant species worldwide, 45% (138,500) are woody species. Development of human civilisation led to the disappearing of 1.4 trillion trees comprising of more than 45% of forest biomass. Over-exploitation, land use conversion and climate change have threatened extinction of 10,000 woody species (Fazan et al. 2020). Thus, returning some agricultural land back to nature is an important consideration (Lal 2023). Returning some marginal land back to nature would weaken the case against Being a Human Being (Hutchings 2020). Therefore, humanity must learn how to control its needs and focus on continuous economic growth without jeopardising ecological sustainability, and by living in harmony with nature (Kakoty 2018). It is the right time for humanity to make a critical choice whether to continue business as usual and become the primary cause of ecological crisis or make the much-needed transition to create an awakening and save the planet and itself (Van Pelt 2018) and avert the change of Anthropocene to Plutocene[2] (Glikson 2017a,b,c). The awakening would be soil-centric with focus on the protection, restoration and sustainable management of world soils so that half of the agricultural land in 2023 (2.6 out of 5.2 B ha) can be returned to nature by 2100 (Lal 2023).

Soil health, food security, regeneration nexus

There is a strong soil health-food security-regeneration nexus (Lal 2020a). The One Health Concept states that health of soil, plants, animals, people, environment and planetary processes is one and indivisible (Lal 2020a). The concept was originally proposed by Sir Albert Howard (1945), the "father" of modern organic farming. In contrast, there is also a strong soil degradation-food insecurity-extinction nexus. It is the prerogative of the Carbon Civilisation to decide which nexus it wishes to pursue. Extinction vs. regeneration is governed by the urgency to restore soil health and its biodiversity. The latter can be defined as the total sum of all flora and fauna in soil which support animal and plant life. A healthy soil must contain about 5 Mg/ha of live biomass in the surface 30 cm layer. Soil biodiversity is an attribute of an area and specifically refers to the variety within and amongst living organisms, assemblages of living organisms, biotic communities and biotic processes, whether naturally occurring or modified by humans and that which regulates soil's multifunctionality (Singh et al. 2018, 2023).

Soil degradation

Soil degradation implies loss of real or potential productivity and utility of soil caused by decline in its quality and functions due to natural and/or anthropogenic factors. One-third of the ice-free land area of Earth is degraded by one or more of several degradation processes (IPBES 2018; IPCC 2019). It is aggravated by land misuse and soil mismanagement. Amongst principal causes of soil degradation are erosion by wind, water on tillage (Carpenter et al. 2001; Zuazo et al. 2009; Baumhardt et al. 2015; Lieskovsky and Kenderessy 2023), livestock overgrazing (Crovo et al. 2021), recurring forest fire (Bradstock 2008; Nadporozhskaya et al. 2018; Andrés-Abellan et al. 2023), biological soil crusts (Szyja et al. 2023), mining such as that of coal (Rocha-Nicoleite et al. 2018), salinisation (Cano et al. 2003), desertification and aridification (Slimani et al. 2010; Mora et al. 2012), deforestation (Islam et al. 2001), logging (Sukhbaatar et al. 2019) and intensive arable cropping (Berdeni et al. 2021).

Loss of microbial biodiversity is another indicator of soil degradation. When microbial diversity drops to below the critical level, soil's life support processes are severely jeopardised. Loss of soil microbial diversity may increase insecticide uptake by crops (Zhang et al. 2017) and endanger the safety of the food produced. A soil subject to severe loss of biodiversity may be considered "dead" and lose its capacity to produce ecosystem services (ESs) but aggravate production of ecosystem disservices (EDs). A healthy soil must contain about 5 Mg/ha of live biomass of diverse organisms (macro, meso and micro).

Overgrazing is another cause of soil degradation in pasture lands. The Cerrado region of Brazil has the largest cultivated pastures for cattle in Brazil, and 40% of these pastures are degraded because of overgrazing (Silva et al. 2023). In Argentina, low livestock density and establishment of *Sebastiania commersoniana* (a type of plant) were effective in restoration of soil quality of degraded pastures. Conversion of degraded croplands to permanent pastures is a useful strategy to restore degraded soils (McLenaghen et al. 2017). Land over-run by *imperata* (a type of grass) can be restored by reforestation and secondary succession (plants can re-grow when conditions are right). These also lead to an increase in soil organic content and stock.

Nutritional imbalance (nutrient mining, acidification, alkalisation) is another primary cause of soil degradation (Grammenou et al. 2023). Restoration of degraded soil can be hindered by the cause and severity of degradation (Chua et al. 2016), which can deplete soil organic carbon stock and biotic (soil life) activity (Berdeni et al. 2021). Plant re-establishment for recovery is also affected by the parent material (Mora et al. 2012).

On grazing lands, restoration can be set in motion by livestock exclusion (Moradi et al. 2022), closed silvo-pastoral systems (Spaan and Van Dijk 1998) and restoring of perennial vegetation.

Forest regeneration is critical for the carbon and nitrogen budget after clear cutting (Liu et al. 2020). Natural regeneration also depends on the strength of the seed bank in degraded sandy grasslands (Wang et al. 2022), and input of biomass-carbon leading to a positive soil/ecosystem carbon budget (Lal 2004). Recarbonisation of soil organic carbon stock can also be helped by use of bio-stimulants (Grammenou et al. 2023), organic/inorganic amendments (Gabioud et al. 2020) and soil and water conservation technologies. Bituminous materials are also used as amendments to improve soil aggregation (Fortún et al. 1996). A judicious use of biochar can restore fertility of degraded soils (Singh et al. 2023).

Are soils endangered and also going extinct?

Just like other living organisms, good soils can also be endangered and vulnerable to extinction. As a group of conservation biologists, the Alliance of World Scientists has issued a warning to humanity on insect extinctions (Cardoso et al. 2020), a similar warning may be warranted on soils. For example, Red Ferralitic soils in western Cuba are amongst those vulnerable to extinction (Febles-González et al. 2014).

Extinction of soil may also imply decline in soil diversity leading to ecosystem disservices. Therefore, variability of soils must be accounted for in economic analysis and business decision-making. Soil diversity is a complex attribute and can be explained on the basis of interaction amongst different spheres as is vividly explained by Mikhailova et al. (2021) and outlined in Figure 7.3. Soil extinction can be set in motion by agricultural activities and urbanisation. However, the process is accelerated by land misuse and soil mis-management and aggravated by the current and projected anthropogenic climate change.

Examples of innovative regeneration practices

There is no “one size fits all” practice(s); recommended management practices are soil/eco-region specific. Listed below are a few examples for some innovative practices of

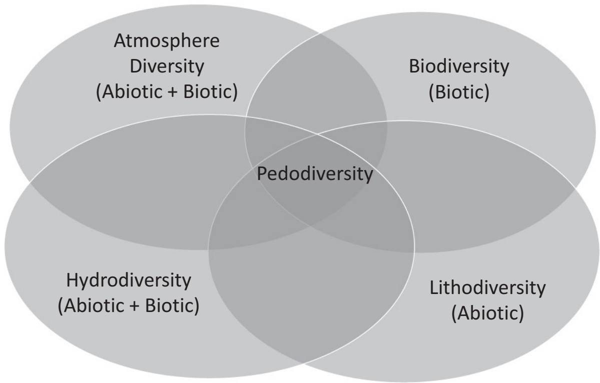

Figure 7.3 Factors affecting pedodiversity can be intrinsic (within soil) and extrinsic (outside soil) which regulate ecosystem services (ESs) and disservices (EDs).

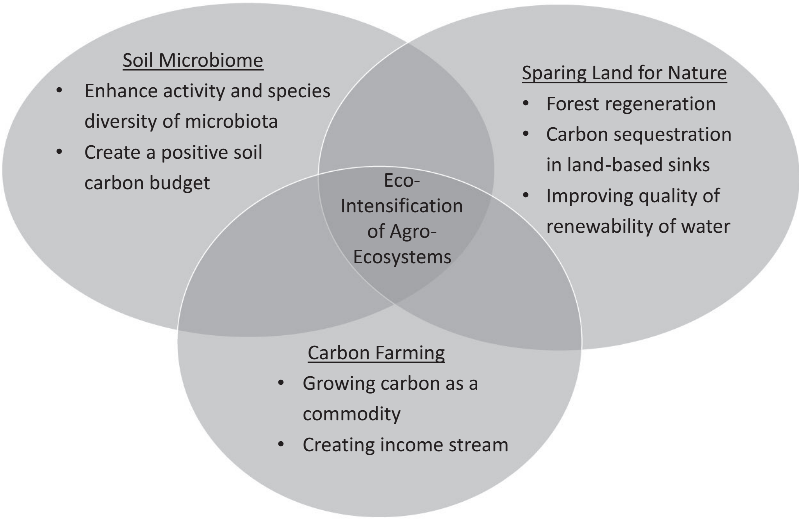

Figure 7.4 Basic components of regenerative practices which lead to protection, restoration and sustainable management of soils of agro-ecosystems.

regenerative agriculture which have been tested under site-specific conditions and are based on the concept of eco-intensification (Figure 7.4, Lal 2019a). In addition to promoting adoption of science-based land use and soil management practices, there is also a need to advance soil protection through legal approaches such as rights-of-soil (Lal 2019b), stewardship based on spirituality and theological approaches (Lal 2024b) and producing more from less. This would enable agriculture to be part of the solution bringing about the much-needed transformation in global food systems to ensure production of nutritious, safe and environmentally friendly food.

1 **Soil microbiome (soil life):** There is a large potential of microbial interventions in regeneration of degraded soils of agro-ecosystems and of increasing resilience of crops to global warming. Shah et al. (2022) suggested harnessing the native capability of soil microbiomes for carbon sequestration (storing of carbon), phyto-stimulation, biofertilisation, rhizo mediation, biocontrol of plant pathogens and other responses in the host plant. However, more research is needed to understand their action. Creative application of microbes, microbiomes and microbial biotechnology is central to promoting human health and wellbeing (Timmis and Ramos 2021).
2 **Use of rock powder and biochar:** Soil inorganic carbon (SIC) is an important component of global drylands (Lal 2019, 2024a), but has not been widely studied. Globally, SIC stock accounts for about half of the soil carbon reserves and has longer mean (average) residence time (MRT) and is more stable than SOC stock. Intensive use of certain fertilisers and other inputs can accelerate losses of SIC. Therefore, innovative management practices are needed to minimise losses of SIC and enhance soil health under harsh arid/semi-arid climates (Lal 2019c). Azeem et al. (2022) suggested rock mineral residues or powder as an amendment to increase soil alkalinity and argued that soil micro-organisms can play an important role in weathering of rocks. Azeem and colleagues also suggested the use of biochar as an amendment (including bone biochar) to supply calcium (Ca) and magnesium (Mg) and increase alkalinity.

3 **Natural regeneration of forest and returning some land to nature:** Of the 5.2 B ha of land under agriculture in 2024, half of it (around 2.6 B ha) can be spared for nature by 2100 (Lal 2023). Regeneration of forest on spared land can sequester (store) carbon, increase the renewability and quality of water, strengthen biodiversity and strengthen numerous ecosystem services (ESs). Several studies have documented that natural regeneration of forest may be the most cost-effective and technically straightforward strategy to mitigate climate change (Chen et al. 2022). Sparing land for secondary forest regeneration has been found to be critical to protecting biodiversity (Gilroy et al. 2014; Edwards et al. 2021).

4 **Restoration of degraded soils and desertified ecosystems:** One-third of ice-free land is degraded (IPBES 2018; IPCC 2019). Restoration of these degraded soils is a win–win–win option leading to food and nutritional security, mitigation/adaptation of climate change and putting the Sustainable Development Goals on track. There exists a large potential of SOC sequestration in the Sahel (Luedeling and Neufeldt 2012). Restoration of degraded lands in the Sahel and elsewhere can be promoted by carbon farming (see next point). Implementation of a Soil Health Act at national and global level may be one of the critical strategies to protect, restore and sustainably manage soil health and make agriculture a part of the solution. These ideas are based on the basic principles involving Rights-of-Soil (Lal 2019b)

5 **Carbon farming:** This is a strategy of providing well-designed incentives to encourage land managers to adopt practices which will grow carbon in terrestrial sinks (soil, trees, degraded ecosystems). Carbon farming can deliver biodiversity and climate gains whilst providing social and economic benefits (Evans 2018; Lal 2023). It is widely agreed that carbon farming in agricultural land may create cost-effective mechanisms for sequestering CO_2 whilst delivering co-benefits for biodiversity and numerous other ecosystem services. It would also promote assisted natural regeneration as a reforestation approach which is cost-effective and delivers both C and biodiversity benefits (Evans et al. 2015). However, the potential benefits of carbon farming are strongly affected by the uncertainty of the future value of carbon (Funk et al. 2014), which should range from $40 to $50 per credit in the 2020s (Lal 2023) and be based on societal value of soil carbon (Lal 2014).

6 **Conservation agriculture:** A system-based conservation agriculture or CA (Lal 2015a) has some basic pillars including:

i no-tillage or minimal soil disturbance;
ii retention of crop residue mulch on the soil surface;
iii growing a “cover crop” during the off-season (to prevent loss of soil) (Lal 2015b);
iv adoption of complex farming systems based on integration of crops with trees and livestock or agroforestry systems (Lal 2022a); and
v use of integrated soil fertility management (ISFM) based on a judicious combination of organic and inorganic sources of plant nutrients. Regenerative agriculture and agroecology (Lal 2020c) are similar concepts and involve practices such as listed under the overall umbrella term of CA. No-till based agriculture is practiced on some 205.4 M ha of crop land (Kassam et al. 2022) out of the total arable land area of 1.5 B ha.

7 **Human health and soil crisis:** The unprecedented rate of soil degradation and desertification during the 21st century is a major constraint to achieving the Sustainable Development Goals of the United Nations. Soil degradation specifically affects SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 13 (Climate Action), SDG 15 (Life on Land) and SDG 16 (Peace, Justice and Strong Institutions).

Soil degradation aggravates risks of political instability and jeopardises peace and stability (Lal 2015c, Lal 2022b). Timmis and Ramos (2021) emphasised the need to treat the soil crisis as a global health problem and the need to recognise the pivotal role of soil microbes in prophylaxis (prevention) and therapy. They proposed a coherent approach to creating: (i) a public health system for development of effective policies for land use, conservation, restoration, restoration of prophylactic measures and epidemiology and (ii) a health care system charged with soil care. Timmis and Ramos also suggested the development of an educative-political-economic-legislative framework that incentivises soil care and promotes the idea that we must all be engaged in improving soil health as a duty of care and stewardship.

Indeed, each one of us (8.12 B in 2024) is both a culprit and a victim, and we have a moral obligation to undertake earth-friendly actions through healthy diets and our overall lifestyle.

8 **Education:** Connecting people with nature requires education and increasing awareness of the importance of protecting, restoring and sustainably managing soil and other natural resources. Thus, soil and environment sciences must be part of the education curricula from kindergarten, primary and secondary school. It is also critical to improving awareness of the importance of soil resources amongst policy makers and the public at large. An educative framework, combined with policy and legislation (Timmis and Ramos 2021), is essential to revising the educational curricula at all levels.

9 **The role of the private sector in translating science into action:** The private sector (industries dealing with the entire food chain from farm to fork) and others have an important role. This includes: translating knowledge into action, investing in innovative research and development, rewarding farmers and land managers for conservation-effective agricultural practices and paying them for strengthening ecosystem services for human wellbeing and nature conservancy. The role of the private sector is especially critical in the transformation of food systems in developing countries in areas such as Sub-Saharan Africa, South and Southeast Asia, Central America and the Caribbean and the Andean region.

10 **Farmers and land managers are the greatest stakeholders in soil stewardship:** Availability of healthy soil is essential for the continuation of the human race and to minimise risks of its extinction. Being the greatest stewards and stakeholders in sustainable management of the soil and other natural resources, land managers mut be given the respect and recognition they deserve. Respectability of the agricultural profession, land managers and those who provide essential services to land managers, must be enhanced through the creation and implementation of political-economic-legislative frameworks to provide rewards for restoring soil health and its ESs. Furthermore, religious organisations and private sectors must be actively involved. As noted above, active participation of the private sector is essential to increasing investment in inter-disciplinary research and education on the soil–human health nexus, and in creating framework which advances and support the nexus.

Conclusions

The demise of numerous once-thriving civilisations was caused by the degradation of soil and the natural resources which supported them. Major global issues of the 21st century indicate that the Carbon Civilisation (the era from 1750 to 2050 or the Anthropocene) is also threatened by the degradation of soil and pollution of the environment. Human survival is at risk if soils are not protected against man-made degradation processes such as erosion, salinisation, SOC depletion, elemental imbalance and loss of soil biodiversity.

The basic strategy of avoiding extinction of modern civilisation is based on the concept of making agriculture a part of the solution, by producing more from less (land, water, energy use, gaseous emissions and loss of biodiversity), enhancing eco-efficiency, using biofertilisers and biopesticides and creating disease-suppressive soils through the enhancement of soil health and improvement of the activity and species diversity of soil biota.

Some examples of recommended management practices include system-based CA involving principles of agroecology and regenerative agriculture, the sparing of land for nature. The goal is to allow natural vegetation to grow on agriculturally marginal lands, restoring degraded soils and desertified ecosystems, using soil amendments such as biochar and rock powder and strengthening the soil microbiome by restoration of biodiversity.

There is an urgent need for implementation of a Soil Health Act at national and international level. It must be based on Rights-of-Soil. Yes, soil is a living entity, and it must be protected and restored and allowed to thrive and flourish. A Soil Health Act may also facilitate promotion of carbon farming through payments to farmers for strengthening of ecosystem services. The private sector can play an important role in translating science into action. There is also a need for revision of education curricula from kindergarten through primary and secondary school to focus on soil, natural resources and environmental sciences.

The complex and humongous problem of the serious threat of extinction of the Carbon Civilisation must involve all approaches including economic (Soil Health Act and payments for ecosystem services through carbon farming), legal (Rights-of-Soil), spiritual (stewardship of natural resources) and educational (revision of curricula) regarding the importance of managing soil health for human wellbeing and nature conservancy.

Notes

1 A term used to describe the recent past where humans have become the most influential species on the planet, causing significant global warming and changes to land, environment, water, organisms and the atmosphere.

2 The Plutocene is a term devised by earth scientist Dr Andrew Glikson who describes it as “a period dominated by a tropical climate and high radioactivity lasting for approximately 20,000 years, as controlled by the half-life of plutonium and the longevity of carbon dioxide in the atmosphere. During the Plutocene the earth will have tropical climate, sea levels will be higher, with not much ice at poles” (ANU, 2017).

References

Andrés-Abellán M, Picazo-Córdoba M, García-Saucedo F et al., 2023. Application of a Soil Quality Index to a Mediterranean Mountain with post-fire treatments. *Forests*, 14(9). http://dx.doi.org/10.3390/f14091745

ANU (Australian National University), 2017. Dr Andrew Glikson on the Plutocene age. https://cass.anu.edu.au/news/qa-dr-andrew-glikson-plutocene-age

Azeem M, Raza S, Li G et al., 2022. Soil inorganic carbon sequestration through alkalinity regeneration using biologically induced weathering of rock powder and biochar. *Soil Ecology Letters*, 4(4): 293–306. http://dx.doi.org/10.1007/s42832-022-0136-4

Barkdull J and Harris P, 2015. Climate-induced conflict or Hospice Earth: the increasing importance of eco-socialism. *Global Change Peace & Security*, 27(2): 237–243. http://dx.doi.org/10.1080/14781158.2015.1019442

Baum S, 2023. Assessing natural global catastrophic risks. *Natural Hazards*, 115(3): 2699–2719. http://dx.doi.org/10.1007/s11069-022-05660-w

Baumhardt R, Stewart B and Sainju U, 2015. North American soil degradation: Processes, practices, and mitigating strategies. *Sustainability*, 7(3): 2936–2960. http://dx.doi.org/10.3390/su7032936

Bencks J, 2021. Did the ancient Maya fall because of a drought, or something else? BrandeisNOW: brandeis.edu/now/2021/november/maya-research-golden.html

Berdeni, D, Turner A, Grayson R et al., 2021. Soil quality regeneration by grass-clover leys in arable rotations compared to permanent grassland: Effects on wheat yield and resilience to drought and flooding. *Soil & Tillage Research*, 212. http://dx.doi.org/10.1016/j.still.2021.105037

Bingaman K, 2022. The end of the world as we have known it? An introduction to collapsology. *Pastoral Psychology*, 71(6): 753–767. http://dx.doi.org/10.1007/s11089-022-01026-y

Bradstock R, 2008. Effects of large fires on biodiversity in south-eastern Australia: Disaster or template for diversity? *International Journal of Wildland Fire*, 17(6): 809–822. http://dx.doi.org/10.1071/WF07153

Cano C, Sanleandro P and Cano A, 2003. State of degradation of the soils dedicated to fig cultivation in Elche (Alicante, SE Spain). Acta Hortic. 605, 301–306. https://doi.org/10.17660/ActaHortic.2003.605.45

Cardoso P et al., 2020. Scientists' warning to humanity on insect extinctions. *Biological Conservation*, 242. https://doi.org/10.1016/j.biocon.2020.108426

Carpenter F, Mayorga S, Quintero E, and Schroeder M, 2001. Land-use and erosion of a Costa Rican Ultisol affect soil chemistry, mycorrhizal fungi and early regeneration. *Forest Ecology and Management*, 144(1–3): 1–17. http://dx.doi.org/10.1016/S0378-1127(00)00361-3

Chen J, 2005. Legal mythmaking in a time of mass extinctions: Reconciling stories of origins with human destiny. *Harvard Environmental Law Review*, 29(2): 279–319.

Chen S, Lu N, Fu B et al., 2022. Current and future carbon stocks of natural forests in China. *Forest Ecology and Management*, 511. http://dx.doi.org/10.1016/j.foreco.2022.120137

Chua S, Ramage B and Potts M, 2016. Soil degradation and feedback processes affect long-term recovery of tropical secondary forests. *Journal of Vegetation Science*, 27(4): 800–811. http://dx.doi.org/10.1111/jvs.12406

Crovo O, Aburto F, da Costa-Reidel C et al., 2021. Effects of livestock grazing on soil health and recovery of a degraded Andean Araucaria forest. *Land Degradation & Development*, 32(17): 4907–4919. http://dx.doi.org/10.1002/ldr.4079

Crutzen P J, 2006. The "Anthropocene". In: Ehlers E and Krafft T (Eds.), *Earth System Science in the Anthropocene*. Berlin, Heidelberg: Springer. https://doi.org/10.1007/3-540-26590-2_3

Doughty C, Wolf A, and Malhi Y, 2013. The impact of large animal extinctions on nutrient fluxes in early river valley civilizations. *Ecosphere*, 4(12). http://dx.doi.org/10.1890/ES13-00221.1

Edwards F, Massam M, Cosset C et al., 2021. Sparing land for secondary forest regeneration protects more tropical biodiversity than land sharing in cattle farming landscapes. *Current Biology*, 31(6): 1284–1293.e4. http://dx.doi.org/10.1016/j.cub.2020.12.030

Evans M, 2018. Effective incentives for reforestation: Lessons from Australia's carbon farming policies. *Current Opinion in Environmental Sustainability*, 32: 38–45. http://dx.doi.org/10.1016/j.cosust.2018.04.002

Evans M, Carwardine J, Fensham R et al., 2015. Carbon farming via assisted natural regeneration as a cost-effective mechanism for restoring biodiversity in agricultural landscapes. *Environmental Science & Policy*, 50: 114–129. http://dx.doi.org/10.1016/j.envsci.2015.02.003

Fazan L, Song Y and Kozlowski G, 2020. The woody planet: From past triumph to manmade decline. *Plants-Basel*, 9(11). http://dx.doi.org/10.3390/plants9111593.

Febles-González J, Vega-Carreño M, Do Amaral-Sobrinho N et al., 2014. Good soils in extinction: Degradation of red ferralitic soils in Western Cuba. *Soil Science*, 179(6): 304–313. http://dx.doi.org/10.1097/SS.0000000000000070

Fortún A, Tomás R and Fortún C, 1996. Effect of bituminous materials on soil aggregation. *Arid Soil Research and Rehabilitation*, 10(2): 161–168. http://dx.doi.org/10.1080/15324989609381430

Funk J, Field C, Kerr S and Daigneault A, 2014. Modeling the impact of carbon farming on land use in a New Zealand landscape. *Environmental Science & Policy*, 37: 1–10. http://dx.doi.org/10.1016/j.envsci.2013.08.008

Gabioud E, Sasal M, Wilson M et al., 2020. Addition of organic and inorganic amendments to regenerate the surface structure of silty soils. *Soil Use and Management*, 36(3): 449–458. http://dx.doi.org/10.1111/sum.12567

Gardner C and Bullock J, 2021. In the climate emergency, conservation must become survival ecology. *Frontiers in Conservation Science*, 2. http://dx.doi.org/10.3389/fcosc.2021.659912

Gilder E and Pal D, 2015. Climate change - probable socio-economic systems (ses) implications and impacts in the anthropocene epoch. In: Barsan G, Udeanu G and Carutasu V (Co-or.), *The Complex Physiognomy of the International Security Environment*, pp. 308–317. https://doi.org/10.1515/kbo-2015-0052

Gilroy J J, Woodcock P, Edwards F A et al., 2014. Optimizing carbon storage and biodiversity protection in tropical agricultural landscapes. *Global Change Biology*, 20: 2162–2172. http://dx.doi.org/10.1111/gcb.12482

Glikson A, 2017a. The demise of the Holocene biosphere. In: Glikson A, *The Plutocene: Blueprints for a Post-Anthropocene Greenhouse Earth*, Berlin, Heidelberg: Springer, pp. 1–37.

Glikson A, 2017b. Homo prometheus. In: Glikson A, *The Plutocene: Blueprints for a Post-Anthropocene Greenhouse Earth*, Berlin, Heidelberg: Springer, pp. 109–122.

Glikson A, 2017c. A republic of insects and grasses. In: Glikson A, *The Plutocene: Blueprints for a Post-Anthropocene Greenhouse Earth*, Berlin, Heidelberg: Springer, pp. 97–108. https://doi.org/10.1007/978-3-319-57237-6_4

Grammenou A, Petropoulos S, Thalassinos G et al., 2023. Biostimulants in the soil–plant interface: Agro-environmental Implications – A review. *Earth Systems and Environment*. https://doi.org/10.1007/s41748-023-00349-x and it

Guga J, 2021. MetaGarden: Technology and nature in the works of Tanja Vujinovic. *AM Journal of Art and Media Studies*, 25: 97–109. http://dx.doi.org/10.25038/am.v0i25.450

Howard A, 1945. An Agricultural Testament. https://en.wikipedia.org/wiki/An_Agricultural_Testament#References

Hutchings P, 2020. Is there a case against being a human being? Reappraising David Benatar's better never to have been: Can late capitalism halt climate change? If not, who wants to be a human, or posthuman? *Sophia*, 59(4): 809–819. http://dx.doi.org/10.1007/s11841-020-00797-2

IPBES, 2018. Land degradation and restoration assessment. Summary for policy makers. https://doi.org/10.5281/zenodo.3237392

IPCC, 2019. *Climate Change and Land*. An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Cambridge, UK: Cambridge University Press.

Islam K, Ahmed M, Bhuiyan M and Badruddin A, 2001. Deforestation effects on vegetative regeneration and soil quality in tropical semi-evergreen degraded and protected forests of Bangladesh. *Land Degradation & Development*, 12(1): 45–56. http://dx.doi.org/10.1002/ldr.418

Kakoty S, 2018. Ecology, sustainability and traditional wisdom. *Journal of Cleaner Production*, 172: 3215–3224. http://dx.doi.org/10.1016/j.jclepro.2017.11.036

Kassam A, Friedrich T and Derpsch R, 2022. Successful experiences and lessons from conservation agriculture worldwide. *Agronomy*, 12: 769. http://dx.doi.org/10.3390/agronomy12040769

Lal R, 2004. Soil carbon sequestration impacts on global climate change and food security. *Science*, 304: 1623–1627.

Lal R, 2007. Soil science and the carbon civilization. *Soil Science Society of America Journal*, 71(5): 1425–1437. http://dx.doi.org/10.2136/sssaj2007.0001

Lal R, 2014. Societal value of soil carbon. *Journal of Soil and Water Conservation*, 69: 186A–192A.

Lal R, 2015a. A system approach to conservation agriculture. *Journal of Soil and Water Conservation*, 70(4): 82A–88A.

Lal R, 2015b. Cover cropping and the "4 per thousand proposal". *Journal of Soil and Water Conservation*, 70: 141A.

Lal R, 2015c. The soil-peace nexus: Our common future. *Soil Science and Plant Nutrition*, 61: 566–578.

Lal R, 2018. Digging deeper: A holistic perspective of factors affecting soil organic carbon sequestration in agroecosystems. *Global Change Biology*, 24: 3285–3301. https://doi.org/10.1111/gcb.14054

Lal R, 2019a. Eco-intensification through soil carbon sequestration: Harnessing ecosystem services and advancing sustainable development goals. *Journal of Soil and Water Conservation*, 74(3): 55A–61A.

Lal R, 2019b. Rights-of-soil. *Journal of Soil and Water Conservation*, 74(4): 81A–86A.

Lal R, 2019c. Carbon cycling in global drylands. *Current Climate Change Reports*, 5(3): 221–232.

Lal R (Ed.), 2020a. *The Soil-Human Health-Nexus. Advances in Soil Science*. Boca Raton, FL: Taylor and Francis/CRC.

Lal R, 2020b. Integrating animal husbandry with crops and trees. *Frontiers in Sustainable Food Systems*, 4: 113. https://doi.org/10.3389/fsufs.2020.00113

Lal R, 2020c. Regenerative agriculture for food and climate. *Journal of Soil and Water Conservation*. http://dx.doi.org/10.2489/jswc.2020.0620A

Lal R, 2022a. Agroecology. Rural 21. https://www.rural21.com/english/search/detail/article/many-ways-one-goal-achieving-sustainable-agroecosystems.html

Lal R, 2022b. Sustaining soil for advancing peace: World is one family. *Journal of Soil and Water Conservation*, 77: 43A–47A. https://www.jswconline.org/content/jswc/77/3/43A.full.pdf

Lal R, 2022c. Reducing carbon footprint of agriculture and food systems. *Carbon Footprints*, 1(1). http://dx.doi.org/10.20517/cf.2022.05

Lal R, 2023. Farming systems to return land for nature: It's all about soil health and re-carbonization of the terrestrial biosphere. *Farming System*, 1(1): 100002. http://dx.doi.org/10.1016/j.farsys.2023.100002

Lal R, 2024a. Carbon farming in global drylands. In: Al Beltagi A, Lal R and Malik K (Eds.), *Climate Change and Sustainable Agroecology in Global Drylands*. Wallingford, UK: Commonwealth Agricultural Bureau International (CABI).

Lal R, 2024b. Soil, soul, spirituality and stewardship. *Journal of Soil and Water Conservation*, 79(1): 10A–14A. http://dx.doi.org/10.2489/jswc.2024.1129A

Li X, Wu J and Li B, 2019. The battle for biodiversity and human future. *Chinese Science Bulletin-Chinese*, 64(23): 2374–2378. http://dx.doi.org/10.1360/N972019-00283

Lieskovsky J and Kenderessy P, 2023. Degradation of traditional vineyards in Slovakia by abandonment and soil erosion: A case-study of Vrable. *Land Degradation & Development*, 34(1): 98–108. http://dx.doi.org/10.1002/ldr.4446

Liu S, Luo D, Cheng R et al., 2020. Soil-atmosphere exchange of greenhouse gases from typical subalpine forests on the eastern Qinghai-Tibetan Plateau: Effects of forest regeneration patterns. *Land Degradation & Development* 31(15): 2019–2032. http://dx.doi.org/10.1002/ldr.3586

Lobban R and de Liedekerke V, 2000. Elephants in ancient Egypt and Nubia. *Anthrozoos*, 13(4): 232–244. http://dx.doi.org/10.2752/089279300786999707

Luedeling E and Neufeldt H, 2012. Carbon sequestration potential of parkland agroforestry in the Sahel. *Climatic Change*, 115(3–4): 443–461. http://dx.doi.org/10.1007/s10584-012-0438-0

McLenaghen R D, Malcolm B J, Cameron K C et al., 2017. Improvement of degraded soil physical conditions following the establishment of permanent pasture. *New Zealand Journal of Agricultural Research*, 60(3): 287–297. http://dx.doi.org/10.1080/00288233.2017.1334668

Mikhailova E, Zurqani H, Post C et al., 2021. Soil diversity (pedodiversity) and ecosystem services. *Land*, 10: 3. http://dx.doi.org/10.3390/land10030288

Mora J, Armas-Herrera C, Guerra J et al., 2012. Factors affecting vegetation and soil recovery in the Mediterranean woodland of the Canary Islands (Spain). *Journal of Arid Environments*, 87: 58–66. http://dx.doi.org/10.1016/j.jaridenv.2012.07.016

Moradi M, Jorfi M, Basiri R et al., 2022. Beneficial effects of livestock exclusion on tree regeneration, understory plant diversity, and soil properties in semiarid forests in Iran. *Land Degradation & Development*, 33(2): 324–332. http://dx.doi.org/10.1002/ldr.4154

Nadporozhskaya M, Chertov O, Bykhovets S et al., 2018. Recurring surface fires cause soil degradation of forest land: A simulation experiment with the EFIMOD model. *Land Degradation & Development*, 29(7): 2222–2232. http://dx.doi.org/10.1002/ldr.3021

Rasmussen L, 2023. How the anthropocene changes religious ethics. *Journal of Religious Ethics*, 51(1): 171–185. http://dx.doi.org/10.1111/jore.12413

Raven P, 2022. How the living world evolved and where it's headed now. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 377(1857). http://dx.doi.org/10.1098/rstb.2021.0377

Reding M, 2021. H20: The molecule that made us. *Jung Journal-Culture & Psyche*, 15(4): 114–122. http://dx.doi.org/10.1080/19342039.2021.1979373

Robinson N, 2020. Ecological civilization and legal norms for resilient environmental governance. *Chinese Journal of Environmental Law*, 4(2): 131–161. http://dx.doi.org/10.1163/24686042-12340055

Rocha-Nicoleite E, Campos M, Colombo G et al., 2018. Forest restoration after severe degradation by coal mining: Lessons from the first years of monitoring. *Brazilian Journal of Botany*, 41(3): 653–664. http://dx.doi.org/10.1007/s40415-018-0486-4

Rozanov S, 1998. Is there a link between biodiversity and greenhouse effect? *Biofizika*, 43(6): 1101–1105.

Sayari S and Bin Marsuki M, 2014. The integration and sustainability: The forgotten image of the universe. In: Hussein S and Abdullah M (Eds.), 2nd World Conference on Islamic Thought & Civilization, Vols I and II, pp. 414–419. https://www.academia.edu/30510462/Conference_paper_docx

Shah A, Khan I, Shah T et al., 2022. Soil microbiome: A treasure trove for soil health sustainability under changing climate. *Land*, 11(11). http://dx.doi.org/10.3390/land11111887

Silva T, Rodrigues S, Bringel J et al., 2023. Factors affecting savanna and forest regeneration in pastures across the cerrado. *Journal of Environmental Management*, 330. http://dx.doi.org/10.1016/j.jenvman.2022.117185

Singh A K, Rai A, Banyal R et al., 2018. Plant community regulates multifunctionality in a tropical dry forest. *Ecological Indicators*, 95(Part 1): 953–963. http://dx.doi.org/10.1016/j.ecolind.2018.08.030

Singh S, Luthra N, Mandal S et al., 2023. Distinct behavior of biochar modulating biogeochemistry of salt-affected and acidic soil: A review. *Journal of Soil Science and Plant Nutrition*, 23(3): 2981–2997. http://dx.doi.org/10.1007/s42729-023-01370-9

Slimani H, Aidoud A and Rozé F, 2010. 30 Years of protection and monitoring of a steppic rangeland undergoing desertification. *Journal of Arid Environments*, 74(6): 685–691. http://dx.doi.org/10.1016/j.jaridenv.2009.10.015

Spaan W and van Dijk K, 1998. Evaluation of the effectiveness of soil and water conservation measures in a closed sylvo-pastoral area in Burkina Faso. In: Blume H, Eger H, Fleischhauer E, Hebel A, Reij C et al. (Eds.), *Advances in GeoEcology*, 31: 1295–1301. Catena Verlag, Reiskirchen

Stroud S, Fennell M, Mitchley J et al., 2022. The botanical education extinction and the fall of plant awareness. *Ecology and Evolution*, 12(7). http://dx.doi.org/10.1002/ece3.9019

Suarez, C, Edmonds M and Jones A, 2019. Earth catastrophes and their impact on the carbon cycle. *Elements*, 15(5): 301–306. http://dx.doi.org/10.2138/gselements.15.5.301

Sukhbaatar G, Nachin B, Purevragchaa B et al., 2019. Which selective logging intensity is most suitable for the maintenance of soil properties and the promotion of natural regeneration in highly continental scots pine forests? Results 19 years after harvest operations in Mongolia. *Forests*, 10(2). http://dx.doi.org/10.3390/f10020141

Szyja M, Felde V, Lückel S et al., 2023. Biological soil crusts decrease infiltration but increase erosion resistance in a human-disturbed tropical dry forest. *Frontiers in Microbiology*, 14. http://dx.doi.org/10.3389/fmicb.2023.1136322

Timmis K and Ramos J L, 2021. The soil crisis: The need to treat as a global health problem and the pivotal role of microbes in prophylaxis and therapy. *Microbial Biotechnology*, 14(3): 769–797. http://dx.doi.org/10.1111/1751-7915.13771

Tripathi J, Bock B, Rajamani V and Eisenhauer A, 2004. Is river Ghaggar, Saraswati? Geochemical constraints. *Current Science*, 87(8): 1141–1145.

Van der Kamp J, Yassir I and Buurman P, 2009. Soil carbon changes upon secondary succession in Imperata grasslands (East Kalimantan, Indonesia). *Geoderma*, 149(1–2): 76–83. http://dx.doi.org/10.1016/j.geoderma.2008.11.033

Van Pelt J, 2018. Climate change in context: Stress, shock, and the crucible of livingkind. *Zygon*, 53(2): 462–495. http://dx.doi.org/10.1111/zygo.12418

Wang Y, Chu L, Liu Z et al., 2022. The feasibility of using soil seed bank for natural regeneration of degraded sandy grasslands. *International Soil and Water Conservation Research*, 10(3): 414–421. http://dx.doi.org/10.1016/j.iswcr.2021.11.001

Watanabe, T, Yamazaki A and Pfeiffer M, 2019. Oman corals suggest that a stronger winter shamal season caused the Akkadian Empire (Mesopotamia) collapse. *Geology*, 47(12): 1141–1145. http://dx.doi.org/10.1130/G46604.1

WMO, 2023. *Greenhouse Gas Bulletin #19: The State of Greenhouse Gases in the Atmosphere Based on Global Observations Through 2022*. Geneva, Switzerland: World Meteorological Organization. https://library.wmo.int/idurl/4/68532

Zhang M, Liang Y, Son A et al. 2017. Loss of soil microbial diversity may increase insecticide uptake by crop. *Agriculture Ecosystems & Environment*, 240: 84–91. http://dx.doi.org/10.1016/j.agee.2017.02.010

Zou C, Xue H, Xiong B et al., 2021. Connotation, innovation and vision of "carbon neutrality." *Natural Gas Industry B*, 8(5): 523–537. http://dx.doi.org/10.1016/j.ngib.2021.08.009

Zuazo V and Pleguezuelo C, 2009. Soil-erosion and runoff prevention by plant covers: A review. *Agronomy for Sustainable Development*, 28: 65–86. http://dx.doi.org/10.1051/agro:2007062

Part 3

Human health and sustainable diets

8 Eating plant-based for better health

Shireen Kassam

Our current food system is not fit for purpose. We increasingly produce food that harms human health and the planet. This system also questions our ethical and moral framework as it relies on the slaughter of more than 80 billion land animals and two trillion fish annually.

Unhealthy diets are the leading cause of chronic ill health and premature deaths. Dietary risk factors are responsible for a quarter of deaths globally and around a third of premature deaths in Europe. All forms of malnutrition from hunger to obesity continue to rise, often co-existing in the same country (Collaborators 2022). This is despite the fact that we produce enough food to feed at least ten billion people, if not more.

What is wrong with our diets?

An analysis by the Global Burden of Disease Study published in 2019 examined the dietary risk factor contributions to chronic health conditions and causes of death in 195 regions worldwide (GBD Diet Collaborators 2019). The findings showed that unhealthy diets were the single leading risk factor for ill health, contributing to 11 million deaths per year globally.

Diets were found to be too high in sodium, a reflection of our reliance on pre-packaged food and prepared foods, and meat. They were also found to be insufficient in the healthy plant foods that promote good health, i.e., fruit, vegetables, whole grains, legumes, nuts and seeds. These dietary risk factors were shown to be leading to excess deaths from cardiovascular disease, cancer and type 2 diabetes. As an example, in the UK, more than 50% of energy intake comes from ultra-processed foods, whilst only 28% of adults consume five portions of fruit and vegetables a day (Rauber et al. 2019).

What constitutes a healthy diet?

There is scientific consensus and little debate about the basics of a healthy diet. Figure 8.1 depicts the key components of a healthy diet, with the lower section being the essential components. These are fruits, vegetables, whole grains, legumes, nuts and seeds with mainly water for thirst. The remainder of the pyramid is optional and should only contribute a minority of energy intake (Cena and Calder 2020).

This type of diet can be adapted to cultural and traditional diet patterns and form the key components of diet patterns we know to be healthy. Such diets include the Mediterranean, DASH (Dietary Approaches to Stop Hypertension), Nordic and traditional Asian diets. In addition, we know that healthy plant-based diets, both vegetarian and vegan, can meet the essential requirements of a healthy dietary pattern.

DOI: 10.4324/9781032684369-12

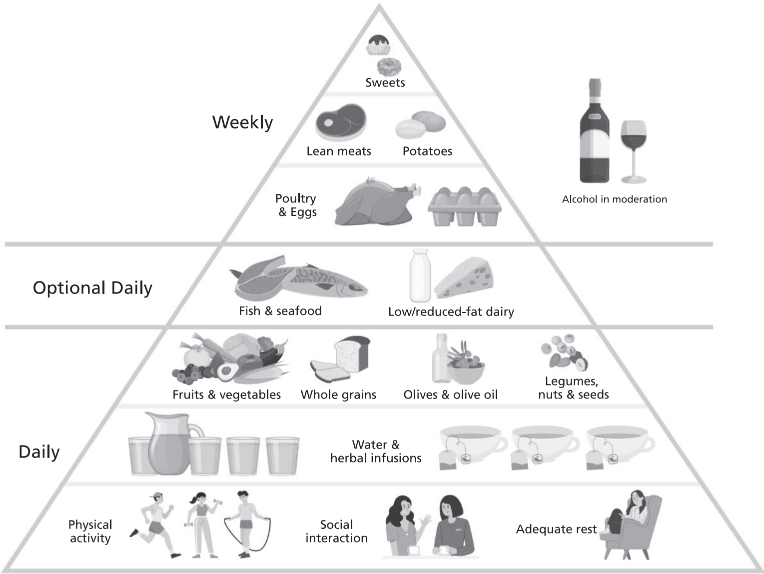

Figure 8.1 A generalised healthy diet and lifestyle pyramid.

The pyramid reminds us that diet is only one component of a healthy lifestyle. Regular physical activity, healthy social interactions with human and non-human animals, time in nature and restorative sleep are also important to physical and mental well-being.

Plant-based diets are already part of clinical practice guidelines

Predominantly plant-based diets are embedded into clinical practice guidelines given their association with better health outcomes and their ability to prevent and manage chronic conditions. Most guidelines acknowledge that exclusively plant-based diets such as a vegan diet can also be a healthy option.

The American College of Lifestyle Medicine has a position statement on healthy nutrition. It recommends an eating plan based predominantly on a variety of minimally processed vegetables, fruits, whole grains, legumes, nuts and seeds. Water is recommended as the main beverage and herbs and spices should be used liberally, not only for their flavour but also for their anti-inflammatory and antioxidant properties. It then comes down to personal choice as to whether one consumes animals or animal-derived foods.

The American College of Cardiology (Arnett et al. 2019) and the American Society for Preventive Cardiology (Belardo et al. 2022) endorse plant-based diets, including a vegan diet, as heart healthy. The international guidelines for cancer prevention recommend a diet centred around fruit, vegetables, whole grains beans nuts and seeds (Rock et al. 2020). European recommendations for dietary management of diabetes state: "Consume minimally processed plant foods, such as whole grains, vegetables, whole fruit, legumes, nuts, seeds and non-hydrogenated non-tropical vegetable oils" (Aas et al. 2023).

All guidelines agree that the consumption of red and processed meat should be greatly limited or ideally avoided. There is consensus that there is no requirement for these foods in the diet and they are associated with an increased risk of a number of chronic conditions. Processed and unprocessed red meats are classified as group 1 and group 2a carcinogens, respectively. This means their consumption directly contributes to cancer development (World Health Organization 2015).

Combating chronic disease

Decades of scientific research shows a diet centred around healthy plant foods can address the root cause of chronic conditions including cardiovascular disease, type 2 diabetes, certain cancers and dementia. This is because a plant-based diet can combat the key drivers of these conditions. These drivers include chronic inflammation, cellular stress and injury, disruption of the gut microbiome and abnormalities of blood lipids or fats (Katz et al. 2018). Plant-based diets have been shown to induce favourable epigenetic changes. They also increase the length of our telomeres (the caps at the end of the chromosomes that shorten with ageing and illness), reduce inflammation and restore gut health. In addition, it is clear that one can not only survive but also thrive on a plant-based diet. This is evidenced by the fact that more and more professional athletes are adopting a plant-based diet to achieve optimal performance.

Healthcare services around the world, including the UK's National Health Service (NHS), are increasingly focused on supporting people once they develop a chronic condition. This means sick care rather than true healthcare, which could and should focus on preventing ill health. We are now spending up to 20 years at the end of our lives in ill health from conditions that are preventable.

A staggering 80% of chronic conditions could be prevented if we all paid attention to dietary risk factors alongside other healthy lifestyle behaviours (Katz et al. 2018). But the good news is that dietary interventions can support better health at any stage of life. It is never too late to reap the benefits of plant-based diets, which have been shown to halt the progression of and in some cases reverse chronic conditions.

This is effectively illustrated by people around the globe who live the longest and healthiest lives, who are more likely to reach 100 years of age in good health. These are people living in the so-called "Blue Zones", a term coined by the researcher Dan Beuttner. The Blue Zones are Ikaria, Greece; Loma Linda, California; Nicoya Peninsula, Costa Rica; Okinawa, Japan; and Sardinia, Italy. They share nine healthy lifestyle factors (Buettner and Skemp 2016).

When it comes to diet, Blue Zone residents consume a minimally processed and predominantly plant-based diet. Loma Linda in California has a large population of vegetarians and vegans. A key component of the diet thought to contribute to good health and longevity is the central importance of beans to all these cuisines.

The food system also contributes to two further health crises. The rising burden of antibiotic resistant infections results in 1.3 million deaths per year, more than HIV infection and malaria combined (Murray et al. 2022). Around 70% of all antibiotics are used in animal farming and this is a major driver of antibiotic resistance. If we were all to limit meat consumption to 40g per day we could reduce the use of antibiotics in farming by two-thirds (Van Boeckel et al. 2017).

Additionally, factory farming where animals are removed from the land and housed indoors in cramped and squalid conditions is creating new infectious threats. Three-quarters of new and emerging infectious threats come from animals. Without addressing our use of animals in farming, alongside the destruction of their habitats, further epidemic and pandemic infections are inevitable (Hayek 2022).

Health of long-term vegetarians and vegans

The ideal food system would be one where animals are no longer used for food. The British Dietetic Association (BDA) and other international dietetic organisations confirm that well-planned vegan diets are suitable for all ages and stages of life (BDA 2017). We have a fair amount of data on the health outcomes for people following a vegetarian or vegan diet from two long-running prospective cohort studies. These are the Adventist Health Study-2 from the US and the EPIC-Oxford study from the UK (Dinu et al. 2017; Orlich et al. 2019). More recently, the UK Biobank study has provided further information on health outcomes for people following a meat-free diet. In general, these studies have shown that vegetarians and vegans have significantly lower rates of hypertension and type 2 diabetes. They are also more likely to be a healthy body weight, have lower blood cholesterol levels and have significantly lower rates of type 2 diabetes. These benefits lead to a significant reduction in rates of heart disease. In addition, people following a meat-free diet have consistently been shown to have lower rates of cancer.

There are similar data on health outcome from non-White populations. The Tzu Chi study from Taiwan has shown that people following a meat-free diet have significantly lower rates of type 2 diabetes, fatty liver, gallstones and stroke. They also spend around 15% less on healthcare compared with omnivores (Orlich et al. 2019).

Recent analyses have highlighted that bone health may be a concern for people following a meat-free diet, with increased rates of bone fracture. However, the data are nuanced. In general, the higher fracture rates are predominately in women with a lower body mass index who are not obtaining sufficient amounts of calcium, vitamin D, vitamin B12 and protein. These data provide us with actionable knowledge that bone health, which is multi-factorial, requires special attention on a plant-based diet (Tong et al. 2020).

Diet quality is important when adopting a vegan diet

What remains paramount is diet quality when considering any dietary pattern. To promote health and well-being, a vegan diet should be centred around a variety of whole plant foods with an emphasis on protein-rich foods at each meal. Ultra-processed foods should be minimised. A regular, reliable source of vitamin B12 is needed, usually in supplement form, and certain nutrients, including calcium, iodine, selenium and vitamin D require special focus.

We now have several studies showing that a high-quality plant-based diet is associated with a significant reduction in a number of chronic conditions and a longer life. Conversely an unhealthy plant-based diet may have worse health outcomes than a typical omnivorous diet (Table 8.1; Satija et al. 2017).

Table 8.1 Impact of a plant-based diet, healthy and unhealthy, on disease risk

Disease	*Plant-based diet (PBD)*	*Healthy PBD*	*Unhealthy PBD*
Coronary heart disease (Satija et al. 2017)	8%↓	25%↓	32%↑
Type 2 diabetes (Satija et al. 2016)	20%↓	34%↓	16%↑
Total cancer risk (Kane-Diallo et al. 2018)	15%↓	–	–
Stroke (Baden et al. 2021)	Neutral	10%↓	Neutral
Kidney failure (Hyunju et al. 2019)	6%↓	14%↓	11%↑
Fatty liver (Mazidi and Kengne 2019)	21%↓	24%↓	34% ↑
Parkinson's disease (Tresserra-Rimbau et al. 2023)	18%↓	22%↓	38%↑
All-cause mortality (Baden et al. 2019; Thompson et al. 2023)	5%↓	10%–16%↓	12%↑

Table 8.2 Nutrient intake and status in vegans, vegetarians and meat eaters

Dietary pattern	*Risk of inadequacy*	*Favourably high intake*
Vegans	EPA, DHA	Fibre, PUFA, ALA
	Vitamins B12, D	Vitamins B1, B6, C, E, folate
	Calcium, iodine, iron (in women), zinc	Magnesium
Vegetarians	Fibre, EPA, DHA	PUFA, ALA
	Vitamins B12, D, E	Vitamin C, folate
	Calcium, iodine, iron (in women), zinc	Magnesium
Meat eaters	Fibre, PUFA, ALA (in men)	Protein
	Vitamins D, E, folate	Niacin, vitamin B12
	Calcium, magnesium	Zinc

The prevailing narrative continues to suggest that vegan diets are restrictive and nutrient deficient. This could not be further from the truth. An excellent systematic review brought together 141 different studies to compare the nutrient intake and status of people following a plant-based diet (vegetarian and vegan) compared to meat eaters. The data showed that regardless of diet pattern, there are certain nutrients that need special focus (Table 8.2) and vegan diets are not unique in this respect (Neufingerl and Eilander 2022).

Country-based and international guidelines

Country-based diet guidelines are catching up with the evidence and are considering both health and sustainability outcomes when making recommendations.

Health Canada guidelines from 2019 recommend half the diet is centred around fruit and vegetables, a quarter whole grains and a quarter healthy sources of protein. At least 50% of protein should be derived from plant-based sources such as legumes and nuts. Dairy has been removed as a food group. This is because it is not necessary for health, excludes a vast proportion of society who are lactose intolerant, and its production is increasingly unsustainable.

Dietary guidelines from Denmark state "Eat Plant-Rich, varied and not too much" (DFVA 2023). The UK dietary guidelines, in the *Eatwell Guide*, have not been updated since 2016. However, recent Government recommendations acknowledge that to meet climate and nature targets whilst promoting better health, citizens should prioritise plant-based meals. The recommendations also indicate that people who choose to limit animal-sourced foods can meet nutrient requirements.

The EAT-Lancet planetary health diet, which has considered both human and planetary health outcomes, recommends a diet that derives more than 85% of energy from healthy plant foods. Meat and dairy are not considered essential but if consumed should be minimised. This type of diet is estimated to prevent 11 million deaths globally (Willett et al. 2019).

Fish consumption is where health and sustainability recommendations diverge. Regular fish consumption has been associated with better health outcomes when considering omnivorous populations. However, the continued recommendation to consume two portions of fish a week is not sustainable. Obtaining certain nutrients found in fish from plant sources, such as omega-3 fats, should be encouraged.

A large analysis using data from the EPIC study included more than 400,000 participants from 10 European countries. It demonstrated that adherence to the EAT-Lancet planetary health diet could reduce deaths from all causes by more than 60% and reduce cancer rates by up to 40% (Laine et al. 2021).

Healthcare professionals and organisations need to lead the way

Healthcare organisations must lead by example and use every encounter as a teachable moment. Given that unhealthy diets are the leading cause of ill health, it makes sense that hospitals prioritise meals that promote both physical and mental health. It is hopeful and inspiring that Eric Adams, the Mayor of New York City, has introduced plant-based meals as the default in 11 city hospitals. Patients have to opt in to eating animals. The latest data from the team implementing the programme shows that at least 60% of patients stick with a plant-based meal and patient feedback is excellent (GBD, 2023).

It is time healthcare professionals supported the transition away from meat consumption towards a plant-based food system. A recent opinion piece in the *American Journal of Cardiology* is titled, "Are we what we eat? The moral imperative of the medical profession to promote plant-based nutrition" (Hull, Charles, and Caplan 2023).

The authors conclude:

> The medical profession can help to move the needle by embracing radical change when possible - especially within our own ranks - and incremental change when necessary to promote harm reduction. We owe it to the profession, to our patients, and to the planet we share.

We have the knowledge, skills and ability. We can create a food system that promotes human and planetary health, whilst recognising the need to be kind and compassionate to the animals we share our world with. Let us act now before it is too late.

References

Aas A et al., 2023. Evidence-based European recommendations for the dietary management of diabetes. *Diabetologia*, 66(6): 965–985. https://doi.org/10.1007/s00125-023-05894-8

Arnett D K et al., 2019. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease. *Circulation*, 140: 11. https://doi.org/10.1161/CIR.0000000000000678

Baden M Y, Liu G, et al., 2019. Changes in plant-based diet quality and total and cause-specific mortality. *Circulation*, 140: 979–991. https://doi.org/10.1161/CIRCULATIONAHA.119.041014

Baden M Y, Shan Z, Wang F et al., 2021. Quality of plant-based diet and risk of total, ischemic, and hemorrhagic stroke. *Neurology*, 96(15): e1940–e1953. https://doi.org/10.1212/WNL.0000000000011713

BDA 2017. British Dietetic Association Confirms Well-Planned Vegan Diets Can Support Healthy Living in People of All Ages. https://www.bda.uk.com/resource/vegetarian-vegan-plant-based-diet.html

Belardo D et al., 2022. Practical, evidence-based approaches to nutritional modifications to reduce atherosclerotic cardiovascular disease. *American Journal of Preventive Cardiology*, 10: 100323. https://www.sciencedirect.com/science/article/pii/S2666667722000101

Van Boeckel T P et al., 2017. Reducing antimicrobial use in food animals. *Science*, 357: 6358. https://doi.org/10.1126/science.aao1495

Buettner D and Skemp S, 2016. Blue zones: Lessons from the world's longest lived. *American Journal of Lifestyle Medicine*, 10(5): 318–321. https://doi.org/10.1177/1559827616637066

Cena H and Calder P C, 2020. Defining a healthy diet: Evidence for the role of contemporary dietary patterns in health and disease. *Nutrients*, 12: 2.

Collaborators, 2022. Global Nutrition Report. https://globalnutritionreport.org/

Dinu M et al., 2017. Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*, 57(17): 3640–3649.

DVFA (Danish Veterinary and Food Administration), 2023. The Official Dietary Guidelines – good for health and climate. https://en.foedevarestyrelsen.dk/food/nutrition-and-health/the-official-dietary-guidelines

GBD Diet Collaborators, 2019. Health effects of dietary risks in 195 countries, 1990–2017: A systematic analysis for the global burden of disease study 2017. *The Lancet*. https://doi.org/ 10.1016/S0140-6736(19)30041-8

GBD (Greener by Default), 2023. Research. https://www.greenerbydefault.com/research

Hayek M N, 2022. The infectious disease trap of animal agriculture. *Science Advances*, 8: 44.

Hull S C, Charles J and Caplan A L, 2023. Are we what we eat? The moral imperative of the medical profession to promote plant-based nutrition. *American Journal of Cardiology*, 188: 15–21.

Hyunju K, Caulfield L E, Garcia-Larsen V, et al., 2019. Plant-based diets and incident CKD and kidney function. *Clinical Journal of the American Society of Nephrology*, 14(5): 682–691. https://doi.org/10.2215/CJN.12391018

Kane-Diallo A, Srour B, Sellem L, et al., 2018. Association between a pro plant-based dietary score and cancer risk in the prospective NutriNet-santé cohort. *International Journal of Cancer*, 143(9): 2168–2176. https://doi.org/10.1002/ijc.31593

Katz D L et al., 2018. Lifestyle as medicine: The case for a true health initiative. *American Journal of Health Promotion*, 32:6. https://doi.org/10.1177/0890117117705949

Laine J E et al., 2021. Co-benefits from sustainable dietary shifts for population and environmental health: An assessment from a large European cohort study. *The Lancet Planetary Health*, 5: 11.

Mazidi M and Kengne A P, 2019. Higher adherence to plant-based diets are associated with lower likelihood of fatty liver. *Clinical Nutrition*, 38(4): 1672–1677. https://doi.org/10.1016/j.clnu.2018.08.010

Murray C J L et al., 2022. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. *The Lancet*, 399: 10325.

Neufingerl N and Eilander A, 2022. Nutrient intake and status in adults consuming plant-based diets compared to meat-eaters: A systematic review. *Nutrients*, 14: 1.

Orlich M J et al., 2019. Vegetarian epidemiology: Review and discussion of findings from geographically diverse cohorts. *Advances in Nutrition*, 1(10(Suppl_4)): S284–S295.

Rauber F et al., 2019. Ultra-processed foods and excessive free sugar intake in the UK: A nationally representative cross-sectional study. *BMJ Open*, 9: e027546. doi: 10.1136/bmjopen-2018-027546

Rock C L et al., 2020. American Cancer Society guideline for diet and physical activity for cancer prevention. *CA: A Cancer Journal for Clinicians*, 70(4): 245–271. https://doi.org/10.3322/caac.21591

Satija A, Bhupathiraju S N, Rimm E B, et al., 2016. Plant-based dietary patterns and incidence of type 2 diabetes in US men and women. *PLoS Medicine*, 13(6): e1002039. https://doi.org/10.1371/journal.pmed.1002039

Satija A et al., 2017. Healthful and unhealthful plant-based diets and the risk of coronary heart disease in U.S. adults. *Journal of the American College of Cardiology*. https://doi.org/10.1016/j.jacc.2017.05.047

Thompson A S, Tresserra-Rimbau A, Karavasiloglou N et al., 2023. Association of healthful plant-based diet adherence with risk of mortality and major chronic diseases among adults in the UK. *JAMA Netw Open*, 6(3): e234714. https://doi.org/10.1001/jamanetworkopen.2023.4714

Tong T Y N et al., 2020. Vegetarian and vegan diets and risks of total and site-specific fractures: Results from the prospective EPIC-Oxford study. *BMC Medicine*, 18: 353. https://doi.org/10.1186/s12916-020-01815-3

Tresserra-Rimbau A, Thompson A S, et al., 2023. Plant-based dietary patterns and Parkinson's disease: A prospective analysis of the UK Biobank. *Movement Disorders*. https://doi.org/10.1002/mds.29580

Willett W et al., 2019. Food in the anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*, 6736: 3–49.

World Health Organization, 2015. Q & A on the Carcinogenicity of the Consumption of Red Meat and Processed Meat. www.who.int/news-room/questions-and-answers/item/cancer-carcinogenicity-of-the-consumption-of-red-meat-and-processed-meat

9 Intensive farming and the antibiotic resistance crisis

Cóilín Nunan

The silent pandemic

As the world recovers from COVID, it is very unsettling to hear that many scientists and experts believe we are already in the midst of another public-health crisis. Despite its seriousness, this health threat is barely noticed, which is why it is increasingly being referred to as the "silent pandemic" (ECDC 2022).

This time it is not a single virus that is spreading around the world, and nor is it likely to be solved through vaccination alone. Instead, what is causing so much concern is antibiotic resistance – the ability of bacteria to evolve so that they are no longer killed by the antibiotics to which they were originally sensitive.

Since their introduction to human medicine in the 1940s, antibiotics have become a cornerstone of modern medicine and helped save enormous numbers of lives. At the beginning of the 20th century, infectious diseases such as smallpox, cholera, diphtheria, pneumonia, typhoid fever, plaque, tuberculosis, typhus and syphilis were responsible for high levels of mortality worldwide (Adedeji 2016). By 1950, at the beginning of the antibiotic era, average life expectancy worldwide was still only 46.5 years (Dattani et al. 2023).

The introduction of antibiotics revolutionised the treatment of infectious diseases. The leading causes of deaths changed from communicable diseases to non-communicable diseases, like cardiovascular disease, cancer or strokes. Furthermore, antibiotics were not just used to treat patients that already had an infection, they also became essential for preventing infections for those undergoing life-saving procedures like cancer chemotherapy, organ transplants or caesareans, or other types of major surgery. By 2019, average life expectancy worldwide had increased to 72.8 years (Dattani et al. 2023).

Hip replacements provide a good illustration of the extent to which much of modern medicine has come to rely on antibiotics. According to a British study, at present infection rates for hip-replacement surgery are only about 0.5%–2%, thanks to antibiotics being used preventatively. In addition, if a patient is infected, antibiotics are available to treat the infection. But, without antibiotics, the scientists estimate that the infection rate would be 40%–50% and that 30% of those with an infection would die (Smith and Coast 2013).

Unfortunately, the World Health Organization (WHO) warns that a possible "post-antibiotic era" puts many of these gains of modern medicine at risk (Reardon 2014; WHO 2023). The United Nations Environment Programme (UNEP) says that the spread of antibiotic resistance is a pandemic hiding in plain sight (UNEP 2022).

It is not hard to understand why concern is so high. According to the first comprehensive assessment of the global impact of antibiotic resistance, the deaths of 1.27 million people a year are directly attributable to antibiotic resistance, and 4.95 million deaths a year are associated

DOI: 10.4324/9781032684369-13

with antibiotic resistance (Antimicrobial Resistance Collaborators 2021). For the UK alone, it has been estimated that 7,600 deaths a year are directly due to antibiotic resistance and a total of 35,200 deaths are associated with antibiotic resistance (Robert Koch Institute 2022; HM Government 2023). The European Centre for Disease Prevention and Control (ECDC) says that the health impact of infections with antibiotic-resistant bacteria in Europe is comparable to that of influenza, tuberculosis and HIV/AIDS combined (ECDC 2022).

These numbers are already shocking, but the Review on Antimicrobial Resistance, commissioned by the UK government (O'Neill 2014), has forecast that, unless strong action is taken, ten million people a year could die globally because of antibiotic resistance by 2050. This Review also estimated that the cumulative cost to the economy by 2050 could be $100 trillion dollars and that if we take into account the loss of prophylactic antibiotics for surgery and cancer chemotherapy, the total cost could increase to $210 trillion dollars.

Of course, antibiotics are not only used in human medicine. They have also become essential medicines for much of livestock farming, ensuring that many diseases can be effectively treated or prevented. So clearly antibiotics have had the potential to increase animal health and welfare, in the same way they have had enormous benefits for human health and longevity.

Unfortunately, their ultimate impact on the lives of farm animals has often been very different. This is because the practice of feeding antibiotics routinely to groups of animals has enabled many farmers to raise far greater numbers of animals, in close confinement, indoors. Repeated doses of antibiotics can help control the diseases caused by the unhygienic, and highly stressful conditions in which many of these animals are kept, an unhealthy environment which would otherwise cause high mortality. As a result, many intensive livestock farmers around the world have come to rely on antibiotics as a key management tool. Estimates of global human and farm-animal use suggest that around 66% of antibiotics are actually used in livestock, not humans (Van Boeckel et al. 2017; Tiseo et al. 2020).

Most antibiotics used in medicine are substances produced naturally by certain microorganisms or are derived from these microbial products. So, antibiotics have been present in the environment for millions of years, and during this time some bacteria developed resistance. Antibiotic resistance is therefore undoubtedly a natural phenomenon, but rapidly increasing levels of resistance are due to the use and overuse of antibiotics in human medicine, farm animals and sometimes even on plants (WHO 2023). So, the post-antibiotic era that threatens to roll back medical progress is largely due to human behaviour, and to our own decisions to use these medicines irresponsibly.

Furthermore, since the 1980s, very few genuinely new antibiotics have been discovered. In 2024 a newly discovered antibiotic was shown to be effective in mice, raising some hope it might be developed for humans, although scientists warned that there was no guarantee this would happen (Geddes 2024; Wade 2024). Generally, the prospects for new antibiotic discoveries are not considered bright (Iskandar et al. 2022). This means that the best way we have of dealing with the resistance problem is to address our overuse of these antibiotics. And when it comes to livestock farming, as we shall see, making very large cuts in antibiotic use are eminently feasible if we are willing to reconsider how we farm animals.

Antibiotics and the emergence of intensive farming

In the late 1940s, scientists at American Cyanamid, a pharmaceutical company that had recently developed the antibiotic aureomycin, were experimenting with feeding the bacteria that produced the antibiotic to chickens. The chicken industry had begun to feed its birds soybean meal as a cheaper substitute for fishmeal, but soybean meal lacked a vitamin which the poultry required. The Cyanamid scientists reasoned that the bacteria which produced aureomycin were likely to contain the vitamin. They found it had a large growth-promoting effect, much larger than expected. They soon realised that it was due to the presence of the antibiotic, rather than the vitamin. They had discovered that feeding low doses of aureomycin to chickens made the animals grow faster.

The *New York Times* hailed the discovery on its front page with the headline "Wonder drug aureomycin found to spur growth 50%", welcoming the promise of increased meat production, and concluding by saying that "no undesirable side effects have been observed, it is said" (Lawrence 1950).

However, Fleming, and other scientists, already had evidence that misusing antibiotics could lead to resistance, and that the challenge was to use the drugs as strategically and appropriately as possible. As early as 1945, in his acceptance speech for his Nobel Prize, Fleming warned, "There is the danger that the ignorant man may easily under-dose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant".

Nevertheless, antibiotic growth promoters were legalised in the US in 1951 and in the UK in 1953. Soon enough, antibiotic growth promoters became the norm worldwide, with Iceland the only country to buck the trend by refusing to legalise the practice.

Adding low, subtherapeutic doses of antibiotics to animal feed, or drinking water, didn't just make the animals grow faster. It had another effect too: it enabled farm animals to be farmed much more intensively. Certain livestock, particularly pigs and poultry, could now be raised entirely indoors, in often cramped and unhygienic conditions, with the inevitably occurring bacterial infections being kept under control by routine dosing with antibiotics.

Ruminant animals, like cattle and sheep, do not generally respond as well to oral dosing with antibiotics because it inhibits grass digestion and thereby growth rate. This is particularly the case for sheep, and as a result, these are usually the least intensively farmed of the major species. However, calves raised for white veal are fed on predominantly liquid diets that do not permit development of the normal processes of microbial fermentation of fibrous feeds in the rumen, and these animals are often routinely dosed with antibiotics and kept in highly intensive conditions.

Routine subtherapeutic antibiotic use was essential in enabling the establishment of truly intensive indoor farming, where costs were lowered because of reduced need for land and labour and faster animal growth. This in turn led to average growth rates of pig and poultry consumption in the rich, developed countries, where the faming was most intensive, of 5%–7% per year from the 1960s onwards (Alexandratos and Bruinsma 2012).

Antibiotic resistance in human infections is linked to farm antibiotic use

Unfortunately, much as Fleming had warned, the emergence of antibiotic resistance in farmed animals occurred almost as soon as the antibiotics began being used. As a result, vets started reporting that they were having increasing difficulties in treating sick animals, but perhaps even more significantly evidence was found that the resistant bacteria were transmitting to humans and causing resistant infections.

But it also became clear that the misuse of antibiotics in farming had an effect on the levels of antibiotic resistance in human infections too, although human antibiotic use is widely recognised as the main cause of antibiotic resistance in most human infections. This is sometimes disputed by those with a vested interest. However the Review on Antimicrobial Resistance found that there is a broad scientific consensus that farm antibiotic use does contribute to resistance in human infections (O'Neill 2014).

To understand how, we need to understand how resistance arises and how it spreads. Antibiotics kill or stop the growth of bacteria which are "susceptible" to it, but do not kill bacteria that have acquired resistance. If antibiotics are overused, the susceptible bacteria are killed off, leaving the resistant ones to proliferate. Many of these resistant bacteria live in the intestines, and when animals are slaughtered and eviscerated at the abattoir, contamination of the carcases can occur, and some bacteria end up on the meat – other bacteria live naturally on skin, and so their presence on retail meat is to be expected. If the meat is cooked properly, most or all the bacteria will be killed, but handling of raw meat and eating undercooked meat can allow the bacteria to be transferred to humans. Direct contact with the animals can also enable the bacteria to be transferred.

Farm-animal bacteria, which have acquired resistance in animals and can cause infections in humans, include the food-poisoning bacteria *Salmonella* and *Campylobacter*. For example, the use in poultry of fluoroquinolone antibiotics, which are classified as highest-priority critically important by the WHO, is known to have led to resistance to these antibiotics in human *Campylobacter* infections. According to a report by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA), "this is a compelling example of how antimicrobial resistance in food and animals may impact the availability of effective antimicrobial agents for treating severe human Campylobacter infections" (ECDC and EFSA 2016).

Other examples of resistant bacteria than can transfer from farm animals to humans include well-known "superbugs" methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile*. For many years, these infections were overwhelmingly associated with hospitals, but over the past couple of decades, new strains have emerged in farm animals, which can cause infection in humans. The widespread use of tetracycline antibiotics is thought to be the main cause for the spread of a strain of *C. difficile* in livestock, in particular pigs (Dingle et al. 2019). This strain, one of several livestock-associated strains, became one of the leading causes of *C. difficile* infection in Europe (Freeman et al. 2018). Livestock-associated MRSA has also spread around the world and caused numerous infections in humans (Nunan and Young 2007).

In addition, some resistant farm-animal bacteria, even when they do not directly cause an infection in humans, may still be transferred to humans and live for some time in the human gut. There, they have an ability to share resistance genes by a process called "horizontal gene transfer" with other human-origin bacteria in the gut. Bacteria which are resistant to a particular antibiotic usually have a gene (or genes) which enables them to resist the effects of the antibiotic. Sometimes the bacteria can produce copies of this gene and pass them on to other bacteria which then also become resistant. This can happen with farm-animal *Escherichia coli* bacteria passing on genes to human-origin *E. coli*. If the human-origin *E. coli* subsequently cause an infection, such as a urinary-tract infection, the *E. coli* may be of human origin, but the resistance is of farm-animal origin.

This complicated way of resistance spreading can make it challenging to determine how much of the problem is of farm-animal origin and how much of human origin. However, there are several cases of antibiotics only being used in farm animals, and resistance to these antibiotics being subsequently found in human infections, including *E. coli* and *Klebsiella*, proving that this gene transfer does happen in practice.

One example, which made headlines around the world, was the emergence of resistance to the antibiotic colistin. Colistin is an antibiotic which is toxic to people's kidneys and is best avoided as a treatment option in most cases. For many years, the antibiotic was not prescribed to humans, but it was used in farm animals, sometimes as a growth promoter. Better and less dangerous antibiotics were available for human use, but gradually resistance to them increased.

As a result, over the past 10 or 15 years colistin has come to be used as a last resort in humans, for serious and highly resistant infections that most other antibiotics would be unable to treat.

In 2015, Chinese scientists found the first-ever cases of colistin-resistant bacteria that possessed a colistin-resistance gene that could be transferred horizontally from bacteria to bacteria (Liu et al. 2015). They found the gene in 1% of human *E. coli* infections, a totally unexpected finding, since colistin had not yet been licenced for use in humans in China. Their study showed that colistin-resistant *E. coli* were also present in 21% of pigs and in 15% of pig and poultry meat. Colistin, at the time, was used in livestock as a growth promoter in China, and it was clear that this was the cause of the emergence of colistin resistance.

Very soon after the Chinese discovery of this new gene, it was found in many countries around the world, including the UK, in livestock, in meat and in human infections (Gallaher 2015). Despite this, most countries, including the UK, still refuse to ban the use of colistin in farming.

In 2017, the Chinese government licenced the use of colistin in humans and banned the use of colistin as a growth promoter in China, leading to a 90% reduction in its use in livestock. By 2018–2019, colistin resistance in *E. coli* in livestock and in humans had fallen, providing yet more evidence that resistance was transferring from livestock to human *E. coli* (Wang et al. 2020). Colistin resistance in human Salmonella infections in China also fell sharply (Sun et al. 2023).

Fortunately, as the colistin example and many others show, major reductions in antibiotic use can result in the levels of antibiotic resistance falling.

Ending growth promotion is not enough

In 1995, Austria, Finland and Sweden joined the European Union (EU) and it was decided that there was a need to harmonise legislation governing farm antibiotic use. Sweden had banned antibiotic growth promoters in 1986 and Finland was also phasing out their use. After negotiations, the EU agreed to phase out antibiotic growth promoters between 1997 and 2006.

One reason the EU agreed to this was that, whilst it made the EU appear to be acting responsibly, it was understood by regulators and farmers that it wouldn't significantly restrict access to antibiotics. Although a veterinary prescription was now required before antibiotics could be added to animal feed, there was no requirement that any disease be diagnosed before a vet could write a prescription. Unsurprisingly, many farmers switched to using more antibiotics under veterinary prescription, and usage remained extremely high in many European countries.

Globally, most focus also remains on the use of antibiotic growth promoters, despite widespread understanding that this approach is hard to justify based on science or experience.

In 2019, the Food and Agriculture Organization (FAO), the then Office International des Epizooties (OIE), now known as World Organisation for Animal Health (WOAH) and the WHO published a joint report *No Time To Wait* (Interagency Coordination Group on Antimicrobial Resistance 2019), setting out their plans to tackle the rise of antibiotic resistance globally. The report was produced following an unprecedented Political Declaration of the High-Level Meeting of the United Nations General Assembly on Antimicrobial Resistance which called for greater urgency for dealing with the resistance crisis (General Assembly on Antimicrobial Resistance 2016). The report accurately stated that

> The use of antimicrobials to promote growth and routinely prevent disease in healthy animals and crops without appropriate indication and in the absence of good agricultural practices to prevent infectious diseases on farms are further contributing to the development and spread of antimicrobial resistance.

However, despite accepting that routine preventative antibiotic use in livestock was contributing to the spread of antibiotic resistance, the report made no recommendations for phasing out or ending such use. Instead, it recommended only that growth promotion be phased out.

According to the WOAH, in 2021, just 41 countries out of the 157 countries (26%) which reported to it said that they were still using antibiotic growth promoters, whereas 107 out of 157 (68%) said that they were not used (WOAH 2023). Whilst this phaseout of growth promotion does represent some progress, the reality is that it has not had a large effect on reducing global farm antibiotic use. Not only is about two-thirds of global antibiotic use still in animals, but also farm use is projected to increase by another 11.5% by 2030 (Tiseo et al. 2020).

Europe finally starts to take action

In the Netherlands, total farm antibiotic use reached an all-time high in 2007, one year after the EU growth-promoter ban. As a result, the Dutch authorities, concerned about the continued misuse of farm antibiotics, and the emergence of new superbugs in pigs, poultry and intensively farmed veal calves, such as MRSA and highly resistant *E. coli*, which were spreading to humans, decided to ban all preventative group treatments with antibiotics in 2011 (Speksnijder et al. 2015). By 2012, Dutch farm antibiotic had fallen by 56% compared with 2007, and usage subsequently continued to fall. By 2022, it was down by 80% from the 2007 peak (NethMap 2023).

The Netherlands wasn't the first country to ban group preventative use. Five Nordic countries, EU members Denmark, Finland and Sweden, and non-EU countries Iceland and Norway, also had prohibitions on the practice (Nordic Farming Unions 2015) and overall, they used far fewer farm antibiotics than other most other European countries (European Medicines Agency 2023).

The failure of the EU growth-promoter ban, and the clear evidence for the effectiveness of restricting preventative use, led the European Parliament to call for "legislative proposals to phase out the prophylactic use of antibiotics in farming" in 2011 (European Parliament 2011). After years of negotiations, in late 2018, the EU agreed to new rules governing farm antibiotic use (Regulation (EU) 2019/6). These came into force on 28 January 2022 and contained some strong restrictions.

All forms of "routine" farm antibiotic use were banned, including preventative group treatments. Group treatments are still allowed but are only permitted when an infection is present and the risk of the infection spreading is high and no alternative treatments are available. There is also a requirement for Member States to collect antibiotic-usage data by farm-animal species.

Critically, the new legislation includes a prohibition on using antibiotics to "compensate for poor hygiene, inadequate animal husbandry or lack of care or to compensate for poor farm management". This is potentially a very radical and transformative restriction, since it is effectively saying that if animals are managed in ways that cause them to fall ill routinely, then antimicrobials cannot be used.

Full implementation of the Regulation will require any farms that currently have poor hygiene or inadequate animal husbandry to make important improvements to their farming systems. Yet, in the five years since this legislation was agreed, there has been little evidence that European farming is significantly altering husbandry practices, which raises questions about how the legislation is being implemented.

Between 2011 and 2022, European farm antibiotic use reduced by about 53% as many countries prepared for the new legislation and made further large reductions in 2022, once the legislation came into force (European Medicines Agency 2023). However, about 85.1% of European farm antibiotic use is still for group treatments, whereas in the lowest-using countries, Iceland, Norway and Sweden, over 90% of farm antibiotic use is for individual treatments. This shows that most European countries are still not using antibiotics in a sufficiently responsible and targeted way.

Despite leaving the EU in 2020, the UK was involved in negotiating the new EU legislation, and the UK government said that it would implement it in full, subject to a public consultation (HM Government 2019). Unfortunately, this has not happened. In early 2023, a public consultation was finally held on proposed new veterinary medicines legislation. However, whilst the ban on routine antibiotic use, and on using antibiotics to compensate for poor hygiene and inadequate animal husbandry were retained in the proposals, the ban on preventative group treatments was not included, having been strongly opposed by industry groups. Furthermore, the UK government proposed to rely on voluntary, industry data collection for species usage data.

By the end of 2023, no government response to the consultation had been published, and there were increasing concerns that the UK government would renege on its promises to tighten legislation (PA Association Media 2023).

Regulation of antibiotics won't be enough – we need to change farming too

The EU's move to end routine farm antibiotic use is perhaps the most significant improvement in antibiotic regulation ever since antibiotics were introduced to livestock farming. In 2022, European farm antibiotic use fell by another 12.7%, and further reductions are expected in years to come. In contrast, in the US, which opposes ending group prophylaxis, farm antibiotic use increased by 4% (Torrella 2023).

There are, however, limits to how much progress can be made by taking an approach which focuses primarily on how antibiotics are prescribed.

Denmark, for example, banned preventative group treatments long before the EU did and introduced numerous other initiatives aimed at improving prescribing: setting reduction targets, penalties for excessive antibiotic use (the "yellow card" system), prohibiting vets from profiting from antibiotic sales to farmers and introducing taxes on certain critically important antibiotics (DANMAP n.d.). All these initiatives have helped ensure that intensively farmed pigs in Denmark receive significantly fewer antibiotics than pigs in most other European countries. However, Danish intensively farmed pigs still receive 2.5 times more antibiotics than pigs in Sweden, which are kept in less intensive and stressful conditions, and about 10 times more than Danish organic pigs (Nielsen et al. 2021).

Similarly, in the UK, successful voluntary initiatives have greatly reduced antibiotic use in the pig and poultry sectors, which are largely dominated by intensive production. This is very welcome, but preliminary data from sheep farming, where less effort has been made to reduce antibiotic use to date, but where animals are usually raised on pasture, has shown that antibiotic use per livestock unit in sheep appears to be about half that of chickens, a quarter of that of turkeys and nine times lower than in pigs (RUMA 2023).

The potential for improvements to animal husbandry and for higher levels of animal health and welfare to contribute to far greater reductions in antibiotic use appears to be overlooked far too often. And it is not just governments and regulators, and lobbyists for intensive farming and the pharmaceutical industry who downplay the importance of making changes to the way we farm animals. A review of scientific studies examining ways to reduce antibiotic use in the pig industry found that 94% of the studies were clinical trials for other medicines, such as non-antibiotic feed additives or vaccines. Only 3% of studies looked at housing, stocking densities or access to the outdoors, with another 3% looking at weaning practices (Wisener et al. 2021).

Clearly, far more research needs to be done into minimising reliance on all forms of routine medication in livestock farming by improving husbandry. Nevertheless, there is already strong evidence that many of the practices of intensive farming are associated with high levels of antibiotic use (Nunan 2022).

Very high stocking densities and a barren environment devoid of enrichment materials, like straw bedding, are associated with worse hygiene, increased levels of stress and much easier disease transmission. The resulting increase in respiratory and intestinal diseases is often controlled with antibiotics. Animals raised entirely indoors are denied access to healthy fresh air and the opportunity to fully express their natural behaviours.

Genetic selection for high levels of productivity is another cause of poor health. The extremely rapid growth rate of modern broilers causes poor health and welfare and leads to far higher levels of antibiotic use. Similarly, genetic selection for high milk production in dairy cows is positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders, diseases which are frequently controlled with antibiotics. In intensive pig production, hyper-prolific sows, which have been genetically selected to produce as many piglets as possible, are often unable to provide enough milk for their piglets, which then need to be weaned early. The early weaning of piglets causes post-weaning diarrhoea and is a major cause of antibiotic use in the pig industry.

One scientific review of the causes of high antibiotic use in the pig industry concluded that current intensive farming practices are "failing to keep pigs healthy and 'happy'". The scientists argued for a "reduction in stressors and boredom in pig herds (i.e. "happier" pigs), saying that "This will simultaneously address two demands from society: improving the welfare of pigs (ethical demand) and reducing the use of antibiotics (public health demand)" (Albernaz-Gonçalves et al. 2022). Of course, this applies to other livestock species too.

So, to address these many causes of ill health, we need to fundamentally change our approach to farming animals. Legislation is needed to ensure that animals are kept in far less stressful conditions, in systems which are preferably pasture-based, where the health and happiness of animals are given real priority. And consumers will also need to accept that protecting our antibiotics, and farming animals more humanely, will mean fewer but higher-quality and healthier animal foods.

References

Adedeji W, 2016. The treasure called antibiotics. *Annals of Ibadan Postgraduate Medicine*, 14(2): 56–57. www.ncbi.nlm.nih.gov/pmc/articles/PMC53546

Albernaz-Gonçalves R et al., 2022. Linking animal welfare and antibiotic use in pig farming—A review. *Animals*. https://www.mdpi.com/2076-2615/12/2/216

Alexandratos N and Bruinsma J, 2012. World agriculture towards 2030/2050. *Food and Agriculture Organization of the United Nations*. www.fao.org/3/ap106e/ap106e.pdf

Antimicrobial Resistance Collaborators, 2021. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. *The Lancet*. https://doi.org/10.1016/S0140-6736(21)02724-0

DANMAP, n.d. Danish Programme for surveillance of antimicrobial consumption and resistance in bacteria from food animals, food and humans. https://www.danmap.org/

Dattani S, Rodés-Guirao L, Ritchie H et al., 2023. Life Expectancy. https://ourworldindata.org/life-expectancy

Dingle K et al., 2019. A role for tetracycline selection in recent evolution of agriculture-associated clostridium difficile PCR Ribotype 078. *mBio*, 10(2): e02790-18. https://doi.org/10.1128/mBio.02790-18

ECDC (European Centre for Disease Prevention and Control), 2022. Video: Antimicrobial resistance – The silent pandemic. www.ecdc.europa.eu/en/publications-data/video-antimicrobial-resistance-silent-pandemic

ECDC (European Centre for Disease Prevention and Control) and EFSA (European Food Safety Authority), 2016. The European Union summary report on antimicrobial resistance in zoonotic and indicator bacteria from humans, animals and food in 2014.

European Medicines Agency, 2023. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC): 2009–2023. www.ema.europa.eu/en/veterinary-regulatory-overview/antimicrobial-resistance-veterinary-medicine/european-surveillance-veterinary-antimicrobial-consumption-esvac-2009-2023

European Parliament, 2011. European Parliament resolution of 27 October 2011 on the public health threat of antimicrobial resistance. https://www.europarl.europa.eu/doceo/document/TA-7–2011–0473_EN.html

Freeman J et al., 2018. The ClosER study: Results from a three-year pan-European longitudinal surveillance of antibiotic resistance among prevalent Clostridium difficile ribotypes, 2011–2014. *Clinical Microbiology and Infection*, 24(7): 724–731. https://doi.org/10.1016/j.cmi.2017.10.008

Gallaher J, 2015. Bacteria that resist 'last antibiotic' found in UK. *BBC News*. www.bbc.co.uk/news/health-35153795

Geddes L, 2024. Scientists hail new antibiotic that can kill drug-resistant bacteria. *The Guardian*. www.theguardian.com/science/2024/jan/03/scientists-new-class-antibiotic-kill-drug-resistant-bacteria

General Assembly on Antimicrobial Resistance, 2016. Political Declaration. Draft resolution. https://digitallibrary.un.org/record/842813?In=en

HM Government, 2019. Tackling antimicrobial resistance 2019–2024 The UK's five-year national action plan. https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2019-to-2024

HM Government, 2023. National Risk Register 2023 Edition. www.gov.uk/government/publications/national-risk-register-2023

Interagency Coordination Group on Antimicrobial Resistance, 2019. No Time to Wait. https://www.who.int/docs/default-source/documents/no-time-to-wait-securing-the-future-from-drug-resistant-infections-en.pdf

Iskandar K et al., 2022. Antibiotic discovery and resistance: The chase and the race. *Antibiotics*, 11(2): 182. https://doi.org/10.3390/antibiotics11020182

Lawrence W, 1950. 'Wonder drug' aureomycin found to spur growth 50%. *New York Times*, April 10.

Liu Y et al., 2015. Emergence of plasmid-mediated colistin resistance mechanism MCR-1 in animals and human beings in China. *Lancet Infectious Diseases*, 16(2). https://doi.org/10.1016/S1473-3099(15)00424-7

NethMap, 2023. Consumption of antimicrobial agents and antimicrobial resistance among medically important bacteria in the Netherlands. https://www.rivm.nl/publicaties/nethmap-2023-consumption-of-antimicrobial-agents-and-antimicrobial-resistance

Nielsen C et al., 2021. Antibiotic and medical zinc oxide usage in Danish conventional and welfare-label pig herds in 2016–2018. *Preventive Veterinary Medicine*, 189: 105283. https://doi.org/10.1016/j.prevetmed.2021.105283

Nordic Farming Unions, 2015, 13 October. Letter to the Nordic ministers of health, food and agriculture and to the Nordic Council. https://bit.ly/41S2Xr7

Nunan C, 2022. Ending routine farm antibiotic use in Europe. *European Public Health Alliance*. https://epha.org/ending-routine-farm-antibiotic-use/

Nunan C and Young R, 2007. MRSA in farm animals and meat – A new threat to human health. *Soil Association*. www.soilassociation.org/media/4945/policy_report_2007_mrsa_farm_animals.pdf

O'Neill J, 2014. Review on Antimicrobial Resistance. https://amr-review.org

PA Media, 2023. Zac Goldsmith calls for end to delay in banning overuse of antibiotics on farms.

Reardon S, 2014. WHO warns against 'post-antibiotic' era. *Nature*. https://doi.org/10.1038/nature.2014.15135

Regulation (EU) 2019/6 on veterinary medicinal products. https://eur-lex.europa.eu/eli/reg/2019/6/oj

Robert Koch Institute, 2022. The burden of antimicrobial resistance in G7 countries and globally: An urgent call for action. www.rki.de/EN/Content/infections/antibiotic/brochure_IHME_RKI.pdf?__blob=publicationFile

RUMA (Responsible Use of Medicines in Agriculture), 2023. RUMA Targets Task Force 2: Three years on. https://www.ruma.org.uk/wp-content/uploads/2023/10/RUMA-TTF-Report-2023-FINAL.pdf

Smith R and Coast J, 2013. The true cost of antimicrobial resistance. *British Medical Journal* 346: f1493. https://doi.org/10.1136/bmj.f1493

Speksnijder D et al., 2015. Reduction of veterinary antimicrobial use in the Netherlands. The Dutch success model. *Zoonoses Public Health*, 62(Suppl. 1): 79–87.

Sun R-Y et al., 2023. Carriage and transmission of mcr-1 in *Salmonella typhimurium* and its monophasic 1,4,[5],12:i: Variants from diarrheal outpatients. *Microbiology Spectrum*, 11(1): e0311922. https://doi.org/10.1128/spectrum.03119-22

Tiseo K et al., 2020. Global trends in antimicrobial use in food animals from 2017 to 2030. *Antibiotics*, 9(12): 918. https://doi.org/10.3390/antibiotics9120918

Torrella K, 2023. Big Meat just can't quit antibiotics. *Vox*. www.vox.com/future-perfect/2023/1/8/23542789/big-meat-antibiotics-resistance-fda

UNEP (United Nations Environment Programme), 2022. Environmental Dimensions of Antimicrobial Resistance. https://wedocs.unep.org/bitstream/handle/20.500.11822/38373/antimicrobial_R.pdf

Van Boeckel T et al., 2017. Reducing antimicrobial use in food animals. *Science*, 357(6358): 1350–1352. https://doi.org/10.1126/science.aao1495

Wade G, 2024. Membrane-destroying drug works against antibiotic-resistant bacteria. *New Scientist*. www.newscientist.com/article/2410571-membrane-destroying-drug-works-against-antibiotic-resistant-bacteria/

Wang Y et al., 2020. Changes in colistin resistance and mcr-1 abundance in Escherichia coli of animal and human origins following the ban of colistin-positive additives in China. *Lancet Infectious Diseases*, 20(10): 1161–1171. https://doi.org/10.1016/S1473-3099(20)30149-3

WHO (World Health Organization), 2023, 21 November. Antimicrobial Resistance. www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

Wisener et al., 2021. Non-antibiotic approaches for disease prevention and control in nursery pigs. *Frontiers in Veterinary Medicine*, 8. https://doi.org/10.3389/fvets.2021.620347

WOAH (World Organization for Animal Health), 2023. Annual report on antimicrobial agents intended for use in animals. www.woah.org/app/uploads/2023/05/a-seventh-annual-report-amu-final.pdf

10 Transforming Chinese agrifood systems to achieve sustainable healthy diets

Shenggen Fan and Xiaolong Feng

Introduction

Malnutrition and environmental degradation are two major challenges facing the world today that demand urgent attention. In 2021, almost a third (29.3%) of the world's population, or 2.3 billion people, experienced moderate or severe food insecurity (FAO et al. 2021). At the same time, approximately 40% of adults and 20% of children were overweight or obese (Development Initiatives Poverty Research 2022). Poor diets are the leading cause of malnutrition, but food production and consumption patterns are also taking a significant toll on the environment. In fact, food systems contribute to one-third of global greenhouse gas (GHG) emissions, with agricultural production accounting for 39% of these emissions (Crippa et al. 2021; UNEP 2022). Anthropogenic impacts account for 35% of the degradation of agricultural land, and agriculture is a major source of water pollution in many countries (FAO et al. 2021).

In recent years, global focus on the synergistic effects of diets on both health and the environment has increased (Springmann et al. 2018; Zhang and Chai 2022). Healthy diets are more environmentally sustainable, whilst sustainable diets can bring significant health benefits (Guasch-Ferré and Willett 2021; He et al. 2021). By moving towards sustainable healthy diets, a win–win outcome can be achieved for both nutritional health and environmental sustainability (Springmann et al. 2020; AGFEP et al. 2021; Sheng et al. 2021).

Therefore, the promotion of sustainable healthy diets and the transformation of demand-side agrifood systems are important and urgent for the world and for China. The latter is currently facing severe challenges of nutrient imbalance and environmental degradation. This chapter aims to analyse the current state and the challenges of diets in China and explore policy options to achieve sustainable and healthy diets in the country.

Rapid transition of Chinese diets

With the increase in agricultural productivity and income levels, China has made significant strides in reducing hunger and malnutrition. There has been notable progress in the quality and composition of the population's diet. The consumption of nutritious foods, such as fruits, eggs, aquatic products and dairy products, has increased gradually (Figure 10.1). There is also a steady rise in consumption of animal-based foods such as red meat and chicken as well as a significant increase in the consumption of refined cereals and edible oils, indicating a transition from the traditional Chinese plant-based dietary pattern to a Western dietary pattern (Zhao et al. 2018). This change may be the result of changes in sociodemographic factors and consumer characteristics and trade and investment have been shown to influence dietary change (Kearney 2010). Currently, the diet of Chinese individuals is characterised by an imbalanced

DOI: 10.4324/9781032684369-14

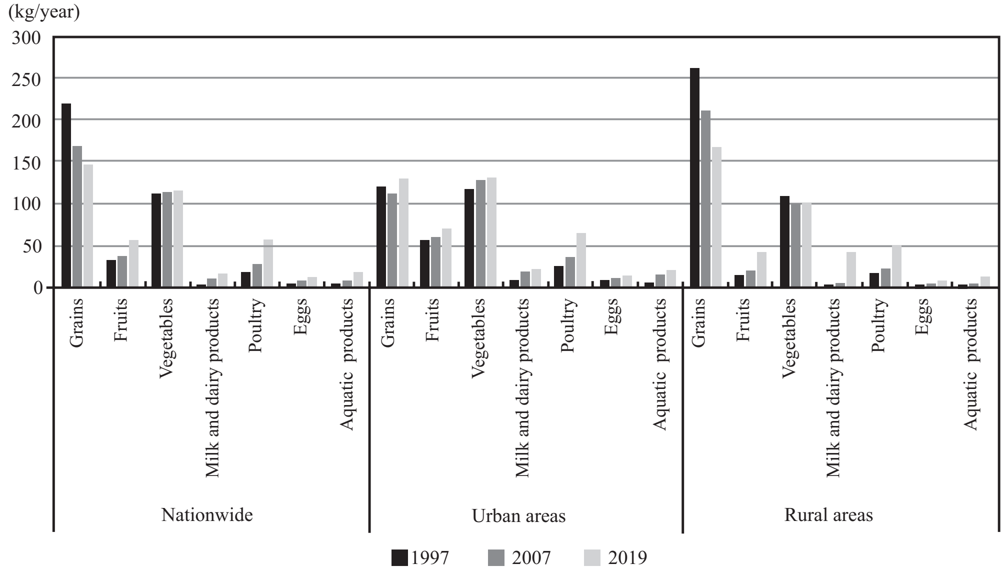

Figure 10.1 Dietary changes from 1997 to 2019 of urban and rural residents in China. Source: AGFEP 2021.

eating pattern with excessive cereal and meat consumption and insufficient intake of vegetables, fruits and dairy products (AGFEP et al. 2022), which presents new challenges for nutritional health and the natural resource environment.

Diet-related nutrition and health issues are becoming increasingly important. The coexistence of over- and undernutrition amongst Chinese residents continues to highlight the problem of overweight and obesity and the incidence of major chronic diet-related diseases continues to increase (He et al. 2019a), thereby giving rise to nutritional health issues and challenges (Bureau of Disease Prevention and Control 2020; Institute of Food and Nutrition Development 2022). First, the population of overweight and obese individuals is increasing rapidly across all age groups in both urban and rural areas; obesity has emerged as a significant public health issue in China (Pan et al. 2021). The rate of overweight and obesity in the Chinese population age 18 years and older is 50.7% in 2020, with 34.3% of this population overweight and 16.4% obese. Obesity in adults is increasing at a faster rate than overweight, and increased rates of overweight and obesity in rural population are higher than in the urban population. The rates of overweight and obesity in the adult male population in 2018 were 37.6% and 16.1%, respectively (Chinese Nutrition Society 2021). Second, chronic disease is a significant problem. Malnutrition is the leading cause of illnesses and death in Chinese residents (Afshin et al. 2019; He et al. 2019b); chronic noncommunicable diseases like cardiovascular disease, cancer, chronic respiratory disease and diabetes account for 88% of all deaths in China (Bureau of Disease Prevention and Control 2020). The prevalence of diabetes in adults is increasing year by year, touching 11.9% in 2020, which almost doubles the prevalence in 2002 and is four times higher than in 1989. The prevalence of hypertension is also increasing, with almost a third of the population already suffering from hypertension in 2020. There has been an increase of approximately ten percentage points compared to 2002 (Chinese Nutrition Society 2021). Third, the problem of hidden hunger remains. Many individuals in China, particularly key populations such as children and pregnant women, continue to face significant micronutrient deficiencies. As of 2018, up to 21.2% of children aged six years and younger have anemia. The prevalence of vitamin A marginal deficiency in children aged 6–17 years is 14.7%, and zinc deficiency in children under 14 years of age is as high as 27% (Bureau of Disease Prevention and Control 2020; Cai et al. 2021).

At the same time, changes in the dietary structure of the Chinese population have also exacerbated environmental issues. China is the world's second most populous country, and its demand for meat and cereals increased by 19% and 10% of global food, respectively, between 2010 and 2020 (OECD and FAO 2021). FAO statistics show that carbon emissions from China's agricultural food system increased from 1,177 million metric tons in 1990 to 1,864 million metric tons in 2020, an increase of 58%. Methane and nitrous oxide emissions from agricultural production activities are responsible for more than 40% and 50% of the national emissions of methane and nitrous oxide, respectively (Ministry of Ecology and Environment 2018). China's agricultural food system is experiencing an increase in emissions, water consumption and land use area of approximately 1.1%, 1.8% and 2% per year, respectively, with the growth in meat consumption being the largest contributor to these three environmental pressures (He et al. 2018). In particular, enteric fermentation of livestock and management of animal manure are important sources of agricultural emissions. With the change of food structure, consumption of animal products per capita has gradually increased, resulting in an increase in the demand on agricultural land for food production (Zhao et al. 2014), and the water footprint (WF) of food consumption is increasing (Liu and Savenije 2008). A disproportionate share of food consumption for meat (highest WF) and a small share of consumption for vegetables (lowest WF) is the primary reason for the large WF per unit of food consumption (Xu et al. 2021).

Challenges to the transformation of sustainable healthy diets in China

With increasing nutrient imbalances and environmental degradation, there is a pressing need to transform the diets of China's people. Studies conducted in recent years have demonstrated the potential for a transition to sustainable and healthy diets for China's population that can improve their nutritional health and optimise the use of resources. By 2030, it is expected that the prevalence of chronic diet-related diseases will be significantly reduced, resulting in a reduction of 1,802,000 premature deaths and 665,000 deaths. This represents a 19.2% and 19.5% reduction, respectively, compared to the 2010 reference standard (Springmann et al. 2020). Furthermore, this shift to sustainable diets can lead to a 19%, 15% and 30% reduction in carbon, water and ecological footprints, respectively, and decrease emissions by 146 million to 202 million metric tons (Sheng et al. 2021; Yin et al. 2021). Nevertheless, the following four challenges remain to be addressed to further the transition to a sustainable and healthy diet for China's population.

There is inadequate research on healthy diets in China. First, the *Dietary Guidelines for Chinese Residents* (China Nutrition Society 2022) are based on Western guidelines and do not have Chinese features; some parts are difficult for Chinese residents to achieve in their daily diets. Second, current national dietary guidelines do not consider the major differences in resource endowments and dietary patterns of different regions, and analyses based on national-average data cannot provide specific insights into the diverse daily diets of local residents and the precise transformation that they merit. Third, the pervasive problems of overweight, obesity and hidden hunger have not been adequately addressed, and no specific guidance programmes have been developed to ameliorate them.

The *Dietary Guidelines for Chinese Residents* do not consider the sustainability of resources and the environment. The current trend of shifting the dietary structure of the population toward animal-based foods will result in greater pressure on resources and the environment in the agricultural food system. Even if we follow the recommended diets in the *Guidelines*, a gap will remain. There is much room for optimising sustainable healthy diets in China, but there is a lack of clear direction for optimisation, and the gap between actual supply and recommended consumption should not be ignored.

International trade and foreign investment have become increasingly important in transforming diets of residents in China but have been neglected in their impact on sustainable healthy diets of the population. International trade has altered the structure and quality of diets of Chinese people, as their food preferences gradually shift toward animal-source foods. Foreign direct investment, represented by Western-style fast food, has increased the consumption of unhealthy foods by residents of China, affecting their nutritional health whilst simultaneously constraining the sustainability of resources and the environment. However, China has never used international trade and foreign investment as a grip to change the diets of its population.

A specific and effective intervention system to guide the population's dietary intake is lacking. Interventions on the consumption side are the key to achieving a sustainable and healthy diet for the population and are a powerful traction for the transformation of the agrifood system. Residents' consumption behaviour is influenced by a variety of factors and interventions: information intervention, behavioural intervention and economic incentives can effectively contribute to the transformation of diets. Although China's nutrition support policies have been effective in improving the nutrition of specific groups of people, the existing nutrition support policies have not considered the shift toward sustainable healthy diets and lack targeted interventions for key groups and scenarios.

Strategic direction for advancing the transformation of sustainable healthy diets in China

During the past decade, an increasing number of countries have begun to integrate health and sustainability into both national food policies and consumer education programmes as a primary response to nutritional imbalances and environmental sustainability. This will contribute to the transformation of agrifood systems for human health and planetary sustainability by influencing national nutrition programmes, trade and investment patterns, consumer food choices and agricultural production. However, in-depth research on the precise dietary shifts in different countries or regions is needed to propose concrete and feasible guidelines. In light of the many challenges facing China's sustainable healthy dietary transition, how should China actively respond? Based on the international context of sustainable healthy diets and the findings of our study on sustainable healthy diets in China, this chapter proposes four major strategies to promote the transformation of sustainable healthy diets in China.

First, establishing a healthy dietary pattern that is appropriate for the Chinese population. Whilst appropriately preserving and advocating Chinese characteristics such as more plant-based foods in traditional diets, China should also provide regional guidelines on healthy diets that are easy to operate and unique to the resource endowments and dietary habits of different regions. To address the common problems of diets in different regions, increasing the consumption of whole grains, fruits and soya products and reducing the consumption of ultra-processed foods, refined grains and red meat through increasing supply and food substitution should be encouraged. The frequent problem of hidden hunger should be addressed by providing a variety of alternative food options.

Second, proposing a sustainable healthy diets optimisation programme. Based on the premise of satisfying the nutritional health of the population, the environmental impact of food consumption should be considered, and the dietary structure of the population should be further optimised. Taking into full consideration the resources and environmental endowments of different regions and the characteristics of agricultural production, a cross-sectoral coordination mechanism should be established to jointly formulate national and regional guidance programmes on "sustainable healthy diets for the population" to guide the transformation of the population's food consumption toward sustainability and health. The programme should involve adjustments to the structure of the food supply, with increased research and production support for legumes, fruits, etc. The "Big Food Concept" should be implemented to improve the supply of diverse foods to meet the population's needs for sustainable healthy diets. Additionally, all segments of the agrifood system should be transformed into a green and low-carbon system.

Third, adjusting international trade and overseas investment to improve the diet of the population. Taking advantage of the development trend of economic globalisation, China should incorporate dietary improvement into its policy objectives for international trade and overseas investment, optimise trade policies and adjust overseas investment tactics to achieve the dual objectives of population health and environmental sustainability. In terms of trade, the goal of improving dietary nutrition should be included in trade negotiations, making full use of domestic and international markets resources to ensure China's food security level. Investment access restrictions in the food sector should be liberalised, directing investment towards industries related to sustainable healthy diets. This can be achieved by promoting the implementation of a detailed investment review system and regulatory regime in this area. In the future, nutrition, health and sustainable development must be included in the agenda of agricultural negotiations in World Trade Organization (WTO) negotiations.

Finally, taking several measures to guide interventions to change the diet of the population toward sustainable health. Food education for all should be provided; and families, schools and communities (villages) should serve as entry points for food education for all individuals. This will help establish a sustainable healthy diet and encourage individuals to take responsibility for their own health. Policies and regulations can work together to establish a supportive market and consumer environment that guides and motivates consumers to change their diets toward sustainable health. Precise interventions for different populations, regions and consumption scenarios can also be implemented to promote sustainable and healthy diets.

References

AGFEP (Academy of Global Food Economics and Policy) et al., 2021. China and Global Food Policy Report. https://agfep.cau.edu.cn/art/2021/5/14/art_39584_747191.html

AGFEP (Academy of Global Food Economics and Policy) et al., 2022. China and Global Food Policy Report. https://agfep.cau.edu.cn/art/2022/6/9/art_39584_866236.html

Afshin A et al., 2019. Health effects of dietary risks in 195 countries, 1990–2017: A systematic analysis for the Global Burden of Disease Study. *The Lancet*. 393: 1958–1972. https://doi.org/10.1016/S0140-6736(19)30041-8

Bureau of Disease Prevention and Control of the National Health Commission, 2020. China's Population Nutrition and Chronic Diseases Report 2020. Beijing.

Cai-Jin Y, Jing-Ying S and Gang-Xi L, 2021. Meta-analysis of zinc deficiency and its influence factors in children under 14-years-old in China. *Journal of Family Medicine*, 8(5): 1257.

Chinese Nutrition Society, 2021. Research Report of the Academy of Sciences on Dietary Guidelines for Chinese Residents.

China Nutrition Society, 2022. Dietary Guidelines for Chinese Residents.

Crippa M et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2(3): 198–209.

Development Initiatives Poverty Research Ltd, 2022. Global Nutrition Report 2022: Stronger Commitments for Greater Action. Bristol.

FAO et al., 2021. The State of Food Security and Nutrition in the World 2021. www.fao.org/publications/sofi/2021/en

Guasch-Ferré M and Willett W C, 2021. The Mediterranean diet and health: A comprehensive overview. *Journal of Internal Medicine*, 290(3): 549–566.

He P et al., 2018. The environmental impacts of rapidly changing diets and their nutritional quality in China. *Nature Sustainability*, 1: 122–127. https://doi.org/10.1038/s41893-018-0035-y

He Y et al., 2019a. Data resource profile: China national nutrition surveys. *International Journal of Epidemiology*, 48(2): 368–368f.

He Y et al., 2019b. The dietary transition and its association with cardiometabolic mortality among Chinese adults, 1982–2012: A cross-sectional population-based study. *Lancet Diabetes & Endocrinology*, 7(7): 540–548.

He P et al., 2021. Shifts towards healthy diets in the US can reduce environmental impacts but would be unaffordable for poorer minorities. *Nature Food*, 2(9): 664–672.

Institute of Food and Nutrition Development, 2022. China Food and Nutrition Development Report.

Kearney J, 2010. Food consumption trends and drivers. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 365(1554): 2793–2807.

Liu J and Savenije H H G. 2008. Food consumption patterns and their effect on water requirement in China. *Hydrology and Earth System Sciences*, 12(3): 887–898.

Ministry of Ecology and Environment, 2018. China Climate Change Second Biennial Update Report 2018. Beijing.

OECD and FAO, 2021. OECD–FAO Agricultural Outlook 2021–2030.

Pan X F, Wang L and Pan A, 2021. Epidemiology and determinants of obesity in China. *Lancet Diabetes & Endocrinology*, 9(6): 373–392.

Sheng F et al., 2021. Changing Chinese diets to achieve a win-win solution for health and the environment. *China & World Economy*, 29(6): 34–52.

Springmann M et al., 2018. Options for keeping the food system within environmental limits. *Nature*, 562(7728): 519–525.

Springmann M et al., 2020. The healthiness and sustainability of national and global food based dietary guidelines: Modelling study. *BMJ*, m2322.

UNEP (United Nations Environment Programme), 2022. Emissions Gap Report 2022. https://www.unep.org/emissions-gap-report-2022

Xu F et al., 2021. Mechanisms of food price effects on improving dietary structure and reducing water demand. *Resource Science*, 43(12): 2490–2502.

Yin J et al., 2021. The potential benefits of dietary shift in China: Synergies among acceptability, health, and environmental sustainability. *Science of the Total Environment*, 779: 146497.

Zhang J and Chai L, 2022. Trade-off between human health and environmental health in global diets. *Resources, Conservation and Recycling*, 182: 106336.

Zhao Y et al., 2014. Study on the impact of the changing dietary structure of the population on the demand for land for food production in China. *China Population-Resources and Environment*, 24(03): 54–60.

Zhao et al., 2018. Challenges brought about by rapid changes in Chinese diets: Comparison with developed countries and implications for further improvement. *Biomedical and Environmental Sciences*, 31: 73–78.

11 The environmental benefits of vegan pet food

Andrew Knight

Unfortunately, our current lifestyle choices are leading to environmental catastrophe. We are already living through the sixth mass extinction event since fossil records began, with 60% of animal populations having disappeared since 1970 (Barrett et al. 2018). The need for a wholesale shift towards more sustainable lifestyles is imperative, to avoid further exacerbating this unfolding disaster.

The food sector is a key component that needs to change. Numerous studies have examined the environmental impacts of food production systems. Some of the best updated information is provided by recent studies within *Nature Food*. Examining data from 2015, Crippa et al. (2021) demonstrated that our food system accounted for about a third of all anthropogenic (human-generated) greenhouse gases (GHGs) globally. Using data from around 2010, Xu et al. (2021) calculated GHG emissions globally from plant- and animal-based human food. They found that our food systems were responsible for at least 35% of anthropogenic global GHG emissions, and that 57% of food-related emissions were attributable to the production of animal-based food (including livestock feed). Combining these indicates that the production of animal-based food is responsible for at least 20% of anthropogenic GHG emissions. Livestock produce consumption is increasing globally, so calculations using current data would probably indicate an even greater impact of the livestock sector.

Accordingly, numerous studies have concluded that substantial reductions in the consumption of livestock products including meat, milk and eggs, are necessary to achieve sustainable societies. Until recent times, however, little consideration was given to the impact of pet diets. However, a rapidly growing list of manufacturers (www.sustainablepetfood.info > suppliers) are now creating vegan pet foods, using plant, mineral and synthetic ingredients to ensure the nutritional needs of dogs and cats are met. By early 2024, a large body of studies in both species (dogs – 10, cats – 3; www.sustainablepetfood.info > health) had demonstrated that dogs and cats fed nutritionally sound vegan diets enjoy health at least as good, and in some respects better than, those fed meat-based diets. Dogs and cats fed vegan diets also appear just as happy with their meals (Knight and Satchell 2021). Given that pet welfare is not compromised by feeding nutritionally sound vegan diets, it now seems reasonable to consider the environmental benefits such diets might bring.

One of first studies examining the environmental impacts of the pet food sector was published by Okin in 2017. Okin calculated the environmental impacts attributable to pet food in the US, which is the country with the largest dog and cat population – over 163 million dogs and cats. Okin calculated that 25%–30% of the environmental impacts of the livestock sector, in terms of consumption of land, water, fossil fuel, phosphate, and biocides, were attributable to pet food, as well as 64 ± 16 million tons of carbon dioxide (CO_2)-equivalent methane and nitrous oxide – two powerful GHGs. If we conservatively apply the lower range limit of 25% to the 20% of anthropogenic GHG emissions we already know are due to the livestock sector as

DOI: 10.4324/9781032684369-15

noted previously (Xu et al. 2021), this would mean that at least 5% of US GHG emissions are attributable to the pet food sector.

This raises the question: what would the environmental savings be, if cats and dogs were transitioned to nutritionally sound vegan diets, within the US, and globally? Until very recently it was near impossible to calculate this accurately, due to lack of accurate data concerning ingredients used with pet food at an industry-wide level. Recently however, such data became available. In 2020, Decision Innovation Solutions (DIS) conducted a large-scale study examining the ingredient composition of US dog and cat diets. Their report (DIS 2020a) was supplemented by online data (DIS 2020b), providing ingredients and tonnages used within US dog and cat food. In my recent study (Knight 2023), I used these data to analyse ingredients used within US dog and cat food at that time. This chapter summarises the resultant study.

I calculated dietary energy requirements of dogs, cats and people, based on population numbers. The US pet food ingredients data was published in 2020, so for the US I used 2020 population numbers. I aimed to compare these to global calculations. For global dog and cat populations, the most reliable recent figures related to 2018. Hence for global calculations the year 2018 was used.

Nutritionally sound vegan diets also have environmental impacts that must be considered. However, these are usually far less than impacts created during the production of animal produce, because most of the plant material fed to livestock animals is used to support their bodily maintenance, rather than producing directly consumable products such as meat, milk or eggs. Food conversion ratios (FCRs) indicate the losses that occur during the conversion of various plant to animal products. In my final calculation steps, I examined published data on these FCRs for a range of environmental impact categories (e.g., land and water use, etc.). I quantified the savings that would accrue from the use of nutritionally sound vegan diets. These included reductions in the use of land, freshwater and biocides, and in the emissions of GHGs, acidifying and eutrophifying gases. Acidifying gases cause environmental acidification, resulting in phenomena such as acid rain. Eutrophifying gases result in waterway eutrophication through excessive nutrient deposition, notably of nitrogen and phosphorus. This results in algal overgrowth, depleting oxygen, killing other organisms, and damaging ecosystems. I also calculated the potential savings of food energy. These were used to determine the numbers of additional people who could be fed if dogs, cats and humans were each transitioned onto nutritionally sound vegan diets.

Key results

Proportionate livestock consumption

The relative proportions of livestock consumption with the diets of dogs, cats and people, within the US in 2020 and globally in 2018, are indicated in Tables 11.1 and 11.2.

Animals no longer slaughtered

The numbers of terrestrial vertebrates who would no longer be slaughtered annually, if nutritionally sound vegan diets were fully implemented within the US or globally, are indicated in Tables 11.3 and 11.4.

Aquatic animal deaths are more challenging to calculate because their numbers are measured in tons. The proportions of aquatic species used within US dog and cat food respectively were 2.8% and 15.6% by mass (DIS 2020b). If in excess of just 1% of society's overall consumption, as appears likely, this would equate to billions of aquatic animals being consumed within dog and cat food annually (Table 11.5).

Table 11.1 Proportionate use of average livestock animals required to meet animal-sourced dietary energy needs, within US dog, cat and human diets in 2020 (after Knight 2023, Table 10)

	Livestock animal consumption
Humans	80.0%
Dogs	17.7%
Cats	2.3%
Total	100.0%
Dogs + cats	20.0%

Table 11.2 Proportionate use of average livestock animals required to meet animal-sourced dietary energy needs, within dog, cat and human diets globally in 2018 (after Knight 2023, Table 11)

	Livestock animal consumption
Humans	91.1%
Dogs	7.7%
Cats	1.2%
Total	100.0%
Dogs + cats	8.9%

Table 11.3 Terrestrial vertebrates killed for food in 2020, within the US, used within the diets of dogs, cats and humans. World totals: FAOSTAT (n.d.) (Knight 2023, Table 12)

	US total (2020)	*Humans (80.0%)*	*Dogs (17.7%)*	*Cats (2.3%)*	*Dogs and cats (20.0%)*
Poultry	9,592,147,000	7,673,717,600	1,697,810,019	220,619,381	1,918,429,400
Pigs	131,639,000	105,311,200	23,300,103	3,027,697	26,327,800
Bovine animals	33,366,100	26,692,880	5,905,800	767,420	6,673,220
Sheep and goats	2,942,800	2,354,240	520,876	67,684	588,560
Other land animals	77,594	62,075	13,734	1,785	15,519
Total	**9,760,172,494**	**7,808,137,995**	**1,727,550,531**	**224,483,967**	**1,952,034,499**

Table 11.4 Terrestrial vertebrates killed for food in 2018, globally, used within the diets of dogs, cats and humans. World totals: FAOSTAT (n.d.) (Knight 2023, Table 13)

	World total (2018)	*Humans (91.1%)*	*Dogs (7.7%)*	*Cats (1.2%)*	*Dogs and cats (8.9%)*
Poultry	74,640,136,000	67,997,163,896	5,747,290,472	895,681,632	6,642,972,104
Pigs	1,478,059,606	1,346,512,301	113,810,590	17,736,715	131,547,305
Sheep and goats	1,047,391,220	954,173,401	80,649,124	12,568,695	93,217,819
Other land animals	726,797,375	662,112,409	55,963,398	8,721,569	64,684,966
Bovine animals	353,868,375	322,374,090	27,247,865	4,246,421	31,494,285
Total	**78,246,252,576**	**71,282,336,097**	**6,024,961,448**	**938,955,031**	**6,963,916,479**

Table 11.5 Fish and decapods consumed annually within the diets of dogs, cats and humans, globally (billions) (Knight 2023, Table 16)

	World total
Fish – fisheries (2007–2016 avg.)	787.458–2,328.767
Decapods (2017)	255.227–604.731
Fish – aquaculture (2017)	51.107–167.476

Impact reductions achievable by vegan diets

As noted, reductions in impacts potentially achievable by vegan diets were calculated for a range of environmental sustainability metrics. These included land and water use, GHG emissions as CO_2 equivalents, acidifying emissions as sulphur dioxide (SO_2) equivalents, eutrophifying emissions as phosphate (PO_4^{3-}) equivalents, and biocide use. These impact reductions were then combined with the relative proportions of livestock consumption required to supply the animal-sourced dietary energy (E_A) within the diets of dogs, cats and humans (Tables 11.1 and 11.2). This allowed calculation of the reductions in total livestock sector impacts achievable through use of vegan diets for dogs, cats and humans, for each sustainability metric. These were calculated both for the US (2020 consumption levels) and globally (2018 consumption levels) (Tables 11.6 and 11.7).

The impact reductions above were then applied to a range of livestock sector impacts calculated in other studies, to illustrate the benefits likely to accrue from transitions to vegan diets for dogs, cats and people. Examples follow for land and freshwater use, and GHG emissions, as excerpted from Knight (2023). These are summarised in Figure 11.1.

Land use

In 2006, Steinfeld et al. noted that 78% of the world's agricultural land, and 33% of the world's cropland, is used for livestock production. Since then, livestock numbers have increased significantly. Hence, Poore and Nemecek (2018a) calculated that meat, aquaculture, eggs and dairy production utilised around 83% of the world's agricultural land. The more conservative 2006 figures alone indicate that livestock grazing and feed crop production uses 3.9 billion hectares (ha) of land, or 30% of the non-polar terrestrial surface of the Earth. Hence, considering global consumption levels, at least the following land savings would result from vegan diets (in billion ha): dogs – 0.26 (larger than Saudi Arabia or Mexico), cats – 0.04 (larger than Japan or Germany), dogs and cats – 0.30 (larger than Argentina), humans – 2.39 (larger than Russia (the world's largest country), and India, combined) (worldpopulationreview.com 2023).

Additionally, livestock are often major sources of pollution, releasing large quantities of organic matter, pathogens and drug residues onto soil and into rivers, lakes and coastal zones (Aarnink et al. 1995; Losey and Vaughan 2006; Fiala 2008). The 100+ million cattle produced in the US annually each generate an average of 9,000 kg of solid waste per year (Losey and Vaughan 2006). Livestock impacts landscapes, often profoundly diminishing biodiversity. The Amazon rainforest is amongst the world's most biodiverse ecosystems. Around 70% of the previously forested Amazonian land has been converted to pastures, with much of the remaining 30% converted to croplands, largely for livestock feed (Steinfeld et al. 2006). Vegan diets would free up vast amounts of land, allowing rewilding and biodiversity recovery.

Table 11.6 Reductions in total livestock sector impacts within the US, achieved through use of vegan diets for dogs, cats or humans, based on 2020 consumption levels (Knight 2023, Table 17)

Diet	*Parameter*	*Land use (m2)*	*Freshwater (L)*	*Str-Wt WU (L eq)*	*GHG (kg CO_2eq, IPCC 2013)*	*Acid. (kg SO_2eq)*	*Eutr. (kg $PO_4^{3-}eq$)*	*Biocides*
Dog food	Reduction of diet impact due to vegan diet	85.9%	32.7%	31.2%	75.1%	74.6%	74.7%	63.0%
	Proportion of total livestock consumption	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
	Reduction of total livestock impact due to vegan diet	15.2%	5.8%	5.5%	13.3%	13.2%	13.2%	11.1%
Cat food	Reduction of diet impact due to vegan diet	84.7%	30.7%	29.2%	73.3%	72.8%	72.9%	60.7%
	Proportion of total livestock consumption	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
	Reduction of total livestock impact due to vegan diet	1.9%	0.7%	0.7%	1.7%	1.7%	1.7%	1.4%
Dog food + cat food	Reduction of diet impact due to vegan diet	85.8%	32.5%	31.0%	75.0%	74.4%	74.6%	62.8%
	Proportion of total livestock consumption	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
	Reduction of total livestock impact due to vegan diet	17.2%	6.5%	6.2%	15.0%	14.9%	14.9%	12.6%
Human diet (US)	Reduction of diet impact due to vegan diet	75.3%	21.4%	20.1%	56.9%	57.7%	55.8%	58.9%
	Proportion of total livestock consumption	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
	Reduction of total livestock impact due to vegan diet	60.3%	17.1%	16.1%	45.5%	46.1%	44.6%	47.1%

Table 11.7 Reductions in total livestock sector impacts globally, achieved through use of vegan diets for dogs, cats or humans, based on 2018 consumption levels (Knight 2023, Table 18)

Diet	*Parameter*	*Land use (m2)*	*Freshwater (L)*	*Str-Wt WU (L eq)*	*GHG (kg CO2eq, IPCC 2013)*	*Acid. (kg SO2eq)*	*Eutr. (kg PO43– eq)*	*Biocides*
Dog food	Reduction of diet impact due to vegan diet	85.9%	32.7%	31.2%	75.1%	74.6%	74.7%	63.0%
	Proportion of total livestock consumption	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%
	Reduction of total livestock impact due to vegan diet	6.6%	2.5%	2.4%	5.8%	5.7%	5.8%	4.8%
Cat food	Reduction of diet impact due to vegan diet	84.7%	30.7%	29.2%	73.3%	72.8%	72.9%	60.7%
	Proportion of total livestock consumption	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
	Reduction of total livestock impact due to vegan diet	1.0%	0.4%	0.4%	0.9%	0.9%	0.9%	0.7%
Dog food + cat food	Reduction of diet impact due to vegan diet	85.8%	32.5%	31.0%	75.0%	74.4%	74.6%	62.8%
	Proportion of total livestock consumption	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%
	Reduction of total livestock impact due to vegan diet	7.6%	2.9%	2.8%	6.7%	6.6%	6.6%	5.6%
Human diet (global)	Reduction of diet impact due to vegan diet	66.6%	15.1%	14.1%	46.2%	47.0%	45.1%	48.3%
	Proportion of total livestock consumption	91.1%	91.1%	91.1%	91.1%	91.1%	91.1%	91.1%
	Reduction of total livestock impact due to vegan diet	60.6%	13.7%	12.8%	42.1%	42.8%	41.1%	44.0%

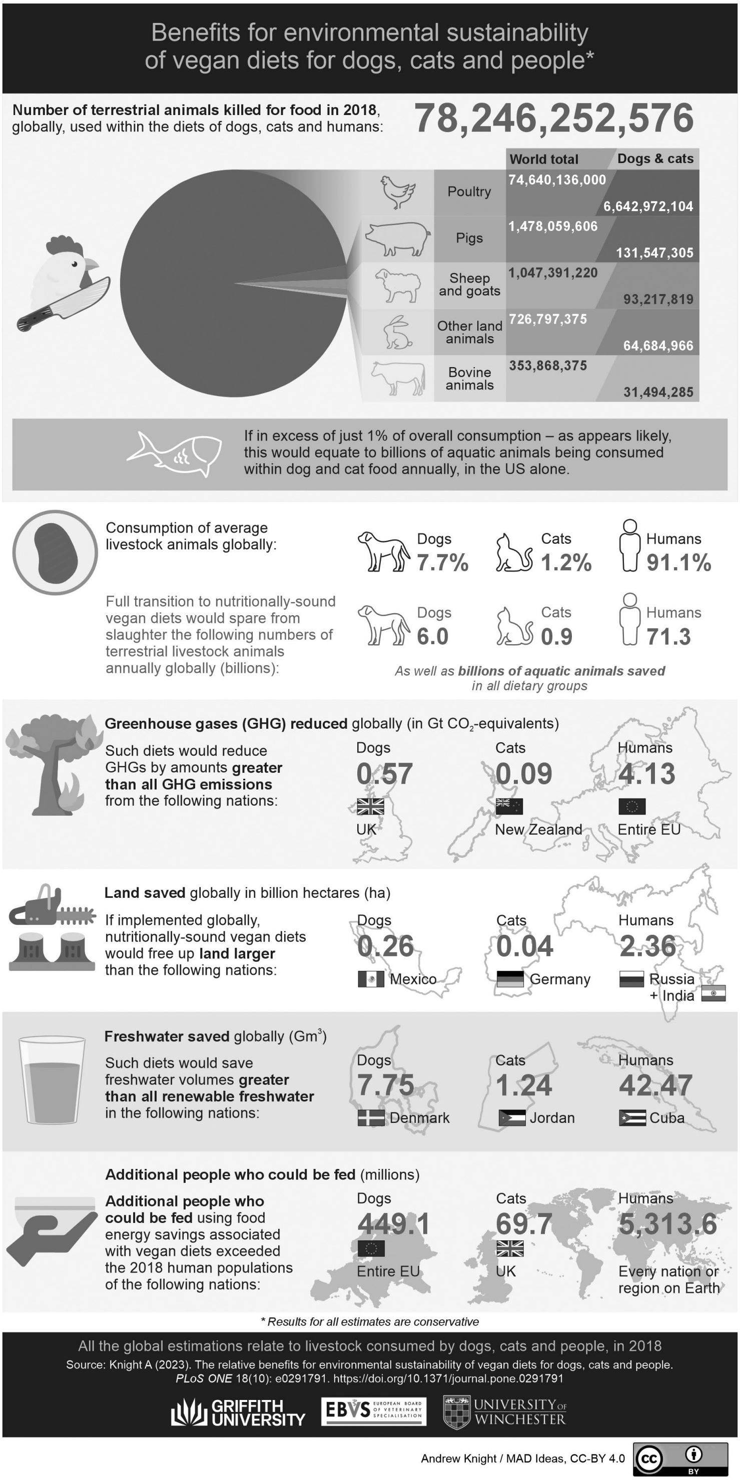

Figure 11.1 Benefits for environmental sustainability of vegan diets for dogs, cats and people.

Source: Knight (2023, “Comments”).

Freshwater use

The water used by the livestock sector exceeds 8% of global human water use (Abbasi and Abbasi 2016). Global animal production requires about 2,422 Gm^3 of water per year (87.2% green, 6.2% blue, and 6.6% grey water). This equates to 2.4 PL, or about 5,000 times the volume of the Sydney Harbour. The green water footprint derives from precipitation. Blue water is sourced from surface or groundwater, and grey water is fresh water required to assimilate pollutants to meet water quality standards. One third of this collective volume is consumed by the beef cattle sector, and another 19% by the dairy sector. Almost all (98%) of water consumed is required to grow feed crops. Drinking water for the animals, service water and water for feed mixing, require only for 1.1%, 0.8% and 0.03% of this water, respectively (Mekonnen and Hoekstra 2010). Freshwater is encapsulated by the blue and grey water components. Globally, this freshwater used for animal production comprises 310.01 Gm^3. Hence, considering global consumption levels, freshwater use reductions achieved by vegan diets would be (in Gm^3): dogs – 7.75 (greater than all renewable water in Denmark), cats – 1.24 (greater than all renewable water in Jordan), dogs and cats – 8.99 (greater than all renewable water in Gambia), and humans – 42.47 (greater than all renewable water in Cuba) (FAO 2003; CIA 2009; Wikipedia 2023a).

Greenhouse gases

Livestock-associated GHGs come from deforestation for pasture and feed crops, pasture degradation, and from direct emissions from livestock and their waste products. The main GHG emissions associated with livestock production are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). 19% of CH_4 emissions come from the livestock sector. Enteric (gastrointestinal) fermentation and manure collectively contribute 80% of these CH_4 emissions (Abbasi et al. 2013; Tauseef et al. 2013). Of next greatest importance is N_2O. Livestock production contributes 15% of N_2O emissions. Finally, livestock production contributes 1.35% of CO_2 emissions (Gerber et al. 2013). The global warming potential of these gases varies greatly. To aid comparisons, they are converted to CO_2-eq (CO_2 equivalents). IPCC (2013) reported a warming potential for CH_4 of 34 CO_2-eq and for N_2O of 310 CO_2-eq, over a 100 year timeframe. The equivalent figures reported by UNFCCC (2014) for CH_4 were 21 CO_2-eq, and for N_2O were (also) 310 CO_2-eq.

As noted previously, the food system results in 35% of all GHGs globally, and 20% of all GHGs – or 9.8 Gt CO_2-eq – were attributed to the livestock sector (Xu et al. 2021). Hence, reductions in total anthropogenic GHGs achieved by vegan diets globally would be 20% of the reductions shown in Table 11.7, given that Table 11.7 relates only to those impacts attributable to the livestock sector. As percentages of all anthropogenic GHGs, these would represent reductions of: dogs – 1.2%, cats – 0.2%, dogs and cats – 1.3%, and humans – 8.4%.

Considering the 9.8 Gt CO_2-eq from livestock, and the reductions achieved by vegan diets shown in Table 11.7, these would equate to GHG emissions savings, in Gt CO_2-eq, of: dogs – 0.57 (greater than all emissions from South Africa or the UK), cats – 0.09 (greater than all emissions from Israel or New Zealand), dogs and cats – 0.66 (greater than all emissions from Saudi Arabia or Australia), and humans – 4.13 (greater than all emissions from India or the entire EU). These refer to the total emissions used for the productions of all goods and services in these nations or regions, based on 2018 figures (Wikipedia 2023b).

Very substantial though these environmental benefits are, my calculations are nevertheless very conservative (Knight 2023). With respect to GHGs, for example, they assume 20%

of all anthropogenic GHGs arise from the livestock sector, or just 57% of the 35% of GHGs attributable to the food sector (Xu et al. 2021). Yet, a recent study utilising the Emissions Database for Global Atmospheric Research ("EDGAR-FOOD") estimated that the livestock sector (including land use/change activities) proportion of all food sector GHGs, was 71% (Crippa et al. 2021). Others have calculated this at approximately 80% (Friel et al. 2009; Bowen et al. 2014). Assuming 35% of all anthropogenic GHGs are attributable to the food sector (Xu et al. 2021), these proportions would mean the livestock sector was responsible for 25% or 28% respectively of total anthropogenic GHGs. Hence, my results attributing just 57% of all food-related GHGs to the livestock sector, rather than 71% or 80%, probably significantly underestimated the GHGs created by animal-sourced ingredients, and the consequent reductions in GHGs likely through use of nutritionally sound vegan diets for dogs, cats and people.

Additional people who could be fed

These numbers of additional people who could be fed using purely vegan diets were also determined. The following results are also excerpted from Knight (2023). Within the US, the numbers of additional people that could be fed are provided in Table 11.8. Globally, the numbers of additional people that could be fed are provided in Table 11.9.

Concordance with prior studies

The environmental impacts of dog and cat food demonstrated within this study were very considerable. These concur with other studies described in Knight (2023) which have also demonstrated very substantial environmental impacts of meat-based dog and cat diets. Such studies

Table 11.8 Proportion of the 2020 US population who could be fed with food energy savings associated with vegan diets (Knight 2023, Table 19)

Vegan diet	*Food energy savings (PJ)*	*People fed (millions)*	*% of 2020 US population*
Dog food	265.7	77.5	23.6
Cat food	34.3	10.0	3.0
Dog + cat food	300.0	87.5	26.6
Human food	1,199.2	349.6	106.3

Table 11.9 Proportion of the 2018 world population who could be fed with food energy savings associated with vegan diets (Knight 2023, Table 20)

Vegan diet	*Food energy savings (PJ)*	*People fed (millions)*	*% of 2018 world population*	*Regions that could be fed*
Dog food	1,544.8	449.1	5.8	European Union
Cat food	239.9	69.7	0.9	France or the UK
Dog + cat food	1,784.7	518.8	6.8	Europe and Central Asia
Human food	18,278.7	5,313.6	69.2	Every single nation or collective region on Earth

Note: In all cases, the numbers of additional people who could be fed exceeded the populations within the regions listed as examples. These are based on 2018 populations and World Bank (2023) regional definitions. Examples of collective regions defined by the World Bank include all heavily indebted poor countries, all low and middle income countries, and all high income countries.

have focused on the UK (Vale and Vale 2009), North-Western Europe (Leenstra and Vellinga 2011), the US (Okin 2017), China (Su et al. 2018), Japan (Su and Martens 2018), the Netherlands (Martens et al. 2019), the entire world (Alexander et al. 2020) and Brazil (Pedrinelli et al. 2022). The latter study by Pedrinelli et al. also demonstrated markedly greater impacts of wet diets compared to dry diets.

Conclusions and recommendations

Major reductions in livestock produce consumption are clearly necessary for humanity to achieve environmental sustainability. Until recently, this was assumed to be largely limited to human diets. However, the proportion of livestock animals consumed by dogs and cats are also very significant, especially in wealthy nations with high pet ownership, such as the US (Tables 11.1 and 11.2). Hence dietary change must also be considered for our dogs and cats.

As noted previously, nutritionally sound vegan diets do not compromise the welfare of dogs and cats. And as indicated in my recent study (Knight 2023) and the others described, these diets can provide major environmental benefits. My study used very conservative estimates, and the true benefits for environmental sustainability of vegan diets for dogs and cats are probably significantly greater than those calculated.

However, to safeguard pet welfare, such diets must be formulated to be nutritionally complete and balanced. Use of a nutritionally complete commercial diet is normally recommended. Pet guardians should check for labelling claims that diets are nutritionally complete and balanced. The company should also be considered, with the aim of choosing reputable pet food manufacturers that work with veterinary nutritionists or other nutritional experts, and that can provide credible information about steps taken to ensure nutritional soundness and quality of diets. More detailed guidance, along with key studies cited herein, are available at the author's website www.SustainablePetFood.info.

References

Aarnink A J A, Keen A, Metz J H M, Speelman L and Verstegen M W A, 1995. Ammonia emission patterns during the growing periods of pigs housed on partially slatted floors. *Journal of Agricultural Engineering Research*, 62: 105e116.

Abbasi T and Abbasi S A, 2016. Reducing the global environmental impact of livestock production: The minilivestock option. *Journal of Cleaner Production*, 112: 1754–1766.

Abbasi T, Tauseef S M and Abbasi S A, 2013. Energy recovery from wastewaters with high-rate anaerobic digesters. *Renewable and Sustainable Energy Reviews*, 19: 704–741.

Alexander P, Berri A, Moran D et al., 2020. The global environmental paw print of pet food. *Global Environmental Change*, 65: 102153.

Barrett M, Belward A, Bladen S et al., 2018. *Living Planet Report 2018: Aiming Higher*. London: Institute of Zoology and WWF. www.wwf.org.uk/sites/default/files/2018-10/wwfintl_livingplanet_full.pdf

Bowen K J, Ebi K and Friel S, 2014. Climate change adaptation and mitigation: Next steps for cross-sectoral action to protect global health. *Mitigation and Adaptation Strategies for Global Change*, 19: 1033–1040.

Central Intelligence Agency (CIA), 2009. *The World Factbook—Total Renewable Water Resources*. Chicago, IL: CIA.

Crippa M et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2: 198–209. https://doi.org/10.1038/s43016-021-00225-9

Decision Innovation Solutions, 2020a. *Pet Food Production and Ingredient Analysis*. Arlington, VA: Institute for Feed Education and Research. www.petfoodinstitute.org/wp-content/uploads/20200310-Pet-Food-Report-FINAL.pdf
Decision Innovation Solutions, 2020b. *Supplementary Online Data*. Arlington, VA: Institute for Feed Education and Research. https://public.tableau.com/views/Petfoodingredientweights/Story1?:display_count=y&publish=yes&:showVizHome=no#2
FAOSTAT, n.d. *Food Balances (2010–)*. Rome: FAO. https://www.fao.org/faostat/en/#data/FBS
Fiala N, 2008. Meeting the demand: An estimation of potential future greenhouse gas emissions from meat production. *Ecological Economics*, 67(3): 412e419.
Food and Agriculture Organization of the United Nations (FAO), 2003. Review of World Water Resources by Country.
Friel S, Dangour A D, Garnett T et al., 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: Food and agriculture. *The Lancet*, 374(9706): 2016–2025.
Gerber P J, Steinfeld H, Henderson B et al., 2013. *Tackling Climate Change through Livestock: A Global Assessment of Emissions and Mitigation Opportunities*. Rome: FAO.
IPCC (Intergovernmental Panel on Climate Change), 2013. Climate change 2013: The physical science basis. In: Stocker T F, Qin D, Plattner G-K et al. (Eds.), *Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press, p. 1535.
Knight A, 2023. The relative benefits for environmental sustainability of vegan diets for dogs, cats and people. *PLoS ONE*, 18(10): e0291791. https://doi.org/10.1371/journal.pone.0291791
Knight A and Satchell L, 2021. Vegan versus meat-based pet foods: Owner-reported palatability behaviours and implications for canine and feline welfare. *PLoS ONE*, 16(6): e0253292. https://doi.org/10.1371/journal.pone.0253292
Leenstra F and Vellinga T, 2011. *Indication of the Ecological Foot Print of Companion Animals: First Survey, Focussed on Cats, Dogs and Horses in the Netherlands*. Report no. 410650. Wageningen, The Netherlands: Wageningen UR Livestock Research.
Losey J E and Vaughan M, 2006. The economic value of ecological services provided by insects. *BioScience*, 56(4): 311–323.
Martens P, Su B and Deblomme S, 2019. The ecological paw print of companion dogs and cats. *BioScience*, 69(6): 467–474.
Mekonnen M and Hoekstra A Y, 2010. *The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products*. Delft, The Netherlands: UNESCO IHE–Institute for Water Education.
Okin G S, 2017. Environmental impacts of food consumption by dogs and cats. *PLoS ONE*, 12(8), e0181301.
Pedrinelli V, Teixeira F A, Queiroz M R and Brunetto M A, 2022. Environmental impact of diets for dogs and cats. *Scientific Reports*, 12(1): 18510.
Poore J and Nemecek T, 2018. Reducing food's environmental impacts through producers and consumers. *Science*, 363(6392): 987–992.
Steinfeld H, Gerber P, Wassenaar T et al., 2006. *Livestock's Long Shadow: Environmental Issues and Options*. Rome: Food and Agricultural Organization.
Su B and Martens P, 2018. Environmental impacts of food consumption by companion dogs and cats in Japan. *Ecological Indicators*, 93: 1043–1049.
Su B, Martens P and Enders-Slegers M J, 2018. A neglected predictor of environmental damage: The ecological paw print and carbon emissions of food consumption by companion dogs and cats in China. *Journal of Cleaner Production*, 194: 1–11.
Tauseef S M, Premalatha M, Abbasi T and Abbasi S A, 2013. Methane capture from livestock manure. *Journal of Environmental Management*, 117: 187–207.
UNFCCC (United Nations Framework Convention on Climate Change), 2014. Global warming potentials. http://unfccc.int/ghg_data/items/3825.php
Vale B and Vale R J D, 2009. *Time to Eat the Dog? The Real Guide to Sustainable Living*. London: Thames and Hudson.

Wikipedia, 2023a. List of countries by total renewable water resources. https://en.wikipedia.org/wiki/List_of_countries_by_total_renewable_water_resources

Wikipedia, 2023b. List of countries by greenhouse gas emissions. https://en.wikipedia.org/wiki/List_of_countries_by_greenhouse_gas_emissions

World Bank, 2023. Population, total. https://data.worldbank.org/indicator/SP.POP.TOTL?end=2021&start=2021&view=map

Xu X, Sharma P, Shu S, et al., 2021. Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food*, 2(9): 724–732. doi: 10.1038/s43016-021-00358-x

Part 4

Animal health and welfare

12 One biology, sustainable and regenerative farming

A role for pig and poultry production?

Donald M. Broom

Introduction

World public attitudes are changing and food production practice needs to change with it. For some years, more and more consumers have been changing their thinking and restricting their purchasing to sustainable systems (Aland and Madec 2009). A production system that is profitable with current demand for the product will not necessarily continue production as the public may reject it (Broom 2010). Because of better availability and traceability of information about food production, the economy of societies is becoming more of a consumer-driven pull society and less of a producer-driven push society (Broom 2014, 2017b).

When a sample of the Brazilian public were asked what they thought about the future for sustainability in relation to beef production, they responded that sustainability is crucial for the future. They considered the welfare of production animals as the most important part of product and system sustainability (Burnier et al. 2021). Many consumers thought that carbon footprint is also important. In the EU, 94% of the 27,000 members of the public surveyed in 28 Member States agreed that the welfare of farm animals is important (EU DG Health and Food Safety 2016).

One biology, one health and one welfare

As it has been known for many years that the fundamental biological processes in the living cells and systems of all animals, including humans, are the same, the concept of one biology is logically based. Genetic differences between humans and other species of animals are small and the similarities are large (Boffelli et al. 2004). All of the qualities that some people have presented as exclusive to humans, for example language, emotions, the notion of culture or society, cooperation, altruism, tool use, empathy and having a concept of the future and of objects or individuals when they are not present have now been described in various groups of non-human animals (Broom 2003, 2014, 2022; Premack 2007; Clayton and Emery 2015; de Waal 2016; McBride and Morton 2018). There are some differences in gross anatomy of brains but great similarities in the functioning of high-level cognitive analytical systems, pain systems and other emotion analysis mechanisms. The ways in which pathogens are combatted by the immune and other systems do not differ much between humans and other vertebrate species. It is for these reasons that other species can be used to better understand humans. Just as the word biology has the same meaning whichever species is considered, the concepts of health and welfare mean the same in humans and all other animals (Monath et al. 2010; Colonius and Earley 2013; Karesh 2014; García Pinillos et al. 2015, 2016; Broom 2017a, 2022; García Pinillos 2018; Tarazona et al. 2020).

DOI: 10.4324/9781032684369-17

Sustainability and regeneration

Sustainability now has a wider meaning than it had some years ago (Herrero et al. 2010; Broom 2017a,b, 2021). The production method is now considered in relation to ethics and a range of negative impacts can render a system unsustainable. A definition of sustainability is: a system or procedure is sustainable if it is acceptable now and if its expected future effects are acceptable, in particular in relation to resource availability, consequences of functioning and morality of action (Broom 2014). In addition to the positive effects of food as a source of nutrients, possible negative practices and effects are also considered by consumers selecting food. Sustainability has many components and consumers look especially for the negative. Examples of negative components are: adverse effects on human welfare, including health; poor welfare of production or wild animals; animals being killed during production; inefficient usage of land, water and other world resources; harmful environmental effects, such as greenhouse gas production; reduction in carbon sequestration; water pollution; low biodiversity and insufficient conservation; unacceptable genetic modification; not being "fair trade", in that producers in poor countries are not properly rewarded; insufficient job satisfaction for those working in the industry; and damage to rural or other communities (Broom 2010, 2017b, 2023a). A science-based scoring system, taking account of all the components of sustainability, can produce a total sustainability score (Broom 2021). Consumers evaluating the quality of goods also consider a range of sustainability components and require transparency about these.

The meanings of regenerative are diverse. The general meaning of regeneration is to improve a place or system, especially by making it more active or successful. However, the more specific meaning of natural regeneration of woodlands is often that when they are restocked this happens when trees develop from seeds arriving and growing without human agency. Regenerative agriculture describes land management practices that rebuild soil organic matter and return the land to a former or natural state. However, regenerative does not necessarily mean going back to the original state. Rewilding implies return towards the wild condition. This usually increases biodiversity, although some stable wild situations are not very biodiverse, for example: Scots pine woodland, *Zostera* (eel grass) forest in the sea, or marsh with *Phragmites* only. Biodiversity refers to the variety and variability of life in an area or system and may include genetic diversity, species diversity or ecosystem diversity. In general, efforts to regenerate are positive for biodiversity.

Welfare meaning and misunderstandings

The welfare of an individual is its state as regards its attempts to cope with its environment (Broom 1986) so scientific measures of welfare evaluate how well an individual is faring or going through life. Coping means having control of mental and bodily stability. Coping with disease and using feelings to help in coping (Broom 1998) combine with other mechanisms to control life. A nervous system and other mechanisms are needed to cope and the state, and hence the individual's welfare, can be scientifically measured (Broom and Johnson 2019). Welfare thus refers to all animals, but not to plants or inanimate objects. Since it is the individual whose welfare is assessed, we cannot speak of the welfare of a group or population but can refer to the mean welfare in a population. Well-being means the same as welfare, as does quality of life except that it is not used in relation to very short time scales. Welfare can be positive or negative, good or poor, so should not be used as if only positive. Net welfare, which is the balance between good and poor, can be evaluated (Boissy et al. 2007; Lawrence et al. 2018; Broom 2023b).

Health meaning and misunderstandings

Health is a key part of welfare, not something separate from it and, like welfare, health can be qualified as good or poor, and varies over a range. It refers to body systems, including those in the brain, that combat pathogens, tissue damage or physiological disorder, so health can be defined as the state of an individual as regards its attempts to cope with pathology (Broom 2006). The colloquial use of health to refer only to the positive is not appropriate for scientific discussion where the extent of the negative and positive should be stated. The accurate use of the term health refers to individuals and their mechanisms for coping with pathology. Whilst it is scientific to refer to the mean health of a group of individuals, health should not be used to refer to inanimate objects. The gaia hypothesis suggested that planets might have systems for correcting something that goes wrong but they cannot do so. For example, a great excess of carbon dioxide affecting the heating of a planet cannot be corrected by the planet itself. Hence it is incorrect to use the term "planetary health" as is sometimes written in policy documents.

Food production sustainability

How sustainable are the various kinds of foods that humans consume? All plant and animal production can be evaluated taking account of all the components of sustainability. This involves considering the whole life cycle of production, including all the externalities, the consequences of preparing, producing, marketing, consuming and disposal of any waste or unused material (Ciambrone 2018) and the various externalities of the main production process (Delucchi 2000; Balmford et al. 2012, 2018).

An example of calculation of sustainability taking account of all components is that for beef production. There are large differences amongst beef production systems in the amount of land and water needed per kilo of beef (Broom 2019). Beef can be produced using plant material that humans cannot eat. This is a better use of world resources than feeding substantial amounts of grain to ruminants (Eisler et al. 2014; Wilkinson and Lee 2018). An analysis of the following widely used beef production systems was carried out: extensive pasture degraded or not degraded; fertilised irrigated pasture with and without concentrate feeding; feedlots preceded by fertilised irrigated pasture or by extensive pasture; indoor housing throughout life or preceded by fertilised irrigated pasture or by extensive pasture; and semi-intensive silvopastoral system (Broom et al. 2013). The sustainability components for which there were some differences across these systems were: human health; welfare of production animals; efficiency of use of world resources: land usage; efficiency of use of world resources: land area per kg meat; efficiency of use of world resources: amount of conserved water per kg meat; greenhouse gas production per unit of product; extent of water pollution and nitrogen/phosphorus cycle disruption; biodiversity decline; and reduction in carbon sequestration (Broom 2021). For example, degraded extensive pasture used most land per kilo of beef, semi-intensive silvopastoral used the least land and feedlot was intermediate whereas cattle welfare was worse in the confined systems. The major result of the overall system comparison was the demonstration that there were large differences in sustainability across production systems. The efficient extensive systems, especially semi-intensive silvopastoral systems with shrubs or trees with edible, high-protein leaves (Figure 12.1), were the most sustainable whilst grain-feeding systems and extensive systems that caused land degradation were the least sustainable.

The analysis that has been done comparing beef systems could be carried out for other plant and animal systems. Plant production has the major efficiency advantage that the energy loss when plants are consumed by livestock does not occur if the plants themselves are eaten by humans. The efficiency of use of world resources is better by a factor of between 3 and 15 if plants are eaten rather than feeding the same plant material to animal species and then eating

Figure 12.1 Semi-intensive silvopastoral system planted with pasture plants, shrubs such as *Leucaena* with edible high-protein leaves and trees that may also have edible leaves. Photo by D M Broom and colleagues.

those animals. Livestock that eat leaves have a big advantage as compared with those that eat grain or other food that humans could eat. There will be differences amongst plant production systems in water use, pollution risk and the extent to which animals are killed during the production process. The lowest biodiversity on land managed for human food production is that where crop production involves much use of herbicides and pesticides. The best crop production systems will be more sustainable overall than animal production systems but the worst may be less sustainable than some animal production systems.

How sustainable are pig and poultry production systems?

No comprehensive scientific analysis of all components of the sustainability of other meat and of plant production has yet been conducted. I hope that this work will be done. Pigs and poultry compare unfavourably with animals that are fed grass and other leaves, the largest food resource in the world. Mammals, birds, fish, insects and molluscs that eat leaves are more important as human food than seed or fruit eaters. If, as noted above, plants are eaten rather than feeding the same plant material to animal species and then eating those animals, the efficiency of use of world resources is better by a factor of between 3 and 15.

Historically, one of the reasons why both pigs and poultry were kept was that they consumed human food waste. Eggs from chickens or ducks and meat from each species were valuable contributions to human diet. As much as 30% of all food produced for humans is wasted so this situation should be changed. Some food that would otherwise be wasted can be collected and provided for people who do not have the resources to buy it. Pigs and poultry might return to their earlier role of consuming human food waste after it has been properly treated to avoid disease spread (zu Ermgassen et al. 2016). This is already done in Japan and Korea with no disease mishaps so why should it not be done in Europe? The feeding of grain that humans could eat to pigs or poultry or cattle, or the growing of grain crops for pig and poultry consumption when the same land could be used for human plant food, should be reduced or discontinued.

Some consumers refuse to eat pig or poultry products, or refuse to eat all animal products, because of their concerns about the welfare of such animals. Is this avoidance of pigs and poultry on welfare grounds justified? The best methods for keeping pigs and poultry result in productive animals whose welfare is very good. However, many of the methods currently in use cause poor welfare in the animals. Good and bad methods are reviewed by Broom (2022) and many other authors. The keeping of pregnant sows for a substantial proportion of their lives in stalls or tethers that do not allow them to turn around is one of the cruellest treatments of any domestic animal by humans. The pigs are animals with a high level of cognitive ability and social behaviour is very important to these sows. There is a very large gap between the needs of the sows and the conditions in which they are forced to live. In Europe and some other countries and states, this close confinement of pregnant sows is illegal but the practice continues in much of the world.

The welfare and production of farrowing sows and their piglets can now be good in well-designed farrowing pens, but the vast majority of animals are kept in farrowing crates. Pigs growing from weaning to slaughter age have a well-documented range of needs. One of these is to have the opportunity to root in the ground and manipulate material such as straw with their snouts. Although this need has resulted, in some countries, in a legal requirement for manipulable material for all growing pigs, the majority of pigs have too little material to manipulate. This results in poor welfare and abnormal, harmful behaviour such as tail-biting. Most pig meat in the world at present is produced with much poor welfare in the pigs.

Figure 12.2 Chickens reared for meat production. Photo by CIWF/Martin Usborne.

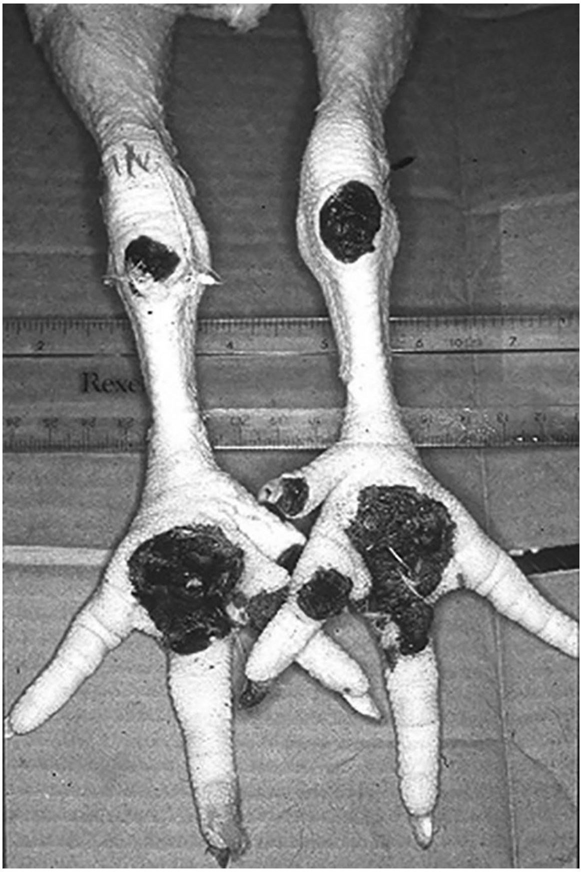

Figure 12.3 Legs of broiler chicken showing painful dermatitis and abscesses caused by contact with corrosive substratum that the bird could not avoid because of leg weakness. Photo by D M Broom and colleagues.

The worst animal welfare problem in the world at present is the leg and other pain caused by breeding and feeding broiler chickens, i.e. chickens kept for meat production, so that their bodies grow too fast for their legs. The vast majority of broiler chickens are kept in buildings (Figure 12.2) on litter that may become corrosive because of the accumulation of droppings. The period of leg pain, together with dermatitis and abscesses caused by inability to avoid resting for long periods on the corrosive substratum (Figure 12.3), ranges from a few days to two weeks, i.e. 40% of the life of the birds. The number of chickens negatively affected is enormous and every country in the world has this problem, so chicken meat is produced with a very high welfare cost. Egg production in those countries or states that have banned the use of small battery cages can take place with relatively low levels of poor welfare but in many countries in the world the welfare of the hens is still poor. The conclusion from the above information is that poultry production scores very low when the welfare component of sustainability is assessed.

Estimates for pork and chicken suggest that they would score much worse than beef for efficiency of use of world resources and for production animal welfare but a little better for land area, water use and greenhouse gas. The overall sustainability score would probably be slightly worse for pork and chicken than for beef. This estimate contradicts the widely stated view, based largely on greenhouse gas production, that beef is less sustainable than pork and chicken. For each meat, the best systems are much more sustainable than the worst.

Future food production

The increasing trend to seriously consider the sustainability of human products and actions has consequences for livestock food and feeding. Systems of production that cause poor welfare of the production animals, such as high production rates in broiler chickens, will be modified greatly and close confinement in systems that do not provide for the needs of pigs and other livestock will cease. The feeding of grain, soya, and other foods that humans can eat, to cattle and other ruminants will cease. Poultry, pigs and other monogastrics will be fed less grain, soya and other human-edible material. Human food waste treated to prevent disease spread will be fed to poultry and pigs. Systems for the management of livestock involving the animals foraging, or being fed cut forage from edible high-protein leaves of trees, shrubs and pasture plants will increase. The production of cultured meat, that is produced from cells that were originally taken from muscle, has not been properly tested by evaluating all components of sustainability but may be important for the future.

Conclusions

1. Beef and other meat and plant production systems have a wide sustainability range with the best much better than the worst.
2. The least sustainable beef production systems are poorly managed extensive grazing that causes land degradation and the use of feedlots or indoor housing with grain feeding whilst the most sustainable are semi-intensive silvopastoral systems. Well-managed pasture fed beef from land where crop production is uneconomic is also sustainable.
3. For all meat and meat-like products, consumers need reliable sustainability labels taking account of all sustainability components. These would allow them to avoid purchase unless there is a sustainability label and to avoid the least sustainable meat.
4. Consumers should not avoid beef and lamb on grounds of overall sustainability, they should probably prefer beef and lamb to poultry and pig meat.
5. The use of high-protein pasture plants, shrubs and trees should increase.
6. Use semi-intensive silvopastoral systems when possible and increase efficient use of extensive pasture.
7. Stop feeding maize, wheat, other cereals and soya to cattle. Include more plant food in human diets and reduce feeding all food that humans could eat to pigs and poultry.
8. Stop using feedlots and indoor housing of beef cattle.
9. Reduce pig and poultry production and increase sustainable beef and lamb.
10. There is a place for pigs and poultry in a sustainable world. Improve pig welfare and increase use of treated, unwanted human food for pigs, poultry and farmed fish.

References

Aland A and Madec F (Eds.), 2009. *Sustainable Animal Production*. Wageningen, Netherlands: Wageningen Academic Publishers.

Balmford A, Green R and Phalan B, 2012. What conservationists need to know about farming. *Proceedings of the Royal Society B,* 279: 2714–2724.

Balmford A, Amano T, Bartlett H et al., 2018. The environmental costs and benefits of high-yield farming. *Nature Sustainability*, 1: 477–485. doi: 10.1038/s41893-018-0138-5

Boffelli D, Nobrega M A and Rubin E M, 2004. Comparative genomics at the vertebrate extremes. *Nature Reviews Genetics*, 5: 456–465. doi: 10.1038/nrg1350

Boissy A, Manteuffel G, Jensen M B et al., 2007. Assessment of positive emotions in animals to improve their welfare. *Physiology and Behavior*, 92: 375–397. doi: 10.1016/j.physbeh.2007.02.003

Broom D M, 1986. Indicators of poor welfare. *British Veterinary Journal*, 142: 524–526.

Broom D M, 1998. Welfare, stress and the evolution of feelings. *Advances in the Study of Behavior*, 27: 371–403.

Broom D M, 2003. *The Evolution of Morality and Religion* (p. 259). Cambridge: Cambridge University Press.

Broom D M, 2006. Behaviour and welfare in relation to pathology. *Applied Animal Behaviour Science*, 97: 71–83.

Broom D M, 2010. Animal welfare: an aspect of care, sustainability, and food quality required by the public. *Journal of Veterinary Medical Education*, 37: 83–88.

Broom D M, 2014. *Sentience and Animal Welfare.* Wallingford, UK: CAB International.

Broom D M, 2017a. *Animal Welfare in the European Union* (p. 75). Brussels: European Parliament Policy Department, Citizen's Rights and Constitutional Affairs. doi: 10.2861/79436

Broom D M, 2017b. Components of sustainable animal production and the use of silvopastoral systems. *Revista Brasileira Zootecnia*, 46: 683–688. doi: 10.1590/S1806-92902017000800009

Broom D M, 2019. Land and water usage in beef production systems. *Animals*, 9(6): 286. doi: 10.3390/ani9060286

Broom D M, 2021. A method for assessing sustainability, with beef production as an example. *Biological Reviews*, 96: 1836–1853. doi: 10.1111/brv.12726

Broom D M, 2022. *Broom and Fraser's Domestic Animal Behaviour and Welfare*, 6th edn (p. 545). CABI. doi:10.1079/9/9781789249835.0001

Broom D M, 2023a. Welfare, environment and resource use: considering all components of the sustainability of food production. In: Ferranti, P. (Ed.), *Sustainable Food Science: A Comprehensive Approach*, vol. 1 (pp. 194–198). Elsevier. doi: 10.1016/B978-0-12-823960-5.00073-1

Broom D M, 2023b. Can positive welfare counterbalance negative and can net welfare be assessed? *Frontiers in Animal Science*, 4: 1101957. doi: 10.3389/fanim.2023.1101957

Broom D M, Galindo F A and Murgueitio E, 2013. Sustainable, efficient livestock production with high biodiversity and good welfare for animals. *Proceedings of the Royal Society B*, 280, 20132025. doi: 10.1098/rspb.2013.2025

Broom D M and Johnson K G, 2019. *Stress and Animal Welfare: Key Issues in the Biology of Humans and Other Animals*, 2nd edn (p. 230). Cham, Switzerland: Springer Nature.

Burnier P C, Spers E E and de Barcellos M D, 2021. Role of sustainability attributes and occasion matters in determining consumers' beef choice. *Food Quality and Preference*, 88, 104075. doi: 10.1016/j.foodqual.2020.104075

Ciambrone D F, 2018. *Environmental Life Cycle Analysis* (p. 160). Boca Raton, FL: CRC Press.

Clayton N S and Emery N J, 2015. Avian models for human cognitive neuroscience: A proposal. *Neuron,* 86: 1330–1342. doi: 10.1016/j.neuron.2015.04.024

Colonius T J and Earley R W, 2013. One welfare: A call to develop a broader framework of thought and action. *Journal of the American Veterinary Medical Association*, 242: 309–310. doi: 10.2460/javma.242.3.309

Delucchi M A, 2000. Environmental externalities of motor-vehicle use in the US. *Journal of Transport Economics and Policy*, 34: 135–168.

de Waal F B M, 2016. *Are We Smart Enough to Know How Smart Animals Are?* New York: W W Norton & Company. ISBN: 978-0-393-35366-2

Eisler M C, Lee M R, Tarlton J F et al., 2014. Agriculture: Steps to sustainable livestock. *Nature*, 507: 32–34.

EU D.G. Health and Food Safety, 2016. *Special Eurobarometer 442 Attitudes of Europeans towards Animal Welfare.* Brussels: European Commission.

García Pinillos R, 2018. *One Welfare: A Framework to Improve Animal Welfare and Human Well-Being* (p. 112). Wallingford: CABI.

García Pinillos R, Appleby M, Manteca X et al., 2016. One welfare – A platform for improving human and animal welfare. *Veterinary Record*, 179: 412–413. doi: 10.1136/vr.i5470

García Pinillos R, Appleby M C, Scott-Park F and Smith C W, 2015. One welfare. *Veterinary Record*, 179: 629–630. doi: 10.1136/vr.i5470

Herrero M, Thornton P K, Notenbaert A M et al., 2010. Smart investments in sustainable food production: Revisiting mixed crop-livestock systems. *Science*, 327: 822–825.

Karesh W B (Ed.), 2014. *One Health*. O.I.E. Scientific and Technical Review, 38. Paris: OIE.

Lawrence A B, Newberry R C and Špinka M, 2018. Positive welfare: What does it add to the debate over pig welfare? In *Advances in Pig Welfare* (pp. 415–444). Sawston, Cambridge: Woodhead Publishing. doi: 10.1016/B978-0-08-101012-9.00014-9

McBride S D and Morton A J, 2018. Indices of comparative cognition: Assessing animal models of human brain function. *Experimental Brain Research*, 236: 3379–3390. doi: 10.1007/s00221-018-5370-8

Monath T P, Kahn L H and Kaplan B, 2010. One health perspective. *ILAR Journal*, 51: 193–198.

Premack D, 2007. Human and animal cognition: Continuity and discontinuity. *Proceedings of the National Academy of Sciences USA*, 104: 13861–13867. doi: 10.1073/pnas.0706147104

Tarazona A M, Ceballos M C and Broom D M, 2020. Human relationships with domestic and other animals: One health, one welfare, one biology. *Animals*, 10: 43 (p. 23). doi: 10.3390/ani10010043

Wilkinson J M and Lee M R F, 2018. Use of human-edible animal feeds by ruminant livestock. *Animal*, 12: 1735–1743. doi: 10.1017/S175173111700218X

zu Ermgassen E K H J, Phalan B, Green R E and Balmford A, 2016. Reducing the land use of EU pork production: Where there's swill, there's a way. *Food Policy*, 58: 35–48.

13 Understanding sentient minds, Darwin, Humpty Dumpty and the Buddha

John Webster

Within the UK, two Acts encapsulate our moral and legal responsibilities to animals in our care. The UK Protection of Animals Act (1911) states that it is "an offence to cause suffering by doing, or not doing, any act". This is clear but limited. It does not, for example, command us to give regard to their quality of life. In the EU, the Treaty of Amsterdam (1997) states "since animal are sentient beings, members shall provide full regard to their welfare requirements". This expression conveys a broader sense of empathy and compassion, but it lacks precision.

The word sentience lacks specificity so has become, in practice one that can mean, in the words of Humpty Dumpty: "Just what I choose it to mean, neither more nor less". It does not address questions that could be posed by an enquiring eight-year-old (or a lawyer) such as: "Are all animals sentient?", "Are some more sentient than others?", "If so, where do we draw the line?"

In this chapter, I shall explore biological and ethical principles that lay the foundations for our understanding of the complex nature of animal sentience and sentient minds. The bedrock of my ethical approach is laid by the immortal words of Albert Schweitzer:

> The great fault of all ethics hitherto has been that they believed themselves to have to deal only with the relations of man to man. In reality, the question is, what is his attitude to the world and all that comes within his reach? Ethics is nothing other than Reverence for Life.

The biological foundations are grounded in the central truths of Charles Darwin, incontestable because they were built on hindsight deriving from lengthy and meticulous observation. The central tenet of Darwinism is: "It is not the most intellectual of the species that survives; it is not the strongest that survives, but the species that is able best to adapt to the changing environment in which it finds itself".

Successful sentient species develop the skills that matter most, those that best enable them to ensure their own fitness and that of the environment on which they depend. It also means that they neglect others. All species, including ours, are ignorant; we are just ignorant about different things.

It follows that no successful species can claim to be better than any other. There is nothing in Darwinism to justify the anthropocentric belief that evolution has involved a progressive advance in cognitive and emotional development from primitive creatures via the "higher" mammals to humans at the top of the pyramid. For example:

Crows are more advanced toolmakers than chimpanzees.

The albatross can travel thousands of miles across the featureless southern oceans and return to the same nest but may fail to recognise a chick that has fallen out.

The capacity of dogs to comprehend human speech may only compare to that of a three-year old, but their capacity to acquire and interpret information by scent exceeds our imagination.

DOI: 10.4324/9781032684369-18

I should not need to add that in the context of sustained fitness within a sustainable environment, the human race, at the moment, can hardly be defined as a success.

Another meaningless anthropocentric question is "What are sentient animals for?" Species evolve to promote their own fitness. They were not put on earth by God to serve our needs. It is irrelevant to their needs how we categorise them as wild (with subsets such as game and vermin), or domestic (with subsets, pet (dog), farm (pig), sport (horse)).

A tiny minority of species (less than 4%) have accepted domestication, but there is no such thing as a domestic animal. We have to imagine the world as perceived through their eyes and other senses, not ours.

The skandhas of sentience

Whilst all animals may be sentient, some are clearly more sentient than others. I believe that the most satisfactory *scientific* classification of the varied nature of sentience within the living world is contained within the teachings of the Buddha (Wikipedia 2023).

He recognises five categories, or "skandhas" of sentience: matter, sensation, perception, mental formulation and consciousness. These are illustrated in Figure 13.1 as five concentric circles of increasing depth, signifying increasing complexity from the outer, superficial circle of matter to the deepest circle of consciousness.

According to the Buddha, all living forms, animals and plants, meet the simplest criterion of sentience, *matter***.** This makes scientific sense since all are dynamic systems, all respond to environmental stimuli and all exploit resources to promote their own fitness.

Sensation describes the capacity of living creatures to interpret stimuli from the external and internal environments (e.g., pain and hunger) as *feelings* that may be sensed as more or less aversive or pleasant. The intensity of these feelings serves as motivation to appropriate action.

In the absence of any convincing evidence to the contrary, we may assume this degree of sentience is restricted to animals. How far it extends within the animal kingdom is not known and this is a matter of concern.

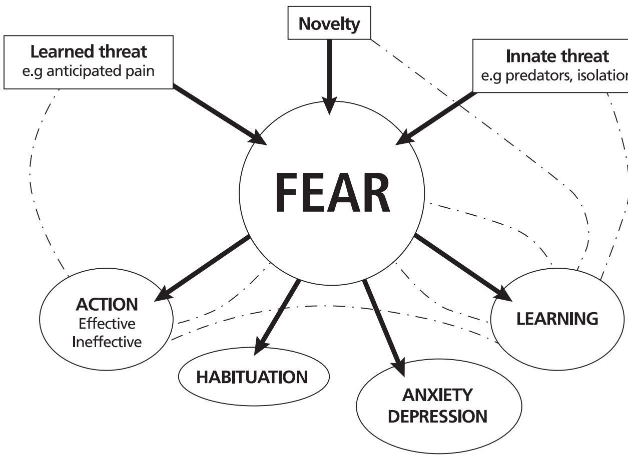

Figure 13.1 The five skandhas of sentience. The solid lines indicate proven examples of the depth of sentience involved in experience and social behaviour. Dotted lines indicate possible, unproven extensions of sentience (from Webster 2022).

Table 13.1 Emotional and cognitive expressions of sentient minds

	Emotion	*Cognition*
Perception	Pain and fear	Avoidance
	Hunger and thirst	Food selection
	Comfort	Nest building
	Curiosity and security	Interpret simple social signals
Mental formulation	Anxiety and depression	Understand social signals
	Pleasure, joy, hope, grief	Education and culture
Consciousness	Affiliative behaviour	Aware of self and non-self
	Empathy and compassion	Deceit

The UK's Animals (Scientific Procedures) Act 1986 that regulates and restricts procedures likely to cause "pain, distress, suffering or lasting harm" currently applies to all vertebrates and some invertebrates (cephalopods like the octopus). This list will grow with time. At this degree of sentience, the recognition of stimuli such as pain, heat, cold, hunger, alarm may involve no more than reflex responses designed to deal with immediate challenge. Nevertheless, it should be sufficient to qualify for protection from any human actions likely to cause pain or lasting harm.

The three inner, more profound, rings of sentience are perception, mental formulation and consciousness. These may be defined as properties of a sentient mind.

Animals with sentient minds do not just experience acute sensations. They can, to a greater or lesser extent, remember the sensations and interpret the effectiveness of their response. These, animals with sentient minds cannot be said to live only in the present. Their response to environmental challenge is modified by experience.

Table 13.1 outlines some of the main emotional and cognitive expressions of sentient minds. The power of perception gives animals the ability to adapt to sensations such as pain, fear and hunger. Figure 13.2 illustrates how the sensation of fear is perceived not just as an emotion and a stimulus to action but as a learning experience.

An animal that learns that it can take effective action will habituate, i.e., it will develop an increased sense of security. If it learns that it cannot take effective action then it will suffer. The reasons behind this can be because the stresses are too severe, too complex, or too prolonged. Or it may be because the animal is confined (usually by us) in an environment wherein it is not possible to take effective action.

The power of mental formulation gives animals the capacity to do more than learn by rote. They acquire an understanding of cause and effect. This enables them to develop coping strategies, not only as individuals but also through observing and understanding the actions of others. Parents educate their offspring and communities develop a culture.

There is good evidence of education and cultural development in a wide range of mammals and birds. Amongst mammals, primates, cetaceans (dolphins and whales), elephants and wolves are proven examples. Birds displaying evidence of cultural development include corvids, herons, songbirds and even the humble domestic fowl. For further discussion of these and other examples, see Webster (1992) or my website, websterwelfare.com.

The power of consciousness, as defined by the skandhas, equates to a human sense of "being aware that we are aware". This is usually equated with a sense of self and non-self and from this, the ability to consider the thoughts and feelings of others. This enables the expression of positive emotions and actions such as empathy and compassion. It also conveys the capacity for deceit.

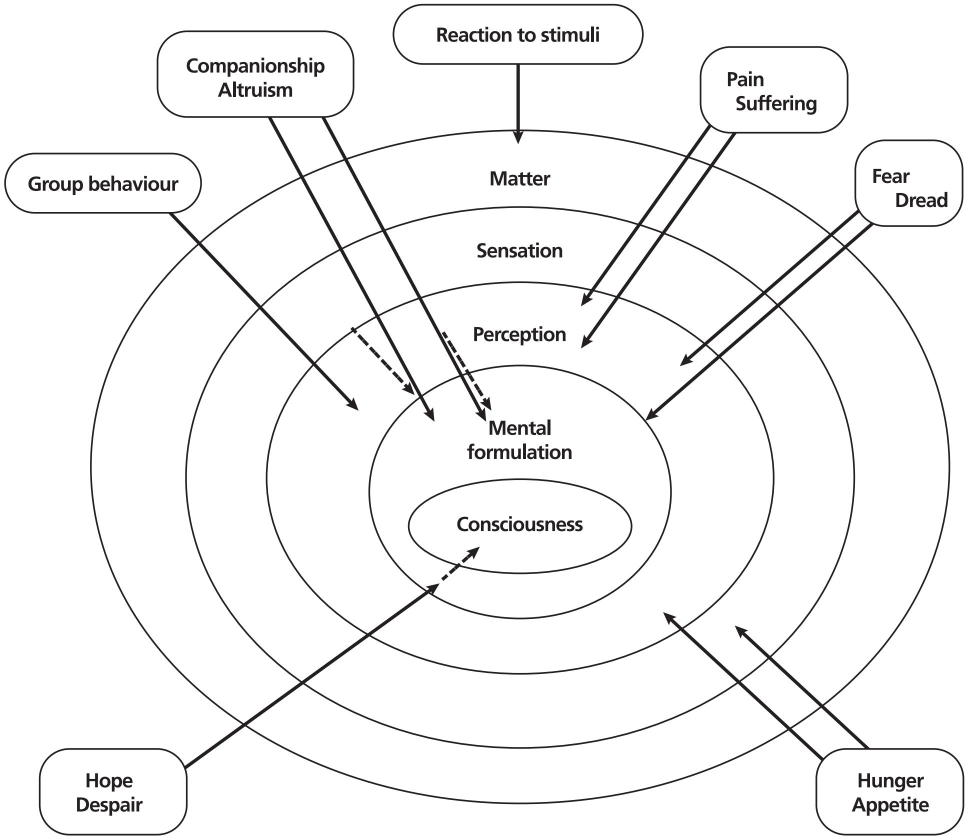

Figure 13.2 Perception of fear: reactions and consequences, coping or suffering (from Webster 2022).

There is some evidence for these expressions of consciousness in mammals, birds and possibly cephalopods. However, I believe that it is unnecessary to invoke the property of consciousness in support of our duty of care. The properties of perception and mental formulation justify the premise that our responsibility to animals with sentient minds extends beyond the need to prevent suffering. It commits us to promote quality of life.

Duty of care: Rights and responsibilities

According to the Schweitzer principle of "Respect for Life" (which in the sense of the skandhas means all life), we are the Moral Agents. We have our rights and our responsibilities to them. The animals are the Moral Patients. They have their rights but no responsibilities to us. The responsibility to promote the welfare of other animals, extends to us all, from the grossest omnivore to the most ascetic vegan. This is because we all, one way or another, depend on other species for our welfare.

We must however make a clear distinction between caring *about* animals and caring *for* them. If we are to care for them, we need to understand them. Fortunately for us, more than 95% of animal species are wild animals and here our aim can be described simply as "leave them well, alone" (the comma is important). In practice, of course, this is far from simple. This it is because it involves the controlled maintenance of sustained habitats in a way that achieves the fairest compromise between their needs and ours.

The animals for which we hold the greatest responsibility of care are farmed animals, pets and animals used for sport and entertainment. Of these, of course, the greatest majority are farmed animals and it is their welfare that has given rise to the greatest concern.

The husbandry and welfare of farm animals is much too big a subject to get into in this chapter (but it is covered extensively in Webster and Margerison, 2022, *Management and Welfare of Farm Animals*). However, after many years, I still believe that the essence may be encapsulated within the Five Freedoms:

- Freedom from hunger and thirst;
- Freedom from physical and thermal discomfort;
- Freedom from pain, injury and disease;
- Freedom from fear and stress; and
- Freedom of choice.

The fifth freedom was originally written as "Freedom to exhibit natural behaviour". This (like the word sentience) meant different things to different people. I prefer "Freedom of choice" since it encapsulates our responsibility to ensure that animals are kept in a sufficiently enriched environment. Such an environment should ensure that they can, through their own actions, make a positive contribution to their own quality of life.

One of the consolations of being a farmed animal is that it is normal for them to be in the company of their own kind. This enables them to live in a social environment with others who have evolved to think, feel and act in much the same way.

The same cannot be said for many animals kept as pets or for sport and entertainment. It is a sad fact that the animals we love the most, dogs and horses, are those that are most likely to suffer from emotional and behavioural problems. These are due, almost entirely, to our failure to understand their needs.

Planet husbandry: Food, farming and the living environment

The theme of the conference that inspired this book was "Extinction or Regeneration". So it is proper that I finish the chapter by outlining our rights and responsibilities within the overall moral principle of Respect for Life and the practical implementation of Planet Husbandry. This is particularly relevant within the context of farming practices.

Table 13.2 illustrates this in the form of an ethical matrix. The matrix is based on two fundamental principles, *Beneficence*, the pursuit of general wellbeing, and *Autonomy*, recognition of the rights of the individual. Taken together, these may be considered as equal-first aims in pursuit of justice. Farmers and landowners have the responsibility for the welfare of their animals and the land. In return, they have the right to expect reasonable financial reward and pride both for their work with animals and their commitment to conserve the quality of their environment.

Consumers (society at large) have the right to wholesome, affordable, attractive food. However, they also have the responsibility to pay more for husbandry systems that give proper respect to the totality of the living environment.

Farmed animals have the general right to physical and mental wellbeing and the individual right to express themselves, primarily through freedom of choice.

Finally, we all share the responsibility to conserve and, where possible, to enrich the living environment.

Table 13.2 Food, farming and the living environment: an ethical matrix

	Wellbeing	*Autonomy*	*Justice*
Moral agents			
Producers and landowners	Financial reward Pride in work	Free competition	Fair trade Good husbandry Support for sustainability
Society at large	Wholesome, affordable food	Freedom of choice	Pay more for good husbandry
Moral patients			
Farmed animals	Good husbandry	Environmental enrichment Freedom of choice	"A life worth living"
The living environment	Conservation Sustainability	Biodiversity "Live and let live"	Respect for environment and stewards

Coda

For nearly all of recorded time, good farmers were ecologically stable contributors to a sustainable environment. They drew their sustenance from the sun, the water and the soil. This required them to make the most efficient use of available resources. They used animals to provide them with food, work and clothing and to sustain the fertility of the land. This was about as near as it gets to net-zero farming. Today, we would call it organic. In the last "seconds" of geological time (since the mid-20th century), non-renewable resources, fossil fuels, artificial fertilisers and antibiotics have generated an explosion of industrialised farming practices and a huge, unsustainable increase in consumption of foods of animal origin. These great changes and their implications have been agonised over at great length.

However, the solution (often expressed at conferences) is simple: "Eat food, not too much, mostly plants". The word *mostly* is critical. To ensure a stable ecosystem, plants and the soil, need animals just as much as animals need plants. Consequently vegan diets, however healthy and honourable they may be for us, are ecologically unsound.

Food from animals, consumed in modest amounts, can be consistent with sustainability. Cows graze grass we cannot digest. Chickens scavenge for energy from seeds we don't notice and harvest protein from insects that today we might control with pesticides. Pigs eat the food we throw away. These animals are not competing with us for food. When fed this way, they do not compete with us, their needs are complementary. Moreover, they are helping to keep the place tidy. So, whilst I cannot fully subscribe to the argument that organic food is healthier for us, I can state with confidence that it is healthier for the living planet.

References

Webster J, 2022. *Animal Welfare: Understanding Sentient Minds and Why It Matters*. Hoboken, NJ: Wiley Blackwell.

Webster J and Margerison J, 2022. *Management and Welfare of Farm Animals*. Hoboken, NJ: Wiley Blackwell.

Wikipedia, 2023, 25 October. Skandha in Buddhist teaching. https://en.wikipedia.org/wiki/Skandha

14 Culture in sentient beings

Purpose, evolution, conservation

Carl Safina

All human beings have culture. But the fact that humans have many different cultures raises several questions: What is culture? What is it for; what does it do? If we can answer that question, we can begin to look at other living species and ask whether any other beings have culture.

Cultures change, and cultures vary. Humans do a dizzying array of cultural things. So – what is culture? Culture isn't art or religion or fashion or sports. Those things are *products* of culture. One definition of culture that is pretty good is: "the way we do things" (McGrew 2004). Behaviour is what we do. Culture is how we do it.

Knowledge from elders is mostly what makes human cultures what they are today. Ways to dress, and foods we eat, and music we hear. From birth, we are simply immersed in the ways of our elders and peers.

Rare individuals innovate something and a social group adopts it. That's how cultures change. To encompass both the ways we do things *and* innovation, we can say: Culture is information and behaviour that can be learned and shared socially. Most importantly, culture is the answer to the question of, "How do we live here, where we live?"

Why does culture exist?

What does culture do? Culture gives us an identity. We know who we are by who we are with. And we tend to be with those who do similar things; culture aids cooperation. Perhaps the simplest cultural thing that makes this point is language. Sharing a language greatly eases cooperation. Not sharing a language is a barrier to cooperation.

When cultures change, we may lose our sense of who we are and how we do things, and many aspects of various cultures are quickly changing. Indigenous cultures are becoming more Westernised, the role of women is changing, and so on. When we are no longer exactly sure how we do things here where we live, the effect can be disorienting.

To understand the crucial importance of knowing, "how we do things here, where we live", think of growing up Indigenous in the Amazon rainforest. You will know how to live in the rainforest. Now think of growing up Indigenous in the Arctic. Any baby raised in either culture will learn how to survive in either place. But if you take someone raised in the Amazon and drop them in the Arctic, they will die. Someone raised in the Arctic who suddenly found themself in the Amazon, would die. Culture can mean the difference between a long natural life and rapid death.

We're not the only ones who get culture from our mothers and our social group. Culture is much more important for many more species than we tend to know. And the more researchers look into the question, the more culture they find in more species.

Social mammals such as chimps and elephants and orcas – and many birds and fishes – learn their cultures similarly to how humans long learned their cultures before formal education:

DOI: 10.4324/9781032684369-19

simply by hanging around their mother, their elders, seeing what they do, and coming to understand how things are done.

What do they have to learn? Chimpanzees, for instance, have to learn essentially everything. They must learn what is food, where food is, how to collect or hunt food. They must learn who is in their social group. They must learn social dynamics such as how to groom, whom to groom, and when; and how to show respect.

Imagine a chimpanzee born and raised in captivity, then brought to the best chimpanzee habitat remaining, and left there. Having learned only how to live in captivity, that chimp would die.

Elephants have to learn who the other families in their area are, where foods are, and what is dangerous. And they sometimes must learn from their eldest where to go to survive drought. As with us, it takes them all of a long childhood to learn what an adult needs to know.

Dolphin groups often specialise in a particular foraging technique, clearly learned. In South Carolina, resident bottlenose dolphins have a way of driving fish up on shore, then partly beaching themselves to snap up the stranded fish. Dolphins who occasionally pass through the area, never do this. Off Brisbane, Australia, the arrival of shrimp trawlers caused about two-thirds of the bottlenose dolphins there to begin following for discarded fish. They and the other third began avoiding each other. When the boats depleted their prey and abandoned the area, the panhandling dolphins went back to hunting *and* they all went back to mixing and socialising (Whitehead and Rendell 2015, p. 114).

Dolphins cooperate with human fishermen in India, Australia, Mauritania, Burma, the Mediterranean, Brazil and elsewhere. In Brazil, about half of the dolphins in one locale drive fish towards fishermen who cast their nets (Whitehead and Rendell 2015 pp. 110–113). The ones who do sound different from the ones who don't (Romeau 2017). When not foraging, the two groups don't socialise.

In all free-living parrots that have been studied, nestlings develop individually unique calls, learned from their parents. Researchers have described this as, "an intriguing parallel with human parents naming infants" (Berg et al. 2011). Indeed, these vocal identities help individuals distinguish neighbours, mates, sexes, and individuals; the same functions that human names serve.

Culture creates identity. Identity creates: community

Culture lets individuals form cultural groups, then culture can keep those groups apart. Off North America's West Coast, several salmon-hunting orca pods form a "southern resident" community and others form the "northern resident" community. The pods can be identified, even by human experts, by their vocalizations. The two different "communities" avoid each other. The only current explanation for this avoidance is that the self-segregation is purely cultural.

Hal Whitehead and Shane Gero have shown that, using click patterns, sperm whales announce who they are individually, which family they belong to, and which clan their family is a member of (Shultz et al. 2008; Whitehead et al. 2012). A family will socialise with any other family in the same clan. But members of different clans avoid each other. Using their clicks, whales who are complete strangers can tell whether they are communicating with members of the same clan or a different clan. Sperm whales and human beings are the only known animals who can tell if a total stranger is a member of the group to which they themselves belong. The reason appears to be that clans do things differently, such as how, where, and when they travel and hunt.

When something like a vocal dialect is used to represent – and thus differentiate – a group, it's called "symbolic marking". Group identity, often considered a hallmark of human culture, turns out to be more widespread.

Birds learn vocal cultures, too. In budgerigars and black-capped chickadees, distinctive calls show that groups have their own identity, and that the members group-identify (Nowicki 1983; Hile and Striedter 2000). Ravens, fruit bats, many primates and carnivores and in fact too many animals to list also know what group, troop, family, or pack they belong with (Massen 2014; Prat et al. 2017).

Culture appears to affect evolution

Evolution is a little explored and little recognised consequence of culture. Let's say one group learns a specialty. Their techniques for foraging, say, are very different. Say the specialist groups avoid each other. Cultural segregation prompts further specialisation. Then the specialisations lead to genetic evolution and actual physical changes. In that scenario, culture leads, and genes follow (Whiten 2017; Aplin 2019).

This seems evident in, for example, orcas. Different *types* of orca whales differ in what they hunt. In the Pacific Northwest, "resident" orcas hunt fish, "transients" hunt mammals (Ford 2011). Those who hunt fish live in big noisy groups and scare fish into tight clusters whereby they can catch them more effectively. Those who hunt mammals live in small, stealthy, quiet groups; because mammals can hear their vocalizations and take evasive action. If you are a mammal hunter you cannot hunt with fish hunters; you'd spoil one another's approach and techniques. The fish hunters would make too much noise and scare off the prey; the mammal hunters would fail to scare fish together.

The two strategies are not compatible, so the specialists must not mix. So, they don't. The function of culture really shows itself here: Sticking to one's group can mean everyone knows what to expect and how to cooperate. Members in each group do things in particular ways, answering that question of, "How do we live, here?"

Around the world, various orca types specialise on hunting either salmon, herring, seals, Antarctic toothfish, penguins, or whales (Pitman 2011). Although they are currently all classed as the same species, cultural groups do not mix and have not bred together for millennia. Their hunting cultures have had a lot to do with creating and maintaining that separation. Some types have evolved sufficiently different appearance and size that they can be distinguished by humans on sight. They've avoided each other for several hundred thousand years and they are evolving separately – apparently due solely to cultural differences. As mentioned, they are considered one species. But because they do not breed freely when they meet in the wild, they fit one common definition of different species.

Culture seems to drive evolution in a variety of animals, including certain birds and certain fishes. A bird known as the Iberá Seedeater lives entirely inside the range of the Tawny-bellied Seedeater (*Sporophila iberaensis* and *S. hypoxantha*) in Argentina. They are so closely related that they are capable of producing viable offspring. But they don't. And they haven't for about a million years. Male song – which is learned socially, and thus is cultural – and male plumage are apparently all that is keeping them apart (Jarvis 2021).

African cichlid fishes have exploded into diverse arrays of species, sometimes hundreds within the same lake. It appears that socially learned courtship behaviours play an important role in isolating groups that evolve into species. For example, experiments with Lake Victoria cichlid fishes show that young females develop sexual preferences for males who look like their fathers – even when researchers rigged it so that the "fathers" were actually males of a different species (Verzijden and Ten Cate 2007). In similar experiments, certain songbirds will act for their entire lives as though they are members of the different species who raised them (Hansen et al. 2008). Other studies confirm that behavioural specialisations can be learned socially (Danchin and Wagner 2010).

Culture's implications for conservation

We usually talk about biodiversity as occurring on three levels: the genetic diversity within a species, the diversity amongst species, and the diverse different habitats such as rainforests, reefs, and so on. The basic thing those three categories of diversity have in common is their implicit *genetic* diversity. The thing that's missing from that list is, of course, *cultural* diversity. Many reintroductions of endangered or extirpated species, from parrots to ungulates, suffer very heavy mortality because released animals do not carry with them the culture of their species in the region to which they are being introduced. What is food, where is food, where are the safe roosting and resting sites, what and where are the dangers. These questions collectively ask that most basic question for which culture provides the answer, "How do we live, here?"

Knowledge of the seasonally changing distributions of food resources, or migration routes out of high summer meadows, or lowland wintering destinations, are examples of the kinds of crucial information that culture transmits. That transmission depends on unbroken lines of learning. Without remaining individuals who can pass along such traditions, reintroductions run higher risks of failure. Reinventing the needed knowledge can incur high initial mortality and require several generations to be reinvented and spread amongst survivors.

That might not happen. When conservation biologists attempted to reintroduce thick-billed parrots to parts of the southwest U.S. where they'd been wiped out, the effort failed. Researchers wrote, "Captive-reared birds released to date were behaviorally deficient in predator evasion, feeding and foraging capabilities, and flocking behavior" (Lamberski and Healy 2002). If they'd had wild parents or a remaining wild social flock, they would have learned it as a matter of course.

In social animals, generally the prospects for survival of released individuals are severely undermined when there are no free-living elder role models. Elders also appear important for social learning of migratory routes. Famously, conservationists have raised young cranes, geese, and swans to follow micro-lite aircraft as a surrogate parent on first migrations. Various storks, vultures, eagles, and hawks depend on following the cues of their elders to locate strategic migration flyways or important stopover sites, their migration cultures. Famously, conservationists have raised young cranes, geese, and swans to follow microlight aircraft, which then acted as a surrogate parent on their first migrations. The young birds culturally absorbed the modelled knowledge of the routes and used it in later seasons on their own self-guided migrations. Roughly four thousand species of birds migrate, and Andrew Whiten of St. Andrews University in Scotland speculated that following experienced birds could be "a potentially very significant realm of cultural transmission" (Whiten 2017).

Young mammals, too – moose, bison, deer, antelope, wild sheep, ibex and many others – learn crucial migration routes and destinations from elder keepers of traditional knowledge.

Conservationists have recently re-introduced large mammals in a few areas where they'd been extirpated. Some translocations have worked – for wild sheep and ibex and others – but many introductions have failed (Festa-Bianchet 2018). Animals released into unfamiliar landscapes don't know where food is, where dangers lurk, or where to go in changing seasons. Without native-born elders as keepers of traditional knowledge, released individuals often fail to migrate from places where seasonal changes can turn deadly (Jesmer 2018). Often, they quietly die.

Some fish, too, learn and maintain crucial social traditions from elders. Bluehead wrasse, guppies, and French grunts all learn to follow knowledgeable residents to feeding and resting areas, proving that some fish are literally "schooled" in generationally transmitted traditions (Warner 1988).

When you simply look at other animals, you don't usually *see* culture. Culture makes itself felt when it gets disrupted. Then we see that the road back to reestablishing cultures – the answers to the questions of "how we live in this place" – is difficult, often fatal. It is crucial that wild cultures be maintained by maintaining viable populations and avoiding extirpations.

Erosion of cultural knowledge can accelerate the extinction vortex. In Australia, the Regent Honeyeater, a formerly common bird, has become rare due to habitat loss (Crates et al. 2021). Young males learn their species' song by copying the song of adult males. In other words, the song is transmitted culturally. But there are now so few adult male Regent Honeyeaters that cultural breakage is accelerating their decline. Young males are failing to learn the songs that attract females. Although the species is rare, females sometimes fail to be attracted to a male they manage to meet, because the male, having never been culturally tutored, is not singing properly. Bluntly, if males can't sing the song of their species, females don't want them.

In sum, culture is knowledge and behaviours and preferences that are shared socially. Culture answers the question of how we live in the area where we live. Culture is usually learned from elders who learned it from their elders. Culture lets individuals form group identities. It can then cause cultural groups to specialise in certain behaviours and skills and cause cultural groups to avoid each other. In this way, culture promotes evolution and speciation.

Culture is crucial in diverse vertebrates. The roster of cultural beings known to science continues to grow. But in conservation strategies and practices, the crucial role of culture is just beginning to be appreciated. In sum, in conservation it is imperative that preservation of culture be recognised as equally important as – sometimes more important than – preservation of gene pools. Genes can be preserved in captive and artificial situations, but cultures cannot.

References

Aplin L M, 2019. Culture and cultural evolution in birds: a review of the evidence. *Animal Behaviour*, 147:179–187.

Berg K S et al., 2011. Vertical transmission of learned signatures in a wild parrot. *Proceedings of the Royal Society B*, 279:585–591.

Crates R et al., 2021. Loss of vocal culture and fitness costs in a critically endangered songbird. *Proceedings of the Royal Society B*, 288:20210225.

Danchin E and Wagner R H, 2010. Inclusive heritability: combining genetic and non-genetic information to study animal behavior and culture. *Oikos*. https://doi.org/10.1111/j.1600-0706.2009.17640.x

Festa-Bianchet M, 2018. Learning to migrate. *Science*, 361:972–973.

Ford J, 2011. Killer whales of the Pacific Northwest Coast. *Whalewatcher,* 40(1): 15–23.

Hansen B T et al., 2008. Imprinted species recognition lasts for life in free-living great tits and blue tits. *Animal Behaviour*, 75:921–927.

Hile A G and Striedter G F, 2000. Call convergence within groups of female budgerigars (Melopsittacus undulatus). *Ethology*, 106:1105–1114.

Jarvis E D, 2021. At the beginning of speciation. *Science*, 371:1312–1312.

Jesmer B R et al., 2018. Is ungulate migration culturally transmitted? Evidence of social learning from translocated animals. *Science*, 361:1023–1025.

Lamberski N and Healy S, 2002. The thick-billed parrot (*Rhynchopsitta pachyrhyncha*). *Journal of Avian Medicine and Surgery*, 16:50–52.

Massen J J M et al., 2014. Ravens notice dominance reversals among conspecifics within and outside their social group. *Nature Communications*, 5:3679.

McGrew W C, 2004. *The Cultured Chimpanzee*. Cambridge: Cambridge University Press.

Nowicki S, 1983. Flock-specific recognition of chickadee calls. *Behavioral Ecology and Sociobiology*, 12:317–320.

Pitman R L, 2011. Antarctic killer whales. *Whalewatcher*, 40(1):39–45.

Prat Y et al., 2017. Crowd vocal learning induces vocal dialects in bats. *PLoS Biology*, 15:e2002556.
Romeau B et al., 2017. Bottlenose dolphins that forage with artisanal fishermen whistle differently. *Ethology*, 123:906–915.
Schulz Tyler M et al., 2008. Overlapping and matching of codas in vocal interactions between sperm whales. *Animal Behaviour*, 76:1977–1988.
Verzijden M N and Ten Cate C, 2007. Early learning influences species assortative mating preferences in Lake Victoria cichlid fish. *Biology Letters*, 3:134–136.
Warner R W, 1988. Traditionality of mating-site preferences in a coral reef fish. *Nature*, 335:719–721.
Whitehead H et al., 2012. Multilevel societies of female sperm whales (*Physeter macrocephalus*) in the Atlantic and Pacific: why are they so different? *International Journal of Primatology*, 33:1142–1164.
Whitehead H and Rendell L, 2015. *The Cultural Lives of Whales and Dolphins*. Chicago, IL: University of Chicago Press.
Whiten A, 2017. A second inheritance system: the extension of biology through culture. *Interface Focus*, 7:20160142.

Part 5

Regenerative farming and agroecology: The future of farming

15 Compassion

The foundation of regenerative farming

Vandana Shiva

Extinction by design

Industrial agriculture, which is the dominant model of production, is based on war technologies, continues to kill millions of species and is driving the sixth mass extinction. Agroecology, which uses ecological practices in farming, is the future.

We are facing an existential emergency; one million species are threatened with extinction (IPBES 2019). Humanity's current path is clearly non-sustainable because it is destroying the very infrastructure of life on Earth and threatening the survival of humanity itself.

My food and agriculture journey started in 1984 when I witnessed the violence of the Green Revolution, the industrial-scale agriculture model based on artificial fertilisers, pesticides and high-yield crop varieties. The use of the word "green" in that phrase is far removed from today's positive associations with the word. The Green Revolution was a contributing factor to bitter unrest and ecological fragmentation experienced in the Punjab region of India.

Also, in 1984, in Bhopal, India, a pesticide plant owned by America's Union Carbide Corporation leaked, killing thousands and crippling hundreds of thousands of local people. The pesticide it produced was carbaryl, a nerve poison used to kill insects. This poison is still used today and often sold under the name Sevin.

I wrote *The Violence of the Green Revolution* to understand the roots and consequences of the violence of industrial agriculture. Since that time, I have sought and walked a path of non-violent agriculture. For me, non-violence begins in recognising that we are part of a living earth. Our being is enmeshed with other beings so that we are "inter-beings". Biodiversity is a network of relationships. Care and compassion are bonds that unite us.

In 1991, I set up Navdanya – meaning "nine seeds" – based in Doon Valley in Uttarakhand in the foothills of the Himalayas. It is both a biodiversity farm and the headquarters of the movement I established to link seed sharers across India's landscape. Our movement has established 122 community seed banks in India and encouraged five million farmers to convert to organic farming.

Connecting us to the earth – compassion and non-violence

My work over four decades has taught me that compassion is the basis of regenerative farming and must be the basis of the food we eat.

Food is nourishment and good food is health. It is the flow that embodies our relationship to the earth, materially, biologically, nutritionally, ecologically and symbiotically. Food connects us to biodiversity and the web of life; it is the metabolism that connects humans with the earth.

DOI: 10.4324/9781032684369-21

I have identified nine principles that should be inherent in non-violent food and farming:

1 We are part of nature, not separate;
2 We are not superior to other species;
3 Nature, her soil, her plants and animals are living;
4 All living beings are sentient, self-organised and interconnected;
5 Symbiosis, living together in mutuality and harmony, is the law of nature;
6 Diversity is the principle of how nature works. Nature abhors monocultures and uniformity;
7 The law of return – recycling, giving back, is nature's law. In nature, there is no waste and no pollution;
8 Compassion is what connects us to the earth and each other; and
9 Being alive with other living beings calls for reverence and respect for others, the duty to do no harm and the duty to care.

Regeneration and regenerative farming respect the biodiversity of life on the planet and the earth's ecological processes. They involve respecting, co-creating and co-producing with the living soil, plants, animals and insects. Through regeneration and regenerative farming we can create an economy of abundance.

Mechanising violence – the relentless path towards extinction

As well as driving extinction, industrial agriculture is mechanistic and militaristic. It sees plants and animals as objects, as machines to be manipulated for profit or as enemies to be exterminated. Industrial agriculture's violence is underpinned by its structure, tools and technologies. It assumes that the earth, her animals and plants are not sentient, but that they are mere raw material for exploitation.

This violent system's underlying mechanistic philosophy involves a militarisation of the mind. This means seeing humans as being at war with the Earth, all her species and other humans. Mechanistic philosophy is intimately connected with an economy of greed and extraction.

Such an economy assumes scarcity. It then creates technologies as instruments of control over scarce resources for extraction of profitable commodities for the markets. The mechanistic world view leads to the arrogance of the engineering of life – seeds and plants, animals and now food.

The world of industrial agriculture assumes that biodiversity is a threat and an impediment for extermination. Consequently, only those species – seeds and breeds which have been engineered to maximise commodity production – find a place in industrial agriculture's food systems. This assumption ultimately produces what I call the "Monoculture of the Mind" – a mind blind to the richness and productivity of biodiversity.

Through such mindsets, biodiversity disappears. Species are pushed to extinction when living beings are not seen as self-organised, symbiotic members of the earth family, but as objects of profits, control and "intellectual property". Such an approach and terminology reduces life and living organisms to simply the products of the minds of those manipulating them.

The industrial globalised food system's relentless and violent path is at the heart of our planetary and human health emergencies. It is responsible for:

- Extreme exploitation and destruction of the planet – the system is the largest user of the world's precious freshwater and a heavy polluter of water, it pollutes and degrades the world's soils and is the principal cause of accelerating biodiversity loss;

- Around a third of global human-induced greenhouse gas emissions (Crippa et al. 2021), causing climate havoc and threatening agriculture; and
- Unhealthy diets and air pollution (agriculture is a significant source of air pollution) are contributors to non-communicable diseases (NCDs). NCDs cause nearly three quarters of all deaths worldwide (World Health Organization 2023).

And chronic diseases are not the only health problems caused by this food system. Pandemics have their roots in the limitless expansion into forests by agribusiness to grow commodities like GMO soya in the Amazon and palm oil in Indonesia. Ebola, Zika, HIV and SARS are amongst 300 new infectious diseases detected in the last three decades as forest ecosystems have given way to large agribusiness agriculture (Navdanya International 2020).

Disappearing biodiversity – fuelling the extinction crisis

Industrial food systems have destroyed the biodiversity of the planet through the spread of monocultures, and the widespread use of toxic technologies and poisons that kill bees, butterflies, insects and birds.

Insecticides, herbicides, fungicides are instruments of war against the web of life and are leading us to the sixth mass extinction. Chemicals go hand in hand with monocultures; monocultures push diversity to extinction.

In 1996, the Leipzig Conference on Plant Genetic Resources acknowledged that 75% of the disappearance of agricultural biodiversity was because of the introduction of “Modern Varieties”. More than 90% of crop varieties are no longer farmed (FAO 2004).

Reclaiming seeds – ending seed imperialism

We used to eat more than 10,000 species of plants. Commodification of food has reduced the crops cultivated to a dozen globally traded commodities. This transformation is described in *The Law of the Seed* (Navdanya International 2013a, 2013b), which contrasts corporate industrial breeding, based on uniformity and monocultures and maximisation of yield, with the model of breeding for diversity, nutrition, taste, quality and resilience.

My mission to save seeds and defend farmers’ right to save and share seeds was sparked in 1987 at a pivotal “Laws of Life” conference, where chemical industry representatives asserted that by the year 2000, there would be five companies controlling seed, all seeds would be genetically engineered and patented, and it would be illegal for farmers to save and share seeds. The General Agreement on Tariffs and Trade (GATT), which later became the World Trade Organization (WTO), was to be the legal instrument to impose this “seed imperialism”.

The results of industrial agriculture’s seed imperialism are nutritionally empty toxic food commodities that do not truly feed people. Today, 37.5% of the world’s cereals and 77% of the world’s soya is used for animal feed (Our World in Data 2022 and 2021). This deprives humans of food, aggravates the hunger crisis and effectively creates a competition between animals and humans for food. In India, 75% of corn grown is fed to livestock; the nation imports corn for animal feed too (USDA 2019).

Despite the “we feed the world” rhetoric of industrial agriculture, millions of people remain hungry. Half of the hungry are farmers (WEF 2015). And the hunger crisis has deepened since COVID-19 (FAO et al. 2023).

Industrial agriculture is unsustainable and unjust. It violates the human right to food and health, life and livelihood.

Recognising symbiosis, sentience and interconnectedness

The great American conservationist Rachel Carson said: "In nature nothing exists alone" (Carson 1962). These words must become our mantra and guiding light if we are to truly save our world.

All ecosystems have plants and animals. All non-violent ecological agriculture systems are based on a symbiosis between plants and animals. Plants and animals are sentient beings and they need each other.

Yet these beings and their systems are violently separated, manipulated and controlled through industrial agriculture and they are reduced to machines, fed artificial fertilisers and artificial feed to produce unhealthy commodities for the market. This creates dysbiosis – the opposite of symbiosis – at every level.

To avoid extinction, we must cultivate compassion. We must also cultivate a paradigm shift that centres on recognising that plants and animals are sentient and self-organised – that they are our relatives. Feeling their pain, contributing to their wellbeing is our ecological and ethical duty.

Most Indigenous cultures hold both plants and animals as sacred and as sentient. The relationship between humans, plants and animals in these cultures is based on compassion and care. And the consequence is there for us to see. Indigenous people protect 80% biodiversity of the planet by looking after the 22% of the land still under their stewardship (United Nations 2022).

Plants feed animals, animals feed plants. Cows eat plants that are nourished by the manure the cows give. This creates a regenerative circular economy that needs no fossil fuel, no external inputs, creates no pollution, no waste.

Before industrial agriculture dominated our world, indigenous varieties of crops were bred to maximise both straw and grain production. The straw (the dry stalks of cereal plants left after removal of the grain and chaff) was used to feed animals, whilst the grain (the harvested seed of grasses) fed people.

Animals also were bred for diversity before industrial agriculture. They were expected to be multipurpose: to feed the soil with manure, to give energy for farming – for example for draught and transport – and to provide food for humans.

Yet, just as the breeding of seeds by farmers to create crop diversity has been ignored in industrial agriculture, breeding genetic diversity to create multi-tasking livestock has also been ignored. Industrial animal breeding "factories" have simply reduced cows and their progeny to milk machines and meat machines.

Furthermore, the traditional model of cows and farmed animals eating grass and organic matter like straw whilst humans eat grain has been shattered. Industrial agriculture broke this symbiotic relationship between plants and animals. So instead of plants being fertilised with organic manure, fossil fuel-based synthetic fertilisers are used (Marquez and Morgan 2022; Navdanya International 2022).

Plants from indigenous seeds were engineered into synthetic fertiliser-receptive dwarf varieties by American agricultural scientist Norman Borlaug. Plants were reduced to grain for the market, much of which went to feed intensively farmed animals.

But corn-based diets are unnatural. Cows are herbivores – they like to eat grass. Shifting them to an intensive grain diet disturbs their metabolism and can result in ill-health. Research shows that well-managed grassland can store carbon, which can make a significant contribution to offsetting cows' methane emissions.

Breaking natural links – India faces the consequences

India's sacred cow has been reduced to a milk machine. Our superefficient and resilient Indian breeds are declared (quantitatively) inefficient.

The industrial "Monocultures of the Mind" model is breeding uniformity, one dimensionality, standardisation. The pure indigenous breeds of India are being replaced by homogenised hybrids of the Zebu cow and foreign-branded strains to supposedly improve the Zebu's dairy "productivity".

When I wrote *Staying Alive: Women, Ecology and Development* (Shiva 1989), more than two-thirds of the energy needs of rural India were met by 80 million work animals. Just when we need our farm animals to break free of fossil fuel dependence to play an important role in meeting the UN Sustainable Development Goals, we are destroying our animal wealth. With it we are also destroying the ecological and economic contributions they make.

Facing the facts – responsibility for climate change

As noted earlier, fossil fuel-based industrial agriculture and a globalised industrial food system are responsible for around a third of emissions contributing to climate change (Crippa et al. 2021).

But the problem is not the livestock. The problem is factory farming – industrial agriculture. The alternative to the factory farming of animals is not getting rid of animals. It is treating them with care, love and respect as Indigenous cultures do. The violence to animals in factory farming is driven by profits and greed. We can end animal cruelty by putting an end to factory farming and ending the subsidies that promote and protect it.

We need to regenerate biodiversity of animals and plants in farming and re-establish the critical synergy and symbiosis between plants and animals. We must have reverence for both.

Feeding the world with care and compassion – the basis of regeneration

Care is the currency of the economy of life in a living and interconnected world. Intensifying care intensifies biodiversity. This in turn intensifies the availability of food. And in interconnected living systems, care has to be for the whole, not just for the individual parts of a system. Life cannot be divided because life is interconnectedness.

By caring for the soil and the land, caring for plants and animals as sentient beings, as our relatives and elders, we can grow more food, reverse extinction and contribute to negative emissions.

Care becomes natural when you see microbes, plants and animals as alive, as subjects with agency, not objects to be owned, controlled and pushed to extinction. Extinction is a consequence of carelessness, not caring.

To fix more living carbon from the atmosphere, we need to intensify our farms and forests biologically through photosynthesis, in terms of both biodiversity and biomass. Biodiversity and biomass density produces more nutrition and food per acre (Navdanya International 2019), thus helping to address the problem of hunger and malnutrition.

It also increases not just the living carbon in the soil, but all other nutrients including nitrogen, magnesium, zinc and iron and enhances the density of beneficial organisms.

The soil on Navdanya's Organic Farm in Doon Valley has increased soil organic matter by 100%; it is now 2.2 tonnes per hectare. And our practice and research has shown that the more we intensify photosynthesis, by intensifying and regenerating biodiversity and the production of living carbon, the more food and nutrition we grow. Such intensification also results in more excess carbon dioxide and nitrous oxide being drawn down through plants to the soil rather than released into the atmosphere (Navdanya International 2019).

We can bridge the climate change emissions gap through ecological agriculture now, not at some point in the future. Even if only 10% of farms and pastures are managed regeneratively by

Table 15.1 Showing effect of continuous farming on soil under organic and chemical mode

Nutrient	*Change under Chemical farming*	*Change under Organic farming*
Organic matter	–14%	+29% to 99%
Total nitrogen (N_2)	–7% to 22%	+21% to 100%
Available phosphorous (P)	0%	+63%
Available potassium (K)	–22%	+14% to 84%
Zinc (Z)	–15.9% to 37.8%	+1.3% to 14.3%
Cooper (Cu)	–4.2% to 23.1%	+9.4%
Manganese (Mn)	–4.2% to 17.6%	+14.5%
Iron (Fe)	–4.3% to 12%	+1%

Source: Shiva et al. (2017).

maximising photosynthesis and root exudates, we can mitigate emissions by fixing more living carbon in plants and building up carbon in soil (Leu 2023).

The solution to hunger extinction and the climate emergency is to return to Earth and regenerate her biodiversity in soils, our farms, forests, our diets and our guts. Natural food and regenerative farming offer solutions to the multiple emergencies that the greed economy has created.

The symbiotic flow of nutrition between the biosphere and atmosphere heals the broken climate cycles. The flow of biodiversity and its nourishment from the soil to our gut microbiome heals our broken health. We are members of one Earth Family. We are part of biodiversity as regenerators and as eaters.

And so we can participate in the web of life with love, care and compassion, regenerating biodiversity and the infrastructure of life. Or we can try to escape it through violence and carelessness.

We can live under the illusion that we are separate from nature and live outside her ecological processes, we are her masters and conquerors. Such an illusion of mastery, control and separation is the root cause driving extinction, beginning with the extinction of our compassionate humanity.

As Rachel Carson cautioned us in Silent Spring: “The ‘control of nature’ is a phrase conceived in arrogance, born of the Neanderthal age of biology and the convenience of man” (Carson 1962).

We have a duty to our fellow beings to allow them to live healthy, happy lives in freedom. We have a duty to cultivate an agriculture and economies of care, compassion and love.

References

Carson R, 1962. *Silent Spring*. Boston, MA: Houghton Mifflin.

Crippa M et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2:198–209. https://doi.org/10.1038/s43016-021-00225-9

FAO (Food and Agriculture Organization of the United Nations), 2004. What is agrobiodiversity? https://www.fao.org/3/y5609e/y5609e00.htm#Contents

FAO, IFAD, UNICEF, WFP and WHO, 2023. 122 million more people pushed into hunger since 2019 due to multiple crises, reveals UN report. https://www.who.int/news/item/12-07-2023-122-million-more-people-pushed-into-hunger-since-2019-due-to-multiple-crises--reveals-un-report

IPBES, 2019. IPBES Global Assessment Report on Biodiversity and Ecosystem Services. www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

Leu A F, 2023. Maximizing photosynthesis and root exudates through regenerative agriculture to increase soil organic carbon to mitigate climate change. *SCIREA Journal of Agriculture*, 8:1. www.scirea.org/journal/PaperInformation?PaperID=8630

Marquez J and Morgan M, 2022. The Legacy of the Men Who 'Pulled Bread from Air'. https://deathinthegarden.substack.com/p/the-legacy-of-the-men-who-pulled?r=cres6&utm_medium=ios&utm_campaign=post

Navdanya International, 2013a. Health per Acre. https://navdanyainternational.org/wp-content/uploads/2017/07/Health-Per-Acre.pdf

Navdanya International, 2013b. The Law of the Seed. https://navdanyainternational.org/publications/the-law-of-the-seed/

Navdanya International, 2019. Manifesto – Food for Health. https://navdanyainternational.org/publications/manifesto-food-for-health/

Navdanya International, 2020. One Planet, One Health: Connected through Biodiversity. https://navdanyainternational.org/cause/one-planet-one-health/

Navdanya International, 2022. The Nitrogen Problem in Agriculture. https://navdanyainternational.org/the-nitrogen-problem-in-agriculture/#_ftn7

Our World in Data, 2021. Is our appetite for soy driving deforestation in the Amazon? https://ourworldindata.org/soy

Our World in Data, 2022. Cereals allocated to food, animal feed and fuel, World. https://ourworldindata.org/grapher/cereal-distribution-to-uses

Shiva V, 1989. *Staying Alive: Women, Ecology and Development*. London: Zed Books Ltd.

Shiva V et al., 2017. Seeds of Hope, Seeds of Resilience. Navdanya/RFSTE. https://www.navdanya.org/attachments/article/617/Seeds-of-Hope-Report-Download.pdf

United Nations, 2022. International Day of the World's Indigenous Peoples, 9 August. https://www.un.org/en/observances/indigenous-day/stories

USDA, 2019. India. Grain and Feed Annual, 2019. https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Grain%20and%20Feed%20Annual_New%20Delhi_India_3-29-2019.pdf

WEF (World Economic Forum), 2015. Why are most of the world's hungry people farmers? https://www.weforum.org/agenda/2015/05/why-are-most-of-the-worlds-hungry-people-farmers/

Wilson J, 2019, 8 September. Reducing the Carbon Footprint of Cattle Operations through Diet. https://water.unl.edu/article/manure-nutrient-management/reducing-carbon-footprint-cattle-operations-through-diet

World Health Organization, 2023. Noncommunicable Diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

16 Regenerating agriculture, ecosystems and climate

André Leu

"Regeneration" is a simple concept that is currently resonating widely. When linked with agriculture, it describes the fastest-spreading global agricultural movement.

But what does regenerative agriculture actually mean? Although regenerative agriculture is commonly linked with sustainability, the association can cloud its meaning. This is because sustainability essentially means maintaining resources and the environment without degrading them. However, our system is already degraded. So, it is necessary to do more than sustain it – we must improve and regenerate it.

Industrial agriculture is an existential threat to the planet through its inherent degenerative and unsustainable nature. It is one of the most significant emitters of greenhouse gases (GHGs) and the leading cause of deforestation. It pollutes ecosystems with high levels of water-soluble nutrients and poisons the environment and human health with toxic synthetic pesticides (UNCCD 2022). Industrial agriculture is also the leading cause of poverty and food insecurity and it inflicts massive cruelty on animals in intensive and confined animal feeding operations.

Agriculture must change from a chemically intensive degenerative industrial system to a regenerative, biological, biodiverse, nature-based one. Such a system improves resources, and reduces, and ultimately avoids the use of synthetic chemicals. It is not based on animal cruelty. Instead, its foundations are plant biology, living soil science and humane livestock systems.

Forming a global regeneration movement

Inspiring the development of these firm foundations globally is at the heart of Regeneration International's work. This pivotal organisation was launched in 2015 by leaders of the organic, agroecology, holistic management, environmental and natural health movements in Costa Rica. Their vision was an inclusive and representative global network dedicated to regenerating our food and farming systems, health, environment, climate and communities.

Regeneration International quickly expanded to include relevant leaders from every continent. Today, it is the planet's largest and most significant regenerative organisation. During 2023, it had more than 500 partners in over 70 countries in Africa, Asia, Latin America, Australasia, the Pacific, North America and Europe.

Thanks to these partners' efforts, "regenerative agriculture" is now a widely used umbrella term. It covers the many farming systems using techniques such as longer rotations, cover crops, green manures, legumes, compost and organic fertilisers.

Significantly, regenerative agriculture, through a combination of evidence-based practices and peer-reviewed science, is recognised as increasing the resilience of production systems to climate change weather impacts. It also reduces production costs whilst ensuring reasonable

DOI: 10.4324/9781032684369-22

returns to farmers. This ability to improve climate change adaptation and economic viability is essential for the future of agriculture.

Defining regenerative agriculture

By definition, regenerative systems improve the environment, soil, plants, animal welfare, health and communities.

The opposite of regenerative is degenerative. This is an essential distinction in determining practices that are not regenerative. Agricultural systems that use degenerative practices and inputs that damage the environment, soil, health, genes and communities and involve animal cruelty are not regenerative.

The use of synthetic toxic pesticides, synthetic water-soluble fertilisers, genetically modified organisms, confined animal feeding operations, exploitive marketing and wage systems and destructive tillage systems are examples of degenerative practices.

Such systems must be called degenerative agriculture to stop greenwashing and hijacking.

Regeneration International asserts that to heal our planet, all agricultural systems should be regenerative, organic and based on the science of agroecology.

Farmers can determine acceptable and regenerative practices using the Four Principles of Organic Agriculture. These principles are as follows.

Health

Organic agriculture should sustain and enhance the health of soil, plant, animal, human and the planet as one and indivisible.

Ecology

Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

Fairness

Organic agriculture should build on relationships that ensure fairness in the familiar environment and life opportunities.

Care

Organic agriculture should be managed in a precautionary and responsible manner to protect the health and wellbeing of current and future generations and the environment.

How does regenerative agriculture work?

Regenerative agriculture is based on various food and farming systems that maximise plant photosynthesis to capture carbon dioxide (CO_2) and sequester it as soil organic matter/carbon (SOC). It can be applied to all agricultural sectors.

The regenerative agriculture umbrella includes many farming systems. These include organic agriculture, agroecology, agroforestry, permaculture, holistic grazing, low till and other agricultural systems that can increase SOC. SOC is an essential measurement of soil health – soils with low levels of SOC are unhealthy (Leu 2021a).

The best systems maximise photosynthesis to increase the capture of CO_2. Photosynthesis converts CO_2 and water into glucose and other carbon compounds that are essential for life. 10%–40% of these carbon compounds are secreted into the soil through the roots whilst the plants grow (Prescott et al. 2021; Verma and Verma 2021).

These carbon compounds penetrate deeper into the soils due to the roots' depths compared to above-ground or tilled SOC. Above-ground and tilled SOC can rapidly change back into CO_2. Systems with deeper roots are encouraged as their carbon compounds build more durable SOC, as deep soil carbon is more stable (Christopher, Lal and Mishra 2009; Leu 2013, 2021b; Verma and Verma 2021).

A substantial body of evidence shows how the carbon compounds from roots feed the soil microbiome, thereby increasing SOC (Badri and Vivanco 2009; Jones, Nguyen and Findlay 2009; Leu 2021b; Verma and Verma 2021). The key is ensuring the agricultural systems have photosynthesising plants for the longest periods in their climates.

This is achieved by using a diversity of correctly managed plant species to ensure they can capture the maximum amount of sunlight per hectare. The captured sunlight is the energy needed to convert CO_2 into the organic compounds that build SOC through the soil microbiome. Permanent covers of living plants and limited tillage systems are the best methods to increase SOC (Leu 2021b).

A general rule is to cover the soil with the maximum amount of living plants for as long as possible. Dead plants and bare soil do not photosynthesise. Consequently, the most productive regenerative systems avoid killing plants with herbicides and excessive tillage. Instead, plants are managed as ground covers and cover crops to build soil fertility; this maximises the carbon compounds the roots secrete into the soil. Various strategies are used to manage weeds and use them as cover crops to build fertility. Grazing is a widespread management tool of these regenerative systems (Teague et al. 2016; Leu 2021b).

Adopting adaptive multi-paddock – regenerative grazing

Ruminant livestock systems are often vilified as a significant source of agriculture's GHGs. Some countries, including New Zealand, are proposing taxing ruminant production to minimise production to reduce methane output. The Netherlands is forcibly closing farms and removing their land from primary production; Ireland intends to force farmers to cull 200,000 cows (RTE 2023).

The output of methane and other GHGs is considerable for Confined Animal Feeding Operations (CAFOs) and other intensive livestock production systems. The Food and Agriculture Organization of the United Nations (FAO) asserts that cattle, buffaloes, goats and sheep for meat and milk generated 5.8 Gt (gigatons) of CO_2 in 2010 (FAO 2010).

Many quality studies show that regenerative grazing livestock systems on pasture sequester more GHGs than they emit – they are GHG negative.

A high percentage of the methane animals produce on pasture is degraded by soil and water-based methane-eating microorganisms in farm ecosystems. These organisms do not exist in CAFOs and intensive livestock systems, so 100% of their emissions go into the atmosphere (Leu 2013). Furthermore, methane is a short-lived GHG that quickly decays into CO_2. This CO_2 is sequestered into the soil by photosynthesis in correctly managed grazing systems. This does not happen in CAFOs.

Most studies on livestock system emissions do not factor in the SOC sequestration levels resulting from different livestock management systems. Researchers compared different livestock management systems through a life cycle analysis. They found that converting to a regenerative grazing method called adaptive multi-paddock (AMP) grazing resulted in significant levels of SOC sequestration and became net CO_2 negative. Such systems draw down more CO_2 than they emit (Tong et al. 2015).

AMP grazing mimics herds of animals constantly moving to avoid predators in the wild. The herd of animals is left in a paddock for a short period and moved to the next before all the plants have been eaten. The animals are continuously rotated to paddocks with fresh feed and are not returned to the original paddock until the pasture has recovered.

Grazing times and sizes of paddocks can change during the seasons. For example, more time can be spent in summer in smaller paddocks with more significant volumes of forage than in winter. This is why it is called AMP grazing.

Research by Dr Richard Teague and colleagues from several universities showed that changing from set stocking rates to AMP grazing can significantly increase SOC levels. They achieved an average of 11 tons of CO_2 per hectare per year. If scaled up across the world's 3.3 billion hectares of permanent pastures, 36 gigatons would be sequestered annually, significantly contributing to reversing global GHG emissions (Teague et al. 2011; FAOSTAT 2015).

A review of numerous studies conducted by researchers from multiple universities found that transitioning to regeneratively managed ruminant grazing systems on pasture results in more sequestration than emissions. This turns ruminant agriculture from a significant emitter to a major mitigator of GHG emissions.

They recommended the widespread adoption of regenerative agriculture systems that include AMP grazing and not just for increasing SOC; there were also considerable ecological and biodiversity benefits.

Incorporating grazing plants (forages) and ruminants into regeneratively managed agroecosystems elevates SOC and improves the soil's ecological function. It does this by minimising the damage of tillage and inorganic fertilisers and biocides. Another result is the enhancement of biodiversity and wildlife habitat.

The researchers concluded that policies and regenerative management protocols, including ruminant grazing, should guide agricultural production. This ensures agroecosystems' long-term sustainability and ecological resilience (Teague et al. 2016).

In another project, researchers from the University of Georgia and the University of Florida using regenerative grazing practices in the southeastern United States sequestered 29.36 metric tons of CO_2eq per hectare per year. Significantly, the authors gave other examples of worldwide research that have achieved similar levels of SOC sequestration through regenerative grazing (Machmuller et al. 2015). If these regenerative grazing practices were implemented on the world's permanent pastures, they would sequester 96.8 gigatons annually, reversing global GHG emissions and regenerating the climate.

Measuring success – the Agave Agroforestry System

Ronnie Cummins, a founder of Regeneration International, started the Billion Agave Project to scale up this innovative agroforestry system. It is a high-biomass, high-forage-yielding system that works well on degraded, arid lands. It combines the dense cultivation (2,000 per hectare) of agave plants and nitrogen-fixing companion tree species (such as mesquite) with AMP grazing of livestock on native pasture.

According to the United Nations Convention to Combat Desertification (UNCCD), 500 million pastoralists herd their animals across highly diverse, grass-dominated rangelands that cover one-third of the Earth's land surface (UNCCD 2022).

Most of these rangelands are unsuitable for annual crops as tillage erodes and damages the soil and decimates the biodiversity of these diverse ecosystems. In many cases, the amount and timing of rainfall are inadequate to grow row crops such as grains, fruits and vegetables without irrigation. They are only suitable for grazing livestock, the residents' primary livelihood. Most of these rangelands have been degenerated by incorrect grazing, resulting in eroded and human-created desert landscapes. The animals suffer due to a lack of feed in the drier periods.

Agaves require no irrigation. They efficiently store seasonal rainfall and moisture from the air in their leaves and stems. This enables the plant to grow and produce significant biomass even under prolonged droughts. Various species of agave are now naturalised on all continents, so scaling up this agroforestry system with native legume trees and grasses will not cause an environmental problem.

Fermenting the leaves and stems of the agaves and the companion legume trees removes the toxic saponins and lectins to produce a high protein, inexpensive, palatable stock feed. The forage can be used as feed during the dry periods to take animals off the pastures and native ecosystems to allow them time to recover. Recovery time is essential to successful regenerative grazing systems. The supplemental forage ensures that the animals do not lose condition during these periods and remain healthy.

It also delivers valuable ecosystem functions including reducing soil erosion, recharging water tables, increasing native biodiversity and sequestering and storing large amounts of CO_2 in plant biomass and soils. Research shows that the agaves can sequester 14.3 tons of CO_2 per hectare annually. This is without counting below-ground SOC sequestration nor the amount of CO_2 sequestered by the 500-per-hectare companion trees (Hudson Carbon, in publication).

Extrapolated globally across the 3.3 billion hectares of permanent pastures, the Agave Agroforestry System sequesters 47.2 gigatons of CO_2 annually. This is drawing down more than the annual increase in CO_2 globally.

Conclusion

Closing down all livestock production in ill-informed, sledgehammer attempts to reduce GHGs would destroy livelihoods and cause starvation for more than 500 million people. The critical issue is one of transition. This involves banning cruel, polluting CAFOs and degenerative industrial livestock production systems and moving towards regenerative ones. Under regenerative systems all livestock are kept on pasture, under trees, and can naturally express themselves in such systems. The result turns livestock production from a significant problem into a primary climate change solution.

We need to assist producers in transitioning to these humane, productive systems where animals and plants are respected as sentient beings. We must regenerate agroecosystems to enhance the health of the soil, plants, animals, humans and the planet. These must be seen as one and indivisible so that everyone can flourish.

Dr. Vandana Shiva, one of the founders of Regeneration International, stated in *Regenerative Farming Is the Next Stage of Agricultural Evolution*: "Regenerative agriculture provides answers to the soil crisis, the food crisis, the climate crisis, and the crisis of democracy" (Leu 2021c).

References

Badri D V and Vivanco J M, 2009. Regulation and function of root exudates. *Plant, Cell & Environment*, 32(6):666–681. https://doi.org/10.1111/j.1365-3040.2009.01926.x

Christopher S F, Lal R and Mishra U, 2009. Regional study of no-till effects on carbon sequestration in the Midwestern U.S. *Soil Science Society of America Journal*, 73:207–216.

FAO, 2010. *Global Livestock Environmental Assessment Model (GLEAM)*. Food and Agriculture Organization of the United Nations.

FAOSTAT, 2015. FAOSTAT data on land use.

Jones D L, Nguyen C and Findlay R D, 2009. Carbon flow in the rhizosphere: carbon trading at the soil–root interface. *Plant and Soil*, 321(1–2):5–39. https://doi.org/10.1007/s11104-009-9925-0

Leu A, 2013. Commentary V: Mitigating climate change with soil organic matter in organic production systems. In: UNCTAD (Ed.), *Trade and Environment Review 2013: Wake Up Before It Is Too Late*. https://unctad.org/system/files/official-document/ditcted2012d3_afront_en.pdf

Leu A, 2021a. *Our Global Regeneration Revolution: Organic 3.0 to Regenerative and Organic Agriculture*. https://regenerationinternational.org/2021/07/12/our-global-regeneration-revolution-organic-3-0-to-regenerative-and-organic-agriculture/

Leu A, 2021b. *Growing Life: Regenerating Farming and Ranching*. Greeley, CO: AcresUSA. https://bookstore.acresusa.com/products/growing-life-regenerating-farming-ranching

Leu A, 2021c. *Regenerative Farming Is the Next Stage of Agricultural Evolution*. https://regenerationinternational.org/2021/12/30/andre-leu-regenerative-farming-is-the-next-stage-of-agricultural-evolution/

Machmuller M B et al., 2015. Emerging land use practices rapidly increase soil organic matter. *Nature Communications*, 6, 6995. https://doi.org/10.1038/ncomms7995

Prescott C E, Rui Y, Cotrufo M F and Grayston S A J, 2021. Managing plant surplus carbon to generate soil organic matter in regenerative agriculture. *Journal of Soil and Water Conservation*, 76(6): 99A–104A. https://doi.org/10.2489/jswc.2021.0920A

RTE, 2023. Decision on scheme to reduce dairy herd due 'over next few months' – McConalogue. https://www.rte.ie/news/ireland/2023/0531/1386614-agri-dairy/

Teague W R et al., 2011. Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie. *Agriculture Ecosystems and Environment*, 141:310–322. https://wysga.org/Media/WYSG/Docs/teague-et-al2011-g.pdf

Teague W R et al., 2016. The role of ruminants in reducing agriculture's carbon footprint in North America. *Journal of Soil and Water Conservation*, 71(2): 156–164. https://doi.org/10.2489/jswc.71.2.156

Tong W, Teague W R, Park C S and Bevers S, 2015. GHG mitigation potential of different grazing strategies in the United States Southern Great Plains. *Sustainability*, 7(10): 13500–13521. https://doi.org/10.3390/su71013500

UNCCD (United Nations Convention to Combat Desertification), 2022. *The Global Land Outlook*, second edition. Land Restoration for Recovery and Resilience. https://www.unccd.int/sites/default/files/2022-04/UNCCD_GLO2_low-res_2.pdf

Verma S and Verma A, 2021. Plant root exudate analysis. In: Verma A, Saini J K, Hesham A and Singh H B (Eds.), *Phytomicrobiome Interactions and Sustainable Agriculture*. Malden, MA: Wiley Blackwell. https://www.wiley.com/en-gb/exportProduct/pdf/9781119644620

17 Achieving a peaceful and verdant future

A farmer's perspective

Seth Watkins

Carl Safina's book *Becoming Wild* (Safina 2020) provides excellent insight into what I believe it will take to build a peaceful and verdant future. He outlines many meaningful points in *Becoming Wild* that have great potential to improve our world.

These include the importance of non-conformists, the importance of eternal hope. And my personal favourite, that our planet would be a better place if we were all more like bonobos.

I agree that we have a lot to learn from these gentle, fun-loving animals. They have a matriarchal society, are known for food sharing and cooperation and often resolve conflict through friendly sex.

Bonobos look like chimpanzees, share DNA with chimpanzees yet behave very differently because of species separation when the Congo River formed. Those on the south bank became bonobos; those on the north became modern chimps.

As Carl Safina says: "Compared to their warmongering, covetous, calculating chimp cousins, bonobos play nice" (Safina, 2020).

I first listened to *Becoming Wild* in my tractor on my farm in Page County, southern Iowa, USA. And since then, the Safina quote I've thought of the most is: "The human species has made itself incompatible with everything else on earth" (Safina 2020).

Hearing this statement whilst driving my tractor – literally farming – weighed heavily on me as did the concept of the choices we make that govern our own regeneration or extinction.

Making powerful connections

Being directly connected to the land reminds me daily that the way we farm is the most powerful way we use our planet. This connection has taught me that as a farmer I am responsible for all the living things that I share my land with. Because the way I farm and care for our land will serve as Nature's arbitrator for our future.

It's clear that to build a peaceful and verdant future, we must overcome human nature, rejecting covetousness and aggressiveness and adopting the sharing nature of bonobos. The late sociobiologist E O Wilson once said: "The real problem of humanity is the following: we have palaeolithic emotions, medieval institutions and God-like technology. And it is terrifically dangerous" (Wilson 2009).

His insight is that our power to make the most of immediate opportunities can be institutionalised. This makes it very difficult to change entrenched behaviour when we learn how to do things better.

Technology is important, but just because we can, doesn't mean we should. For example, the technology of synthetic fertiliser masks the degradation of our soil whilst polluting our water.

DOI: 10.4324/9781032684369-23

Technologies such as antibiotics have allowed us to confine livestock. Both are short-term solutions with long-term consequences.

Often it's our technology that holds us back from the sustainable solutions needed to fix our failing food system. Our technology can create more problems for others downstream – literally.

Rejecting senseless influences

Institutions such as slavery and my government's genocide of Native Americans on behalf of farming settlers were reinforced by primitive emotions. These emotions made us accept and justify the destruction of natural resources and the exploitation of people in securing our self-interest. And we still see the senseless influence of such emotions, institutions and God-like technology in our food system today.

I feel this influence personally when the Iowa Farm Bureau, an organisation claiming to represent me as a farmer, lobbies to keep atrazine, a proven endocrine disruptor (Almberg et al. 2018; EWG 2017; Waller et al. 2010) on the market (Iowa Farm Bureau 2021). Their communications tell me they value chemical-driven profits over the health of my family. The Bureau also says they are about: "People, Progress, and Pride". I'm just not sure what people they're referring to.

It's deeply concerning when the US bullies Mexico to buy genetically modified (GMO) corn, convinced that our God-like technology is superior to thousands of years of Indigenous knowledge.

Instead, we should be helping Mexico with research and extension training so their farmers can successfully raise non-GMO grain. Simultaneously, our farmers could learn with Mexico's farmers – expanding our knowledge whilst also making our food system more resilient and diverse.

In Iowa, we are seeing this influence with the concept of a carbon pipeline that's considered a mechanism to remove carbon from the distillation process of ethanol production. This multibillion-dollar investment is expected to sustain the life of the ethanol industry another 30 years. But it does nothing to restore our degraded soil, polluted water or our lost biodiversity.

Ecological solutions that include multi-species crop rotations, cover crops, habitat restoration and grazing can sequester carbon back into our soil. Once there this carbon will restore our natural resources and our communities for generations.

The 2023 winner for me of God-like technology at its worst is the John Deere autonomous tractor. Because we couldn't destroy our precious soil, water and habitat fast enough on our own, John Deere built us a robot. I believe this is called "The Jevons Paradox" – the more efficient it is to produce something, the more resources we use to produce it.

Focusing on stewardship and social equity

If I have learned one encouraging thing in caring for land and livestock, it is that Mother Nature is incredibly benevolent and forgiving. We simply need to listen to her and work with her. We know our modern farming practices are not sustainable. We also know there are better ways to farm that will regenerate our natural resources and provide a better life not only for us, but also all the living things we share this planet with.

This understanding provides the eternal hope we need to move forward with Nature to build a peaceful and verdant future for all living things on our planet. Moving forward starts with focusing on stewardship and social equity. These issues are intertwined. Without stewardship we will continue to erode our natural resources, creating a future of scarcity and conflict. These

Figure 17.1 Cattle help me maintain and restore biodiversity on our landscape. Grazing is what has allowed me to protect the oak trees on my farm. Iowa has lost over 404,685 hectares (1,000,000 acres) of forests and grasslands to crop production because of farm policy that incentivises farming marginal lands. Photo by Seth Watkins.

conditions will never allow for social equity. Yet, when we ignore the inequality and exploitation inherent in our food system, we create a vicious cycle that's only made possible by rationalising that what we are doing is acceptable.

In my own experience and on my farm, I have chosen to trust my heart instead of the conventional wisdom taught by my industry, academia and even fellow farmers. For example, in Iowa, we had been taught as "caring cattlemen" to breed our cattle for calving inside during the blizzards of January and February. The reason? Not so much care for animals, but care for ourselves, so that we could concentrate on our crops in April.

I decided to match the calving system to the environment and seasons. This meant allowing the cows to give birth in April and May when the grass is green and it's warmer.

Working with nature in this way confirmed the benefits I had imagined. The cows found it much easier to give birth in the spring when they could get outside and eat and behave naturally.

Compared with battling the cold, mud, snow and slop associated with winter births when as many 30%–40% of my cows and newborn calves needed my help annually, I have only had to help a cow give birth once over the past three years. Their stress is so much lower because of their springtime births. Simply allowing the cows the right to express their natural instincts means better immunity. This means fewer illnesses, lower death rates, lower vet bills and greater productivity.

Respecting, protecting and regenerating the land are also central to the way I farm. This has meant moving away from chemicals – pesticides and fertilisers – and growing legumes for forage. It has also meant much less reliance on fossil fuels. To be sustainable, our farms must be ecologically sound. Farms are living systems. Living systems are sustained by natural resources including soil, sunlight and rainfall. It is important to understand how these work together. Our farms can't be sustained by finite resources like fossil fuel, chemicals and synthetic fertilisers, because over time the costs of these resources will greatly exceed the costs of the food I raise.

I welcome the many different plants such as native bluestem, coneflower, butterfly milkweed and countless others I'm still learning to identify that have appeared on my land. I can see the improvements they have brought to my animals' lives and health and to my farm's productivity (Figure 17.1). My costs have gone down too. I often think that a botanist is the most important expert an aspiring regenerative farmer could employ.

Driving cultural change

Non-conformists drive cultural change. Breaking this vicious cycle means identifying and supporting the non-conformists who are making our world a better place.

I'd like to highlight some truly inspirational figures, starting with the farmers I met at Global Greens. This non-profit in Des Moines, Iowa, provides land to around 20 refugee farmers from countries including Myanmar, Bangladesh and Burundi and helps them sell their produce at regular markets.

I was so touched by their stories. Many work several jobs – often at night – and travel miles by public transport during the day to reach their land which ranges in size from around 0.10 hectare to 1.6 hectares. These farmers' knowledge and skills around plants, soil and water have made me ashamed of how little I know about agriculture. How much support I have, and how little they receive. Yet, the knowledge they have is critical to our future.

To move forward, farmers like those at Global Greens need access to land, credit and infrastructure. Most of all they deserve our support and respect.

Moving forward to a regenerative future also means supporting non-conformists like Reginaldo Haslett-Marroquin (see Chapter 20) in building smaller more diverse farms. He engages immigrant, young, small, new and established agricultural entrepreneurs in the US. Together, they are championing a global model for a small-scale, poultry-powered (and planet cooling), scalable regenerative agriculture system.

Regi grew up in extreme poverty in the Northern rainforest of Guatemala. He is committed to alleviating conditions that caused his community's suffering, for other people worldwide. He sees his task as lifelong and global, and he brings to it boundless passion and a long history of entrepreneurship.

By using Indigenous knowledge to create Tree-Range® Farms and Tree-Range® Chickens, Regi is building a system that he accurately describes as being "better for chickens, better for your family, better for farmers, and better for the earth". The farms are based on establishing or maintaining a "jungle-like" habitat that honours the true nature of chickens.

His company demonstrates the power of making Mother Nature a partner instead of an adversary.

We must make our farms smaller and more diverse, if we are really going to have a chance of providing healthy and sustainable diets for nine billion people. Policy is a huge part of this. But we must build policy that rewards the regeneration of our resources, not just production. This means human and natural resources.

Non-conforming and farming

Zack Smith from Iowa is a great example of the power and potential of human ingenuity. Zack has developed a circular farming system that he calls the Cluster Cluck 5000. His system allows sheep, pigs and chickens to graze in precision 9.1 metre (30 foot) swathes between rows of standing corn. The livestock can express their natural instincts grazing a smorgasbord of cover crops, whilst rebuilding soil to provide a perfect nutrient balance for next year's crop.

This system is outperforming conventional cropping systems whilst also greatly reducing the need for inputs made from finite resources. By working with nature to improve biodiversity, Zack and his Cluster Cluck are improving farm income and creating an opportunity for young people to farm.

Non-conformists like Zack, Regi and the farmers at Global Greens are all using our most valuable natural resource, human innovation. We can all contribute to a more peaceful and verdant future by supporting them.

Embracing regeneration – rejecting unsustainability

We must embrace regeneration because what we are doing is not working. If we look at the efficiency of food production in the preindustrial era, it took one calorie of food production to produce five calories of food. Today, in the US, we use 13.3 calories of energy to produce one calorie of food. Our modern, technologically driven food system is 66% less efficient at converting energy to food.

Regenerative agriculture can correct this obviously unsustainable system. To be successful on this journey, we must return to teaching agriculture as an art and a science. This is not to downplay the importance of science. But if something doesn't feel right in our hearts, or smell right, or sound right, or taste right, we should trust our gut that we are doing something wrong. Then, we should trust our brains to fix it.

The downfall of caring for livestock was when my vocation changed its name from "Animal Husbandry" to "Animal Science". Words do matter and this change paved the way for confinement agriculture. The sooner we can return to teaching Animal Husbandry, the sooner we can end the madness of not allowing animals the right to express their natural instincts(Figure 17.2). The sooner we can start to restore our rural communities.

Finally, none of this will work unless we embrace equity and diversity in everything we do. We must be inclusive and actively work to create opportunities to make more farmers. There's no sustainability without diversity. This means diversity on our landscape and diversity in our communities.

Always remember there is no sustainability without profit. But enough is as good as a feast.

People always ask me about money. I like to share that I don't think our money always reflects the value of the things that matter most. The things that matter most are our natural resources, our families and all the living things we share this planet with.

When my children were little, I set the following financial goals:

1 Never jeopardise the land that supports us and all living things.
2 Get my daughter, Tatum, to a good college and provide a good life for my son Spencer, who has special needs.
3 To have enough money to have a beer or two every Friday night.

Figure 17.2 Sentience. Animals deserve the right to express their natural instincts. For ruminants, this means foraging on grasslands, not confined animal feeding operations. Photo by Seth Watkins.

Figure 17.3 Power of biodiversity. The clover replaced synthetic nitrogen, reducing input costs, improving forage quality, improving habitat for pollinators, sequestering carbon, cleaning our water and providing perfect nutrition for cows giving birth in late April and May. Mother (Nature) knows best. Photo by Seth Watkins.

What's happened with these goals? Tatum's off to an excellent college with a scholarship and I'm very proud of her. Spencer deserves the greatest credit for teaching me the power of compassion and equity. He and I are working to make our farm smaller, more diverse, more accessible and even more ecologically sound.

Best of all, on his 21st birthday, Spencer had a great party, and we shared our first Friday night beer together. All of this is possible because I decided to work with Mother Nature instead of against her (Figure 17.3).

References

Almberg K S et al., 2018. Atrazine contamination of drinking water and adverse birth outcomes in community water systems with elevated Atrazine in Ohio, 2006–2008. *Int J Environ Res Public Health*, 15(9):1889. doi: 10.3390/ijerph15091889

EWG (Environmental Working Group), 2017. *Atrazine: A Harmful Weedkiller Taints Tap Water for Millions in U.S.* https://www.ewg.org/news-insights/news/2017/08/atrazine-harmful-weedkiller-taints-tap-water-millions-us

Iowa Farm Bureau, 2021, 10 February. Email. 'Action Alert: Future use of Atrazine threatened by EPA.'

Safina C, 2020. *Becoming Wild: How Animals Learn to Be Animals*. London: Oneworld Publications.

Waller S A et al., 2010. Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. *Am J Obstet Gynecol*, 202(3):241.e1–241.e6. doi: 10.1016/j.ajog.2010.01.023

Wilson E O, 2009. *Looking Back Looking Forward: A Conversation with James D Watson and Edward O Wilson* (09/09/09). https://hmnh.harvard.edu/file/284861

18 How agroecology is mitigating the worst effects of climate change in Tanzania

Janet Maro

Tanzania is highly threatened by climate change. According to the National Climate Change Strategy (NCCS) of 2012 (Government of Tanzania 2012), the impacts of climate change are already being felt across the country. They are projected to increase both in frequency and severity; this will lead to severe socio-economic implications.

The country is experiencing deteriorating soil fertility and degradation. Tree cutting for firewood and land clearance for agriculture is destroying forests and biodiversity. Furthermore, increasing dry spells and longer periods of drought mean communities have less access to water for domestic use and for agriculture than ever before.

The effects of current climate vulnerability and future expected climate changes combine to prevent Tanzania from achieving key economic growth, development and poverty reduction targets. Tanzania's economic base depends on the use of natural resources, rain-fed agriculture and biomass fuels for household energy.

The National Strategy for Growth and Reduction of Poverty (NSGRP) Phase II of 2010 indicates that Tanzania's economy depends on agriculture (Vice President's Office 2010). It accounts for 25% of GDP and provides livelihoods for more than 82% of the population. Consequently, the economy is highly vulnerable to the adverse impacts of climate change such as extreme weather events.

Tanzania's ability to address the current and projected impacts of climate change and to adapt and protect its people is strongly hindered by several climatic and non-climatic factors.

Non-climatic factors include poverty; inadequate institutional governance arrangements; lack of adequate financial resources; and insufficient human resource and technological capacities. Low public awareness and lack of adequate climate change information management and dissemination are also issues. This is despite the clear environmental and geo-physical consequences of climate change.

Communities next to Tanzania's 13 Nature Forest Reserves, other protected areas, savannahs, mountains and coasts are clear victims of climate change impacts. The impacts include escalating conflicts between communities for water and land. The most vulnerable groups in affected communities include women and elderly people who depend on subsistence agriculture and natural resources for their survival.

Planning adaptation strategies

It is crucial to plan interventions for disaster risks reduction – including droughts, floods and wildfires – and climate change adaptation strategies to protect crop and livestock production. Sustainable farming methods help communities develop adaptation strategies. By contrast,

DOI: 10.4324/9781032684369-24

Figure 18.1 Agroforestry system at SAT Farmer Training Centre with *Gliricidia Sepium* and maize. Photo by SAT.

destructive farming practices that disrupt the topsoil threaten the survival of ecologically important plants and animals and must be halted.

Sustainable Agriculture Tanzania (SAT) is a non-profit organisation founded in 2011. Its mission is to extend agroecology to all farmers so that their livelihoods can be improved and pressure on natural resources reduced. Since its founding SAT has run twenty-five projects throughout the country which have involved over 75,000 farmers and pastoralists, of whom over 60% are women, in agroecology practices. It is active in 16 regions.

A feasibility study for the development of a 2023 project found that rural communities around Mkingu Nature Forest Reserve, towards the north-east of Tanzania, face numerous problems (SAT 2023). These include:

a Climate change which causes unreliable rainfalls and more dry spells, shortening production periods and giving rise to crop pests and diseases;
b Change in forest land causing biodiversity and habitat loss;
c Degradation of soils which has reduced crop yields and increased soil maintenance costs;
d Lack of quality inputs – fertilisers and seeds – and knowledge of how to apply them; this results in poor yields, high production costs and little or no profit;
e Lack of, or poorly built, irrigation infrastructures; this causes low rice paddy yields and floods as local infrastructures are easily destroyed;
f Little capital to invest in agriculture, limiting production;
g Few entrepreneurial skills resulting in failure to find other income generating sources;
h Cattle invasion of crop fields causing conflicts between farmers and pastoralists, leading to violent confrontations; and
i Low participation of women in village government positions and gender inequality.

To mitigate against the increased frequency and intensity of extreme weather events, such as droughts, floods and wildfires, SAT recommends the following:

- Restoring wetlands and reducing emissions, and monitoring climate change impacts through the implementation of sustainable agriculture practices;
- Conservation practices such as sustainable forestry, agroforestry and the promotion of native species to improve ecosystem resilience (Figure 18.1); and
- Community engagement and capacity building to educate people about the importance of Nature Forest Reserve conservation and the need for climate action.

SAT works with communities at the grassroots level – meeting and talking with them to understand the causes and effects of environmental degradation. Adaptation and implementation plans are identified which can be used to reduce or, even better, stop the degradation. These plans are then carried out by the farmers.

SAT projects focus on and facilitate inclusivity. They involve men, women, youngsters and persons with disabilities.

Ending land conflict

Tanzania covers 94.5 million hectares of land, 44 million of which are classified as suitable for agriculture. Around 37.4 million hectares are protected areas dedicated to game reserves, game-controlled areas and wildlife management. Because this land cannot be used for agriculture and unsustainable farming methods are used elsewhere, the country is experiencing increasing conflict over access to land for agriculture and water.

There are tensions between farmers and pastoralists that sometimes lead to violent confrontations.

SAT's Farmers and Pastoralists Collaboration (FPC) project has succeeded in reducing conflicts between farmers and pastoralists. Its focus is a unique approach of a circular economy where both farmers and pastoralists benefit from each other. Through the project, communities work out climate disaster risk assessments and develop climate adaptation plans which are then implemented.

Resilient farming systems such as agroecology, organic and regenerative are entrenched within the SAT approach. These socially inclusive systems offer opportunities for communities to improve their livelihoods in a decent and dignified way. They offer a possible solution for the sustainable growth and development of communities and societies. The central principle is that farmers are guardians and custodians of the land. So, when they take care of the soil health, nurture the land and all in it, they harvest abundance to feed themselves, their families and have a surplus to sell.

Measuring agroecology success

SAT conducted an external impact assessment (FPC/iDev 2023) of their projects amongst farmers and pastoralists in communities where conflicts had been prevalent. The assessment covered four districts involving 496 respondents (256 participants and 240 non-participants) and found that the project had brought some remarkable successes. Farmers and pastoralists had adopted several climate-resilient techniques and technologies to ensure the sustainability of their agricultural and livestock-keeping practices.

Improved income, nutrition and food security

Income had increased by 142% for project participants, and nutrition and food security were also greatly improved. 82% of participants consumed three meals per day – an increase from 35%. Dietary diversity had also improved to include cereals and tubers, pulses, milk and dairy, vegetables, oils and fruits.

Box 18.1 Agroecology: promoting peaceful coexistence and inclusivity as well as sustainable farming methods

Circular economy reducing waste and promoting reduced conflict

The project promoted a circular economy within the communities of farmers and pastoralists. This revolved around the reuse and recycling of resources. It aimed to create a closed-loop system that minimises waste and maximises the value of by-products. The promotion of the exchange of farm by-products such as manure from cows and crop residues from the fields enabled both parties to see the direct benefits of cooperating and coexisting peacefully. Land conflict cases reported at the village level dropped by more than 75% in the project villages; this is mostly attributed to the circular economy approach.

Promoting inclusivity

Gender relations were strengthened with inclusivity within agroecological practices in the project with nearly 57% female participants, compared to before the project, when groups and projects did not include women.

Soil improvement and protection of the environment and biodiversity

Soil health improvement practices were widely adopted. Organic fertiliser (compost) and controlled burning of field grass and leaves, which help in soil rejuvenation and weed management, were adopted by 90% of the participants.

Intercropping and crop rotation, also important for soil health, were adopted by nearly 43% of farmers involved in the project. Frequent combinations were maize intercropped with legumes such as beans or cow peas, tomatoes intercropped with onions and cassava with pigeon peas. The project saw a significant increase in the diversity of crops. Crops grown include maize, sunflower, paddy, cowpeas, pigeon peas and more.

Project participants chose to plant indigenous flora – native trees and use local seed varieties. These practices aid in preserving biodiversity (Figure 18.2) and strengthening the resilience of farming systems against environmental stressors.

The project saw eradication of slash and burn practices amongst those involved in the project. Tree planting in dryland areas was promoted resulting in 54,697 trees planted in 2022 with a 70% survival rate.

Most involved in the project used botanical extracts from hot pepper (*Capsicum* sp.) and from Neem tree (*Azadyrachta indica*) – local available materials which are highly effective.

Figure 18.2 Highly diverse vegetable plot with sweet pepper, spinach, amaranthus and marigold flowers (*Tagetes* sp.) to attract pollinators. Photo by SAT.

Botanical extracts are important because they help to protect the plants from pests and diseases. It is an indication of the project's positive influence, since researchers found that only 4% of those who were not involved in the project used botanical extracts. Project participants also used ash and local medicinal herbs to manage pests.

Box 18.2 Pastoralists and pasture management

For the pastoralists in the group, mobility during dry seasons is a critical adaptive strategy. Moving livestock to areas with better grazing conditions is key to their survival during such periods. Some pastoralists also invest in supplemental feeds that are harvested during the rainy season and used during dry spells and prioritise rearing drought-resistant breeds, as well as planting grasses such as *Cenchrus ciliaris* (African Foxtail) which are more likely to survive and thrive under harsh conditions (see Figure 18.3).

Pasture establishment and management was significant: 104 hectares of pasture plots were developed; and 3,150 hectares of natural grass were conserved, and 50,000 hay bales were created.

Protection of water resources and reduction of waste

There were increases in appreciation of water resource management, with practices such as well-digging and irrigation coming to the fore.

The use of specific storage techniques, such as grain storage in plastic bags, also emerged as a technique to reduce post-harvest losses and better manage resources amidst changing climate conditions.

The circular economy (see Box 18.1) also aimed to create a closed-loop system that minimises waste and maximises the value of by-products.

Figure 18.3 Women in a pastoral community harvesting seeds of the African Foxtail (*Cenchrus ciliaris*) for storage and further planting. Photo by SAT.

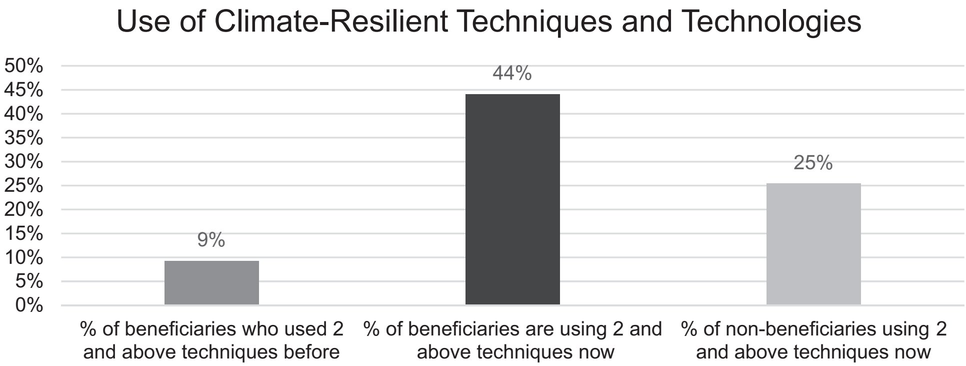

Figure 18.4 Use of climate-resilient techniques and technologies. Graph showing use of climate-resilient technologies amongst beneficiaries and non-beneficiaries. Adapted from FPC/iDEV (2023).

Increased uptake of climate-resilient technologies by project participants

The diverse techniques and technologies highlighted above give valuable insights into enhancing resilience to climate change.

SAT's quantitative findings affirm the impact on project participants. Before the project started, beneficiaries were found to be using an average of just 0.49 climate-resilient technologies.

However, post-intervention, this figure significantly increased to an average of 1.49 climate-resilient technologies per participant. In comparison, the average for non-participants stood at 0.97, suggesting the project's positive effect on the adoption rate of such technologies.

There were also striking improvements regarding the adoption of multiple climate-resilient technologies. Before joining the project, only 9% of participants used two or more techniques. This figure increased remarkably to 44% after the project's intervention, an almost five-fold increase.

In contrast, only 25% of non-participants reported using two or more climate-resilient techniques. This indicates that the project has had a significant role in promoting the adoption of multiple climate-resilient technologies amongst participants. Figure 18.4 illustrates this.

Increasing sustainability

The FPC project's contribution has increased the sustainability of individual households and of entire communities. Farmers and pastoralists are in the front line of climate change impact and the skills and knowledge they have acquired make them better able to withstand adverse weather events.

Tanzania's Ministry of Agriculture and its Ministry of Livestock and Fisheries have directly experienced the effectiveness of SAT's work with local farmers. In 2021, SAT was invited to be part of the technical team which worked with the ministries to develop a National Ecological Organic Agriculture Strategy (NEOAS) (Ministry of Agriculture Tanzania, 2023) which was launched in November 2023 and made public in February 2024.

The result is clear strategic objectives and areas of intervention and more resilient ways of farming being scaled across the country and beyond. The strategy offers a solution on how to improve farming practices to meet the ever-increasing global food demand in a sustainable way. It clearly highlights that increasing yield at any cost is not sustainable and will not solve the problem of long-term food insecurity.

References

FPC/iDEV (Farmers and Pastoralists Collaboration and /iDEV Consulting Company Ltd), 2023. Project Impact Assessment Report for Sustainable Agriculture Tanzania. https://idev.co.tz/wp-content/uploads/2023/11/SAT-Tanzania-FPC-Impact-Assessment-Report-1.pdf

Government of Tanzania, 2012. National Climate Change Strategy (NCCS). https://faolex.fao.org/docs/pdf/tan191137.pdf

Ministry of Agriculture Tanzania, 2023. National Ecological Organic Agriculture Strategy (NEOAS).

SAT (Sustainable Agriculture Tanzania), 2023. *Feasibility Study in Communities around Mkingu Nature Forest Reserve.*

Vice President's Office, Tanzania, 2010. National Strategy for Growth and Reduction of Poverty (NSGRP).

19 Can dairy farming be part of the solution?

David Finlay

In the beginning

I'm a fourth-generation dairy and beef farmer. For over 200 years, my family has farmed on mixed livestock, upland farms in Galloway, SW Scotland.

In 1987, I returned home after ten years working in farm consultancy, determined to shake the old place up a bit. My mission? To bring it up to date with a bit of late twentieth century technology. I was totally committed to the belief that the industry shift towards increased intensification was based on good, evidence-based science. So-called organic, agroecological farming was a joke, a con and a waste of public money.

So we began the move to more intensive farming. This meant purchasing more efficient machinery, establishing more productive ryegrass monocrops, and upping the use of soluble fertilisers and purchased feedstuffs. We also increased stock numbers and introduced breeds with higher genetic potential. All good, to start with.

But there was a downside. Animal and crop parasites, diseases, morbidity and mortality began to increase too. This required an exponential increase in the use of pesticides, antibiotics, vaccines and such.

I must confess I felt uncomfortable with these negative consequences, but reckoned as everyone was doing it, it would be okay. And anyhow in time it would all settle down. Just a case of hanging in there following the tried and tested intensification recipe I'd spent ten years of consultancy preaching to my customers.

And then, somehow before the existence of online dating, I met Wilma – a Glasgow IT consultant – and we shared our dreams. Me to diversify the farm business to add value and improve profitability. Wilma to get out of corporate anonymity and run a small more meaningful business in the countryside. Very different people, with different backgrounds. But as it turned out, we had the makings of the perfect partnership. A partnership that would take us on an incredible journey.

Together, we have achieved net zero farming, substantial biodiversity recovery, diffuse pollution elimination, business resilience, quality healthy food and sustainable profitability. And we have achieved meaningful and rewarding jobs for both ourselves and the people who work with us.

A rude awakening

This journey started when I walked Wilma proudly round the farm for the first time. I showed her our prime beef cattle packed tidily onto the cattle slats. They had enough room to stand up, turn round and move around a bit, but not too much. To say she was unimpressed is an understatement. Wilma was horrified.

DOI: 10.4324/9781032684369-25

Her experience of farming had been limited to her grandparents' small holdings with the two-or-three cows, sheep, ducks, hens. Wilma's reaction very much characterised the division that was growing between public perception of farming and the modern reality. She gave me cause for reflection, but little changed on the ground. At least not immediately.

By the mid-nineties, our diversification journey was well underway. We were selling ice cream and had started an adventure playground in a traditional, family holiday area. Another perfect partnership. There was little competition, and the businesses grew.

But dairy farming was struggling. De-regulation of the milk market had resulted, after an initial bonanza as processors competed for suppliers, in price collapse as the processors divided farmers and turned the screw. The rapidly growing organic market was now widely seen as a possible saviour. Farmers' meetings to study the idea were heavily subscribed. Large farms, small farms. Everyone was interested. Organic at that point had not been identified as a threat to the supply industry. That would come later.

Wilma, my sister and mother were very keen on organic. I wasn't so sure but the price premiums being achieved were a big incentive to at least look a bit further and dig a bit deeper.

And this research brought us into contact with the inhabitants of a parallel universe – farmers and members of the public who talked a different language to our family, friends and neighbours. They talked about sustainability and not just financial sustainability. They talked about global warming, biodiversity loss, diffuse pollution, social degradation, animal welfare… All the stuff people are talking about now.

There really weren't that many, what I'd call, commercial-scale, professional farmers farming organically, and the level of technical support was basic. But the realisation slowly dawned on me that we needed to do something. The business-as-usual farming model was fundamentally unsustainable. Hence we began our conversion of the entire farm to organic through the late nineties.

A deeper understanding

It wasn't easy. It required a complete mindset change. Once we had looked for an artificial technological intervention (fertilisers, pesticides, additives, drugs and drenches) to achieve an outcome. Now we were standing right back and working out how to incentivise natural systems and avoid the problems in the first place. Prevention rather than cure.

This meant we had to understand the needs of our soils, crops and animals as well as develop a better understanding of what we were up against. This meant considering the pests, the diseases, their life cycles and how to avoid them. This was difficult. Anyone who says organic is anti-science, doesn't understand organic. Undoubtedly, we know more about the science of farming now than when we just followed a chemical-based farming formula.

And so we began our very uncertain journey towards an equally uncertain destination. The further we have travelled, the less frequented the trail to the point where we are now almost alone. Pioneers. We've thrown away the old rule book and are writing our own. Exciting, daunting but ultimately deeply rewarding.

Initially organic farming for us was too hard, too complicated and much less profitable. I made mistakes. I didn't have the security of routine medication, just in case. I had to be a better custodian. More alert. More aware. Quicker to react. I had to be a better farmer. I can confidently say that if it hadn't been for the ice cream, I'd have packed in organic farming.

Our organic ice cream hit a rapidly growing UK market with no competition. There was no surplus organic milk available for the processors in the late nineties. What organic milk there was, was all going into the liquid milk market. We were tiny – operating out of a small barn conversion and some shipping containers. We were approached by supermarkets, desperate to get some organic ice cream. We were picking up customers from the Isle of Wight to Shetland. My daughter went round with a distributor in London and opened 40 accounts in just two weeks. It was crazy. But it meant I had to stick with the organic farming.

After ten years our farm consultant reckoned we had been more profitable being organic for only two of those ten years, but it was now beginning to pay off. We'd got our systems sorted out and got our heads around this whole idea.

We were building our clovers and the productivity of our pastures. Yes, pastures. Not grasslands. There's a big difference. "Pastures" are complex and biodiverse. "Grasslands" tend to be monocrops.

We had disrupted the lifecycles of many parasites through management changes, and the farm business was profitable. This was not because of subsidies – in fact our total public support had been cut – or because of the meagre market premium we were getting for our organic products. It was because the farm's productivity was beginning to return to where it had been before converting to organic, and our costs had reduced substantially. In fact, these were our most profitable years in farming.

We realised that if we could better understand these natural processes and facilitate, enhance and harness their power, we could begin to move towards a more truly, holistically sustainable system of food production. How far could we take this idea? It was clearly working for our soils and crops (okay, we call our pastures "crops", because that is what they are!).

What about our animals?

The next step

In modern dairy farming, the cow and calf are separated, typically within the first 24 hours after birth. The primary reason for this practice is that it allows cows to enter the milking herd and maximises the amount of milk available for sale. During our ten years of farm tours one question was repeatedly asked: "Why are you taking the calves away from their mothers?"

This question, primarily from mothers, was constantly echoed by Wilma and our visitor centre manager. I'd raise my eyes skyward in frustration at their insistence and reply defensively: "Are you trying to put me out of business?"

But while the question rankled, it also stuck. Maybe it was a sense of guilt…?

I was painfully aware that many, not all, of the cows expressed deep emotional distress, sometimes for days, after we had taken their calves away shortly after birth.

Then an opportunity arose where we had to make a decision whether to stay in dairy or get out. Our old cow barn was no longer fit for purpose. If we were to replace it and build from scratch, should we incorporate facilities for cows and calves? Was anyone else doing this?

Our research showed that some Dutch farmers were doing something similar. They were farming smaller herds, but it would still be worth a visit. Mid-January and our tenth wedding anniversary. Wilma and I were sitting for several hours on a stationary train somewhere in the waterlogged and rather chilly Netherlands. We were on our way to see a couple of Dutch cow-with-calf dairies (who said farmers aren't romantic?). We returned home and that summer sent the farm team over. On their return, we all agreed (with some reservations): "We can do that. Looks easy…"

Yes, well, suffice to say, it wasn't easy. Far from it. To make a very long story short, the new barn and dairy complex were built, and we moved in, in August 2012. Cow-with-calf dairying was trialled that winter with 37 cows and calves. I can safely say we all judged it to be a chaotic mess and I pulled the plug on it after five months.

Yet, walking through the cattle barn of an evening (it was winter), watching the calves sleeping contentedly beside their quietly cud-chewing mothers had touched something deep inside me. I knew that if we could somehow make this work, this final piece of our holistic agroecological jigsaw, it would be so right.

But in 2012–2013 we had no idea what we were doing. We were stressed, the cows were stressed, and we were in financial freefall. We walked away from the experiment without a backward glance. We had tried. Consciences clear. Job done. The industry was right. It's impossible, it can't be done.

At this point, you might be asking, as indeed we did at the time, "Why are the cows so stressed? They've got what they wanted, surely?" Hah. What we hadn't even considered was that we were dealing with sentient beings. How ironic! You see, forever the cows had given birth and 24 hours, or so, later they would be taken into the milking parlour and while there, their calves would be whisked away to another building. Out of sight and out of hearing. They might call, but there'd be no reply… The cows knew this and associated that first milking after calving as the point of separation from their baby. But now, as they returned from the milking parlour, their calf was still there! Maybe it would be at next milking time? Stress!! What was going on? They didn't know. We didn't know. And like most "folk", cows hate change and uncertainty.

If at first…

But, as so often has happened on this journey, fate intervened. My daughter's university professor at Glasgow, David Logue, on hearing of our exploits, sent a student to analyse the data from the experiment. His assessment? It might work!

Okay. One more time. This time we would be far better prepared, we thought. And in some practical ways we were, but nature had moved the goal posts. In the intervening four years, the pathogen loading of the barn had grown. The cows were resistant, but those poor wee calves weren't.

Our second attempt was even more catastrophic than the first, initially. But our vets came to the rescue. With swab-testing for disease and good advice we changed our management procedures. Those early and often fatal, clinical diseases in the calves are now rare.

We're now entering our eighth year of cow-with-calf dairying. It hasn't been easy getting here but we would never go back. Calf health, vitality and performance is exceptional. The young cattle are reaching mature weights six to eight months sooner, releasing forage they'd otherwise have been eating, allowing us to feed more cows.

Cow health and apparent contentment plus the effect of suckling has resulted in each cow producing substantially more milk. More cows and more milk per cow mean we are producing as much milk for our own use from the system as before the suckling experiment. This is despite the calves drinking more than a third of it. We also have about 25% more cattle to sell, making the system more resource efficient.

Meanwhile…

Back on the farm, by following good agroecological practice, 25 years of soil analysis shows our soils are sequestering carbon, as are our newly planted broad-leaf woodlands. We are independently audited as climate positive – more than offsetting our methane emissions.

A recent reassessment of farm biodiversity has found an increase in plant species since our first assessment in 2000 from 157 to 234. And a further analysis of invertebrates has identified more than 120 species including 78 aquatic beetles, several rare ones and two new to Scotland. That, I am told, is impressive!

The guys who work here have come from "Big Dairy" – industrial dairy farms. They joined us because they wanted balanced, meaningful, fulfilling jobs.

As we've got better at this method of farming, our costs of production have been getting closer to those of our industrial colleagues. Within the next two years I predict, as their costs soar but ours change little (since we don't buy-in much), we could reach parity.

Can we feed the world? Well, my industrial colleagues who produce 10,000 litres of milk per cow per year – roughly ten tonnes – have to purchase roughly 3½ tonnes of a cereal/soya feed to achieve that.

But if we take out the water element and adjust for food quality, for every tonne of human food value their cows produce, they remove more than two tonnes from the global food system. Hardly feeding the world. Our cows only eat leafy forage. No human food. Therefore, they are a net contributor to the global food supply.

It can be done!

Ours is just a tiny example of what is possible. Our experience as a family-sized, tenanted dairy farm is that compassionate, agroecological, nature-based farming can help address many of the numerous challenges facing society. Imagine what might be achieved were this approach to be allocated even a small percentage of the billions spent on conventional, technology-based research and development.

It can be done!

It was for all these reasons that, after many months of cajoling by a good friend in marketing, we branded our raw milk cheeses as being from "The Ethical Dairy". A much fuller version of our story, "A Dairy Story", is available online.

20 Poultry-centred regenerative agriculture

Tree-Range® chicken farming

Reginaldo Haslett-Marroquin

Introduction to the system's logical framework

Chickens, like any other livestock, are part of a magnificent design through which animals have evolved and then have been bred to deliver energy in the form of food. At Tree-Range® Farms, we don't think of ourselves as farmers or producers. We consider ourselves stewards of energy transformation and the chickens as critical entities in this system of energy transformation. Of course, they are sentient beings and providing a good life for them as well as good livelihoods for farmers is at the centre of our design.

Right now, global corporate propaganda asserts that to feed the world we must continue to implement farming systems that destroy ecological systems and disrupt our planet's climate. Nothing could be farthest from the truth.

We chose the chicken for our Tree-Range® business as the simplest entry point into the magnificent cycle of photosynthesis, animal intervention and soil health. It allows us to effectively engage earth and energy-based ecosystems.

Tree-Range® Farms is part of a "poultry-centred regenerative agriculture system" or a poultry-centred agroforestry production model. It is a business-based ecosystem with ecology at its heart.

Livestock are critical in optimising the energy transformation processes of any ecology. Domesticated animals, when re-introduced into a system under ancestral regenerative standards can re-ignite the energy transformation process of a landscape.

For thousands of years, Indigenous communities worldwide have built civilisations grounded on this knowledge. But when they separated themselves from this foundation their civilisations suffered – just as we are suffering on a global basis because of our separation from nature. At Tree-Range® Farms, we utilise Indigenous knowledge in a modern expression of engineering and design. By doing so, we deliver animal protein whilst achieving high-impact social, economic and ecological outcomes.

Our system is designed with chickens at the centre. We aim to provide animals' original jungle-like ancestral environment. This acts as a foundational engineering blueprint through which we codify processes like agronomics, farm management, animal density, understory and overstory species and ground-based forages.

We populate the land with species native or of critical economic, social and ecological importance to the specific region where the model is being applied. And so, our system optimises an environment where the chickens can thrive whilst securing multiple outputs from the same land. Forested paddocks, free-ranging chickens, high animal welfare, it all adds up to a true desire to do better for all.

DOI: 10.4324/9781032684369-26

For example, in the bordering region of Minnesota, Iowa and Wisconsin, we populated the system with native perennial plants with economic and social value. The system now delivers chickens, hazelnuts and elderberries. As the system matures there will be timber, biomass and non-timber forest products such as mushrooms and maple syrup.

By the end of 2023, Tree-Range® Farms and our non-profit partner the Regenerative Agriculture Alliance, along with 13 farming operations produced, processed and marketed 68,000 meat broilers. Fifty thousand hazelnuts were planted and we started harvesting nuts for the first time. We also built a community tree nursery. This means that new farms can have tree rootstock available as they come on board. We also introduced garlic production. Garlic aligns well with the nutritional profile of poultry manure.

But the design goes beyond the areas directly affected by the chickens. It includes more than 14 enterprise sectors within each region where the system is deployed. These include grain production, grain processing, poultry production, poultry processing, transportation, finance, technical assistance, land management and real estate business.

The production model is designed around a few key components.

- 1.5 acres divided into two paddocks planted with multiple understories and overstory perennials, and ground-level forages. The chickens are rotated back and forth between the paddocks from day 29 to day 70 when they are harvested for processing.
- A shelter for night-time protection.
- Feed and water supply infrastructure – both are designed for outdoor operation. Feed is only provided indoors for the first 28 days brooding period. After this period, the food is moved out to the paddocks and moved across to optimise ranging and foraging.
- A series of management principles have been developed to optimise the ground-level forage and grain sprouting capacity of the landscape under management.

For the first 28 days, the chickens stay indoors (brooding). During this time their organs develop and they reach a size that allows them to range. After this the chickens spend 100% of their daytime ranging outdoors where they are rotated between the two-paddock system.

The paddocks are planted with perennials and whole grain is sprouted on the ground to supplement their ground-up feed diet and forages. At night, the chickens come back indoors – into the coop where they are protected against predators, inclement weather and other night-time threats.

The chicken coop is critical for many reasons; protection under a secured structure is a particular consideration. Provision of the coop also respects the chickens' powerful homing instinct. Going back to the same spot to sleep every night is vital to reducing stress and improving animal welfare. It also means that most of their manure is deposited inside the shelter.

This manure is then removed and used to fertilise larger landscapes where the same perennial crops planted in the ranging paddocks are also cultivated. In the alleys between those perennial systems, a farmer can plant a multitude of annual crops, which can be fully fertilised with the poultry manure. This manure has a full spectrum nutrient profile that includes all 13 of the essential nutrients that plants need.

When fully deployed, a poultry-centred regenerative agriculture system can include up to 14 different enterprise sectors. Depending on the crop rotation schedule and preferred crops by regions of farmers, it can deliver between 100 and 250 high-quality different types of vegetables, fruits and nuts as system outputs.

When the larger landscape affected by the poultry is fully accounted for and integrated into the system's ecological, economic and social impact, the results are truly regenerative.

Asking the chickens what they need

The poultry-centred system design started in 2007. Our first step was to understand what we needed to do to design a production unit from a chicken's perspective. We literally asked them "What do you need?"

For Indigenous people, this is not a new question. It reflects the Indigenous intellect approach which allows us to see the other 95% of a solution missed by homocentric, linear and extractive approaches.

Indigenous ways are centred on regenerative ways of thinking, of knowing, learning, sharing and doing things. Regenerative outcomes can only materialise by incorporating a whole system view into the agronomics, practices on the land, farm and landscape design and the business ecosystem that brings the outputs to market. But those ways of doing things are the result of a much deeper, even spiritual understanding of the living systems of the planet.

From this perspective, a farm, or a product cannot be regenerative. Only ecosystems can optimise the earth's energy transformation capacity. This is defined by the biophysical and chemical processes that, governed by the laws of thermodynamics, ensure that energy is constantly becoming food and eaten. The eaters then become food; eventually that energy becomes expressed in forms that we humans harvest out of the ecosystem.

We can argue with authority that the food we harvest is an ecosystem service. And so, when we destroy whole ecosystems for food, the indicators of success used to measure system outputs can also scientifically verify the scale and level of destruction resulting from the process.

In regenerative systems, the ecology improves cycle after cycle, and the energy that circulates within to generate the outputs we harvest continuously improves. Our planet's living systems were originally built through these regenerative processes.

For tens of thousands of years, Indigenous peoples have asked their relatives – the trees, the bugs, the worms – what they need to thrive along us. Indigenous intellectuals have incorporated the answers into their designs for agriculture, governance, community organising and migration patterns.

The blueprint of our regenerative poultry production units follows this logic and methodology. The most important indicator of success in a production unit is measured by the level that the chickens are observed to behave just like jungle fowl – their wild ancestors.

Our fundamental principle is that chickens are meant to be outdoors and under the canopy of their ancestral habitat, the trees and the bushes of the jungle. Within this habitat chickens know how to protect themselves. Consequently, at Tree-Range® we have few or no incidents with predators when a system is either partially or fully established. This is because we have built a habitat where chickens can use their natural instincts.

And this approach works for any species. When an organism is taken out of their natural habitat they must adapt; for some this can take hundreds of generations. The chickens have not evolved sufficiently to do well in confinement, so we built them what they wanted – a jungle-like habitat (Figure 20.1).

Regenerating farmed landscapes

We developed this system to be applied anywhere in the world where some basic conditions are met. These conditions include:

- Sufficient water;
- Native perennial species that have ecological, social and economic value;

Figure 20.1 Chickens are meant to be outdoors and under the canopy of their ancestral habitat, the trees and the bushes of the jungle. Here, chickens can use their natural instincts. Photo by Tree-Range® Farms.

- Grains available for feed and sprouts;
- Basic materials for shelters; and
- Farmer willing to work collectively to aggregate products and build sufficient volumes to support minimal processing, marketing and distribution infrastructure.

The system is designed to aggregate small farmers to create large-scale systems. As the systems are deployed, grain production and processing, poultry production farms and other related enterprises are stacked within a business ecosystem. Together they assure the foundation for a coordinated, standardised and measurable large-scale impact.

Current ecological impact measurements include water infiltration; nitrogen cycling; carbon sequestration; animal welfare; restoration of native perennial species to a region; and soil biological health. Furthermore, nutrient density baselining data has been recently introduced and is starting to show positive trends towards a significant differentiation compared with other poultry systems. Through our work we get to reforest, protect water, engage rural economies, build communities and rebuild regionalised food systems.

The business ecosystem is managed by the Regenerative Agriculture Alliance (RAA). The RAA is a non-profit. Its main role is to support farmer outreach, training, technical assistance and business development. It also manages the process of organising community and ecosystem-level structures for governance and decision-making on collective wealth and property, plant and equipment management.

For example, the RAA is organising the Regenerative Poultry Council, that includes representatives from all different areas of the business ecosystem. The RAA also owns and operates

Figure 20.2 As the birds forage outside, they are also supporting the understory and the overstory from which we can harvest many fruits of the land. Photo by Tree-Range® Farms.

the poultry processing facility for the Minnesota–Iowa–Wisconsin bordering region. This is where the first regional deployment of Tree-Range® farms is taking place.

Tree-Range® Farms, Inc. is the market facing, aggregation, branding and distribution arm of the business ecosystem. This business structure in partnership with the RAA oversees the strategies associated with new business development. These include value added processing for vegetables, poultry products, hazelnuts, elderberries and other outputs of the system (Figure 20.2).

Conclusion

Replacing conventional poultry farming systems with regenerative systems is relatively straightforward when systems like the poultry-centred regenerative system are designed for scale. Each Tree-Range® poultry production unit can deliver up to 7,500 chickens once the soil and perennial cropping systems have been completely established.

Production units are then aggregated to build farm-level enterprises. These farms in turn are organised within regions to support value added and other business infrastructure, and to generate system-level outcomes at multiple levels (social, economic and ecological). This system is not only doable, but it also adds up to a significant food sovereignty and national security advantage.

Regenerative agriculture is not only the way of the future, but it was also always a better way all along.

21 Regenerative farming without farmed animals

Amir Kassam and Laila Kassam

Introduction

There is a myth being propagated that sustainable and regenerative agriculture must include farmed animals. Some even include farmed animals as a necessary default component in their definition of regenerative agriculture. There is neither a scientific nor an empirical basis for such a sweeping belief. Most crop farms generally have no or few farmed animals, and many farms that are managed sustainably from an ecological viewpoint have no farmed animals.

One of the main arguments supporting this myth is that farmed animals are essential for nutrient cycling through the supply of their manure. However, nutrient cycling occurs in nature all the time without the need for animal manure. Animal manure is derived from feeding vegetative biomass to farmed animals which is not a necessary process in nutrient cycling. In nature, vegetative biomass is incorporated into the soil by microorganisms and mesofauna (small soil animals, e.g., earthworms) continuously. The nutrients are then held in the soil in a biological form in the composition corresponding to that required by growing plants.

Earthworms are the best incorporators of vegetative biomass into the soil. In a healthy soil, there can be more than three million earthworms per hectare (ha) (Román-Vázquez et al. 2023). Earthworms mix biomass with mucus, gums and soil particles and produce nutrient-rich stable worm casts. Animal manure, on the other hand, is unstable and has a nutrient composition that is not optimal for crop growth, causing pollution and contamination of surface and underground water systems (Qi et al. 2023).

Integration of grazing cattle in production systems through rotational or mob grazing is also argued by some to be a beneficial or even necessary practice for the regeneration of grassland, soil health and carbon sequestration (Savory 2016). However, these claims have been widely criticised by scientists due to the lack of supporting empirical evidence (Nordborg 2016). The climate impact also seems to be overstated. An extensive review by Food Climate Research Network found: "The contribution of grazing ruminants to soil carbon sequestration is small, time-limited, reversible and substantially outweighed by the greenhouse gas emissions they generate" (Garnett et al. 2017). A recent study published in Nature showed that offsetting the methane and nitrous oxide emissions from farmed ruminants globally would require 135 gigatonnes of carbon increase in soil organic carbon in global grasslands, nearly twice the current global carbon stock in managed grasslands, and that grassland carbon stocks would need to increase by approximately 25%–2,000% (Wang et al. 2023).

In this chapter, we argue that regenerative agriculture does not require the integration of farmed animals or their products for soil health, climate sequestration or any other ecologically based reason. We highlight the destructive nature of the dominant tillage-based agriculture paradigm and put forward an alternative paradigm of Conservation Agriculture (CA) – a

DOI: 10.4324/9781032684369-27

regenerative agriculture paradigm that is by default plant-based and farmed animal-free – as the foundation for a future food and agriculture system that is sustainable and just for all: humans, other animals and the planet.

The destructive nature of conventional tillage-based agriculture

Regenerative agriculture production systems are self-protecting, self-repairing and self-sufficient and require minimal external inputs and intervention. For agriculture systems to be regenerative, and soils to be healthy and productive, farmers must manage the soil as a living and complex biological system, not an inert geological entity. Soil's agronomic productive capacity is ecologically derived from its many components, including its physical, biological, chemical, hydrological, climate and cropping system components. All these components interact dynamically in space and time within cropping systems and agroecological and socioeconomic environments, based on the knowledge and management expertise of the producer.

Kassam and Kassam (2021a) analysed several agriculture paradigms that are being promoted globally and compared their principles and processes to those found in natural land-based ecosystems. They illustrated the inherently destructive nature of the conventional tillage-based agriculture paradigm – the current dominant paradigm of agriculture globally – and therefore its inability to contribute sustainably and meaningfully to present and future societal needs. They highlighted the role of conventional tillage-based agriculture in causing soil, landscape and agroecological degradation and its consequent inability to function optimally in terms of output, profit, efficiency and resilience at any level of agricultural and economic development. Further, they showed that the degrading impact of conventional tillage-based agriculture also means it cannot adequately deliver ecosystem services – the contributions that ecosystems provide for human wellbeing. Ecosystem services include clean water, water storage and regulation, minimisation of runoff and soil erosion, enhancement of soil health and biodiversity, avoidance of land and environmental degradation, and promoting pollination, minimising greenhouse gases, etc.

The underlying reason for agricultural land degradation and loss of ecosystem services is the poor management of soil and landscape health on both small and large farms. This is caused by the following:

i Continuous mechanical disturbance of the soil through tillage, causing the loss of soil organic matter, destruction of soil structure, biology and health, leading to runoff, soil erosion, poor infiltration and water retention and debilitating soil and landscape mediated ecosystem services to society. In nature, there is no mechanical soil tillage.

ii Not protecting the soil surface against climatic extremes and not supplying biomass to maintain soil biology and function, as well as not contributing to maintaining healthy biodiversity, food webs and food chains below and above the ground surface. In nature, the ground is always covered with biomass which is continuously being incorporated into the soil to maintain soil health.

iii Not maintaining adequate crop diversity in rotations and associations to minimise so called "pest" (weed, insects and pathogens) infestations. In nature, vegetation is very diverse which provides several kinds of protection against "pests" and contributes to nutrient, water and carbon cycling (Kassam and Kassam 2021a).

In their analysis, the alternative paradigms of Organic Agriculture, Agroecology and conventional Regenerative Agriculture which incorporates farmed animals, all of which are promoted as sustainable, were also found to be suboptimal. Their weaknesses included reliance on tillage (Organic Agriculture and Agroecology) to mineralise soil organic matter to release plant nutrients, and use of farmed animals and/or their inputs (Organic Agriculture, Agroecology and Regenerative Agriculture).

They concluded that whilst these alternative paradigms

> have all turned agroecosystem development back around toward nature to varying degrees, none of them seem to go quite far enough… no production system or paradigm, which depends on intensive mechanical soil disturbance through tillage, does not treat permanent soil mulch cover (living or dead) as essential, and prefers to rely on farmed animal integration and animal manure for plant nutrients or regeneration rather than in situ recycling of nutrients and managing a positive nutrient balance, will be able to fully harness the desired range of supporting, regulatory, and provisioning ecosystem services that are necessary for society and nature.
>
> (Kassam and Kassam 2021b, pp. 209–210)

What is the ecological foundation for regenerative production management?

For the past five decades, it has been shown worldwide by farmers and researchers that for an agricultural production system to be regenerative and sustainable, the following three interlinked principles must be applied to provide a dynamic ecological foundation (Kassam et al. 2022):

1 ***Continuous minimum or no mechanical soil disturbance***: implemented by the practice of no-till seeding or broadcasting of crop seeds and direct placing of planting material into untilled soil; no-till weeding; minimum soil disturbance from any cultural operation, harvest operation or farm traffic. Sowing seed or planting crops directly into untilled soil and no-till weeding reduces runoff and soil erosion; minimises the loss of soil organic matter through oxidation; reduces disruptive mechanical cutting and compaction of the soil; promotes soil microbiological processes; protects and builds soil structure and connected pores; avoids impairing movement of gases and water through the soil; and promotes overall soil health.

2 ***Maintaining a permanent mulch cover on the soil surface***: implemented by retaining crop biomass, rootstocks and stubbles and biomass from cover crops and other sources of biomass from ex situ sources. Use of crop residues (including stubbles) and cover crops reduces runoff and soil erosion; protects the soil surface; conserves water and nutrients; supplies organic matter and carbon to the soil system; promotes soil microbiological activity to enhance and maintain soil health including structure and aggregate stability (resulting from glomalin production by mycorrhiza); and contributes to integrated weed, insect pest and pathogen management and to integrated nutrient and water management.

3 ***Diversification of species in the cropping system***: implemented by adopting a cropping system with crops in rotations and/or sequences and/or associations involving annuals and perennial crops, including a balanced mix of legume and non-legume crops and cover crops. Use of diversified cropping systems contributes to diversity in rooting morphology and root compositions; enhances microbiological activity; enhances crop nutrition and crop protection through the suppression of pathogens, diseases, insect pests and weeds; and builds up soil organic matter. Crops can include annuals, short-term perennials, trees, shrubs and nitrogen-fixing legumes as appropriate.

Figure 21.1 CA sunflower after winter wheat in a diversified rotation in Cordoba, Spain. Photo by Asociación Española Agricultura de Conservación. Suelos Vivos – AEAC.SV.

Figure 21.2 CA maize intercropped with a legume, hyacinth (*Lablab purpureus*) beans in a diversified cropping system in Arusha, Tanzania. Photo by Saidi Mkomwa.

The application of the above principles through context-specific and locally adapted corresponding practices, combined with context-specific complementary practices of integrated crop, soil, nutrient, water, pest and energy management, constitute CA (see Figures 21.1 and 21.2 for a sub-tropical location and a tropical location respectively). CA is an ecosystem approach to regenerative agriculture and land management (Kassam et al. 2022). CA-based regenerative systems are present in all continents, involving rainfed and irrigated systems including annual cropland systems, perennial systems, orchards and plantation systems, agroforestry systems, crop-livestock systems, pasture and rangeland systems, organic production systems and rice-based systems.

The intensive conventional tillage-based production systems are often referred to as the Green Revolution agriculture paradigm (Kassam and Kassam 2021a). These systems rely on production increases based on intensification of tillage and the notion that more output can only come from more purchased inputs, especially modern seeds, agrochemicals for crop nutrition and protection and energy for tillage and other production related operations (Stone 2019). In intensive conventional tillage-based systems, there is no real concern for soil and landscape health or for the need to maintain adequate crop diversification.

As noted above, alternative agriculture paradigms such as conventional Organic Agriculture systems are also unsustainable and degrading because of their heavy reliance on tillage to mineralise organic matter (including manure obtained from external sources) to release plant nutrients and consequently also poor concern for soil health, crop diversification and ecosystem services (Derpsch et al. 2024).

Whilst CA-based crop-livestock systems exist, none of the three CA principles require the integration of farmed animals or their inputs. In fact, we regard CA as plant-based by default. If farmers want to integrate farmed animals into their production systems that is their choice, but it is not *necessary* for regenerative production systems, and we believe that there are better choices to make. Proponents of regenerative agriculture using farmed animals often compare the carbon sequestration potential of grasslands grazed by animals with that of industrially grown crops using conventional tillage-based production systems (De Rosa et al. 2023). This is a false comparison. Comparing the carbon sequestration potential of grazed grasslands with CA-based crop production systems tells a different story. CA crop systems have higher biomass production (including root and microbial biomass) and carbon sequestration but with relatively low emissions of carbon dioxide, methane and nitrous oxide (Gonzalez-Sanchez et al. 2021). Additionally, the high opportunity cost of grassland systems, such as releasing the land for more efficient carbon sequestration, for CA-based production of annual and perennial horticultural crops and legumes to improve human nutrition and reduce imports, and for harnessing ecosystem services through ecosystem restoration, regeneration and rewilding, must also be considered. Thus, integrating farmed animals and their manure into farming systems is detrimental to the goals of regenerative agriculture and sustainable landscape management and has negative impacts on soil and landscape health, biodiversity, climate, as well as on the animals themselves (Scanes 2018).

The main benefits of farmed animal-free CA-based regenerative farming are:

- Restoration of soil health and function including the minimisation of soil degradation, runoff and soil erosion and maximisation of water infiltration and retention.
- Higher or comparable and stable yields with minimum use of purchased inputs; generally, CA systems require about 50% less production inputs including agrochemicals, fuel and labour and offer double the farm output and productivity than conventional tillage-based farming (Carvalho et al. 2012; Freixial and Carvalho 2010).
- Delivery of ecosystem services including greater volume of cleaner water, carbon sequestration, climate change adaptability and mitigation and reduced damage from extreme climatic events such as drought, floods, heat and cold (Kassam et al. 2020).
- Reduced capital investments due to decreased horsepower required for farm operations and increased operating life of farm machinery.

CA systems without farmed animals work optimally, regeneratively and are resilient because they:

- Have the ecological and biological foundations for sustainability;
- Have enhanced soil health status, biology and functioning;
- Have enhanced biodiversity above and below the ground;
- Have diverse plant root systems interacting with soil systems;
- Enable ecosystem services and benefits to flow to farmers and society;
- Have maximum efficiency and system output; and
- Enable the regeneration and rehabilitation of degraded lands.

The global transition to Conservation Agriculture

CA has been spreading across the world at an accelerating rate. In 2018, the total global CA annual cropland area (not including perennial CA systems such as orchards and vineyards whose area is also expanding globally) was approximately 205 million ha, about 15% of the total global cropland, spread across more than 100 countries. This represents an increase of approximately 99 million ha or 93% from 107 million ha in 2008, with the spread being more or less equally split between the Global South and the Global North. Overall, the increase in the global CA cropland area since 2008 has continued at an annual rate of approximately 10 million ha per year. From 1990 to 2008, the annual growth rate was about five million ha per year (Kassam et al. 2022). The push for CA globally has been generally farmer-led, but more recently there have been increasing levels of government and European Union (EU) support.

In Europe, CA covered 5% of cropland, about 5.6 million ha, in 2018. Since then, there has been a relatively rapid increase in land area managed under CA. In the EU, southern European areas in the Mediterranean region have made significant progress, including with perennial CA systems (Gonzalez-Sanchez et al. 2021).

In the UK, around one million ha of annual cropland area, about 25% of the total cropland area, has been transformed into CA (Reynolds 2023). The main drivers for this transformation are:

- Increasing awareness by farmers of CA;
- Machine companies and government making no-till seeders and roller crimpers accessible to farmers;
- Increased cost of production in recent years; and
- International pressure for agriculture to become part of the solution to several global crises that have involved breaching safe planetary boundaries such as climate breakdown, biodiversity loss and land degradation.

Recently, the global literature on CA was brought together by over 200 co-authors including CA farmers, researchers, policy analysts and extension agronomists, in three volumes: *Systems and Science*, *Practice and Benefits* and *Adoption and Spread* (Kassam 2020–2021). These volumes show the phenomenal growth of CA across every type of production system in every type of agroecology globally.

Looking ahead

As explained above, for farming to be regenerative and sustainable, production systems do not require the inclusion of farmed animals, but they must be managed based on the principles of

CA. In our view, CA currently offers the most promising way forward for regenerative farming. Looking ahead, organic forms of CA (either certified or uncertified) need to be promoted. Small- and large-scale organic CA systems already exist in all continents. More farms will adopt organic farmed animal-free CA systems if technologies to enhance and manage soil health and productivity and protect crops become more readily available and adoptable.

Given the current food and agriculture system is such a significant driver of the interconnected ecological, climate and planetary health crises, food system transformation is central to addressing them all. Transforming the current dominant agriculture paradigm into one that is regenerative and farmed animal-free is necessary but not sufficient to transform our food system into one that is sustainable and just for all.

For us, a just, sustainable and healthy future food and agriculture system is one that follows the framework of "inclusive responsibility" (Kassam and Kassam 2021c). An "inclusively responsible" food and agriculture system would

> encourage society to focus on agroecological sustainability as an integral part of overall ecosystem sustainability based on planetary boundaries… would place importance on quality of life, pluralism, equity and justice for all. It would emphasise the health, wellbeing, sovereignty, dignity and rights of farmers, consumers and all other stakeholders, as well as of nonhuman animals and the natural world.

Such a system would (Kassam and Kassam 2021c):

1 Be ecologically sustainable and multifunctional;
2 Be relevant for smallholders, their innovation and development strategies;
3 Meet the increasing need for sustainable and healthy whole-food plant-based diets;
4 Integrate into the wider social movements resisting the corporate food regime and fighting for local autonomy, food sovereignty and land and seed justice;
5 Respect and protect the rights of all sentient beings, both human and nonhuman, to live free from human oppression, exploitation and harm; and
6 Respect and protect the rights of nature based on a duty of care towards the Earth.

Whilst a shift to farmed animal-free CA can meet principles 1, 2 and in part 5, a food and agriculture system that is sustainable and just for all requires all six principles to be met. In particular, a shift to whole-food plant-based diets and the rewilding and restoration of land currently used by animal agriculture, including grazing cattle, are key levers to focus on. Only then will our food and agriculture system shift from being a key driver of multiple interconnected crises, to being part of the solution.

References

Carvalho M, Basch G, Calado J M G and Barros J F C, 2012. Long term effect of tillage system and crop residue management on soil carbon content of a Luvisol under rainfed Mediterranean conditions. *Agrociencia*, 16(Special Issue 3), 183–187. https://doi.org/10.31285/AGRO.16.667

De Rosa D, Ballabio C, Lugato E, et al., 2023. Soil organic carbon stocks in European croplands and grasslands: How much have we lost in the past decade? *Global Chang Biology*, e16992. https://doi.org/10.1111/gcb.16992

Derpsch R, Kassam A, Reicosky D, Friedrich T et al., 2024. Nature's laws of declining soil productivity and conservation agriculture. *Soil Security*, 14, 100127. https://doi.org/10.1016/j.soisec.2024.100127

Freixial R and Carvalho M, 2010. Aspectos prácticos fundamentales en la implantación de la agricultura de conservación/siembra directa en el sur de Portugal. *Proceedings of the European Congress on*

Conservation Agriculture: Towards Agro-Environmental Climate and Energetic Sustainability. Madrid, pp. 361–369.

Garnett T, Godde C, Muller A et al., 2017. Grazed and confused?: Ruminating on cattle, grazing systems, methane, nitrous oxide, the soi carbon sequestration question – and what it all means for greenhouse gas emissions. FCRN

Gonzalez-Sanchez E J, Basch G, Roman-Vazquez J et al., 2021. Conservation Agriculture in the agri-environmental European context. In: Kassam A (Ed.), *Advances in Conservation Agriculture Volume 3—Adoption and Spread*. Cambridge: Burleigh Dodds, pp. 149–184.

Kassam A (Ed.), 2020–2021. *Advances in Conservation Agriculture. Volume 1—Systems and Science, Volume 2—Practice and Benefits, Volume 3—Adoption and Spread*. Cambridge, UK: Burleigh Dodds, 575pp, 472pp and 639pp, respectivel.y

Kassam A and Kassam L, 2021a. Paradigms of agriculture. In: Kassam A and Kassam L (Eds.), *Rethinking Food and Agriculture: New Ways Forward*, pp. 181–218. Sawston, Cambridge: Woodhead Publishing.

Kassam A and Kassam L (Eds.), 2021b. *Rethinking Food and Agriculture: New Ways Forward*. Sawston, Cambridge: Woodhead Publishing.

Kassam A and Kassam L, 2021c. Towards inclusive responsibility. In: Kassam A and Kassam L (Eds.), *Rethinking Food and Agriculture: New Ways Forward*, pp. 419–430. Sawston, Cambridge: Woodhead Publishing.

Kassam A, Friedrich T and Derpsch R, 2022. Successful experiences and lessons from conservation agriculture worldwide. *Agronomy*, 12, 769. https://doi.org/10.3390/agronomy12040769

Kassam A, Gonzalez-Sanchez E J, Goddard T et al., 2020. Harnessing ecosystem services with conservation agriculture. In: Kassam A (Ed), *Advances in Conservation Agriculture,* vol. 2, pp. 391–418. Cambridge, UK: Burleigh Dodds.

Nordborg M, 2016. *Holistic Management – A Critical Review of Allan Savory's Grazing Method.* Uppsala: Swedish University of Agricultural Sciences & Chalmers (SLU).

Qi J, Yang H, Wang X et al., 2023. State-of-the-art on animal manure pollution control and resource utilization. *Journal of Environmental Chemical Engineering*, 11(5), 110462. https://doi.org/10.1016/j.jece.2023.110462

Reynolds T, 2023. The situation of Conservation Agriculture (CA) in United Kingdom. *European Conservation Agriculture Federation (ECAF) General Assembly*, 2–3 March 2023, Bari, Italy.

Román-Vázquez J, Moreno-García M, Repullo-Ruibérriz de Torres M A et al., 2023. *Conservation Agriculture: Moving towards the Preservation and Improvement of Biodiversity in Agricultural Ecosystems.* Brussels, Belgium: European Conservation Agriculture Federation (ECAF). https://ecaf.org/wp-content/uploads/2023/09/CA_Biodiversity_report_ECAF.pdf

Savory A, 2016. *Holistic Management: A Commonsense Revolution to Restore Our Environment.* Third Edition. Washington, DC: Island Press.

Scanes C G, 2018. Impact of agricultural animals on the environment. In: Scanes C G and Toukhsati S R (Eds.), *Animals and Human Society*, pp. 427–449. New York: Academic Press.

Stone G D, 2019. Commentary: New histories of the Indian green revolution. *The Geographical Journal*, 185(2), 243–250.

Wang Y, de Boer I J M, Persson U M et al., 2023. Risk to rely on soil carbon sequestration to offset global ruminant emissions. *Nature Communications*, 14, 7625. https://doi.org/10.1038/s41467-023-43452-3

22 Aquaculture must be part of the shift towards regenerative farming

Natasha Boyland and Elena Lara

Introduction

Aquaculture, the farming of aquatic plants and animals (e.g. seaweed, finfishes, shellfish), is the fastest growing animal food production sector of recent decades, increasing 5%–7% annually (FAO 2020).

Compared with agriculture, aquaculture is still in its infancy, but it is already following a similar destructive path to that of industrial farming on land. Intensive systems may appear productive in the short term, but they are unsustainable, with huge costs to the environment, human health, biodiversity and animal welfare (Whitmee et al. 2015). Whilst the urgent need for global food system transformation becomes more widely accepted, aquaculture is often left out of the discussion. Yet, aquatic foods provide around 17% of animal-based protein, and 7% of all proteins globally (FAO 2022).

Challenges for our global food system

How can we nourish our growing population, expected to approach 9.7 billion by 2050, in a healthy and sustainable way? This is one of the big questions currently facing humanity. Answering it is indeed a complex challenge, requiring us to simultaneously curb climate change, promote biodiversity, and achieve a healthy environment. However, the dominant narrative is commonly centred on the flawed belief that we must increase intensive production, to provide more calories to feed more people. However, authors of the 2018 Chatham House report state that "once post-harvest losses, processing, livestock, consumer waste and overeating are included, losses for the global food system exceed 60 per cent of calories produced" (Benton, Bailey and Bernice 2018). We already produce enough calories for the world's population, though they are unevenly distributed.

The conservation and sustainable use of marine resources is a global priority within the 2030 Sustainable Development Agenda, along with food security, responsible consumption and production, and ending malnutrition. Aquatic foods are becoming ever more relied upon to feed the world, address human nutrition, food security and poverty alleviation. Historically, they have predominantly come from wild-capture fisheries. However, according to the Food and Agriculture Organization of the United Nations (FAO), nearly 90% of assessed wild fish "stocks" are overfished or fished at maximum yields, leading to fish population reductions, extinctions and the collapse of marine ecosystems (Whitmee et al. 2015). With limited scope to increase wild-capture fisheries, future expansion of aquatic food production is expected to come from aquaculture. In fact, more than half the fishes eaten directly by humans already do (FAO 2020).

DOI: 10.4324/9781032684369-28

Over 600 different freshwater and marine animal species are now farmed worldwide. However, like agriculture, aquaculture is concentrated on a limited number of these. Around 35 species account for 90% of production, with just four (grass carp, silver carp, Indian carps, cupped oysters) making up ~30% of global aquaculture output by volume (Troell et al. 2014). Long-term reduction in species diversity is likely to threaten the global food system's ability to adapt to climate change and meet future human needs.

Food production or food conversion?

Traditionally, aquaculture within developing countries has mostly consisted of low trophic-level species (i.e., low in the food chain). For example, species that can feed on naturally occurring plankton growing in ponds (though ponds are often fertilised to increase plankton growth) or the marine environment and do not require additional feed to be added. These "unfed" systems are producing food with a net gain.

However, global aquaculture is becoming more intensive, with the increase of "fed" aquaculture, i.e. farming using supplementary feeds. Fed aquaculture rose from 60% before 2000 to 72.2% in 2020 (FAO 2022). Aquafeeds are produced using products from the crop, livestock and fisheries sectors, much of which are human edible (Naylor et al. 2021). This has serious implications for the resilience of the world's food system and aquaculture's contribution to it.

Focus within economically developed countries has turned to the farming of high-value, high-trophic level (i.e. high in the food chain), carnivorous species. Each step up a food web involves energy loss so, generally, the higher the trophic level of an animal, the more ecosystem energy is embodied in its production and the less efficient it becomes to farm. Farming carnivorous species (e.g., salmon, sea bass, sea bream, tuna, trout) is highly reliant on wild-caught fishes for feed ingredients. Most of this comes in the form of fishmeal and fish oil (FMFO), from wild fishes caught for this purpose by industrial fisheries (Alder et al. 2008). This practice is extremely wasteful, since FMFO is mostly from nutrient dense fishes that could instead be eaten directly by humans (Cashion et al. 2017). Hence, carnivorous species are produced at a net loss of food for people. This type of aquaculture is wastefully converting one fish protein to another.

Around one third (in tonnage) of all wild-caught fishes end up as FMFO, mostly used to create aquafeeds. Therefore, aquaculture is contributing to overfishing and putting pressure on wild populations. The species caught for FMFO are forage fish (e.g., anchovies, sardines, herring and mackerel) that play a key role in the marine environment, transferring energy from primary producers to higher trophic levels, including larger fish, marine mammals and seabirds (Alder et al. 2008). The capture of vast numbers of fishes for FMFO are also causing food security issues in the Global South. Industrial FMFO producers are equipped with more sophisticated fishing technologies and ships and outcompete local artisanal fisheries, damaging their livelihoods since they rely on small fishes as a food supply and income.

Increasing aquafeed demands are also a new driver of land-use change as feed manufacturers increasingly rely on soybean and cereals. It has been estimated that 49% of global aquafeeds cause direct or indirect feed-food competition, especially processed wild fish, maize and wheat (Sandström et al. 2022).

Aquatic animal welfare

Whilst acknowledging the wasteful use of marine resources as a serious threat to food security, it is critical to remember many of these "resources" are in fact sentient animals and must be regarded as such. Sentience is the capacity to have feelings, such as feelings of pain, pleasure, hunger, thirst, warmth, joy, comfort and excitement. There is substantial scientific evidence for sentience in fish, cephalopods and decapod crustaceans (Birch et al. 2021; Brown 2014). For example, studies reporting the presence of pain receptors and connections to the brain, reactions to painkillers, behavioural responses to pain or fear, individual preferences and associative learning. This means we must protect their welfare.

Commercial fisheries result in severe suffering to aquatic animals on a colossal scale; an estimated 1.1–2.2 trillion fishes (66.7 million tonnes (FAO 2022)) are caught and killed inhumanely every year, and around half of these (in numbers) are then reduced to FMFO (Mood and Brooke 2024). The number of individual crustaceans (5.6 million tonnes), molluscs (5.9 million tonnes) and other animals caught for food (503 thousand tonnes), and the various species caught as bycatch, is unknown (FAO 2022). Aquatic animals are caught in vast numbers and suffer poor welfare for extended periods. Many die from compression or injuries in the capture process. Those still alive when brought onboard the fishing vessel are not stunned and killed. Instead, they die from live gutting and/or suffocation in air or ice water. It can take up to one or more hours for them to lose consciousness (Mood and Brooke 2024).

Globally, an estimated 78–171 billion fishes were farmed in 2019, outnumbering the 80 billion farmed birds and mammals killed each year for food (Mood et al. 2023). This figure does not represent the total number farmed (due to mortalities during rearing and non-food production) and is expected to increase as aquaculture expands.

In aquaculture, animals are commonly reared intensively; they are kept at high stocking densities to maximise profit. Rearing systems are often barren and poorly suited to the species, leading to poor welfare as physical, mental and behavioural needs are rarely met. Animals often experience social stress and aggression, stressful handling and transport and starvation periods (Ashley 2007). Further, welfare research is limited for most farmed species, including for their physical requirements, ethological needs and parameters for humane slaughter. In fact, inhumane killing methods cause severe suffering for most farmed fishes, and less than 1% have any fish-specific legal protection at slaughter (Mood et al. 2023). Mortality rates during rearing are largely unknown, but there are examples of remarkably high rates where data is published, e.g., 14.6%–26.7% mortality for Scottish salmon (during seawater rearing alone) and 30%–50% mortality for Nile tilapia (Mood et al. 2023).

Farms often attract wild fishes and predators such as seals and seabirds. Predator attacks can clearly cause welfare problems for farmed fish, but there are also welfare issues for the wild animals involved since lethal control methods are commonly used by farmers. In some cases, farmed fishes escape from farms which can have implications for wildlife, e.g., transferring diseases into wild populations, displacing native fishes in their natural environment, and altering local biodiversity or genetic resources (Naylor and Burke 2005).

As well as benefits for the animals, better welfare is linked to enhanced food security, contributing to resilience, resource efficiency and social equity/responsibility outcomes, as concluded by the Committee on World Food Security (European Council 2019). For example, efforts to improve animal welfare can be translated to lower mortality, less pollution, healthier fishes and less antibiotic use (Compassion in World Farming 2023).

Aquaculture's environmental footprint

Environmental impacts depend on the type of production system, the species farmed, intensity, location and scale of aquaculture operations. Intensive practices, and many of the dominant species used in aquaculture, are resulting in serious environmental consequences (Chandararathna et al. 2021; Troell et al. 2019). Most commonly, impacts include decreased water quality and eutrophication, alteration or destruction of natural habitats, pollution, greenhouse gas emissions (mainly from feed production) and the introduction and transmission of aquatic animal diseases (Troell et al. 2019). Such impacts risk transgression of key planetary boundaries, the thresholds within which humanity can survive, develop and thrive for generations to come (Steffen et al. 2015).

Wild fisheries must also be considered within aquaculture's environmental impact, given the sourcing of FMFO for feeds. Fisheries are the key cause of marine biodiversity loss and are considered the greatest anthropogenic impact on the world's marine ecosystems (Watson et al. 2013). Recent research suggests that, as well as causing biodiversity collapse, stirring up the seabed releases large quantities of so-called "blue carbon" from marine sediments, which would otherwise remain locked away (Epstein et al. 2022).

Intensive aquaculture has promoted the growth of several bacterial diseases, leading to increased antibiotic use (Defoirdt et al. 2007). Antimicrobials are usually added to feeds but, in some cases, they are added directly to the water. The open nature of aquaculture systems has led to antibiotic residue build up in the farming and adjacent waters, wild fishes, plankton and sediments (Lulijwa, Rupia and Alfaro 2020). Overuse of antibiotics has resulted in the emergence and increase of antibiotic-resistant bacteria, and the transfer of these resistance determinants to bacteria of land animals and to human pathogens (Liu, Steele and Meng 2017).

Trends in aquaculture

Many aquaculture innovations focused on overcoming challenges (e.g., environmental problems) and limitations to growth result in further industrialisation of already intensive production systems. They are often seeking higher outputs and ways to introduce new high-value, carnivorous species. Due to the major environmental problems that can arise when aquaculture has close connections with the environment (e.g. sea cages in coastal waters), the industry has developed systems to farm on land or further offshore. There are also system innovations that combine the production of multiple species to better utilise wastes. However, many of these systems fail to solve environmental issues without creating new ones. They also fail to properly incorporate animal welfare in system design and to seriously question whether certain species are even suitable for farming.

Recirculating aquaculture systems (RAS)

RAS are industrialised, land-based, closed systems (retaining and reusing their water). They can be located far from coastal habitats, allowing aquatic farming anywhere that facilities can be available. However, these systems are expensive, technologically advanced, and are being established in high-income countries to produce high-value species (Troell et al. 2019). There is also very high energy and water use in RAS. Moreover, there are several significant animal welfare issues. For example, there is a high risk of mass mortality due to increased chances of disease spread, poor water quality and system failure. These risks are compounded by the inherent need for high stocking densities for RAS to be profitable. Furthermore, the tanks are entirely artificial and consign animals to a life in barren environments without complexity or enrichment, at detriment to their welfare.

Integrated multi-trophic aquaculture (IMTA)

IMTA is the farming of species from different trophic levels that have complementary ecosystem functions so that one species' uneaten feed and wastes, nutrients and by-products become fertiliser or feed for other species. Such systems are designed to take advantage of symbiotic interactions amongst species, minimising energy losses and environmental deterioration (Hughes and Black 2016). For example, combining fishes fed with feed pellets, with molluscs who filter-feed on organic matter in the water, and macroalgae that can feed on inorganic matter.

Reusing waste materials could enhance aquaculture sustainability, with environmental, economic and social advantages. However, where production still includes feed inputs that rely on wild fish populations or human-edible crops, their benefits may be used more to offset the negatives of an intensive system, rather than providing a real solution.

Farming octopuses and other unsuitable animals

Over the past decades, species have been introduced to intensive aquaculture systems without appropriate welfare consideration or research. As a result, most farmed species lack biological adaptations for confined environments, leading to significant welfare concerns (Franks, Ewell and Jacquet 2021). One such example can be seen in the recent developments to farm octopuses at commercial scale, in systems that cannot meet their needs.

Octopuses are solitary animals. The high stocking densities typical of intensive farming are entirely unsuitable for them, risking increased aggression and cannibalism (Mather and Scheel 2014). Intelligent and curious, octopuses are motivated to interact with their environment. Their mass production is likely to consist of barren, controlled and sterile environments which will lead to poor welfare. In addition, there is no humane slaughter method available, so they will experience prolonged pain and suffering when killed (Compassion in World Farming 2021).

As carnivores, octopuses would require a large amount of live or frozen natural food (e.g. crustaceans and fishes) if farmed – an unsustainable practice as described previously. And while the main markets for farmed octopus are largely food secure countries (e.g., European countries, the US, Japan), their production will heavily rely on wild fishes often caught from lower income countries. This impacts the vulnerable communities that rely on these fishes for nutrition and income.

Regenerative aquaculture

Regenerative aquaculture is aquatic farming that focuses on maintaining a healthy environment through the nature of the farming activities and outcomes (e.g. low or no inputs, carbon and nitrogen fixation and net benefits to marine ecosystems, conserving biodiversity), whilst emphasising contributions to social wellbeing (Mizuta, Froehlich and Wilson 2023). This involves farming of low impact, sustainable and/or native species and practices aimed at decreasing environmental stressors, e.g. minimising feed use, banning the use of toxic substances, avoiding introducing alien species and preventing escapees.

Given that each step up a food pyramid involves a loss of energy, farming at lower trophic levels (i.e. lower in the food chain) is more efficient. The cultivation of low-trophic plant and animal species can provide ecological services, help mitigate climate change, provide healthy and nutritious food and address food security (Froehlich et al. 2019). A recent United Nations paper on nutrition stated that "encouraging people to eat low-trophic aquatic foods is undoubtedly the prime strategy for using our aquatic nutrient resources more efficiently and mitigating the environmental impacts of food production" (Cardinaals et al. 2023).

Bivalves

The farming of bivalves (molluscs with a shell, e.g. oysters, clams, mussels) requires no feed, fertilisers, herbicides, chemicals, drugs or antibiotics. It also has a smaller environmental footprint than most other food production, using almost no land or freshwater. Instead, it relies on seawater, has lower carbon emissions than many cereal crops and helps to restore and protect coastal ecosystems (Willer and Aldridge 2020). Bivalve molluscs are filter feeders; therefore, they can buffer estuaries and coastal waters against phytoplankton blooms, increase water clarity, provide nursery habitats for fish, provide coastal flood and storm protection and capture carbon via shell production (Willer and Aldridge 2020). Also, bivalves often have a higher protein content per calorie compared with many meats and plant crops, as well as high levels of omega-3 fatty acids, iron, zinc, vitamin B12 and vitamin A per calorie (Willer and Aldridge 2020).

Algae

Another low-trophic food group being farmed is algae. They play a vital role in the aquatic ecosystem by forming the energy base of the food web for all aquatic organisms. They provide various environmental benefits and ecosystem services, such as reducing eutrophication and ocean acidification, carbon capture or sequestration, habitat provision, shoreline protection (Cai et al. 2021). Seaweeds, a type of macroalgae, are rich in some health-promoting components such as dietary fibre, omega-3 fatty acids, essential amino acids and vitamins A, B, C and E. Farming seaweed can create sustainable food and other products with minimal requirements of land, water and energy.

Fish

Some farmed fishes are lower trophic species, e.g., omnivorous fishes such as tilapia and carps. However, the way fishes are farmed, and the intensity of the system is key. Only when fishes are reared in extensive (e.g., pond) systems, at low stocking densities, without demands for "optimal growth rates", can they be produced without feed and therefore be properly considered low-trophic species (Strand et al. 2022). Currently, many such omnivorous species are farmed intensively, with feeds containing FMFO, meaning their effective trophic level is high.

Conclusions and recommendations

The food system is a major driver of climate change and there is growing recognition that global food system transformation is needed. For the United Nation's Sustainable Development Goals (SDGs) to be achieved, we need to rebuild the system to be healthier and more diverse, resilient and fair. But focus is often on the impacts of agriculture, with aquatic food largely overlooked. Those studies that do consider aquaculture tend to focus on a few economically valuable finfish, without considering the broader nutritional and cultural value of diverse aquatic foods. This is a barrier to our understanding, given that aquatic foods are deeply interconnected with the rest of the food system. Some of the ingredients for agriculture come from fisheries, and likewise, agricultural crops provide feed inputs for aquaculture. Environmental impacts from each sector can affect the other, and both contribute to changes in land use and depletion of freshwater.

Production of carnivorous species is expanding due to their profitability, but they are inherently unsustainable, especially in relation to FMFO use. A recent study estimated that seafood availability from the wild could be almost doubled if all current wild-caught seafood were used for human food (i.e., not for animal feed) and the use of edible by-products were increased (Cardinaals et al. 2023). As such, the aquaculture industry should phase out its reliance on human-edible, high-quality forage fish and crops. Humans should not be in competition for food with farmed animals.

It is crucial that farmed aquatic animals have high welfare and experience a good life. Research is urgently needed to address the significant knowledge gaps for existing farmed species. This should be a prerequisite for future aquaculture industries. Species that are not well suited to farming conditions, and are not able to experience high welfare, should not be farmed.

It is vital to move towards truly sustainable aquatic farming if we are to preserve aquatic ecosystems, reduce antibiotic use, curb GHG emissions and protect animal welfare.

Future aquaculture should refocus on the farming of low trophic-level species that require minimal/no feed and can provide ecosystem benefits. Of course, alongside changes in production, changes in consumption patterns are needed. Public food policies should favour more diverse and low-trophic farmed species and communicate their many health, social and environmental benefits.

There is enormous potential in regenerative aquatic food production. These systems could help solve some of the most critical global challenges. As the future of food systems is discussed around the world, aquatic foods must be an integral part of the debate.

References

Alder J et al., 2008. Forage Fish: From Ecosystems to Markets. *Annual Review of Environment and Resources*, 33:153–166. http://www.fishbase.org

Ashley P J, 2007. Fish Welfare: Current Issues in Aquaculture. *Applied Animal Behaviour Science*, 104(3–4):199–235. https://www.sciencedirect.com/science/article/pii/S0168159106002954

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0205683

Benton T, Bailey R and Bernice L, 2018. Breaking the Vicious Circle: Food, Climate & Nutrition. https://accelerator.chathamhouse.org/article/breaking-the-vicious-cycle-food-climate-nutrition/

Birch J et al., 2021. The London School of Economics and Political Science Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans.

Brown C, 2014. Fish Intelligence, Sentience and Ethics. *Animal Cognition*, 18(1):1–17.

Cai J et al., 2021. *Seaweeds and Microalgae: An Overview for Unlocking Their Potential in Global Aquaculture Development*. Food and Agriculture Organization of the United Nations (FAO). https://archimer.ifremer.fr/doc/00705/81738/

Cardinaals, R et al., 2023. Nutrient Yields from Global Capture Fisheries Could Be Sustainably Doubled through Improved Utilization and Management. *Communications Earth & Environment*, 4(1):1–10. https://www.nature.com/articles/s43247-023-01024-9

Cashion, T et al., 2017. Most Fish Destined for Fishmeal Production Are Food-Grade Fish. *Fish and Fisheries*, 18(5):837–844.

Chandararathna Uthpala et al., 2021. Animal Welfare Issues in Capture-Based Aquaculture. *Animals*, 11(4): 956. https://www.mdpi.com/2076-2615/11/4/956/htm

Compassion in World Farming, 2023. Rethinking EU Aquaculture: For People, Animals and the Planet. https://www.ciwf.org/resources/reports-position-papers-briefings/rethinking-eu-aquaculture-for-people-animals-and-the-planet/

Defoirdt T et al., 2007. Alternatives to Antibiotics to Control Bacterial Infections: Luminescent Vibriosis in Aquaculture as an Example. *Trends in Biotechnology*, 25(10):472–479. https://pubmed.ncbi.nlm.nih.gov/17719667/

Epstein G et al., 2022. The Impact of Mobile Demersal Fishing on Carbon Storage in Seabed Sediments. *Global Change Biology*, 28(9):2875–2894. https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.16105

European Council, 2019. Animal Welfare: Council Adopts Conclusions – Consilium. https://www.consilium.europa.eu/en/press/press-releases/2019/12/16/animal-welfare-council-adopts-conclusions/

FAO, 2020. The State of World Fisheries and Aquaculture 2020: Sustainability in Action.

FAO, 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation.

Franks B, Ewell C and Jacquet J, 2021. Animal Welfare Risks of Global Aquaculture. *Science Advances*, 7(14):1–8.

Froehlich, H et al., 2019. Blue Growth Potential to Mitigate Climate Change through Seaweed Offsetting. *Current Biology*, 29:3087–3093. https://doi.org/10.1016/j.cub.2019.07.041

Hughes A D and Black K D, 2016. Going beyond the Search for Solutions: Understanding Trade-Offs in European Integrated Multi-Trophic Aquaculture Development. *Aquaculture Environment Interactions*, 8:191–199.

Liu, Xiao, Steele J C and Meng X Z, 2017. Usage, Residue, and Human Health Risk of Antibiotics in Chinese Aquaculture: A Review. *Environmental Pollution*, 223:161–169.

Lulijwa R, Rupia E J, and Alfaro A C, 2020. Antibiotic Use in Aquaculture, Policies and Regulation, Health and Environmental Risks. *Reviews in Aquaculture*, 12(2):640–663. https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12344

Mather J A and Scheel D, 2014. Behaviour. In: José Iglesias, Lidia Fuentes, and Roger Villanueva (Eds.), *Cephalopod Culture*. Dordrecht: Springer Netherlands, 17–39. http://link.springer.com/10.1007/978-94-017-8648-5

Mizuta D D, Froehlich H E, and Wilson J R, 2023. The Changing Role and Definitions of Aquaculture for Environmental Purposes. *Reviews in Aquaculture*, 15(1):130–141. https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12706

Mood A and Brooke P, 2024. Estimating Global Numbers of Fishes Caught from the Wild Annually from 2000 to 2019. *Animal Welfare*, 33:e6. https://www.cambridge.org/core/journals/animal-welfare/article/estimating-global-numbers-of-fishes-caught-from-the-wild-annually-from-2000-to-2019/83F1B933E8691F3A552636620E8C7A01

Mood A, LaraE, Boyland N K and Brooke P, 2023. Estimating Global Numbers of Farmed Fishes Killed for Food Annually from 1990 to 2019. *Animal Welfare*, 32:e12. https://www.cambridge.org/core/journals/animal-welfare/article/estimating-global-numbers-of-farmed-fishes-killed-for-food-annually-from-1990-to-2019/765A7CCA23ADA0249EF37CFC5014D351

Naylor R and Burke M, 2005. Aquaculture and Ocean Resources: Raising Tigers of the Sea. *Annual Review of Environment and Resources*, 30(1):185–218. http://www.annualreviews.org/doi/10.1146/annurev.energy.30.081804.121034

Naylor R et al., 2021, A 20-Year Retrospective Review of Global Aquaculture. *Nature*, 591(7851): 551–563. https://www.nature.com/articles/s41586-021-03308-6

Sandström V et al., 2022. Food System By-Products Upcycled in Livestock and Aquaculture Feeds Can Increase Global Food Supply. *Nature Food*, 3(9):729–740. https://www.nature.com/articles/s43016-022-00589-6

Steffen W et al., 2015. Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science*, 347(6223). https://www.science.org/doi/10.1126/science.1259855

Strand Å et al., 2022. Overview of Culture Systems for Low Trophic Species Part of the AquaVitae MOOC Reading Material. Report No. 818173.

Troell M et al., 2014. Does Aquaculture Add Resilience to the Global Food System? *Proceedings of the National Academy of Sciences of the United States of America*, 111(37):13257–13263. https://www.pnas.org/doi/abs/10.1073/pnas.1404067111

Troell M et al., 2019. The Role of Seafood for Sustainable and Healthy Diets. The EAT-Lancet Commission Report through a Blue Lens Overview of Tuna Aquaculture View Project. https://www.researchgate.net/publication/335397522

Watson R A et al., 2013. Global Marine Yield Halved as Fishing Intensity Redoubles. *Fish and Fisheries*, 14(4):493–503. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-2979.2012.00483.x

Whitmee S et al., 2015. Safeguarding Human Health in the Anthropocene Epoch: Report of the Rockefeller Foundation-Lancet Commission on Planetary Health. *The Lancet*, 386(10007):1973–2028. http://dx.doi.org/10.1016/S0140-6736(15)60901-1

Willer D F and Aldridge D C, 2020. Sustainable Bivalve Farming Can Deliver Food Security in the Tropics. *Nature Food*, 1(7):384–388. https://www.nature.com/articles/s43016-020-0116-8

Part 6

Routes to food systems transformation

Changing the financial architecture

23 Countering corporate and financial concentration in the global food system

Jennifer Clapp

The global industrial food system is increasingly characterised by corporate and financial concentration that has enormous implications for society and the natural environment. At nearly all nodes of global food supply chains, from farm inputs such as seeds, chemicals and fertilisers, to trade, to processing and food retail, a few giant firms and financial investors have an outsized role in determining outcomes.

Corporate and financial power in the food system is jeopardising broader food system goals and functions by driving inequities, promoting unhealthy diets and fuelling environmental degradation. It is imperative to take measures to curb the power of corporate and financial actors in the global food system if we are to have any hope of transforming food systems to be more equitable and sustainable.

The extent of concentration in the food system

Just a handful of giant global firms dominate most functions within the global food system (Clapp 2022b). Only six firms control nearly 80% of the global agricultural chemical market and nearly 60% of the global seed market. These include some of the biggest firms, such as Bayer, Corteva, Syngenta Group and BASF.

The global grain trade is controlled by just four firms – Archer Daniels Midland, Bunge, Cargill and Louis Dreyfus. Collectively, they account for 50%–70% of the international trade in staple grains. Although not as concentrated, the food processing sector is also dominated by large and powerful firms such as Nestlé, Unilever and Coca Cola, amongst others (Clapp 2022b).

The top ten firms in the processed foods sector account for more than one third of the sales of the top 100 firms globally and rake in enormous revenues. The food retail sector, a market worth approximately US$8 trillion, is also highly concentrated in many countries as well as globally (IPES-Food 2017).

Corporate mergers and acquisitions amongst the large agri-food companies have been key in accelerating concentration in the sector. Over the past several decades, some of the largest corporate mergers have been in the agri-food sector. Giant deals such as the combination of Kraft and Heinz in 2013, the merger of Dow and DuPont in 2015 and the merger of Anheuser Busch InBev and SAB Miller in 2008, were each worth more than US$100 billion.

A raft of other mergers has also driven concentration. Such mergers include a major shakeup in the agricultural seed and chemical industry when Bayer purchased Monsanto in 2018, the purchase of Syngenta by ChemChina and the merger of Agrium and Potash Corp in 2016. The latter created the largest fertiliser company in the world. These are examples of just some of the many mergers and acquisitions in the sector in recent years.

DOI: 10.4324/9781032684369-31

Financial incentives have been a leading force in driving these mergers and acquisitions. Close examination of this dimension also reveals the extent to which financial investors themselves have become highly concentrated actors influencing food system outcomes.

This growing role of financial actors in the food system has occurred alongside a greater financialisation of the wider global economy. Financial actors, institutions and their motives now shape economic outcomes.

Financial investors are increasingly seeking to profit from changes in global grain futures markets, for example, by speculating on price shifts in globally traded agricultural commodities. Concentrated grain firms also partake in financial deals on futures markets, which have yielded them massive profits. We saw this happen in the wake of the Russian invasion of Ukraine, which sent grain futures prices soaring (UNCTAD 2023).

Financial actors have also accelerated the rate of concentration in the food system by pressuring firms in which they invest to increase their financial returns. When large firms in the food system face declining profitability, they are increasingly pressed by shareholders to reduce operating costs and increase their market share. This is usually accomplished by large firms moving to buy up their rivals. This trend, which accelerated in the context of very low interest rates in recent decades, makes it easy for these firms to borrow money to close merger deals.

Such trends have been exacerbated by an enormous increase in institutional investment in the food and agriculture sector that has also helped accelerate and deepen concentration. For example, the world's largest asset management companies – BlackRock, Vanguard, State Street and Capital Group – collectively manage more than US$20 trillion of investment in the global economy.

These financial firms have moved en masse into investments in the food system, and now own significant shares in the world's largest agri-food firms. Together, these companies own, on average, 15%–30% of the shares in each of the largest agricultural and food firms across global food supply chains (Clapp 2019).

This phenomenon, referred to as "common ownership", means that a handful of financial investment firms, as large shareholders, have enormous power over the actions of multiple firms in the sector. Research on common ownership shows that the influence of these financial firms on the firms in which they hold shares tends to reduce competition and encourage corporate concentration (Torshizi and Clapp 2021).

The upshot of these recent trends in the sector is that there are high degrees of concentration whereby just a few giant corporate and financial actors have enormous capacity to influence outcomes in the global food system.

The consequences of extreme corporate and financial concentration for food systems

Being large does not necessarily mean that a firm will pursue strategies that have a negative impact on food systems. And financial investment in the sector is not always harmful, especially when it is channelled towards initiatives that promote greater equity and sustainability in food systems.

However, there are clear concerns when specific markets are dominated by a handful of firms dominated by a few financial investors prioritising financial returns over other food system goals. Notably, those firms and investors have access to different kinds of power that could be used to advance their own interests at the expense of society and the environment. These different aspects of corporate and financial power have enormous implications for justice, the environment and health within food systems.

Dominant corporate and financial actors, particularly in highly concentrated markets, have what economists refer to as "market power", enabling them to influence supply and demand within the marketplace. Such market power allows the large and dominant actors to effectively influence producer and consumer prices within the food system. This affects all who produce food, food systems workers and consumers.

Concentrated food processing and retail firms, for example, have market power over suppliers. When there are just a few buyers, those suppliers have little if any choice of buyers when selling their goods. This is a common problem in the livestock sector for example, where markets are highly concentrated (Hendrickson et al. 2020).

It is also a problem in global retail markets for fruits and vegetables. Here small-scale producers in developing countries have little leverage over the price they receive for their produce (de Schutter and Cordes 2011). Large commodity trading firms and financial investors who trade in commodity futures also have a huge capacity to influence the volatility of food prices. Their speculative investment activity reduces consumers' access to food when prices rise because of the trades (Clapp and Isakson 2018).

And the few firms marketing agri-food items in the retail sector have enormous capacity to elevate prices paid by consumers. There is growing concern in many countries over what many deem to be "profiteering" by food retail companies in the wake of the COVID-19 pandemic and the Russian invasion of Ukraine. During this period, we have seen food prices rise by far more than general inflation (Cronin 2023).

Concentrated firms in the agri-food sector also have the power to erect barriers that keep other firms out of the marketplace to reduce competition. When these firms are able to benefit from economies of scale and other technological advantages, such as patent protections, they can extend their dominance within the sector. These kinds of dynamics are common in the seeds and farm machinery sectors, where it has become extremely difficult for smaller firms to break into those markets.

When only a few firms dominate within a sector, they also have the power to shape the material aspects of food systems in important ways. For example, large firms that determine the dominant technologies farmers use to grow food, overwhelmingly tend to focus on selling high-tech machinery and seeds that are more profitable for them. However, these products can have enormous costs for farmers and for society at large. Farmers who wish to access more traditional and ecologically sustainable technologies are often unable to access those alternatives.

Furthermore, when only a few firms dominate in the middle part of food supply chains, they also play a huge role in shaping labour conditions. In many parts of the food system, modern slavery type work conditions are common, as witnessed on tea plantations and in the seafood processing sector (LeBaron 2020). During the COVID-19 pandemic, the poor labour conditions of meatpacking workers came to light, revealing weak rights and low pay (Klassen and Murphy 2020).

Consumers also have fewer choices when just a few dominant firms determine what products end up on supermarket shelves.

Large and concentrated firms all across agri-food supply chains can shape food system policy and governance in ways that serve their own agendas, rather than the public interest. When only a few firms dominate within a market, they are more able to coordinate their lobbying activities to gain access to policymakers and plead their case for fewer regulations.

The amounts these firms spend on lobbying can be considerable. For example, when Bayer was in the process of purchasing Monsanto from 2016 to 2018, the US government was at the time evaluating whether to approve glyphosate, the main herbicide sold by Monsanto. Bayer spent huge sums annually to lobby policymakers – US$9 million and US$14 million per year during that time to influence the regulatory decisions that would serve its interests (Clapp 2021).

Large corporate players can influence policy and governance by funding scientific studies that support their products (Fabbri et al. 2018). They also frequently place corporate actors in government regulatory positions and vice versa. This is known as the "revolving door" between industry and government, which can have huge implications for regulatory decisions (Nestle 2019).

The capacity of large corporate and financial actors to wield power and influence in the food system matters in multiple ways. First, it matters for justice and rights within food systems because corporate power can undermine the agency and voice of less powerful actors within those systems. Specifically, small-scale producers, women, racialised communities and ordinary citizens cannot readily interact with food systems on their own terms because of the undue power of large corporate and financial actors.

When corporations and financial investors call the shots they can bargain down prices paid to suppliers, drive up prices paid by consumers and farmers and cut costs by weakening working conditions for food system workers. Such actions drive up their own profits, whilst further fuelling inequity within the food system.

Financial investors can also exacerbate food price volatility when they speculate on food commodities. This affects food access for all and especially those on limited incomes. And when those same actors have influence over policy and governance, citizens have less say over how the food systems on which they rely for food security and livelihoods are governed. Those who are most affected by poverty, hunger and malnutrition typically have the least agency in food systems. This situation is exacerbated by uneven power dynamics that work against the goals of equity and justice (IPES-Food 2023).

Food systems that are shaped by excessive corporate and financial power also influence the healthfulness of foods offered within those systems. Agri-food firms often go to great lengths to show that their foods are healthy. However, there is growing evidence that ultra-processed foods marketed as having specific healthful nutrients are associated with numerous health problems, including diabetes and high blood pressure. Yet firms and their financial backers continue to market these foods because they are highly profitable, due to their addictive nature (Wood et al. 2021).

Corporate and financial actors increasingly claim that their activities do not impose ecological costs. Many have been active in signing onto sustainability certification schemes in a bid to position their products as being ecologically sound. For example, commodity trading firms advertise that the commodities they market, such as palm oil and cocoa, are certified as grown using sustainable practices. However, results have been weak, and deforestation in the countries where they source their products continues (Dauvergne 2018; Grabs and Carodenuto 2021). At the same time, ultra-processed foods that rely on these commodity ingredients have been shown to have higher environmental costs associated with high energy use (Anastasiou et al. 2022).

Seed and agricultural chemical firms make the case that genetically modified seed and herbicide combinations enable no-till farming methods that sequester carbon in the soil. However, these methods rely on continued chemical use and only have marginal capacity to reduce carbon emissions. Meanwhile the same companies rake in profits by selling the chemicals whilst also establishing their own soil carbon credit schemes, which creates a massive conflict of interest (Kelloway 2021).

What are the lessons for the food systems transformation agenda?

The highly concentrated segments of agri-food supply chains are effectively locked in with financialised agri-food markets (Clapp 2022a). The result is that large and dominant corporate and financial actors end up pursuing avenues that are most profitable for themselves and their investors. Consequently, little private funding goes towards genuine alternatives.

This lock-in of concentrated corporate and financial actors and incentives has huge implications for food systems, as outlined above. It is imperative to overcome these lock-ins if we hope to achieve true food systems transformation. There are several initial policy changes that can work towards breaking these lock-ins and creating more space for alternatives that better serve society and the environment.

First, there is a need for stronger and wider competition policies. In most countries, competition policies in recent decades have focused quite narrowly on the price impacts of mergers and acquisitions. The policies have ignored the broader questions of market structure and the ways in which concentration can undermine people's agency and drive inequities within food systems.

It is entirely possible that corporate mergers and acquisitions could drive prices lower even whilst creating other anticompetitive effects. There is a growing anti-monopoly movement calling for stronger anti-trust policies specifically to address the question of corporate power and to restore democracy (Khan 2018). It is necessary for competition policies to look not just at prices, but also market structure, innovation, environment, health and agency and participation within food systems. This broader approach is needed to create spaces for a more diverse base of food system enterprises that can bring more diversity into food systems.

There is also a need for stronger regulation of agricultural commodity markets to reduce volatility caused by excessive financial speculation and profiteering by large corporate commodity trading firms. Whilst there has been some move towards improving regulations following the 2008 financial crisis, these measures so far have been weak and ineffective.

The UN Conference on Trade and Development (UNCTAD) is now calling for stronger transparency rules and stricter regulation on commodity trading firms and stronger rules on financial speculation on futures markets (UNCTAD 2023). Such measures are necessary to expose how these kinds of transactions affect people's access to food and drive inequities within food systems.

In addition to stronger regulations, there is a need for more public sector financial support for the development of alternative food production and trade. To transform food systems in ways that foster more diversity and sustainability, the public sector must encourage innovations not solely driven by the profit agendas of big business and financial investors.

National governments can also do more to build and support infrastructure that benefits smaller scale producers, processers and retailers in the food system. Ideally, the design of these research and funding programmes would be inclusive of end-users and put sustainability and diversity at the centre of their design.

Agroecology, for example, is a model that currently only receives a tiny proportion of public research funding and market support. However, it shows enormous promise for making food systems more sustainable and just (IPES-Food 2020). This model of food production is more than just a production method. It is also a social movement seeking to reframe entire food systems from production to consumption. The aim is a food system that centres on sustainability and human rights rather than corporate control of the food system (Anderson et al. 2021).

Another area for change is the adoption of policies to unwind the corporate capture of food policy and governance processes, especially in food systems. Stricter measures, for example, to prevent conflicts of interest are essential. Furthermore, it is important to call out "multistakeholder" initiatives that are merely Trojan horses enabling corporate actors to infiltrate public governance processes (Corporate Accountability and FIAN International 2022).

Governments can also do much more to democratise policy and governance spaces in food systems. They must ensure wider participation in decision-making and that key goals such as the right to food and food system sustainability are prioritised over corporate profit-making. Support for the establishment of democratic and community-anchored local food policy councils and public consultations are some steps that could move in this direction (IPES-Food 2023).

These are only the initial steps needed to redirect the process of food systems transformation away from concentrated corporate and financial influence.

Conclusion

We are witnessing unprecedented concentration within food systems. This is encouraged by financial investment and corporate profit incentives that have further generated food price volatility, profiteering and mergers and acquisitions within food systems. Such dynamics have resulted in ever larger firms and financial actors that dominate food supply chains. And these are not just global trends. They are playing out in food systems all over the world and in many contexts.

The concentrated firms and financial actors dominating food systems hold inordinate power to shape markets, material conditions and policy and governance in ways that can negatively affect important food systems goals including sustainability and equity.

Because of these effects, addressing corporate concentration must be on the agenda for food systems transformation. To date, there has been little attention paid to this issue at the global level. However, there is growing focus on the role of corporate power in food systems at the national and subnational levels (Canfield et al. 2021).

The power of these firms to shape food systems requires deeper policy attention at all levels. Although there have been some recent moves towards the policy directions needed such as stronger anti-trust policies, there is still a long way to go. Getting there is vital to ensure food systems are on the path towards a true transformation that ensures equity, justice and sustainability.

References

Anastasiou K, Baker P, Hadjikakou M et al., 2022. A Conceptual Framework for Understanding the Environmental Impacts of Ultra-processed Foods and Implications for Sustainable Food Systems. *Journal of Cleaner Production*, 368:133155.

Anderson, C R, Janneke B, Chappell M J et al., 2021. *Agroecology Now!: Transformations Towards More Just and Sustainable Food Systems*. Cham: Springer International Publishing.

Canfield M, Anderson M and McMichael P, 2021. UN Food Systems Summit 2021: Dismantling Democracy and Resetting Corporate Control of Food Systems. *Frontiers in Sustainable Food Systems*, 5. https://doi.org/10.3389/fsufs.2021.661552

Clapp J, 2019. The Rise of Financial Investment and Common Ownership in Global Agrifood Firms. *Review of International Political Economy*, 26(4):604–629.

Clapp J, 2022a. Concentration and Crises: Exploring the Deep Roots of Vulnerability in the Global Industrial Food System. *The Journal of Peasant Studies*, 50(1):1–25.

Clapp J, 2022b. The Rise of Big Food and Agriculture: Corporate Influence in the Food System. In: *A Research Agenda for Food Systems*, edited by Colin Sage, pp. 45–66. Cheltenham: Edward Elgar.

Clapp J and Isakson S R, 2018. *Speculative Harvests: Financialization, Food and Agriculture*. Halifax: Fernwood Publishing.

Corporate Accountability and FIAN International, 2022. Corporate Capture of FAO: Industry's Deepening Influence on Global Food Governance. https://www.fian.org/files/files/CorporateCaptureoftheFAO-EN.pdf

Cronin D, 2023. Food Prices Are Still High. What Role Do Corporate Profits Play? *Civil Eats*. https://civileats.com/2023/05/22/food-prices-are-still-high-what-role-do-corporate-profits-play/

Dauvergne P, 2018. The Global Politics of the Business of "Sustainable" Palm Oil. *Global Environmental Politics*, 18(2):34–52.

De Schutter O and Cordes K Y (Eds.), 2011. *Accounting for Hunger: The Right to Food in the Era of Globalisation*. London: Bloomsbury Publishing.

Fabbri A, Holland T and Bero L, 2018. Food Industry Sponsorship of Academic Research: Investigating Commercial Bias in the Research Agenda. *Public Health Nutrition*, 12:3422–3430.

Grabs J and Carodenuto S L, 2021. Traders as Sustainability Governance Actors in Global Food Supply Chains: A Research Agenda. *Business Strategy and the Environment*, 30(2):1314–1332.

Hendrickson M, Howard P, Miller E and Constance D, 2020. Food System Concentration and its Impacts. https://farmactionalliance.org/wp-content/uploads/2020/11/Hendrickson-et-al.-2020.-Concentration-and-Its-Impacts-FINAL.pdf

IPES-Food, 2017. Too Big to Feed: Exploring the Impacts of Mega-Mergers, Consolidation and Concentration of Power in the Agri-food Sector. *International Panel of Experts on Sustainable Food Systems*. www.ipes-food.org/_img/upload/files/Concentration_FullReport.pdf

IPES-Food, 2020. Money Flows: What is Holding Back Investment in Agroecological Research for Africa? www.ipes-food.org/_img/upload/files/Money%20Flows_Full%20report.pdf

IPES-Food, 2023. Who's Tipping the Scales? The Growing Influence of Corporations on the Governance of Food Systems, and How to Counter It. www.ipes-food.org/pages/tippingthescales

Kelloway, Claire. 2021. The Tricky New Way That Big Ag Is Getting Farm Data. *Washington Monthly,* October 5. http://washingtonmonthly.com/2021/10/05/the-tricky-new-way-that-big-ag-is-getting-farm-data/

Khan L M, 2018. The New Brandeis Movement: America's Antimonopoly Debate. *Journal of European Competition Law & Practice*, 9(3):131–132.

Klassen S and Murphy S, 2020. Equity as both a Means and an End: Lessons for Resilient Food Systems from COVID-19. *World Development*, 136:105104.

LeBaron G, 2020. *Combatting Modern Slavery: Why Labour Governance Is Failing and What We Can Do About It.* Cambridge: Polity.

Nestle M, 2019. *Food Politics: How the Food Industry Influences Nutrition and Health*. Berkeley: University of California Press.

Torshizi M and Clapp C, 2021. Price Effects of Common Ownership in the Seed Sector. *The Antitrust Bulletin*, 66(1):39–67.

UNCTAD (UN Conference and Trade and Development), 2023. Trade and Development Report 2023. Geneva. https://unctad.org/publication/trade-and-development-report-2023

Wood B, Williams O, Baker P et al., 2021. The Influence of Corporate Market Power on Health: Exploring the Structure-Conduct-Performance Model from a Public Health Perspective. *Globalization and Health*, 17(1):41.

24 Global economic benefits of eating better

Steven Lord, Benjamin Leon Bodirsky, Debbora Leip, Hermann Lotze-Campen and Michael S. Crawford

Overconsumption, diets low in fruits, vegetables, wholegrains, pulses, fibre, calcium, iron and beneficial fatty acids and diets high in processed meats, sugar and salt are responsible for approximately 33% of preventable disease and death in adults globally (Afshin et al. 2019), as discussed in the chapter by Shireen Kassam. Other chapters highlight that current diets high in animal products also have a large environmental footprint, with livestock responsible for approximately 18% of global CO_2-equivalent annual greenhouse gas (GHG) emissions (Steinfeld et al. 2006; Xu et al. 2021), 50% of annual tropical deforestation (Pendrill et al. 2019) and 33% of global reactive nitrogen pollution to air, soil and water (Uwizeye et al. 2020).

Human and natural capital, viewed in classical economics as labour and natural resources, underpin the human economy (TEEB 2018). The disease burden from current diets degrades human capital over the near and medium terms. GHG emissions, nitrogen pollution and habitat loss pose a risk to productivity through heat stress, air pollution and damaging the natural resource base in the near to long term. From the scale of the impact of current food system activities on human and natural capital in the near and long term, it is natural to ask what economic damages and risks are posed by current diets and their production. The United Nations (UN) system of national accounts does not subtract the future liability of damage to human and natural capital from the value-add of sectors and gross product (Dasgupta 2015). Any future losses to the national economy, or the economy of other nations, from this year's food system activities are unaccounted for. If the trends of current diets and production methods continue, then the future losses accumulate year on year as a hidden deficit. This potential puts at risk global economic development and sustainable growth.

Economic reports of the future and unaccounted costs of climate change such as the Stern report (Stern 2007) mainstreamed carbon taxes, emissions trading and other policy instruments. However, there have been few similar, or similarly influential, investigations across the damages associated to food production and consumption. In this chapter we discuss the results of recent studies by the Food and Agriculture Organization of the UN (FAO) to estimate the unaccounted global and regional costs of current diets and by the Food System Economic Commission (FSEC) to estimate the potential economic benefits from avoiding these costs under dietary change.

Costs included in the studies and comparing them across economies

Central to making sense of monetary amounts is the scope of costs to what, to whom and when. Productivity losses (damage to future gross domestic product as total value-add) and welfare losses (reduction of the value provided by consumption of good and services and intangibles such as human rights) are not the same measure (Sandelin, Trautwein, and Wundrak 2014).

DOI: 10.4324/9781032684369-32

The hidden cost studies concern a mainstream argument about the potential correction to value-add missing from national accounts and the implications for growth and development. Society is the "who" paying the price of hidden costs. Some individuals and sectors might bear greater or disproportionate costs than the total cost to society because other individuals and sectors benefit, for example, water treatment or health services. A complementary study of the welfare potential in dietary change was conducted in the Food System Economic Commission (Ruggeri Laderchi et al. 2024), which found additional social welfare benefits beyond the avoided productivity losses described below.

The "what" and "when" of the hidden costs are the disease burden from current food consumption, GHG emissions, nitrogen pollution (N) and habitat loss from food production. These create impact that is dispersed across national borders, the near- to long-term future and through multiple human and natural capital pathways.

GHG emissions increase radiative forcing, warming the planet and changing climate variables such as temperature and precipitation (IPCC 2023). The increase in extreme events in the short term, and changes in ecosystems and water cycles in the medium term, directly affect human capital through heat stress, increase in diseases and lost agricultural production. Ultimately, a mismatch between the shifted natural base and built capital and labour, for example in agricultural production shifting latitudes, can create significant socio-economic damage through lost industries, mass migration and conflict over resources. The most prominent GHG are well mixing gases, meaning that the emission in one country can create costs globally.

Nitrogen pollution includes ammonia and nitrogen oxides that volatilise to air, as well as leaching and run-off of reactive nitrogen from manure and fertiliser application. Ammonia and nitrogen oxides create productivity loss from air pollution in the near- and mid-term and also contribute to crop losses in the near term through terrestrial acidification and ozone production (Fowler et al. 2013). Redeposited volatilised nitrogen, leaching and run-off to waterways create ecosystem service losses downwind and downstream (Erisman et al. 2013). Nitrogen load accumulates in terrestrial ecosystems fed by the water sources and then reach coastal ecosystems (Camargo and Alonso 2006). Acidification and eutrophication are primary drivers of ecosystem impacts (Krupa 2003; Sutton et al. 2013). The effects of nitrogen pollution on waterways and ecosystem occur relatively quickly (Billen et al. 2013) and are mostly near term. However, sustained nutrient loading can cause permanent alteration of ecosystems and nitrogen impacts can be delayed by storage in long-term reservoirs such as groundwater reservoirs (Van Drecht et al. 2003). Nitrogen damages can cross national boundaries from the site of emissions, either through air plumes of particulate matter, deposition or in shared water catchments.

Agricultural land expansion such as deforestation and mangrove clearing changes the basic functioning of ecosystems (habitat loss, disruption of biophysical inputs, disruption of biological cycles and food chains, etc.). This results in a loss of services provided by ecosystems to the human economy. In several countries abandoned agricultural land provides a potential hidden benefit. However, compared to abrupt loss of an established ecosystem, biodiversity and ecosystem services can take decades to recover on abandoned cropland and pasture (Jung et al. 2019; Le Provost et al. 2020). Most land-clearing for agriculture has effectively been permanent with near- to long-term effects depending on economic adaptation (Gomes et al. 2020).

Poverty and undernutrition are associated with distributional failures. An inability to distribute incomes to provide minimum or living wages, and distribute globally the sufficient calories produced each year, results in an underutilisation of human capital. Poverty and undernutrition have lifelong and potentially generational productivity effects (Victora et al. 2008; Hoddinott et al. 2013).

Unhealthy diets have been associated with preventable morbidity and mortality in national populations from neoplasms (cancers), cardiovascular disease and type II diabetes (Afshin et al. 2019; Dai et al. 2020). Labour productivity losses from illness or informal care occur in the near term from intake of exacerbating existing co-morbidities and in the longer term from the onset of morbidities from dietary patterns.

These last sentences describe the "what" and "when" of external economic damages from GHG emissions, nitrogen emissions, land-use change (collectively labelled E costs below), productivity losses from the preventable burden of disease due to unhealthy diets (collectively labelled H costs) and distributional failures (collectively labelled S costs). Altogether they were called hidden food system costs by the FSEC (Gaupp et al. 2021). A primary reason for the lack of accounting for these costs alongside the value-add of food system activities is the difficulty in calculating and rectifying costs that are dispersed across economic sectors, national borders, the near- to long-term future and multiple human and natural capital pathways of impact.

The dispersion also means that aggregating and making sense of the costs requires comparing economies of different countries and at different times. Placing parity and discounting, which are technicalities in economic measurement, at the forefront of debates on appropriate taxes or mitigation of GHG emissions, N pollution and biodiversity loss. In the FAO and FSEC studies, the damages to GDP across countries is measured in purchasing power parity (PPP) (Shapiro 1983). This accounts for the value of consumption in a country, for example, China and India have the first and third highest GDP in PPP terms because of the relatively lower costs of basic items. Damages to lower-income countries are higher in purchasing power than in market exchange rates. Damages across time are turned into present purchasing power using a social discount rate (Moore et al. 2004; Drupp et al. 2018). Present value allows the liabilities from cost bearing to be compared to the value-add in the year of cost production. The monetary measure in the following results is 2020 PPP, which means damages in the equivalent purchasing power in 2020.

Hidden costs of current diets

The FAO State of Food and Agriculture (SOFA) 2023 put the unaccounted liabilities of agri-food systems from GHG emissions, nitrogen emissions, land-use change, productivity losses from the preventable burden of disease due to unhealthy diets and distributional failures at >10 trillion 2020 PPP per year (FAO 2023). In a correction to global gross product for the liabilities of current diets and non-food agricultural production, the subtraction would roughly equal the combined value-add from agriculture, food manufacturing and food service and retail. The result does not indicate that these sectors provide no value, they provide a necessary good, but it does indicate that other sectors in the economy and future agriculture potentially wholly subsidise profits of current activity by absorbing hidden costs.

At a national level, China's hidden costs in the SOFA report at 10.3% of GDP PPP (2.5 trillion 2020 PPP) compare to 7.7% value-add of agriculture, forestry and fishing in 2020 (GVA-AFF), and India's hidden costs at 12.5% of GDP PPP (1.12 trillion 2020 PPP) compare to 18.2% GVA-AFF (Lord 2023b). For the US and the EU, costs are predominately from diets and compare to 6% and 8% of 2020 GDP PPP, respectively. In both regions, the costs exceed estimates for value-add from agriculture, food manufacturing and food service and retail.

In the FAO SOFA 2023 report, the distributional and consumption-related future productivity losses are about four times larger than those from GHG emissions, nitrogen surplus and habitat loss from food production (80%–20% split). These proportions are global and in absolute terms. Absolute purchasing power impacts and relative economic burden are different. Figure 8 in SOFA 2023 discusses the unaccounted liabilities of food production and consumption on a

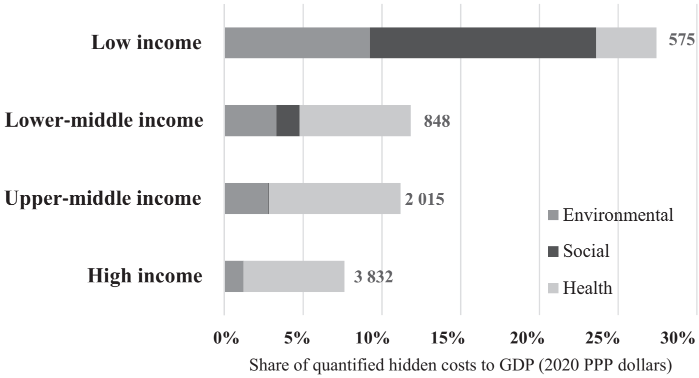

Figure 24.1 Economic burden from hidden costs of current food system activity by World Bank income group. Numbers indicate the per capita burden in 2020 PPP. Costs from greenhouse gas (GHG) emissions, nitrogen emissions, land-use change (collectively Environmental costs), productivity losses from the preventable burden of disease due to unhealthy diets (collectively labelled Health costs) and distributional failures including agrifood worker poverty (collectively labelled Social costs). Source: Figure 8 from FAO (2023).

percentage GDP basis (Figure 24.1). The relative burden for low-income countries (LIC) is 27% of GDP PPP, and for middle-income countries (MIC) is ~12% of GDP PPP, compared to 7.5% for high-income countries (HIC). Priority for the risks the food system poses to economic growth and development is in LIC and MIC. LIC and MIC have significant costs from production, especially MIC where globally the bulk of food is produced. The costs of consumption span income groups.

The SOFA numbers reflect the extent of the harm from diets to human capital. The lost potential for productivity is extensive. Ironically, better diets and less caloric intake might be the greatest benefit to human capital from the food system since the reduction of hunger from the invention of cheap calories. The higher proportion from consumption-related future productivity losses also reflects that mainstream economic management has a historical measurement bias towards labour over natural inputs. Our economic knowledge about ecosystem services is much less, especially the future marginal value of those services under climate change and ecosystem degradation. In many HIC food production is <2% of GDP (it is <1% in the EU bloc). Here, the impact from unhealthy diets, which affect the entire workforce in and outside of agriculture, make up 85% of the hidden costs, whilst production impacts make up 15%. With this lens, even in HIC, the share of unaccounted costs of food production in proportion to its share of value-add, show how expensive the emissions and land-use consequences of production are.

Economic benefits of dietary change

The FAO SOFA does not tell us how much we could reduce hidden costs by transforming the food system. One task of the Food System Economic Commission was to examine whether dietary change could reduce the liabilities (Ruggeri Laderchi et al. 2024). Modelling for the Commission (Bodirsky et al. 2023) had a diets scenario (DIET), where the Planetary Health Diet (Willett et al. 2019), representing a trade-off between improved nutrition and reducing environmental pressures, is gradually adopted over 2020–2050. The Planetary Health Diet increases intake of fruits and vegetables, wholegrains, pulses, nuts and seeds and plant sources of beneficial fatty acids and requires a large reduction in dairy, meat, sugar and salt from current intake.

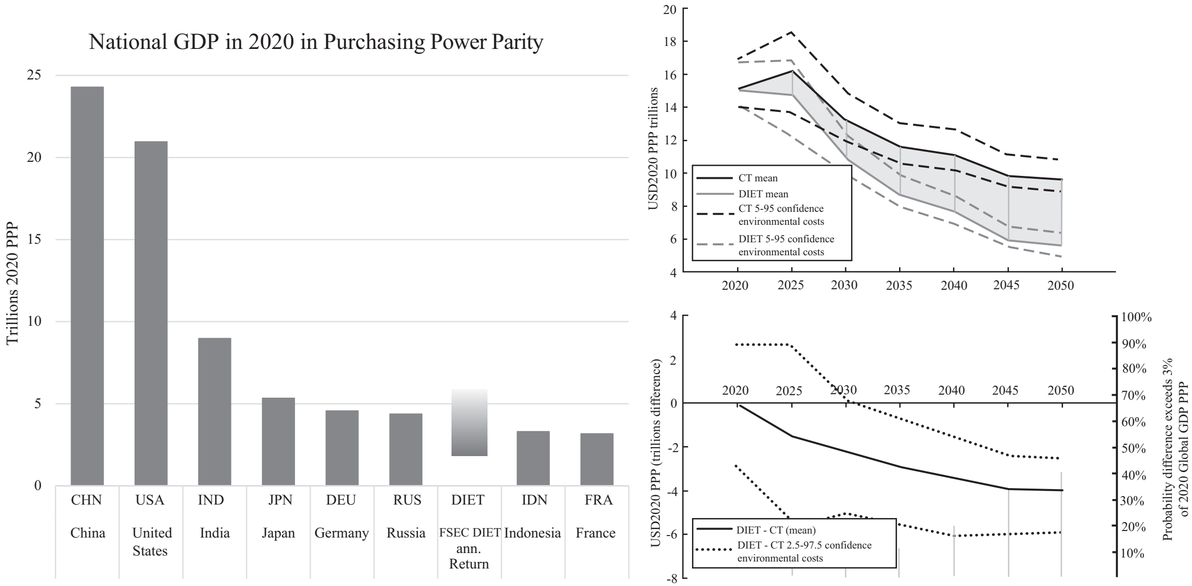

Figure 24.2 Left panel, annuitised return in the FSEC scenario of dietary change in 2020 PPP averaged over three decades, in comparison to the GDP PPP of world economies in 2020. Shading indicates modelled uncertainty. Right upper panel, the trajectory of hidden costs under the currents trends (CT) and dietary change (DIET) scenario, with uncertainty. Avoided costs from annual production and consumption, shown as the area between the CT and DIET hidden cost trajectories in the top right panel and with uncertainty in right lower panel, increase over time.

Table 24.1 Avoided hidden costs under the FSEC scenario of dietary change in 2020 PPP (billions), per capita, and as percentage of 2020 GDP PPP, by World Bank income group. Avoided costs are averaged for each income group and category over the three decades 2020–2050. Costs from greenhouse gas (GHG) emissions, nitrogen emissions, land-use change (collectively E costs), productivity losses from the preventable burden of disease due to unhealthy diets (collectively labelled H costs) and distributional failures including agrifood worker poverty (collectively labelled S costs)

Income group	*Category of hidden cost*	*Avoided cost in DIET 2020 PPP*	*GDP 2020 percentage*	*2020 PPP per capita*
Low income	Total Difference Average	121.5 b	9.4	194
Low income	E Difference Average	96.6 b	7.5	154
Low income	S Difference Average	3.9 b	0.3	6
Low income	H Difference Average	21.0 b	1.6	33
Lower middle income	Total Difference Average	672.6 b	2.8	200
Lower middle income	E Difference Average	256.9 b	1.1	77
Lower middle income	S Difference Average	10.4 b	0.0	3
Lower middle income	H Difference Average	405.3 b	1.7	121
Upper middle income	Total Difference Average	912.5 b	2.0	364
Upper middle income	E Difference Average	266.9 b	0.6	106
Upper middle income	S Difference Average	3.2 b	0.0	1
Upper middle income	H Difference Average	642.4 b	1.4	256
High income	Total Difference Average	953.5 b	1.6	820
High income	E Difference Average	104.8 b	0.2	90
High income	S Difference Average	0.2 b	0.0	0
High income	H Difference Average	848.6 b	1.4	730

Compared to the continuing trend of current food production and consumption, the DIET scenario estimated that the hidden deficit can be reduced by about a third globally (Lord 2023a). This would average 2.66 trillion 2020 PPP or ~2% of global GDP PPP per year over the three decades (Figure 24.2 right panel). For context, this means changing diets would avoid future costs that exceed the cumulative global losses from the 2007–2008 financial crisis. For another comparison, when annuitised, which means we account for the missing growth on the damages, the size of the contribution to future value-add of the avoided costs would make dietary change the seventh largest economy on the planet over the three decades (Figure 24.2 left panel).

Over half of the total savings come from labour productivity gains from healthy diets, across lower-middle-income countries (LMC), upper-middle-income countries (UMC) and HIC classified by World Bank income groups (Figure 24.2, Table 24.1).

Under dietary change low- and lower-income countries reach adequate caloric intake and alleviate poor nutrition whilst avoiding widespread adoption of unhealthy diets. All income groups have hidden environmental gains from avoiding expansion of agricultural land, lowering carbon dioxide and methane emissions relative to current trends and lowering surplus nitrogen. The caveats in the costing assume an international environment where LIC and LMC are financially rewarded for their emission reductions. In terms of opportunity for growth and development, the avoided damage to future economies compares to the economy being 9% larger on average for the next 30 years across lower-income countries (LIC), 2%–3% across MIC and 1.6% across HIC (Figure 24.3).

Modelling showed small benefits for poverty. The Planetary Health Diet is not presently affordable for many in low-income countries and MIC (Hirvonen et al. 2020). One of the major costs of transformation in the DIET scenario is income support for low-income households.

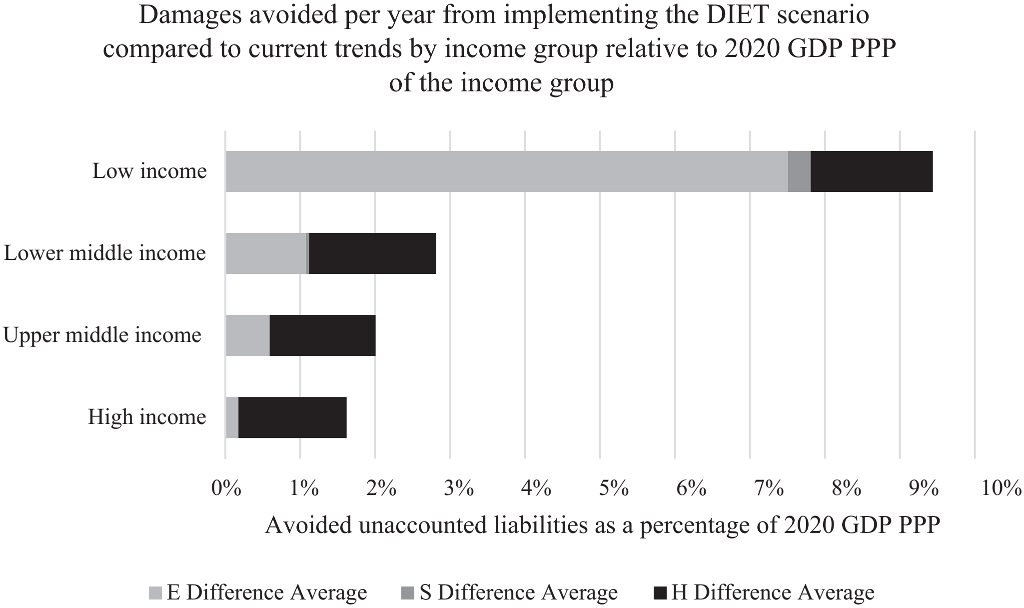

Figure 24.3 Avoided hidden costs under the FSEC scenario of dietary change as percentage of 2020 GDP PPP by World Bank income group. Avoided costs are averaged for each income group and category over the three decades 2020–2050. Costs from greenhouse gas (GHG) emissions, nitrogen emissions, land-use change (collectively E costs), productivity losses from the preventable burden of disease due to unhealthy diets (collectively labelled H costs) and distributional failures including agrifood worker poverty (collectively labelled S costs).

DIET also represents a large and sustained shift in land-use that involves losses to sunk farming infrastructure and requires livelihood transitions including payment for environmental services (Ruggeri Laderchi et al. 2024).

Conclusion

Recent studies of the unaccounted damages from current diets show the potential global economic benefits in dietary change. The benefits compare to avoiding the cumulative losses from the 2007–2008 financial crisis. If we recall the damage of the global financial crisis, the worst economic slowdown since the Great Depression, then we can conceive the brake continuing current diets puts on sustainable growth and development. Joseph Stiglitz, Nobel laureate in economics, said "The war on the climate emergency, if correctly waged, would actually be good for the economy" (Stiglitz 2019). To unlock the economic opportunity in dietary change, it must also be "correctly waged" in terms of progressive and cost-effective actions by governments, civil society, retailers and food manufacturers and institutional actors. More research is required in understanding and managing the transformation costs, livelihood transitions and the role of behavioural and economic incentives for dietary change.

References

Afshin A et al., 2019. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 393:1958–1972.

Billen G, Garnier J and Lassaletta L, 2013. The nitrogen cascade from agricultural soils to the sea: modelling nitrogen transfers at regional watershed and global scales. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368: 20130123.

Bodirsky B L, Beier F, Humpenöder F and Leip D, 2023. A food system transformation can enhance global health, environmental conditions and social inclusion. In: *Preprint: Potsdam Institute for Climate Impact Research*. https://doi.org/10.21203/rs.3.rs-2928708/v1

Camargo J A and Alonso Á, 2006. Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: a global assessment. *Environment International*, 32:831–849.

Dai H, Alsalhe T A, Chalghaf N et al., 2020. The global burden of disease attributable to high body mass index in 195 countries and territories, 1990–2017: an analysis of the Global Burden of Disease Study. *PLoS Medicine*, 17:e1003198.

Dasgupta P, 2015. Disregarded capitals: what national accounting ignores. *Accounting and Business Research*, 45:447–464.

Drupp M, Freeman M C, Groom B and Nesje F, 2018. Discounting disentangled. *American Economic Journal: Economic Policy*, 10:109–134.

Erisman J W, Galloway J N, Seitzinger S et al., 2013. Consequences of human modification of the global nitrogen cycle. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 368(1621).

FAO, 2023. The State of Food and Agriculture 2023: Revealing the true cost of food to transform agrifood systems. https://doi.org/10.4060/cc7724en

Fowler D, Coyle M, Skiba U et al., 2013. The global nitrogen cycle in the twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368:20130164.

Gaupp F C, Ruggeri Laderchi H, Lotze-Campen H et al., 2021. Food system development pathways for healthy, nature-positive and inclusive food systems. *Nature Food*, 2:928–934.

Gomes L C, Felix J J A, Bianchi I M et al., 2020. Land use change drives the spatio-temporal variation of ecosystem services and their interactions along an altitudinal gradient in Brazil. *Landscape Ecology*, 35:1571–1586.

Hirvonen K, Bai Y, Headey D and Masters W A, 2020. Affordability of the EAT-Lancet reference diet: a global analysis. *The Lancet Global Health*, 8:e59–e66.

Hoddinott J, Alderman H, Berhman J R et al., 2013. The economic rationale for investing in stunting reduction. *Maternal & Child Nutrition*, 9:69–82.

IPCC, 2023. Summary for Policymakers. In: Lee H and Romero J (Eds.), *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.*

Jung M, Rowhani P and Scharlemann J P W, 2019. Impacts of past abrupt land change on local biodiversity globally. *Nature Communications*, 10:5474.

Krupa S V, 2003. Effects of atmospheric ammonia (NH_3) on terrestrial vegetation: a review. *Environmental Pollution*, 124:179–221.

Le Provost G, Badenhausser I, Le Bagousse-Pinguet Y et al., 2020. Land-use history impacts functional diversity across multiple trophic groups. *Proceedings of the National Academy of Sciences*, 117:1573–1579.

Lord S, 2023a. Comparative hidden costs of the food system economic commission current trends and food system transformation pathways to 2050. In: *Working Papers FSEC*. Food System Economic Commission. University of Oxford.

Lord S, 2023b. Hidden costs of agrifood systems and recent trends from 2016 to 2023 – Background paper for The State of Food and Agriculture 2023. In: *FAO Agricultural Development Economics Technical Study*. Rome: FAO.

Moore M A, Boardman A E, Vining A R et al., 2004. "Just give me a number!" Practical values for the social discount rate. *Journal of Policy Analysis and Management*, 23:789–812.

Pendrill F, Persson U M, Godar J et al., 2019. Agricultural and forestry trade drives large share of tropical deforestation emissions. *Global Environmental Change*, 56:1–10.

Ruggeri Laderchi C, Lotze-Campen H, DeClerck F et al., 2024. *The Economics of the Food System Transformation*. Berlin: Food System Economics Commission.

Sandelin B, Trautwein H-M and Wundrak R, 2014. *A Short History of Economic Thought*. London: Routledge.

Shapiro A C, 1983. What does purchasing power parity mean? *Journal of International Money and Finance*, 2:295–318.

Steinfeld H, Gerber P, Wassenaar T et al., 2006. *Livestock's Long Shadow: Environmental Issues and Options*. Rome: Food and Agriculture Organization of the United Nations.

Stern N, 2007. *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press.

Stiglitz J, 2019. The climate crisis is our third world war. It needs a bold response. https://www.theguardian.com/commentisfree/2019/jun/04/climate-change-world-war-iii-green-new-deal

Sutton M A, Reis S, Riddick S N et al., 2013. Towards a climate-dependent paradigm of ammonia emission and deposition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368: 20130166.

TEEB, 2018. The Economics of Ecosystems and Biodiversity. https://teebweb.org/

Uwizeye A, de Boer I J M, Opio C I et al., 2020. Nitrogen emissions along global livestock supply chains. *Nature Food*, 1:437–446.

Van Drecht G, Bouwman A F, Knoop J M et al., 2003. Global modeling of the fate of nitrogen from point and nonpoint sources in soils, groundwater, and surface water. *Global Biogeochemical Cycles*, 17.

Victora C G, Adair L, Fall C et al., 2008. Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet*, 371:340–357.

Willett W, Rockström J, Loken B et al., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, 393:447–492.

Xu X, Sharm P, Shu S et al., 2021. Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food*, 2:724–732.

25 Shifting bank funding away from factory farming

Peter Stevenson

The huge sums needed to establish and expand industrial animal farms are provided by banks and other financial institutions. Key funders include both commercial banks and multilateral development banks; the latter are large banks established by a number of nations to fund projects that promote development.

Several reports have shone a light on the funding of factory farming by commercial banks. These reports include *Financial Institutions and Animal Welfare* by Sinergia Animal and Shifting Values (2021), *Butchering the Planet* by Feedback (2020), *Bankrolling Extinction* by Portfolio Earth (2020) and *Banking on Biodiversity Collapse* by Forests & Finance (2023).

To give an example of the scale of the funding, *Bankrolling the Butchers* by Feedback calculates that the UK's "big six" banks provided at least US$77 billion in financing to 55 of the world's largest big livestock and animal feed companies between 2015 and 2022.

These reports detail the massive funds provided by commercial banks to finance industrial animal farms as well as the corporate meat and dairy giants. These companies own farms and also source animals from contract farmers who provide animals to them on a regular basis. They often own slaughterhouses and supply meat and ready meals to retailers and other food businesses.

The report *Bankrolling the Butchers* explains the ways in which banks finance industrial animal agriculture. Most obviously, loans are provided for the construction or expansion of factory farms.

Also, banks may help large companies with the issuing of bonds. Businesses issue bonds when they want to raise money. By buying bonds, one is giving the business a loan which must be paid back, together with interest, by a specific date. Banks help meat and dairy companies by underwriting some of these bonds. This involves the bank buying bonds with the aim of selling them on to investors. The bank will end up owning any underwritten bonds that it is unable to sell. Banks may also hold shares in large meat and dairy businesses.

Banks may provide revolving credit facilities to large meat and dairy businesses. These facilities give a company an option to take up a loan from a bank when it needs finance. Companies can draw down funds from the revolving facility up to a certain limit. These facilities are for a fixed term but are regularly renewed.

The FARMS Initiative

A few years ago some banks began to recognise the need to consider the welfare of farm animals but said that, to do so, they needed clear, practical and applicable standards. Accordingly, Compassion in World Farming, Humane Society International and World Animal Protection established the FARMS (Farm Animal Responsible Minimum Standards) Initiative

DOI: 10.4324/9781032684369-33

(www.farmsinitiative.org). This has developed Responsible Minimum Standards for the main farmed species: pigs, meat chickens, egg laying hens, beef cattle, dairy cows and farmed fish. The principles underlying the RMS are based on those set out in the International Finance Corporation's (IFC) *Good Practice Note on Improving Animal Welfare in Livestock Operations* (IFC 2014).

The FARMS Initiative is able to support banks with training and provide advice for their clients on how to successfully operate higher welfare systems and practices, for example how to keep sows in groups rather than in narrow stalls. Several finance-related bodies have taken the RMS as the reference point for animal welfare standards (Box 25.1).

Box 25.1 Financiers referencing the FARMS animal welfare standards

- The UN Environment Programme (UNEP) Guidance Document to its *Principles for Responsible Banking* lists the FARMS Initiative and its Responsible Minimum Standards (RMS) as a "Key Resource" (UNEP 2021).
- UNEP's *Principles for Responsible Insurance* includes the FARMS Initiative's RMS in a list of standards that can address ESG (environmental, social and governance) risks (UNEP 2020).
- BNP Paribas has announced "BNP Paribas will encourage all its livestock farmers to change their practices towards a system that is more respectful of animal welfare, taking the FARMS Initiative's Responsible Minimum Standards as a reference" (BNP Paribas 2021).
- In its Agro-Industries Position Statement, Standard Chartered (2024) has a policy of not funding production systems using layer cages for poultry, caged rearing systems including gestation and farrowing crates for sows.
- Several other key financial institutions take the FARMS Initiative's RMS as their reference point for animal welfare

  - Rabobank, since 2021 (Rabobank 2024);
  - The Climate Bonds Initiative (2021);
  - Société Générale (2022);
  - ING (2021);
  - Cardano (formerly ACTIAM) (2022);
  - Asia Protein Transition Platform (2022); and
  - Mekong Capital (2022).

A key challenge for banks that wish to require high animal welfare or environmental standards is that in the highly competitive financial world a prospective client is simply likely to go to an alternative funder if a bank seeks to impose standards that it finds too onerous.

Multilateral development banks

Funding for industrial animal agriculture is also provided by a range of public development banks and development finance institutions set up by individual nations and also by the large

Table 25.1 Key welfare risks and mitigation strategies identified by the IFC GPN

Welfare risk identified by IFC GPN	*Mitigation strategy identified by the GPN*
Limitations on space in individual stalls restricting the movement of animals	Increasing the space allowance for each animal (e.g., individual to group housing)
High stocking densities in groups increasing the potential for disease transmission	Stocking densities should be low enough to prevent excessive temperatures and stress
Barren/unchanging environments leading to behavioural problems	Providing environmental enrichment e.g., straw for pigs to manipulate
Feeding diets that do not satisfy hunger	Adding bulk to high energy diets to help satisfy appetite
Injurious husbandry procedures that cause pain	Use alternatives to practices that cause pain e.g., castration, tail docking, beak trimming
Breeding for production traits that heighten anatomical or metabolic disorders	Re-align production-orientated genetic selection to include welfare traits

multilateral development banks. The latter are financial institutions established by multiple nations to fund projects that promote growth in developing countries. The MDBs include:

- European Investment Bank;
- African Development Bank Group;
- Asian Development Bank;
- Asian Infrastructure Investment Bank;
- European Bank for Reconstruction and Development (EBRD);
- Inter-American Development Bank Group;
- Islamic Development Bank;
- New Development Bank;
- World Bank; and
- International Finance Corporation (IFC).

This section will in particular focus on the work of the IFC and the EBRD.

The IFC is a member of the World Bank Group (WBG). Whereas the World Bank provides finance for public ventures, the IFC funds private sector projects. In 2014, the IFC updated its helpful Good Practice Note (GPN) on *Improving animal welfare in livestock operations* (IFC 2014). The GPN sets out key animal welfare risks and mitigation strategies for addressing them. These are shown in Table 25.1.

Regrettably, the IFC seems to pay little attention to its own GPN in its funding of animal farming. In recent years, the IFC has financed the following developments which, on the basis of the information provided on IFC's website, appear to be industrial projects that probably give limited attention to animal welfare and are unlikely to implement the mitigation strategies set out in the GPN. See Table 25.2 for selected IFC funded projects.

In 2022, the IFC adopted an exclusion list stating that it will not fund:

- Non-enriched battery cages for chickens;
- Individual sow stall housing 30 days after conception and tethering of sows;
- Individual pen housing for calves beyond the age of eight weeks;
- Force feeding of geese or ducks; and
- Keeping of animals exclusively for fur or leather production.

Table 25.2 IFC funded projects

Recipient of funding	*Purpose of funding*	*Amount of funding*	*Year of funding*
Suguna in India, Bangladesh and Kenya	Expansion of poultry operations and construction of feed mills	Loan of US$53 million	2020
Pronaca, Ecuador	Expansion of pig farms and feed mills	Loan of US$50 million	2021
GreenFeed Vietnam	Grow GreenFeed business to 200,000 sows per annum. IFC investment will support construction of an additional 200 sow and fattening farms. Note: GreenFeed is also a feed producer.	Loan of up to US$43 million	2021
HMH Rainbow in Uganda	Construction of four new broiler farms (or 16 broiler houses) and upgrading the current abattoir. Also, establishment of grain silos and bulk feed-dispatch systems	Loan of US$5 million	2021
Mavin, Vietnam	Support the expansion of Mavin's pig breeding and pig farming. Note: Mavin is a top ten producer of animal feed in Vietnam.	US$26 million equity	2022
Louis Dreyfus Company Brazil	Purchase of soy and corn	Loan of US$100 million	2022
BAF, Vietnam	Expansion plan to develop 88 new farms. Note: BAF also has feed mills.	Loan of US$38 million	2023
GUANGXI YANGXIANG (GXYX)	Provide working capital for four multi-storey pig farms and a feed mill	Loan of US$42 million	2023

The exclusions are welcome, but do not go far enough. In order to be in line with the IFC's own GPN, they should, for example, exclude the use of fast-growing broilers and pig farms where surgical castration and routine tail-docking are practised.

Moreover, the IFC's exception that permits the use of sow stalls for the first 30 days after conception is out of step with scientific research. In its 2022 Scientific Opinion on pig welfare, the European Food Safety Authority (EFSA) recommended that sows should be kept in groups from the start of the pregnancy (EFSA 2022).

IFC's exclusions include barren battery cages for chickens but permit the use of enriched cages. This too is inconsistent with recent research. The need to move away from enriched cages is increasingly recognised. For example, EFSA's 2023 Scientific Opinion concludes that hens should not be housed in enriched cages (EFSA 2023a).

Turning to the European Bank for Reconstruction and Development (EBRD), research by World Animal Protection indicates that in the period 06/04/2010 to 12/10/21, EBRD invested €810 million in 28 industrial livestock projects (World Animal Protection, 2021/2022).

EBRD requires projects that it finances to meet European Union (EU) animal welfare standards. This is welcome. However, the EU does not have a Directive on the welfare of dairy cows and EBRD has financed several large dairy operations in Serbia, Ukraine, Egypt and Jordan. Insufficient information is available to assess the welfare standards in these dairy farms.

EBRD also finances large-scale broiler chicken production in Georgia and Ukraine. Assurances that these operations meet EU welfare standards provide little comfort as the EU Directive on the welfare of broilers is undemanding and allows the use of very high stocking densities and fast-growing chickens which scientific research show involve serious welfare problems. EFSA's

2023 Scientific Opinion on broiler welfare recommends that broiler growth rates and stocking densities should be much reduced (EFSA 2023b).

Food security

The MDBs tend to justify the financing of industrial animal agriculture by saying that it is needed to develop food security in the Global South. However, the reality is that industrial animal production does not build food security, but in fact undermines our capacity to feed the world's growing population.

Globally 40% of crop calories are used to feed animals (Pradhan et al. 2013). In countries where most animal farming is industrial, the proportion is much higher. Nearly two thirds of EU cereals and 67% of U.S. cereals are used as animal feed (Cassidy et al. 2013; EC 2022). Thus the MDBs' promotion of industrial animal farming in the Global South is likely to boost the proportion of cereals being used as feed in those countries. The cereals used as feed include wheat, maize (also known as corn) and barley.

The problem is that animals convert these cereals very inefficiently into meat and milk (Lundqvist et al. 2008; Cassidy et al. 2013). Studies show that if the grain used as animal feed were instead used for direct human consumption, an extra 3.5 billion people could be fed each year (Nellemann et al. 2009; Cassidy et al. 2013).

The UN Food and Agriculture Organization (FAO) has said:

> When livestock are raised in intensive systems, they convert carbohydrates and protein that might otherwise be eaten directly by humans and use them to produce a smaller quantity of energy and protein. In these situations, livestock can be said to reduce the food balance.
>
> (FAO 2011)

The FAO warns that further use of cereals as animal feed could threaten food security by reducing the grain available for human consumption (FAO 2013).

UNEP's 2022 GAP Emissions Report states that

> more efficient use of resource is essential to fight food insecurity and malnutrition … Reducing the use of much of the world's grain production to feed animals and producing more food for direct human consumption can significantly contribute to this objective.
>
> (UNEP 2022)

Moreover, industrial production's huge demand for cereals for feed has fuelled the intensification of crop production. This, with its use of monocultures and agro-chemicals, has led to soil degradation (Edmondson et al. 2014; Tsiafouli et al. 2015), biodiversity loss (WHO/CBD 2015), overuse and pollution of water (Mekonnen and Hoekstra 2012) and air pollution (Lelieveld et al. 2015).

These problems are recognised by the World Bank Group (WBG). The WBG Guide *Investing in Sustainable Livestock* states that feed production for intensive livestock systems is increasingly sourced from "high-input intensity grain and legume monocultures and supplied from international markets. This can result in remote impacts on natural resources in feed-exporting regions, as well as competition for resources between the production of livestock feed and human-edible food".

The Guide adds: "In regions facing resilience challenges, this can result in the allocation of scarce biomass resources to the production of livestock feed instead of directly human-edible food" (World Bank 2020). And yet, despite the World Bank's warnings, the IFC and other MDBs continue to pour money into the very systems that are dependent on the use of soy and human-edible grain as animal feed.

Synthetic nitrogen fertilisers

Another case where the IFC ignores the World Bank's advice relates to the use of synthetic nitrogen fertilisers. The World Bank's report *Detox Development* shows that whilst these fertilisers can boost productivity in the short term, in the longer term they can lead to diminishing crop productivity and reduced soil fertility and quality.

The World Bank report highlights the low efficiency of nitrogen fertilisers. It states that less than half of the nitrogen applied to agricultural crops, reaches the harvested crop. The report points out that the nitrogen that is not absorbed by crops "gets lost to the surrounding environment, polluting the waterways; worsening air quality; and as nitrous oxide, exacerbating climate change".

The report states: "Science suggests that the world may have surpassed the planetary boundaries for nitrogen, and some believe that nitrogen is the world's largest externality, exceeding even carbon" (Damania et al. 2023).

Ailing waters

In a section headed "Ailing waters", the World Bank report states:

> The massive increase in nitrogen fertilizers has left a scar across many of the world's water bodies.… Runoff of excess nitrogen increases concentrations of nitrate and nitrite in the waters. These concentrations can lead to algal blooms. … Large algal blooms can devastate ecosystems, often resulting in dead zones, a condition that arises when water bodies lack sufficient oxygen. The legacy effects of nitrogen pollution on the environment can also endure decades after nitrogen inputs have ceased, with long time lags between the adoption of conservation measures and any measurable improvements in water quality.

Air pollution

The World Bank report states: "Fertilizer is a key culprit in nitrogen pollution, which fouls the air and water worldwide". The report points out that some of the nitrogen applied as fertilisers ends up in the atmosphere where it is a key cause of air pollution as it contributes to the formation of fine particulate matter that adversely affects human health (Damania et al. 2023).

In light of the World Bank's clear analysis of the detrimental impacts of nitrogen fertilisers, it is anomalous for the IFC and other MDBs to continue financing industrial animal agriculture given that the production of feed for these systems involves the use of large amounts of nitrogen fertilisers.

The IFC has produced a paper entitled *IFC Practices for Sustainable Investment in Private Sector Livestock Operations* (IFC 2022). Whilst aspects of the paper are welcome, it falls short of supporting a move to genuinely sustainable animal farming and instead simply seeks to alleviate the worst aspects of the industrial model.

For example, on animal health, the IFC document places too much reliance on health management protocols and biosecurity and fails to acknowledge the large body of scientific research that shows that intensive animal farming can lead to the emergence, transmission and amplification of pathogens, including zoonoses (Bernstein et al. 2022).

Regarding antimicrobial resistance, the IFC requires "prudent and responsible use of veterinary antimicrobials". To be effective, this broad principle needs to be translated into specific requirements such as excluding routine use of antimicrobials and prophylactic use in groups of animals.

Solutions

What kinds of animal agriculture should banks be funding?

The EU Taxonomy Regulation (EC 2020) aims to prevent greenwashing by enabling investors to identify those economic activities that can be regarded as environmentally sustainable. In this context, the European Commission appointed the Platform on Sustainable Finance (PSF), a group of experts that advises the Commission on which activities can be viewed as sustainable.

In March 2022, the PSF proposed that animal production can be regarded as making a substantial contribution to biodiversity through extensive grazing in habitats where grazing is beneficial for biodiversity (PSF 2022a).

In a further report in October 2022, the PSF was very positive about the benefits of integrated crop-livestock systems in light of their substantial contribution to (i) biodiversity and ecosystems, (ii) the sustainable use and protection of water and (iii) pollution prevention and control (PSF 2022b). These are three of the Taxonomy Regulation's six environmental objectives. The report's emphasis on the value of on-farm nutrient creation and cycling and on-farm feed production is also relevant to transitioning to a circular economy, which is also one of the Regulation's environmental objectives.

In particular, the PSF proposal:

- Emphasises the need to primarily use organic manure and biological N fixation (e.g., by the use of legumes) with only minimal use of chemical fertilisers. Version Two of the proposal requires at least 80% of N fertilisers to be organic fertilisers produced on-farm; a maximum of 20% can be bought-in chemical fertilisers;
- Requires, in Version Two of the proposal, all livestock excreta to be recycled on-farm or treated through nature-based solutions;
- In Version Two of the proposal, limits the proportion of bought-in feed such as cereals and soy to 10% of total feed. It requires a farm to grow at least 75% of any livestock feed on-farm and get the rest locally/from certified sources. This 75% cannot be grown intensively; it must be either grazed or must comprise agroecology outputs such as catch crops and cover crops.

Banks should challenge their belief that productivity gains are best achieved through industrialisation. For example, silvo-pastoral systems in South America with feed at three levels can be highly productive. Alongside pasture at ground level, these systems also provide shrubs (preferably leguminous) and trees with edible leaves and shoots (Broom et al. 2013). Such systems produce more biomass than conventional pasture and so result in increased meat and milk production per animal and per hectare.

Rather than funding industrial animal agriculture which inevitably outcompetes small-scale farmers in the Global South, banks should be financing projects that benefit the livelihoods of smallholders. For example, a farmer in South Africa produces dual-purpose Boschveld chickens that provide both eggs and meat. His crossbred chickens are able to adapt to a harsh climate and have become extremely popular because of their robust capacities. Bred for hardiness and disease resistance, they are well suited for free range and are able to forage for much of their feed; only a small amount of maintenance feed is provided to boost production.

Often they are kept in a run with no floor so that their droppings fertilise the ground. After a few weeks the run is moved and crops such as corn or vegetables can be sown. Better yields from this fertile soil allow households to generate income from selling surplus grain and vegetables. They have been exported to 17 African countries including Malawi, Angola, Zambia, Botswana, Swaziland and Namibia (Boschveld 2024).

Banks prefer dealing in and lending substantial sums. This results in them mainly funding industrial agriculture. They need to develop ways of providing micro-loans to smallholder farmers, particularly those engaged in agroecology and regenerative agriculture.

Turning the financial tanker round

Change will not be easy as both commercial and public banks are deeply wedded to the industrial model of animal agriculture. We must continue to engage with them and present the scientific evidence that shows the highly detrimental impact of industrial agriculture on the environment and the serious risks to human health that it entails.

We need to persuade banks that the funding of industrial animal agriculture is no more acceptable than financing fossil fuels. Just as banks must help finance the move to clean energy, they should support the move to clean forms of animal farming that can build soil quality, restore degraded land, support biodiversity and conserve water. These clean forms must be "health-oriented" – good animal health should be inherent in the farming methods rather than being propped up by routine use of antimicrobials.

The large MDBs are not a law unto themselves; they are owned by governments. For example, the IFC's policies are determined by its Board of Governors and Board of Directors. Each member country appoints one Governor. The Board of Directors comprises 25 Executive Directors. Large countries have an Executive Director of their own; smaller countries share an Executive Director. Similar arrangements apply in other MDBs. We must persuade these Boards of the need to move to clean agriculture.

Many commercial banks are members of the Equator Principles Association (EPA). These Principles are a financial industry benchmark for assessing and managing environmental and social risk in projects. The Equator Principles should be extended to expressly cover farm animal welfare and the risks involved in industrial animal agriculture.

Banks should be encouraged to provide finance on preferential terms to projects with high environmental or animal welfare standards. For example, DBS – the Development Bank of Singapore – has provided a ten-year sustainability-linked loan to Chew's Agriculture, a leading egg producer in Singapore, to enable it to build a new cage-free farm (DBS 2019). Under the terms of the loan, Chew's will enjoy lower interest rates if it meets Humane Farm Animal Care standards (see https://certifiedhumane.org).

Conclusion

Commercial banks and the public multilateral development banks pour huge sums into industrial animal agriculture. In doing so, they are, directly or indirectly, funding animal cruelty, deforestation, climate change, biodiversity loss, soil degradation, antimicrobial resistance and zoonotic disease risks. That's an awful lot of harm to be doing. Banks should instead fund forms of animal farming that are genuinely nature based.

References

ACTIAM (Cardano), 2022. Sustainability drivers. https://www.actiam.com/493757/siteassets/4_verantwoord/documenten/en/c-actiam-material-sustainability-drivers.pdf

Asia Protein Transition Platform, 2022. 2030 Protein Transition Vision in Asia. https://asiareengage.com/protein-transition/

Bernstein A S et al., 2022. The costs and benefits of primary prevention of zoonotic pandemics. *Science Advances*, 8(5):eabl4183. https://doi.org/10.1126/sciadv.abl4183

Boschveld, 2024. Free range chickens. https://boschveld.co.za/

BNP Paribas, 2021. BNP Paribas defines a restrictive policy to fight deforestation in the Amazon and the Cerrado regions. https://group.bnpparibas/en/press-release/bnp-paribas-defines-restrictive-policy-fight-deforestation-amazon-cerrado-regions

Broom D M et al., 2013. Sustainable, efficient livestock production with high biodiversity and good welfare for animals. *Proceedings of the Royal Society B*, 280:20132025. https://doi.org/10.1098/rspb.2013.2025

Cassidy E S et al., 2013. Redefining agricultural yields: from tonnes to people nourished per hectare. *Environmental Research Letters*, 8:034015 (8pp). https://doi.org/10.1088/1748-9326/8/3/034015

Climate Bonds Initiative, 2021. Agriculture Criteria. Climate Bonds Standard & Certification Scheme. www.climatebonds.net/files/files/standards/agriculture/Agriculture%20Criteria%2020210622v3.pdf

Damania R et al., 2023. *Detox Development: Repurposing Environmentally Harmful Subsidies*. Washington, DC: World Bank. http://hdl.handle.net/10986/39423

DBS, 2019. Chew's Agriculture signs Singapore's first SME sustainability-linked loan with DBS. www.dbs.com/newsroom/Chews_Agriculture_signs_Singapores_first_SME_sustainability_linked_loan_with_DBS

EC (European Commission), 2020. Regulation (EU) 2020/852 on the establishment of a framework to facilitate sustainable investment. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852

EC, 2022. Cereals, oilseeds, protein crops and rice. https://agriculture.ec.europa.eu/farming/crop-productions-and-plant-based-products/cereals_en. Accessed 09/02/24

Edmondson J L et al., 2014. Urban cultivation in allotments maintains soil qualities adversely affected by conventional agriculture. *Journal of Applied Ecology*, 51:880–889.

EFSA, 2022. Welfare of pigs on farm. *EFSA Journal*, 20:8. https://doi.org/10.2903/j.efsa.2022.7421

EFSA, 2023a. Welfare of laying hens on farm. *EFSA Journal*, 21:2. https://doi.org/10.2903/j.efsa.2023.7789

EFSA, 2023b. Welfare of broilers on farm. *EFSA Journal*, 21:2. https://doi.org/10.2903/j.efsa.2023.7788

FAO, 2011. World Livestock 2011: Livestock in food security.

FAO, 2013. Tackling climate change through livestock.

Feedback, 2020. Butchering the Planet. https://feedbackglobal.org/butchering-the-planet

Forests & Finance, 2023. Banking on biodiversity collapse. https://forestsandfinance.org/wp-content/uploads/2023/12/BOBC_2023_vF.pdf

IFC, 2014. Good practice note: Improving animal welfare in livestock operations. www.ifc.org/en/insights-reports/2014/publications-gpn-animalwelfare-2014

IFC, 2022. IFC practices for sustainable investment in private sector livestock operations. www.ifc.org/en/what-we-do/sector-expertise/agribusiness-forestry/supporting-sustainability/ifc-practices-for-sustainable-investment-in-private-sector-livestock-operations

ING, 2021. Environmental and social risk (ESR). www.ing.com/Sustainability/Sustainable-business/Environmental-and-social-risk-ESR.htm

Lelieveld J et al., 2015. The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature*, 525:367–371.

Lundqvist J et al., 2008. Saving water: From field to fork – curbing losses and wastage in the food chain. www.siwi.org/documents/Resources/Policy_Briefs/PB_From_Filed_to_Fork_2008.pdf

Mekong Capital, 2022. Our environmental & social commitment. www.mekongcapital.com/our-environmental-social-commitment/

Mekonnen M and Hoekstra A, 2012. A global assessment of the water footprint of farm animal products. *Ecosystems*. https://doi.org/10.1007/s10021-011-9517-8

Nellemann C et al., 2009. The environmental food crisis – The environment's role in averting future food crises. https://www.grida.no/publications/154
Portfolio Earth, 2020. Bankrolling extinction. https://portfolio.earth/campaigns/bankrolling-extinction/
Pradhan P et al., 2013. Embodied crop calories in animal products. *Environmental Research Letters*, 8:044044. https://doi.org/10.1088/1748-9326/8/4/044044
PSF, 2022a. Platform on sustainable finance: Technical working group. Part B – Annex: Technical screening criteria. https://finance.ec.europa.eu/system/files/2022-03/220330-sustainable-finance-platform-finance-report-remaining-environmental-objectives-taxonomy-annex_en.pdf
PSF, 2022b. Platform on sustainable finance: Technical working group. Supplementary: Methodology and technical screening criteria. https://finance.ec.europa.eu/document/download/7599ea2d-975c-4b25-adca-de1d26533e99_en?filename=221128-sustainable-finance-platform-technical-working-group_en.pdf
Rabobank, 2024. Global standard on sustainable development. https://media.rabobank.com/m/3197e93d12fa9d9/original/Sustainability-Policy-Framework.pdf
Sinergia Animal and Shifting Values, 2021. Financial institutions and animal welfare. https://banksforanimals.org/media/filer_public/98/44/98441e7c-d7b8-4c82-b386-8c83bb8e1e61/sinergia_animal_2021-financial_institutions_and_animal_welfare.pdf
Société Générale, 2022. Industrial agriculture and forestry sector policy. www.societegenerale.com/sites/default/files/documents/CSR/industrial-agriculture-and-forestry-sector-policy.pdf
Standard Chartered, 2024. Agribusiness position statement. https://av.sc.com/corp-en/nr/content/docs/agro-industries-position-statement.pdf
Tsiafouli M A et al., 2015. Intensive agriculture reduces soil biodiversity across Europe. *Global Change Biology*, 21:973–985.
UNEP (United Nations Environment Programme), 2020. Managing environmental, social and governance risks in non-life insurance business. https://www.unepfi.org/psi/wp-content/uploads/2020/06/PSI-ESG-guide-for-non-life-insurance.pdf
UNEP, 2021. Principles for responsible banking. Guidance document. www.unepfi.org/wordpress/wp-content/uploads/2022/04/PRB-Guidance-Document-Jan-2022-D3.pdf
UNEP, 2022. The closing window: Emissions Gap Report 2022.
WHO/CBD (World Health Organization and Secretariat of the Convention on Biological Diversity), 2015. Connecting global priorities: Biodiversity and human health.
World Animal Protection, 2021/2022. Analysis of Development Bank spending.
World Bank Group, 2020. Investing in Sustainable Livestock (ISL) guide. www.sustainablelivestockguide.org/investing-sustainable-livestock-isl-guide

Changing food business

26 Putting sentience into food policy

Henry Dimbleby

The food system is one of the most successful, most innovative and most destructive industries on earth. To understand the scale of its success, just look at the illustrations in Figures 26.1 and 26.2.

The first graphic shows the estimated biomass of humans and wild land-dwelling vertebrates (mammals and birds) on the planet in 10,000 BC. This was the start of the Holocene era: the moment in history where the seasons became milder and more predictable, and agriculture therefore become possible. At this point, there were 2.5 million humans on Earth – a population dwarfed by the multitude of wild animals (defined here as land-dwelling vertebrates and birds).

These two charts show the relative biomass of different land-based species. "Wild animals" refers to terrestrial vertebrates and birds. Ocean life and invertebrates are not included (Dimbleby 2021).

The second graphic shows the situation today – to the same scale. The population of humans has swollen to eight billion. The food system created by *Homo sapiens* has enabled us to become earth's dominant species.

But as humans have thrived, almost all other forms of wildlife have declined. You can see on this chart that the biomass of wild animals has withered by 85%, thanks initially to our enthusiastic hunting of megafauna, and then to the damage our increasingly rapacious food system has

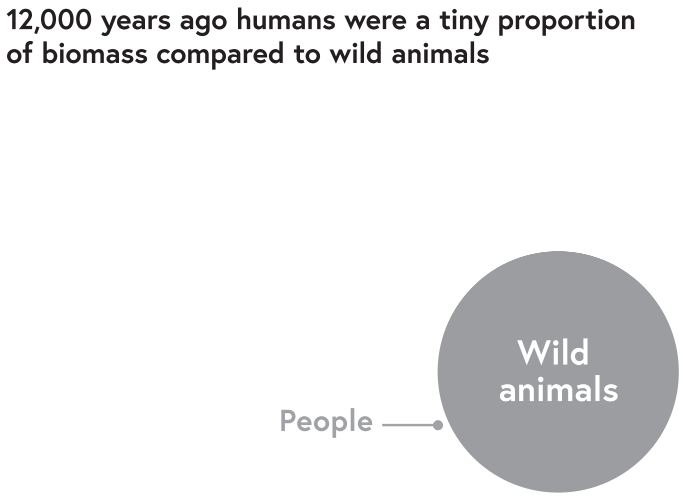

Figure 26.1 12,000 years ago humans were a tiny proportion of biomass compared to wild animals.

DOI: 10.4324/9781032684369-35

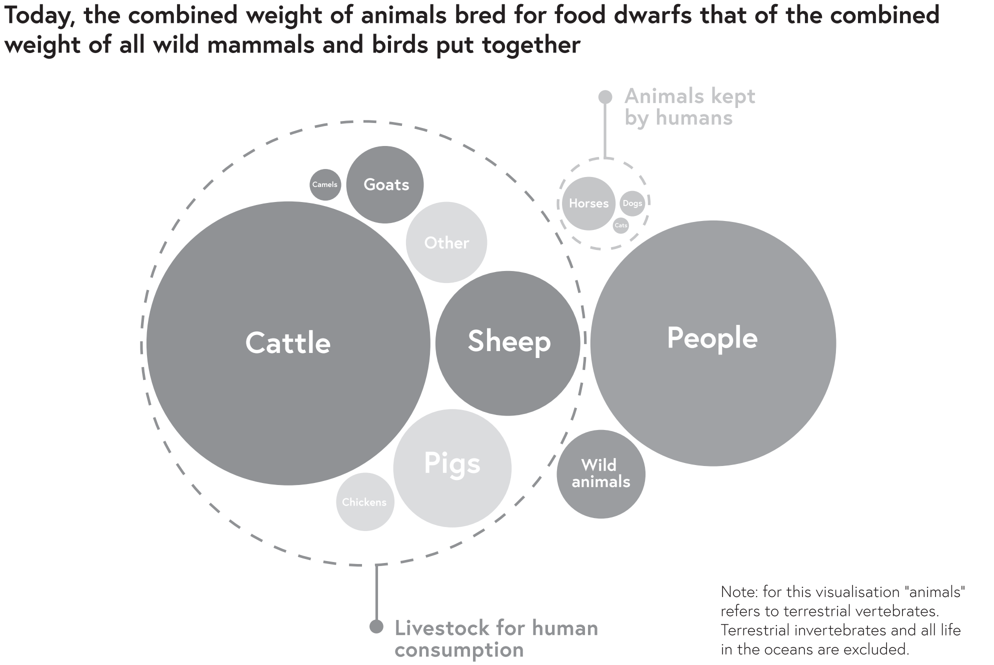

Figure 26.2 Today, the combined weight of animals bred for food dwarfs that of the combined weight of all wild mammals and birds put together.

done to the natural world. These days our pets weigh almost as much as all the wild animals on the planet put together.

The success of the food system goes hand in hand with its destructive power. The bigger it gets, the greater the environmental impact. Globally, the food system is the second-biggest emitter of greenhouse gases (after the fuel industry), and the primary cause of deforestation, drought, freshwater pollution, biodiversity loss and the collapse of aquatic wildlife.

It could be argued that – measured purely by population numbers – the most "successful" species alive today are the animals we eat. The combined weight of animals bred for food is now twice the weight of all humans at any given time, and 20 times the combined weight of all wild vertebrates and birds. But what lives do these animals enjoy – or rather, endure – before they get bundled into lorries and taken to the slaughterhouse?

From a commercial point of view, it is cheaper to be ruthless in livestock farming. Pack as many animals as possible into the smallest space; keep disease under control with massive doses of antibiotics (which also promote rapid growth, because the animals don't have to expend energy on their immune systems); grow them fast; and kill them young.

"Forget the pig is an animal – treat him just like a machine in a factory", a 1976 edition of Hog Farm Management advised US farmers. Not a single federal law on animal welfare has been passed since then, and life remains bleak for the American pig. Farmers in the US are still allowed to keep sows in tight "gestation crates" for their entire pregnancies, so confined that they cannot even turn around.

In China – the world's largest consumer and producer of pork – pigs are increasingly reared in giant, multi-storey indoor farms, where millions of animals pass their lives in metal stalls without ever feeling sun or rain, or earth under their feet. One recently opened farm in Hubei

Figure 26.3 An intensive 12-storey pig production unit near Guigang in Southern China. The inset shows one of the inmates of this unit. Photo by Reuters.

province has 26 storeys and is expected to produce and slaughter 1.2 million pigs a year (Figure 26.3). (The whole of the UK only produces four million pigs a year.) When mass culls are necessary – for example, to contain the spread of African swine fever – Chinese pig farmers have been known to herd their animals into giant pits and bury them alive.

Better, perhaps, than being cooked alive, which was the fate of millions of American pigs during the COVID pandemic. Staff shortages created long backlogs in slaughterhouses and processing plants, so farmers needed to get rid of the mature livestock on their already overcrowded farms. They converted barns into giant ovens by fitting them with heaters and steam generators. Then, they herded the pigs inside and locked the doors. This was judged by the American Veterinary Medical Association to be "humane", because all the animals died within an hour.

The UK has much tougher rules on animal welfare than most countries. Still, all intensive livestock farming involves a degree of suffering. It is an unavoidable side effect of packing animals together in close confinement, away from their natural environment, and then killing them with maximum efficiency.

Chickens, for example, are prone to pecking each other savagely when they are forced to live in close proximity. To prevent this, they have parts of their acutely sensitive beaks cut off. When they are ready for slaughter, most chickens are strung up by their feet on a conveyor belt and dunked headfirst into electrocuted water before being decapitated. Billions of fish die through suffocation, freezing or crushing; pigs are gassed to death. All these are considered "humane" practices, chiefly because the alternatives are worse.

It is awful to contemplate the misery we inflict on animals before we eat them – which is why, on the whole, we prefer not to contemplate it. Ironically, this squeamishness is itself a by-product of the food system. If we hadn't learnt to cook and eat other species, we would never have developed our big, complex brains. And without those brains we would not be able to comprehend the moral consequences of what we have done. But neither would we have the intellectual muscle required to put right our mistakes.

The world's first legislation to improve the lives of animals – the Act to Prevent the Cruel and Improper Treatment of Cattle – was introduced in Britain in 1822. It was largely the work of William Wilberforce, better remembered today for his campaigning against slavery.

At the age of 28, Wilberforce had written in his diary: "God Almighty has placed before me two great objects: the suppression of the Slave Trade and the Reformation of Manners". To modern ears, this second object might sound a bit quaint, but in this context manners meant morals. And for Wilberforce, a devout Christian, the morality of the British nation was compromised by the cruelty that was routinely inflicted on both animals and humans at the time.

Wilberforce believed that God had, in the words of Genesis Chapter 1, Verse 26, given man "dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth". But in exercising this sovereignty, Wilberforce argued, humanity must take care not to be wantonly cruel or thoughtless.

This is similar to the position taken by some modern-day humanists. They, too, regard humanity as a uniquely moral species, alone amongst the animals in having the rights and responsibility that come with extreme sentience. It is this uniqueness, they argue, that means we have an obligation to treat animals with compassion, sparing them unnecessary suffering. (The word "unnecessary" does a lot of heavy lifting here.)

But what if humans are not actually as special as we like to think? As far back as Aristotle, philosophers recognised that the so-called "higher animals" experience some of the same emotions as humans. Charles Darwin went further still, arguing that "there is no fundamental difference between man and higher animals in their mental faculties", and that even the lower animals "manifestly feel pleasure and pain, happiness and misery". "Natura non facit saltum" was how he put it in his Origin of Species – nature does not make leaps.

Darwin was mocked for this view, which was very much in the minority amongst his fellow scientists (Figure 26.4). It is only in recent decades that more detailed research into animal sentience has begun to vindicate him. Even the so-called "lower animals", it seems, have more complex inner lives than most scientists previously imagined.

We now know that invertebrates such as shore crabs and lobsters can feel and remember pain. Bees have been shown to display signs of nervousness and can quickly learn to avoid unpleasant experiences. Fish turn out to have rather good memories and can be trained to perform simple tasks in return for rewards. They can also plan ahead, solve problems and even play.

And what of our farm animals? For at least 10,000 years, humans have been rearing cows for milk. On modern dairy farms, cows are inseminated so that they become pregnant, give birth and start producing milk. Their calves are usually removed from them within 24 hours of birth and reared separately so that the mother can be milked commercially.

The distress this separation causes for both cow and calf is now well-documented. The cow bellows for her lost calf, sometimes for days. The calf, separated from its mother, goes on to develop similar behaviours to those observed in children who grow up without a strong attachment figure. When introduced into a herd, they appear withdrawn, anti-social and sometimes

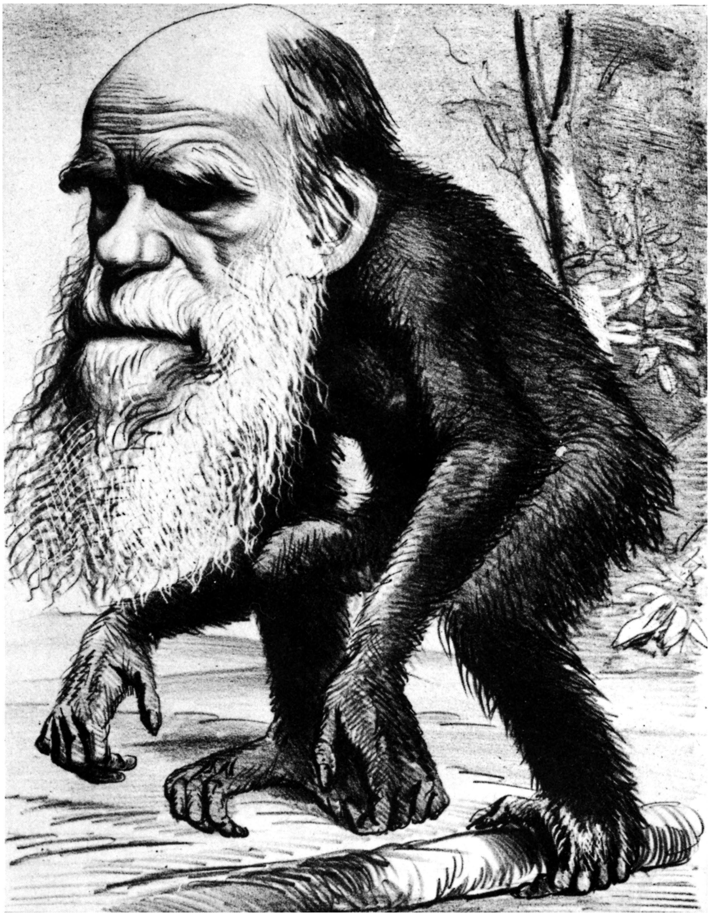

Figure 26.4 Cartoon published in *The Hornet*, a satirical magazine, in March 1871, titled: "A Venerable Orang-Outang. A contribution to unnatural history". Photo by Lordprice Collection/Alamy Stock Photo.

disruptive. Calves that are raised with their mothers have been shown to be more playful and curious, and better at navigating the social rules of the herd.

Even chickens appear to demonstrate maternal instincts. When researchers disturbed hen's chicks with annoying puffs of air, the mothers clucked in protest. Their heart rate increased more than when they were subjected to the same treatment, suggesting that they cared more about the comfort of their young than about themselves.

As our understanding of animal sentience grows, it will become harder and harder to justify the relationship we have built with the animal kingdom. The roots of human exceptionalism look increasingly shallow. And even if you still believe that humans should have dominion over all the creeping things, can you honestly say that we are exerting that power kindly? I believe that it is quite possible that in 200 years' time, we will look back at industrial livestock farming with some of the horror that we feel for bull-baiting now.

We need new legislation to improve the lives of farm animals – a continuous ratcheting up of the standards we expect for factory farmed animals to relieve the cruelty we inflict upon them.

It's no good expecting food producers or retailers to act voluntarily: the commercial incentives to produce cheap meat are simply too strong. Nor can we rely on consumer pressure. Although animal welfare ranks high amongst consumer concerns, most people have neither the time nor the information necessary to trace the provenance of all the meat they buy. Justin King – former CEO of Sainsbury's and a member of the National Food Strategy's expert panel – told me that reading food labels carefully is a "niche sport". Most people simply don't have time for it. They might pay a bit more for food with a Union Jack on it – but otherwise, forget it. The surveys we carried out for the National Food Strategy backed this up: again and again, people told us that they care about animal welfare, but they want the government to set the standards.

As well as improving domestic legislation, governments must ensure that food imported into the country is subject to equally high welfare standards. It makes no sense to sign trade deals with other countries that would allow an influx of cheaper, lower-welfare meat, thereby undercutting their own farmers.

It is more than two centuries since Britain introduced the first laws to prevent animal cruelty. Now it's time to set our sights higher – creating a new standard of kindness for other countries to match.

Author's note

The core of these arguments was first developed in the inaugural RSPCA Wilberforce lecture.

Reference

Dimbleby H et al., 2021. National Food Strategy, Independent Review: The Plan.

27 The role of business in a food system fit for the future

Laura Strangeway and Tracey Jones

Introduction

The global climate, nature and health crises are undoubtedly caused by multiple factors, but highly respected academics and institutions from wide ranging disciplines agree that a major contributor is intensive animal agriculture or what is commonly referred to as factory farming. A clear majority of credible scientific papers – the Intergovernmental Panel on Climate Change (IPCC 2023), the Intergovernmental Science Platform on Biodiversity (IPBES 2019) and the EAT-Lancet Commission (EAT Forum 2019a) – conclude that meat and dairy must begin to play a much smaller role in our daily diets if we are to prevent humanity exceeding planetary boundaries.

Our insatiable appetite for cheap meat and other animal sourced foods is causing immense animal suffering, damaging our health and killing our planet. Intensive animal agriculture, with 92 billion animals reared for food each year, causes animal suffering on a vast scale and lies at the centre of what is wrong with our broken food system. We cannot continue to increase the numbers of animals raised in industrial systems if we want to have a future-fit food system.

Farmed animals are predominantly kept in intensive, often barren systems. Confined in cages or in overcrowded barns, they are unable to fulfil even the most basic natural behaviours. This leads to suffering and poor mental wellbeing. Because of these conditions, and to prevent resulting harmful behaviours, they are often subjected to painful mutilation (hens are beak-trimmed, pigs' tails are docked for example). Many endure long transport journeys in poor conditions and are slaughtered inhumanely. In essence, animals are treated merely as commodities rather than as sentient beings. See Chapters 12 and 13.

The way we produce farm animals also impacts human health. It contributes to antimicrobial resistance and non-communicable diseases as well as emerging and foodborne diseases. Around 70% of the world's antibiotics are given to farmed animals (PHE 2018) – see Chapter 9 for more information – whilst high consumption of red and processed meat, made possible by intensive animal agriculture, contributes to an increased risk of heart disease, obesity, diabetes and certain cancers (CIWF 2023).

It creates poor conditions for workers and a vulnerability to price squeezing for farmers and suppliers. Farmers and farm workers are often the most food insecure group with many overburdened with debt (Patel 2018).

Food production, when not sustainably managed, is a major driver of biodiversity loss, deforestation and a polluter of air, fresh water and oceans, as well as a leading source of soil degradation and greenhouse gas emissions. Instead, we need a food system based on regenerative, agroecological farming and plant-rich diets with alternative proteins.

DOI: 10.4324/9781032684369-36

The need for change

Changing what we eat, how we produce and distribute it as well as how much we waste, is fundamental if we are to prevent humanity exceeding planetary boundaries. This need for change was brought to our collective attention in the stark warning made in 2019 by over 11,000 world scientists (Ripple et al. 2019) and later that year in the EAT-Lancet Commission Report on Food, Planet, Health (EAT Forum 2019b). The EAT-Lancet Planetary Health Diet provided global scientific targets for healthy diets from sustainable food systems. Along with other measures such as halving food loss and waste and improving food production practices, the targets aim to help achieve the Sustainable Development Goals and the Paris Climate Agreement.

The EAT-Lancet dietary recommendations regarding intake of animal protein involve significant reductions amongst high-consuming populations and a subsequent increase in plant-based proteins. Populations around the world need to increase their consumption of whole grains, fruits, vegetables, nuts and legumes**.**

In 2023, Compassion in World Farming provided detailed calculations for the amounts of animal sourced foods consumed by the 103 high- and middle-income countries based on FAO (2018) data (CIWF 2023). The report highlighted the reductions required by country for meat, dairy, seafood and eggs. The results showed that in some high-consuming nations the production and consumption of meat needs to be reduced by at least 70% by 2030 and by 60% globally (against 2018 baseline figures) by 2050. Furthermore, reducing consumption of animal sourced foods will enable nature-positive, agroecological or regenerative systems to regenerate soils, restore and enhance biodiversity and build climate resilience all with high farm animal welfare at the centre.

Achievement of such transformative change of production and consumption is not within the gift of any one actor, group or sector. This is a shared responsibility and requires long-term vision. Whilst this chapter considers the role food companies can play, there is a pressing need for all stakeholders to come to the table and work collaboratively to address these problems and seize opportunities for a future-fit, humane and sustainable food system. Change through collaborative action will bring multiple benefits to all stakeholders; greater stability and security for farmers, more transparency for consumers and businesses will be better placed to face the challenges of our changing climate whilst playing a role in rebuilding our depleted natural world.

With shared responsibility comes the risk of procrastination, denial or even blame. We often hear that food companies simply respond to customer demands; producers respond to retailers and governments to citizen pressure and so on. We need to break this circle of blame, and all register our role in the solution.

What should food businesses do?

A future-fit food system requires not only significant shifts towards higher welfare and regenerative farming but also a considerable reduction in the number of animals produced and consumed each year in high-consuming nations. Changing what we eat, how we produce and distribute it, requires collaborative action across multiple stakeholders, but there are clear steps that food businesses can take now to start transforming food systems for the better.

1 **Recognise the problem**

Company leaders should in the first instance recognise the threat our current food system poses as a critical and relevant business issue. Companies must acknowledge the role their company supply chain has on people, planet and animals and their part in developing solutions that could deliver a future-fit food system. These should be communicated in a clear statement of intent to change, incorporated into corporate policy, governed at board level and communicated to both internal and external stakeholders. See Chapter 28 by James Bailey, Waitrose CEO.

2 **Make the business case for change**

Companies should build the business case for change by adopting a holistic approach. Translating the statement of intent into policy action by cross-organisational team members will guard against unintended consequences.

This should include a statement on who in the company owns responsibility for farm animal welfare, protein diversification and regenerative farming, as well as how they are integrated across the business. Companies should provide an explanation on how the policies will be implemented and managed, including decision-making and supplier integration. Each team member has a role to play in making the business case for change. All stakeholders should be fully engaged and understand the reasons why change is needed. Internal alignment of policies with buying and sourcing strategies along with an understanding of the common goal will be essential for successful implementation. Such alignment should include finance, marketing, buying/commercial, supply, sustainability/CSR, technical and quality. Adopting this multi-team approach to developing solutions and securing internal buy-in at the highest level will help deliver a more humane and sustainable food system.

Compass UK&I took this approach and presented their case study at the 2023 Extinction or Regeneration conference, www.extinctionconference.com (Compass 2022/2023).

3 **Map the supply chain and assess the impact**

Companies should have full and detailed knowledge of the impact of their company supply chain. Mapping out the total protein supply chain is fundamental. This should include identifying the plant/animal protein split and the volumes used and/or sold.

With regards to animal protein, companies should have a comprehensive list of products and the associated suppliers, with details on the production systems (e.g., free-range, barn, cage) by volume along with certification schemes or animal welfare standards used by each supplier.

Companies should know the numbers of animals used by species in their supply, the parts of the carcase used, the method of production, including regenerative farming systems adopted as well as country of origin. Without these measures, environmental and animal impact cannot be accurately assessed.

4 **Set robust targets**

To deliver effective change, companies must set meaningful and measurable time bound targets, for example to be 100% cage free by 2025. Companies should set SMART targets therefore to switch *away from* animal sourced foods, prioritising reductions from intensive production systems and setting targets to *shift towards* more regenerative farming systems with the highest welfare potential. This will be a significant step in building the future-fit food system we need. Companies may well introduce interim targets to secure increased sales from alternative proteins but without a reciprocal target to reduce animal sourced foods in their supply chain we won't see real change.

Compass UK&I has set targets for both animal sourced food reduction and sourcing regeneratively and these are detailed below.

5 **Develop and implement scalable solutions**

Food companies should have a diverse protein portfolio. Solutions include the encouragement of increased natural plant-based alternatives such as whole grains, fruits, vegetables, nuts and legumes. Other alternatives include plant-based meat alternatives, algae, fungi, fermentation. Cultivated meat is an alternative where regulations permit. Trialling and developing initiatives can be introduced as part of menu reformulation and/or part meat replacement in addition to product placement and price incentives.

Companies should also implement food loss and waste reduction initiatives and full carcase balance as measures towards reduction. As companies continue to shift towards higher welfare and regenerative farming, solutions could include initiatives that support supply chain transition to regenerative farming, a commitment to purchase, longer-term supplier contracts, support and investment in pilots, trials and upscaling.

Company examples are outlined below.

6 **Measure and report**

Companies should be transparent on progress and performance. They should provide details of their targets along with appropriate measures of progress and timeframes for delivery of corporate commitments on animal welfare, reducing animal sourced foods and shifting towards regenerative farming practices. Annual reports on key achievements and progress made towards such targets, with an explanation of the results and planned next steps should be clearly communicated on their public facing website.

7 **Bring customers on the journey**

Companies have an important role in helping their customers make a well-informed choice. Providing information and education is therefore key. This includes communicating on a variety of topics such as the way animals have been farmed. Companies should use clear labelling based on the method of production (organic, free-range, indoor). Other initiatives include the encouragement of more sustainable and healthy diets through increased protein diversification and menu solutions, communicating the benefits of regenerative farming systems, explaining the wider environmental impact of animal sourced foods and being exemplars of transparent reporting.

8 **Build new, healthy business models**

Companies may need to adapt or change their business models to deliver a future-fit and humane food system. Shifting away from intensive animal agriculture will see significant and far-reaching changes to business models. Supply chains may need to be shortened. Companies will need to build and commit to longer-term relationships with farmers if higher welfare, regenerative farming is to be scaled up. Companies should provide enhanced levels of reporting and deliver a more equitable share across the value chain.

Examples of company activity

Animal welfare

- **The Business Benchmark on Farm Animal Welfare (BBFAW)** analyses the policies, management systems, reporting and performance of 150 of the world's largest food companies. It is the leading global measure of farm animal welfare within food businesses. Full company rankings and examples of leading companies on animal welfare are listed in the BBFAW (2023) report.

Report number of animals in supply chain

- **Waitrose** publicly reports on the number of animals and farms used in their supply chain by species and by production system for example, the number of conventional beef cattle and organic beef cattle, free-range eggs and organic eggs (Waitrose n.d.).

- **M&S** publicly report on the number of animals by species and by system, for example the number of free-range, organic or Oakham Gold (indoor higher welfare) meat chickens used in their supply including fresh, frozen and ingredient (M&S 2023).

Commitments to increase protein diversification

- **Albert Heijn** stated their ambition that by 2025, 50% of the total number of kilograms of proteins sold in their stores will be of plant origin, rising to 60% by 2030 (Albert Heijn 2022).
- **Aramark** announced a commitment to achieve 44% plant-based menu offerings by 2025 for US residential dining at more than 250 colleges and universities in partnership with the Humane Society of the United States (HSUS) (Aramark 2022).
- **Carrefour** 2026 Strategic Plan is to "Increase sales of plant-based products in Europe to €500m by 2026 (+65% vs 2022)" (Carrefour 2022).
- **Lidl GB** have committed to increasing the proportion of plant-based protein sources in line with the planetary health diet. To support this, they have set the following goal: "By the end of 2025, we will deliver a 400% sales increase in our own brand meat free and milk alternative range against a 2020 baseline" (Lidl n.d.).
- **Sodexo Campus** in the US commits to a "50% plant-based menu by 2025" (Sodexo 2023).
- **Tesco**'s "A balanced diet for a Better Future" report committed to a 300% increase in sales of meat alternatives by 2025 (Tesco 2021). The report encourages its customers to "eat more veg, fruit and wholegrains… and to rebalance protein sources to include more plants".
- **WWF Retailers' Commitment for Nature** ("WWF Basket") aims to reduce the environmental footprint of an average basket of UK groceries by 50% by 2030. Success criteria include a suggested 50/50 split in protein sourced from plants and animals by 2030. Companies who have signed up to this UK initiative include Co-op, Lidl UK, M&S, Sainsbury's, Tesco and Waitrose (WWF 2023).

Commitments to reduce animal sourced foods

- **Compass UK&I** commits to 25% reduced animal proteins by 2025 and 40% reduced animal proteins by 2030.
- **Elior North America (ENA)** (as part of their Forward Food Pledge with HSUS) committed to making at least 50% of new food programs meatless by 2025 (Elior 2023).

Commitments to regenerative farming

- **Compass UK&I** commits to 70% fresh meat, vegetables and dairy sourced from regenerative agriculture sources by 2030.
- **Danone** – "30% key ingredients we source directly will come from farms that have begun to transition to RegAg by 2025" (Danone 2022).
- **Nestle** – Aims to source "20% of key ingredients through regenerative agriculture methods by 2025 and 50% by 2030" (Nestle 2022).
- **Sodexo**'s Good Eating Company (GEC) is committing 15% of its food budget to source from farms with regenerative agriculture practices by 2025.

Companies working on regenerative farming practices

- **Danone** collaborates with 58,000 dairy farmers globally, 94% of whom operate small family farms with under 25 cows in Africa and Latin America. The company not only supports these

farmers with equipment and training for regenerative farming but also has established innovative long-term contracts that account for 23% of its global milk collection (Danone 2022).
- **McDonalds** Regenerative Beef Project with FAI Farms demonstrates the benefits (environmental, ethical and economic) of Adaptive Multi-Paddock (AMP) grazing, a technique mimicking natural processes for more resilient farming. AMP uses robust, easy-calving breeds suited to the environment, allowing year-round outdoor foraging. This approach reduces costs, enhances health and welfare and improves farm resilience and the natural environment (FAI, n.d.).
- **Nestle** partners with over 600,000 farmers to innovate and implement new farming methods, providing necessary technical and financial support. This collaboration upholds the rights of local communities and Indigenous peoples. By aiding farmers in climate-vulnerable areas to bolster their resilience and adopt regenerative practices, the company ensures these farmers earn more, benefiting their families and contributing to a more robust food system (Nestle 2022).

Other initiatives

- **Rewe Germany** introduced the “Better Half” brand containing classic meat items in which 50% of the meat content is replaced with vegetables. The range has launched in 1800 stores (Rewe 2021).
- **Co-op UK** trialled prominent positioning of meat-free products in their meat aisle, citing an 18.4% increase in product sales (Co-op 2022).
- **Albert Heijn** – In 2023, they launched a “True Pricing” Trial for coffee, milk and oat milk. The “real price” includes the social and environmental costs throughout the product chain, such as CO_2 emissions, consumption of water, use of raw materials and working conditions (Pekic 2023).
- **Penny Markets** experimented with true costs accounting. In September 2020, the company teamed up with the University of Augsburg to calculate the “true prices” for eight conventional and organically produced private-label products including milk and mixed meat. The costs took into account all environmental damage caused by producing the foods, including soil, water, emissions and more. Both prices were shown on the products to demonstrate the real cost of consuming that product, although customers only paid the retail cost (REWE 2020).

What we are seeing is a plethora of activity within protein diversification. This is encouraging but we will not see the necessary change needed for a future-fit food system unless businesses make a reciprocal commitment to switch away from an over-reliance on animal sourced foods.

We are witnessing considerable interest and activity by companies in regenerative farming. However, for real change to occur we need companies to make long-term commitments to support farmers in the transition, to commit to buy and to ensure high animal welfare is embedded.

Conclusion: We all have a role to play

Applying a holistic approach is the only effective way to address the climate, nature and health emergencies we face today. Tackling issues in isolation will not succeed because the climate, nature and health issues are, like nature, all interconnected. Shifting to “sustainable intensification” for example may tick the carbon box but it doesn’t meet companies’ wider environmental commitments on land use and biodiversity, nor does it meet companies progress on animal welfare commitments increasingly demanded by customers. What better way for food businesses to demonstrate progress than through well-rounded environmental, social and governance approaches.

There are clear steps that food companies can take as outlined in this chapter.

Other stakeholders should support these efforts. See Chapters 23, 26 and 28 on the role of governments and Chapter 25 on the role of financial institutions. Compassion in World Farming's food business approach is to celebrate those companies' pioneering changes for the better, whilst holding others to account. It is important to collaborate on achieving commitments, promoting best practice, working together on challenges and to find profitable solutions.

Compassion's well-established international Food Business programme team works with major food companies to develop corporate policies and practices that place farm animal welfare at the heart of a future-fit food system. We advocate a holistic approach to food production and seek corporate commitments that drive transformational change for farm animal welfare, reduce the reliance on animal sourced foods and encourage a shift to regenerative farming practices.

We are all affected by the food system and all have a role to play. As individuals we should be mindful about what we consume and how it was produced. We must all use the influence we have on businesses and policy makers to achieve the food system changes that are so urgently needed.

References

Albert Heijn, 2022. Sustainability Report 2022. https://data.maglr.com/3671/issues/42515/525566/downloads/2023.05.10-ah-duurzaamheidsverslag-2022-engels.pdf (page 69)

Aramark, 2022. Progress Report. www.aramark.com/content/dam/aramark/en/environmental-social-governance/reporting/Aramark-ESG-2022-Progress-Report.pdf

BBFAW, 2023. BBFAW Report. https://www.bbfaw.com/benchmark

Carrefour, 2022. Presentation of the "CARREFOUR 2026" strategic plan. https://bbfaw.reportingframework.com/file/704f366c-e437-436a-959b-05c6f7402f21/

CIWF, 2023. More money more meat. https://www.ciwfdocs.org/docs/~D187968

Compass, 2022/23. Climate Impact Report 2021/22. www.compass-group.co.uk/media/0fobchip/compassuk_i_climatereport_final_2022023.pdf (page 21)

Co-op, 2022. Sustainability Report 2022. https://downloads.ctfassets.net/5ywmq66472jr/5VpKP1wSMZWnwnUULahdrD/0a31972547ef7c4cc4885e0b2f9efdd4/Co-operate_Report_2022.pdf (see page 54)

Danone, 2022. Integrated Report. https://www.danone.com/content/dam/corp/global/danonecom/investors/en-all-publications/2022/integratedreports/integratedannualreport2022.pdf

EAT Forum, 2019a. Healthy diets from sustainable food systems. https://eatforum.org/content/uploads/2019/01/EAT-Lancet_Commission_Summary_Report.pdf

EAT Forum, 2019b. The planetary health diet. https://eatforum.org/learn-and-discover/the-planetary-health-diet/

Elior, 2023. Moving Plants Forward at Elior North America. https://www.elior-na.com/spotlight/moving-plants-forward-elior-north-america

FAI, n.d. McDonald's AMP grazing project. https://www.faifarms.com/mcdonalds-uk-amp-grazing-project/

IPBES (Intergovernmental Science Platform on Biodiversity), 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services. https://ipbes.net/global-assessment

IPCC (Intergovernmental Panel on Climate Change), 2023. Climate change and land report. https://www.ipcc.ch/

Lidl, n.d. Sustainable diets. https://corporate.lidl.co.uk/sustainability/healthy-sustainable-diets/sustainable-diets

M&S, 2023. M&S animal welfare. https://corporate.marksandspencer.com/sites/marksandspencer/files/marks-spencer/agriculture-and-supporting/M%26S_Animal_Welfare_Performance_Summary_2023-FINAL.pdf

Nestle, 2022. Creating Shared Value and Sustainability Report 2022.

Patel, R. 2018. Livestock production and human rights. In: D'Silva J and McKenna C (Eds.), *Farming, Food and Nature: Respecting Animals, People and the Environment*, p. 66. London: Routledge.

Pekic B, 2023, 2 May. Albert Heijn launches 'True Pricing' trial. www.esmmagazine.com/retail/albert-heijn-launches-true-pricing-trials-238443

PHE (Public Health England), 2018. Keep antibiotics working campaign. www.gov.uk/government/news/keep-antibiotics-working-campaign-returns

REWE, 2020. PENNY labels its first products with "true prices". www.rewe-group.com/en/press-and-media/newsroom/press-releases/penny-labels-its-first-products-with-true-prices/

REWE, 2021. REWE exclusively introduces meat products with 50 percent vegetables. www.rewe-group.com/de/presse-und-medien/newsroom/pressemitteilungen/rewe-fuehrt-exklusiv-fleischprodukte-mit-50-prozent-gemuese-ein/

Ripple W J, Wolf C, Newsome T M et al., 2019. World scientists' warning of a climate emergency. *Bioscience [Internet]*, 70(1). https://doi.org/10.1093/biosci/biz088

Sodexo, 2023. Sodexo Campus commits to 50% plant-based menu by 2025. https://us.sodexo.com/newsroom/2023/plant-based-menu

Tesco, 2021. A balanced diet for a better future. www.tescoplc.com/media/756844/a-balanced-diet-for-a-better-future.pdf

Waitrose, n.d. Animal welfare. https://www.johnlewispartnership.co.uk/csr/animal-welfare.html

WWF, 2023. What's in store for the planet. www.wwf.org.uk/sites/default/files/2023-12/Whats-in-Store-for-the-Planet-full-report-2023.pdf

28 Food as the problem, food as the solution

James Bailey

> It is an uncomfortable truth that our current food system is harming our planet and our own health. The way we produce much of the food we eat is driving climate change, damaging nature, harming animal welfare and causing obesity. And if this isn't bad enough, we waste a shocking amount of what we grow and manufacture. The debate has gone on for too long - we must urgently change things before it is too late.

This stark paragraph is drawn directly from an internal Waitrose policy development document. The business I represent recognises the existential threat that the current food system poses to the wellbeing of people and our planet. We have a long history of doing good and we are compelled to act. Waitrose believes that urgent change in the way food is produced, consumed and marketed is now essential. This change must protect and rebuild nature and our natural resources, improve human health and ensure business remains relevant. Without such actions we cannot transition to an environmentally responsible and restorative world (John Lewis Partnership 2023).

The definition of existential threat is a threat to something's very existence. Sometimes it feels that the phrase is overused but I believe it is entirely appropriate when applied to the role of food in the global climate mess we find ourselves in. The global food system accounts for approximately one third of all greenhouse gas emissions (FAO 2021), 60% of global biodiversity loss over the last 50 years (WWF 2023) and uses around 70% of our planet's potable freshwater (World Bank 2022).

I'm ashamed to admit that despite working in the food industry for more than 20 years, I've only realised the extent of the problem over the last five. And for most of that time, my understanding of climate change was conflated to a focus on fossil fuels.

The narrative to which I was exposed related to solar panels, carbon-based fuels and industrial pollution. I think most of the UK public has had the same limited understanding as me. Recent government announcements rolling back on some climate pledges have done nothing to clarify the situation for most ordinary people in the country.

Last year I gave a talk at my local village hall in Essex to a gathering of around 40 people representing a relatively broad cross-section of society. I talked about the climate impacts of the food system and shared some of the basic facts – all grounded in clear science. To my utter surprise and shock, my audience was stunned by what I told them.

If customers don't yet understand what's happening, how can they be part of this change?

Thankfully, all the CEOs of UK supermarkets are not like the leaders of big tobacco or big oil in the 1970s.

Every single UK supermarket chain leader is explicit and passionate regarding the cause I'm writing about in this chapter. We understand our role in the changes we need to make and we're

DOI: 10.4324/9781032684369-37

committed to being part of the solution. As the boss of Waitrose, it would be the easiest thing for me to say: "We alone get this, come and shop with us". But that wouldn't be true.

Whether Ken Murphy from Tesco or Simon Roberts from Sainsbury's, leaders at the time of writing, any of the supermarket bosses in the UK would say the same thing – that we understand the problem and we feel the weight of responsibility in being part of the solution.

There is no time at all being spent in UK supermarkets on the question of "if" the food system needs to change. All our time is being spent on "how" to effect that change.

There is no "them and us" in conversations that must happen between individuals and organisations and businesses regarding the regeneration of our world. There must only be "us". Working with supermarkets on food system change will get us all a lot further and help us get to a solution a lot more quickly.

I have divided the way to bring about change into three elements using the key words: disruption, collaboration and customers.

Disruption

By disruption, I mean the real pressing need for innovative, creative and disruptive thinking to solve the problem.

The food system is a vast global entity and its current form is many decades old. It is exceptionally complex with some immeasurable interdependencies and enormous unintended consequences. Trying to see a route to change can sometimes feel like fighting gravity itself, even though so many people are committed to doing things differently and for the greater good.

Making the changes we need and at the pace we need to make them is going to be impossible if we rely on existing tools and ways of thinking. We definitely need to see things from new perspectives, to bring new brains and doctrines into the debate and to turn some accepted wisdom on its head.

Waitrose represents only 5% of the UK supermarket industry. Relative to some other businesses we are a tiny fish in a very big ocean indeed. But a bit like Marlin the father clownfish in Disney's *Finding Nemo*, we're on a mission.

Given our relatively modest size it could be argued that our influence will be limited. But I firmly believe that we could become a very useful little disruptor just as we were with farm animal welfare standards 25 years ago. Since then, Waitrose has won more Compassion in World Farming Awards for its animal welfare standards than any other European retailer. It's my intention that Waitrose will become a much more disruptive, more provocative actor in the industry. This is important because unless someone fulfils that role, the dial won't move far enough, fast enough.

Collaboration

The UK food industry is ferociously competitive. By some measures, it is the most competitive of all UK industries and at any one time, every retailer in the nation is checking the price of 25,000 products on a daily basis. Based on the data, we gather we make instant trading decisions.

But competition alone doesn't hold the answers to the big questions we're posing. We need collectively to address the systemic changes that are needed. To do that, we must learn to collaborate. A key challenge is how to enable open and effective collaboration within an industry that is legally obliged, under retail and competition law, to ensure competitors don't talk to each other.

Some of the answers lie with the UK Government. In his superb and shamefully ignored *National Food Strategy* published in 2020 and 2021, Henry Dimbleby outlines the roles that regulation, competition law, market stimulus and tax can play. He compellingly condenses the strategy in his book *Ravenous* (Dimbleby and Lewis 2023) and offers a suite of recommendations to give us a food system that will:

- Make us well instead of sick.
- Be resilient enough to withstand global shocks.
- Help to restore nature and halt climate change so that we can hand a healthier planet onto our children.
- Meet the standards the public expect on health, environment and animal welfare.

These recommendations include restrictions on the promotion of junk food to children; introduce mandatory reporting for food companies requiring them to give details of sales metrics around metrics such as sales of types of protein, fibre, fruit, vegetables, saturated fat, sugar and salt; introduce a community eatwell plan to allow those on low incomes to improve their diets; use public money to allow landowners to deliver public goods such as managing the land for habitat improvement schemes to boost biodiversity; and set clear targets to bring in legislation to boost long-term change (Dimbleby and Lewis 2023).

There are industry bodies that support collaboration. However, there is an emerging and potentially very important role for more public facing credible, honest and committed intermediaries. These include organisations such as Compassion in World Farming, the World Wide Fund for Nature and the Sustainable Markets Initiative. Waitrose respects and has worked with them all.

Customers

Customers are the most important element in food systems change. No matter how influential supermarkets in general seem we are nothing compared to the people that we work for – the supermarket customer.

Revolutionary change will only happen when it is demanded by shoppers. We need customers who understand what is at stake, willing to buy food produced in more sustainable ways that will probably be a bit more expensive.

The reason that vegan food has quadrupled in shelf space in the last five years in the UK isn't because supermarket priorities have changed. It's because customer priorities have changed. Supermarkets are incredibly competitive animals, and we respond well to customer demand.

A mass scale regenerative farming system is likely to cost more than the current well-embedded intensive system that dominates the food production landscape. At the very least, there will be a prolonged period of costly transition. But to what extent are customers prepared to be part of that solution and pay the price of that transition?

By some estimates, only half of the cost, the real cost, including all the environmental costs of food, is currently represented in the price people pay for their food (Rockefeller Foundation 2021).

Attitude shifts in entrenched customer markets can take a very long time. The first Tesla was sold in 2008, but even after the recent surge in popularity, only 5% of all cars in the UK are EVs (Roberts 2023). And who knows what impacts recent UK government pronouncements rolling back the date of the ban on new petrol and diesel cars will have on those numbers?

People probably only change their car once every five to ten years, but many of us buy food every day. This frequency of purchase gives us an opportunity to test, to learn, to nudge and to move elements of customer attitudes to the food system much more quickly than in many other areas.

But customers will need simple, trustworthy, heuristic cues. Customers – and that's all of us – rarely pay much attention to the food they're buying. My favourite statistic on food shopping is that on the average journey around a supermarket, a customer only spends between nine and 17 seconds reading labels; with online purchases, it is five to ten seconds (Food Standards Agency 2021). So the chance of educating anyone with in store messaging alone is zero.

We need clear labelling and food production standards that help customers play their role in food systems change without needing to be climate or animal welfare experts.

Hope

Along with disruption, collaboration and customer, I would like to add one final keyword, and that is hope. The climate perils we are facing are clear to anyone who regularly watches the news on TV or listens to the radio. What those of us who are concerned about the climate have failed to do is to show just what a pleasant place a net zero future could be to live in.

This is a world with animals farmed entirely in high welfare systems in landscapes that are environmental treasure chests bursting with healthy and diverse animal and plant life. A future where good food is widely available and plays a positive role in a healthy and active society. Surely that's worth all our collective efforts.

Note from the author

The views expressed in this chapter are the author's own and do not necessarily reflect the views of Waitrose or the John Lewis Partnership.

References

Dimbleby H and Lewis J, 2023. *Ravenous - How to Get Ourselves and Our Planet into Shape* (p. 271). London: Profile Books Ltd.

FAO (Food and Agriculture Organization of the United Nations), 2021. New FAO analysis reveals carbon footprint of agri-food supply chain. https://news.un.org/en/story/2021/11/1105172

Food Standards Agency, 2021. Consumer responses to food labelling: a rapid evidence review. https://www.food.gov.uk/sites/default/files/media/document/Consumer%20Responses%20to%20Food%20Labelling_1_0.pdf

John Lewis Partnership, 2023. Ethics and Sustainability Report. https://www.johnlewispartnership.co.uk/content/dam/cws/pdfs/Juniper/ethics-and-sustainability/PR2023/Ethics-and-Sustainability-Report-2022_23.pdf

Roberts G, 2023, 26 April. More than 1m electric vehicles now on UK roads. *Fleet News*. https://www.fleetnews.co.uk/news/latest-fleet-news/electric-fleet-news/2023/04/26/more-than-1m-electric-vehicles-now-on-uk-roads

Rockefeller Foundation, 2021. True cost of food. https://www.rockefellerfoundation.org/wp-content/uploads/2021/07/True-Cost-of-Food-Full-Report-Final.pdf

World Bank, 2022. Water in agriculture. https://www.worldbank.org/en/topic/water-in-agriculture

WWF, 2023. Why we're working on food. https://www.wwf.org.uk/food

29 Holistic frameworks for sustainability in food and farming

Lesley Mitchell, Fabia Bromovsky, Richard Kipling and Emily Lewis-Brown

Why do we need sustainability frameworks for food and farming?

Over the last 75 years, the "Green Revolution" (Science Direct n.d.) has dominated our food and farming systems, industrialising the production of crops and animals. As a result, we have seen astounding increases in outputs, but farming and food production are now widely recognised as significant producers of greenhouse gas emissions as well as causing environmental pollution and soil degradation, as addressed in other chapters in this book. At the same time, the food system has failed to deliver for people, with impacts on human nutrition and health remaining starkly unequal both between and within societies (Pollard and Booth 2019).

The growing attention to environmental impact has led to major food businesses and their investors facing new requirements to measure, report on and reduce greenhouse gas emissions. Addressing climate heating is of utmost importance and is the primary driver of food business action on the environment at present. Business and finance sectors are expected to play their part in meeting legally binding government climate targets and voluntary initiatives are increasingly adopted. For example, climate risk reporting through the Taskforce for Climate Related Financial Disclosures (TCFD), www.tcfdhub.org. The Science Based Targets Initiative, which requires companies to have climate reduction strategy and targets, has been adopted by hundreds of food and agriculture companies (SBTi 2024).

Yet, an approach solely focused on greenhouse gas emissions could lead to profound unintended negative consequences for food and farming. Siloed carbon "tunnel vision" (Burton 2022) focused solely on the amount of emissions produced per kilogram of product inherently biases towards intensive high output production systems. This is exacerbated by failure to account for off-farm impacts, such as emissions associated with inputs like animal feed or changes in the amount of soil carbon.

This narrow approach fails to take account of the diverse breadth of positive and negative impacts associated with farming. These include dependence on inputs such as feed and fertilisers reliant on fossil fuels, which could increase farmers' risk if they become scarce or more expensive as seen in recent years. Other impacts include pollution, biodiversity loss and soil health degradation, all of which pose a risk to future productivity. For farmed animals, any view of sustainability must include positive animal welfare outcomes.

The economics of farming also influence its sustainability. Many supply chains rely on "least cost" models (OFC 2023) that do not reward farmers fairly, impoverishing rural communities and leaving farmers unable to invest in new practices or equipment. Any shift to more sustainable farming systems will need to deliver a "just" transition (Ross et al. 2023) – one that ensures farmers and rural communities can thrive – to ensure resilient food production.

DOI: 10.4324/9781032684369-38

On the global stage, food and farming influence almost all the Sustainable Development Goals (SDGs), https://sdgs.un.org/goals, which are the driving force behind intergovernmental action on sustainable development this decade. Beyond climate change, we are seeing increasing attention to more complex challenges, as new global agreements aim to address massive biodiversity depletion. Expanding on climate risk reporting initiatives, such as TCFD noted above, new methods of nature risk reporting are beginning to be adopted (TNFD n.d.). European legislation now requires financial risk materiality assessments to include environmental impact (Eurosif 2024).

The increasing attention to climate and biodiversity is shining a light on food businesses' dependence on their supply chains to improve outcomes because the vast majority of their greenhouse emissions stem from the activities of their producers and processors (WWF 2023). At the heart of every major supply chain are farmers and their land that produces our food.

Shifting to sustainable farming has major positive potential. Agriculture, if refocused on regeneration, could be harnessed as a major "nature-based" solution for environmental restoration. It could support climate resilient food systems and deliver sustainable nutrition both now and in the future. The links between human and planetary health, and a focus on restoration, mean that farming and food production will increasingly need to deliver multiple social, environmental and economic outcomes.

This all sounds positive, but without a core framing of what needs to be considered in food and farming sustainability, the sector is ripe for greenwashing and confusion. As just one example, a 2020 US Farmers and Ranchers Alliance report noted 16 different sustainability frameworks but reported that only 25% of the food businesses participating in these frameworks were using one or more metric (US Farmers and Ranchers 2019). Other research has identified more than 100 different standards, assessment frameworks and certifications – all of which are asking farmers to address different areas of sustainability, often in diverse ways.

This demonstrates an urgent need for a common approach to on-farm sustainability that can be widely adopted whilst supporting action from farm to fork. This approach needs to deal with the increasing complexity of demands placed on farmers in a way that empowers them as "decision-makers" from the ground up, rather than continuing to over-burden them with top-down demands.

> The resulting proliferation of requests, frameworks, platforms, tools and initiatives has created a complex, time-consuming and often confusing reporting landscape that is difficult for farmers, investors, NGOs, food companies, consumers and other stakeholders to navigate.
>
> US Farmers and Ranchers (2019)

So, how can sustainability frameworks enable farmers to embrace change? And, further along the supply chain, how can they unlock fair rewards for the environmental and social public goods that farmers provide, as well as enabling the new finance models and resources needed for a transition to more sustainable food production systems? Any framework needs to enable supply chain transparency so food businesses can report, and consumers can understand the real impact of their food choices.

Challenges in designing farm sustainability frameworks

Design of a sustainability framework faces five core challenges:

The first challenge is how to navigate simplicity versus complexity. There is no silver bullet or single number that can describe food or farming sustainability (however, much we urgently want one). Any framework needs to support real world assessment and deliver usable information. It also needs to be holistic to capture the full range of material sustainability risks and potential for improvement. Oversimplification could provide a distorted picture of farm sustainability, ignoring other risks. For example, targeting apparently carbon efficient intensive monoculture crops, without addressing biodiversity loss or soil depletion, or favouring forms of intensive animal production without recognising the scale of animal welfare issues present. It also means we might miss important opportunities for nature restoration – for example, low intensity, pasture-based animal farming systems may be less productive per kilogram of product per year, but they can deliver soil carbon sequestration, support nature recovery, provide good animal welfare outcomes and utilise otherwise unproductive areas of land.

The second challenge is who and what the framework is for. Farmers need information to support decision-making and pathways for improvement. Increasingly, they may also seek to demonstrate the environmental impact of their farm to gain access to markets and funding for public goods, such as premiums or government incentive payments. Food businesses, meanwhile, may want tools for supplier engagement, or to prove the sustainability impacts of their products, or to communicate with consumers. Whilst these needs are different, they all depend on what happens on the farm, so any framework inherently needs to start from the ground up.

The third challenge is the scope and boundaries of the farm system being considered, particularly where a farm has multiple inputs, product and service outputs, supply chains and enterprises, or where land is shared over time by different producers. This requires a whole farm approach – pinpointing areas for attention but looking at the whole farm system and how it changes over time.

The fourth design challenge is framework adaptability, both to farm type, region and context – it needs to be workable across a range of settings, not exclusive to one farming type. A smallholder farmer in rural Asia may have very different sustainability challenges to an organic US chicken farmer or an upland sheep farmer in the UK. Consensus on a framework allows all to use a consistent approach and a common language that defines which parts of the farm system matter, and which outcomes are important, whilst enabling targeted action on areas of highest impact in a particular context. For example, in one study looking at the meaning of regenerative agriculture, participants in India placed most importance on social and economic impacts (Forum for the Future 2018). Other actors may need to prioritise environmental outcomes such as water use where it is scarce (e.g., East Anglia in the UK) (Issimdar 2023), as opposed to those where "green water" from rainfall is abundant (Wales, for example) (University of Cranfield 2023). A framework needs to show the whole picture whilst allowing farmers to focus on relevant actions.

Lastly, it is important to see farms as a complex web of different systems, where the state of one part may influence another. For example, use of nitrogen fertiliser will influence soil health and the potential for water pollution, thus potentially influencing wider ecosystems such as local rivers. Whilst introducing regenerative practices, such as cultivating a greater diversity of crops or adding farmed animals into a rotation, might reduce the productivity of a farm overall, it could also improve soil health for future crops and enable carbon sequestration. This wider view is especially important when considering potential "win wins" or facing up to trade-offs between competing priorities.

A holistic framework for farm sustainability

Whilst the SDGs have highlighted the relevance of farming to solving a range of sustainability challenges, there are very few frameworks that deliver a joined-up picture of what is happening in farming and food production. The Global Farm Metric (GFM), www.globalfarmmetric.org, is one of the first widely available sustainability frameworks that seeks to address holistic outcomes across the farm.

Incubated by the Sustainable Food Trust, this framework has been developed, over seven years to date, in collaboration with a wide range of stakeholders from food, farming, civil society and academia. It is supported by a coalition of over 150 organisations across the food system. The input of farmers and consideration of their needs has been integral to its creation. Its associated assessment is being trialled on more than 500 farms across the world, including in Australia, Brazil, Cameroon, Egypt, India, Ireland, Malawi, Mexico, South Africa, Spain, the UK and the US.

The GFM framework and indicators are based on a holistic view of sustainability that requires farms to address current needs without compromising those of the future. The aims are to maintain farms in good environmental, social and economic condition and to improve their impacts on people and planet beyond the farm gate. The framework provides the basis for evaluating diverse farming approaches, systems and practices.

Box 29.1 What do we mean by sustainability in farming?

- Providing sufficient, high-quality food, fuel and fibre to meet society's current needs;
- Safeguarding the ability of future generations to meet their needs for food, fuel and fibre by protecting and improving the environmental, social and economic condition of every farm;
- Moving from minimising the negative impacts of farming, towards farming which actively enhances the state of people and planet beyond the farm gate; and
- A continual process to meet changing environmental, social and economic challenges and needs, rather than the realisation of a single target level or state.

The aim is to create a workable, adaptable and, most importantly, holistic framework, created in the commons and thus available to all, that can underpin the design of a wide range of tools and assessments tailored to the needs of regions and supply chains.

The GFM has so far been influential in shaping approaches of the international Regen 10 initiative, a multi-million dollar project that aims to unlock and accelerate the transformation to regenerative agriculture. It is a foundation point for other organisations to develop from, such as the Soil Association Exchange assessment protocols now being used widely in the UK (see www.soilassociationexchange.com/faqs).

The GFM framework unlocks action across the food and farming system. Its use empowers farmers to understand the state of their farm and identify the impact of their practices on the world beyond their farm. Risks to the ability of the farm to sustain itself can then be identified, and farmers can prioritise actions to increase farm resilience. By doing so, they can increase their positive impacts, whilst reducing negative or unintended consequences on the farm and beyond.

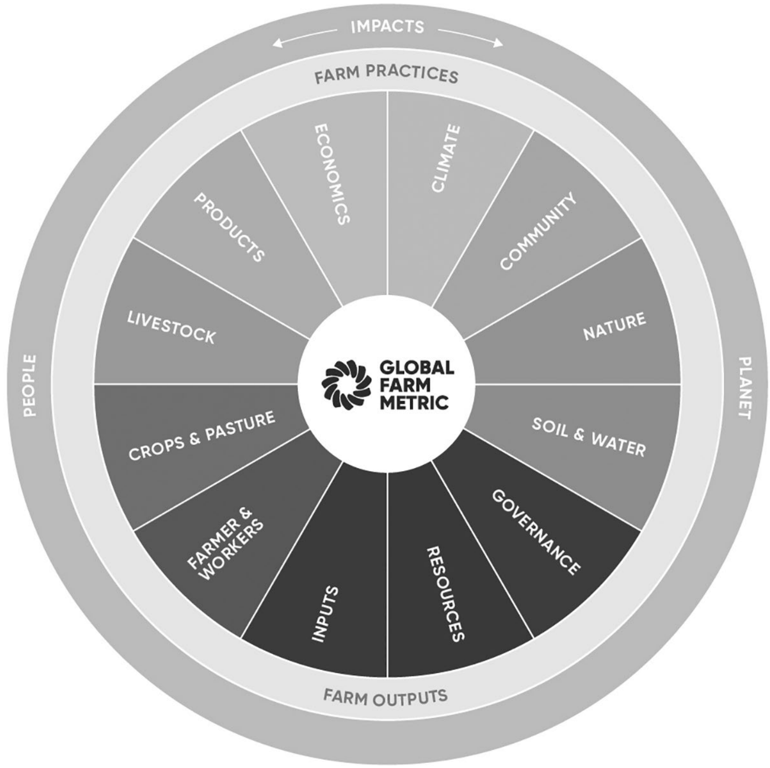

Figure 29.1 The global farm metric framework.

Across the wider food system, the framework enables farmers, food businesses, certifiers, banks and governments to create a shared understanding of where impact may occur and how to support resilient and sustainable food systems. It can be used as the basis of farm support payments, provides access to new markets and supports sustainable investment. A common language can also enable transparency across the supply chain and has the potential to align food labelling. Citizens could be better able to mobilise their consumer power and make informed decisions. A baseline of farm level data also can be aggregated at a local, national and international scale to understand how a region or country is performing against the SDG objectives.

The framework outlines 12 major categories of sustainability concern for farms: economics, products, governance, climate, nature, soil and water, farmers and workers, community; inputs, crops and pasture and animals, including their welfare. It recognises the farm as a system and gives farmers the opportunity to see a whole picture of how actions in one area can influence those in another. It thereby allows for farmers to identify multiple wins, whilst providing effective input to decision-making where potential trade-offs arise. Indicators for each of the 12 categories are included to direct users to relevant data collection (Figure 29.1).

It is important to distinguish the overarching GFM framework from the detailed measures or metrics that are then assessed. In a sense, the framework acts as a guide or map, with indicators providing specificity on the types of things to measure each component. Then, the data metrics that quantify performance at any one point in time provide a quantified snapshot for each indicator.

One critique of the GFM is that it is too complex and time-consuming to assess all at once and that it adds to an already overwhelming audit burden for farmers. However, this misses the point. The GFM framework and data metric collection are not the same. Data metrics can be assessed when a farmer considers them to be necessary – for example, when a major risk or opportunity is identified, or over time as part of the usual farm processes, such as responding to food company audit requirements, or proving the farm meets a standard for certification. The GFM framework allows this information to feed into a coherent whole over time.

By using a common language and framework, diverse initiatives and tools can also move towards a harmonised approach to sustainability. For example, in the UK, the GFM has engaged extensively with Linking Environment and Farming (LEAF), whose Leaf Marque certification, https://leaf.eco/leafmarque/about, looks at on-farm practices and is utilised widely by food companies. The aim is to integrate aspects of monitoring system/holistic outcomes over time into LEAF's well-tested approach to good practice and stewardship. Also, in the UK, alignment between aspects of the GFM framework and the Soil Association Exchange (SAX) assessment and tools means that farmers and food companies using the SAX tools are moving towards a more holistic approach to farm sustainability.

Focus on the GFM is furthering alignment across regions and countries, including adoption of similar frameworks within the global Regen 10 initiative. Other major international initiatives such as the corporate-focused Sustainable Agriculture Initiative have major outreach into global supply chains and have adopted environmental parameters and approach aligned closely with GFM, although they do not yet extend to social and economic considerations.

A note on challenges with measurement and metrics and reporting

In the face of climate and environmental breakdown and volatile food security, we are caught between a quest for perfect measures that everyone can agree, urgency for action and the need for a comprehensive approach. In the race to respond to the crisis, expediency may come to the fore, but the need for valid data on the real impacts of the food system is essential.

To illustrate, carbon emissions assessment is probably the most advanced area of assessment at this point, but the science surrounding greenhouse gas assessments is evolving rapidly. Life Cycle Assessment (LCA) approaches are often used in assessing environmental impacts. Their scope can be limited in terms of wider system impacts, such as the potential for agroecological systems to sequester carbon or boost productivity through better soil health and the effects of off-site land use change for feed production inputs. Due to the practical challenges of measuring what is happening in a particular system, LCA studies often use modelled data or averages for a particular product or region, rather than measuring actual emissions. This highlights the issue of simplicity versus accuracy noted above. This balance of accuracy versus expediency can have significant consequences – for example, using a standardised dataset for all UK beef may overestimate the carbon emissions from a pasture-based farm that is using multiple means of reducing carbon impacts.

The measurement of biodiversity extends this complexity far further. Historically, farm assessments of biodiversity have focused on field margins and land left to nature, rather than "in field" where the actual food production happens. This has led to proxy or indirect measurements being used. One example uses the amount of land occupied for food production per kilogram of product output as a proxy for negative biodiversity impact (IGD 2023). This approach sets up an opposition between farming and biodiversity that is an artefact of the method, not necessarily a reflection of reality. In this case, a more extensive system might be considered as having a worse biodiversity impact if it uses a greater proportion of the land for production, even if that land supports high levels of biodiversity.

The old assumption that biodiversity and yields per area of productive land are inversely related is being challenged, as regenerative and agroecological practices are developed and

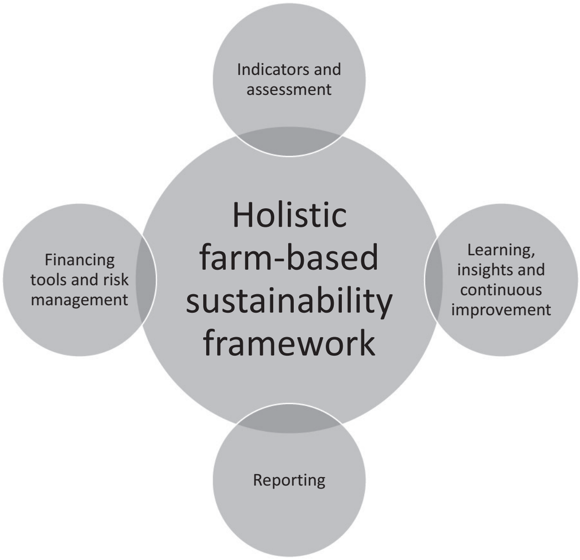

Figure 29.2 Sustainability frameworks support action across the food system.

used more widely (Palomo-Campesino et al. 2022) and we see "in-farm" biodiversity restoration growing alongside maintaining crop production. These issues matter, because the outcomes of sustainability assessments influence what types of farming system are chosen to produce our food. Failure to adopt a holistic approach to metrics could lead to profound unintended consequences such as driving farmed animals off the land or ploughing up permanent pasture. In short, metrics need to be valid and robust in a range of circumstances, and the underlying assumptions around how they are interpreted need to be made clear.

It is important to raise the challenge of translating farm sustainability frameworks through to corporate and financial reporting. There is huge pressure on food business and finance to manage their sustainability risks and to take action to reduce negative impacts and contribute to restoration. The link between resilience of food supply chains and climate related extreme weather is becoming ever more visible and intense. The financial disclosure mechanisms outlined above (TCFD, TNFD) require reporting on financial risk from exposure to climate and nature risks. GFM is directly relevant to TNFD due to its ability to assess dependencies, impacts, risks and opportunities, in line with the priority aims of these reporting frameworks.

New financial mechanisms will be key to investing in resilient and restorative farming. Consequently, there is a growing need to translate the framework at farm level into the type of information that can be used in corporate and financial reporting. Mechanisms such as the Sustainable Markets Initiative's Agribusiness Taskforce, www.sustainable-markets.org/taskforces/agribusiness-task-force/, and banks like Oxbury, oxbury.com, are beginning to develop mechanisms to align supply chains and financing in a way that supports farmers who are achieving positive sustainability impacts. This work will increasingly emphasise the need for real data at farm level (Figure 29.2).

The future of holistic sustainability frameworks

If we are to create a regenerative future for food and farming, it will need to deliver for people both now and in the future, rebalancing and replenishing the natural resources upon which we depend. It will need to be humane, just and fair – providing sufficient resources for farming and food producers to transform, innovate and become resilient in an increasingly precarious world – and balance sustainable production with sustainable consumption.

This means acting on carbon and biodiversity restoration, but also working to ensure that farmers and food producers and their communities are in good shape. A holistic approach is vital to encompass these multiple elements of regeneration.

The science, data and protocols for assessment of key sustainability parameters are likely to evolve further, but there is no time to allow perfection to be the enemy of good enough. Systemic assessments based on the GFM, together with the use of aligned tools, are a good place to start. Reporting can also develop as new measures become clearer. Extensive learnings from trials across the world will enable the GFM to be refined and adapted to new regions and contexts. Most importantly, keeping this collaborative knowledge and insight in the commons is vital to enable all actors to align, share and accelerate the regenerative food and farming transformation.

References

Burton L, 2022. It's time to move beyond "carbon tunnel vision." Stockholm Environment Institute. www.sei.org/perspectives/move-beyond-carbon-tunnel-vision/

Eurosif, 2024. The sustainable finance disclosure regulation. www.eurosif.org/policies/sfdr/

Forum for the Future, 2018. Catalyst fund report: Regenerative agriculture. www.forumforthefuture.org

IGD, 2023. Environmental labelling for the UK Food Industry. www.igd.com/Social-Impact/Sustainability/Reports/Environmental-labelling-for-the-UK-food-industry/32858

Issimdar M, 2023. East of England faces huge water shortage without action – experts. www.bbc.co.uk/news/uk-england-cambridgeshire-67694328#

OFC (Oxford Farming Conference), 2023. OFC Reports: Supply chain synergies. www.ofc.org.uk/ofc-reports

Palomo-Campesino S, García-Llorente M, Hevia V et al., 2022. Do agroecological practices enhance the supply of ecosystem services? *Ecosystem Services*, 57:101474. https://doi.org/10.1016/j.ecoser.2022.101474

Pollard C M and Booth S, 2019. Food Insecurity and Hunger in Rich Countries—It Is Time for Action against Inequality. *International Journal of Environmental Research and Public Health*, 16(10):1804. www.ncbi.nlm.nih.gov/pmc/articles/PMC6572174/

Ross A, Curran B, Robins N and Nicholls M, 2023. Sowing seeds: How finance can support a just transition in UK agriculture. www.lse.ac.uk/granthaminstitute/wp-content/uploads/2023/07/Sowing-Seeds_How-finance-can-support-a-just-transition-in-UK-agriculture.pdf

SBTi (Science Based Targets Initiative) 2024. Target dashboard. https://sciencebasedtargets.org/companies-taking-action

Science Direct, n.d. Green revolution. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/green-revolution

TNFD (Taskforce on Nature-related Financial Disclosures), n.d. TNFD adopters. https://tnfd.global/

University of Cranfield, 2023. Here's how much water it takes to make a serving of beef – and why where it comes from is so important. www.cranfield.ac.uk/press/news-2023/heres-how-much-water-it-takes-to-make-a-serving-of-beef

US Farmers and Ranchers, 2019. Navigating the food metrics maze. https://usfarmersandranchers.org/wp-content/uploads/2020/06/2019-Food-MetricsReport-Summary.pdf

WWF, 2023. Report: How food companies are incentivizing reduction of supply chain greenhouse gas emissions. www.worldwildlife.org/press-releases/wwf-report-how-food-companies-are-incentivizing-reduction-of-supply-chain-greenhouse-gas-emissions

Changing minds to change policies

30 What is needed for transformation?

Molly Anderson

The need to transform our food system is widely recognised, with hardly anyone in dispute. The food system has massive impacts on soil degradation, loss of biodiversity, freshwater and oceans contamination (Borrelli et al. 2017; Mateo-Sagasta et al. 2017; Benton et al. 2021; Fletcher et al. 2021). The Intergovernmental Panel on Climate Change reported that food systems emit up to 37% of greenhouse gases (Crippa et al. 2021). Small-scale farmers struggle to make a living, and marginalised people with less political power such as Indigenous peoples and ethnic minorities experience theft of their lands and traditional waters (GRAIN 2016; Gneiting and Sonenshine 2018; Yang and He 2021). Even mainstream actors are saying we must transform the food system (e.g., Godfray et al. 2010; Webb et al. 2020; von Braun et al. 2023). But what kind of transformation is needed?

Profoundly different ideas are being put forward. On the one hand, the World Economic Forum (WEF), made up of the largest corporations in the world, proposed a Global Redesign Initiative in 2010 (WEF 2010), followed by a Great Reset Initiative (Schwab and Mallaret 2020) as COVID raged around the world. Klaus Schwab, the founder and executive director of the World Economic Forum, asserted that the world needs a "stakeholder economy" in which global decision-making would be shared by non-governmental actors such as corporations working with governments. The mechanism for decision-making would become multistakeholder initiatives (MSIs) of the willing and able.

The WEF also promoted an array of Fourth Industrial Revolution innovations such as drones, satellites, precision agriculture, robotics, the "Internet of Things" and digitalisation (WEF 2018). Advocates of WEF's proposals envision a future of farming without traditional farmers, a future with farmers sitting in offices directing their machines. Small-scale peasant farmers would be squeezed out by large-scale highly mechanised farms.

The 2021 UN Food Systems Summit revealed what happens when corporations and their affiliates are in the driver's seat of global decision-making. It showcased innovations and business leaders, but failed to include the largest group of civil society actors working on food systems, the Civil Society and Indigenous Peoples Mechanism of the Committee on World Food Security. It resulted in a number of new multistakeholder coalitions, which are not accountable to citizens nor based in human rights. Civil society and scholars have issued several warnings about the impacts of MSIs (e.g., Gleckman 2018; Chandrasakaran et al. 2021) yet the Secretary-General of the UN is moving forward with *Our Common Agenda*, a plan to implement MSI-based governance throughout the UN, to be revealed at the Summit of the Future in September 2024.

At the other end of the spectrum from a stakeholder economy are the solidarity economy, the care economy, degrowth and the "pluriverse" – radically different ideas that put people first rather than profits and technology. The pluriverse is a wealth of ways to organise society to

DOI: 10.4324/9781032684369-40

serve everyone's wellbeing and to protect the planet, drawing from Indigenous ways of being, ecofeminism and solidarity. They are woven together in a Global Tapestry of Alternatives, with an underlying philosophy that many worlds are possible. The Wellbeing Economy Alliance is the leading collaboration of organisations, alliances, movements and individuals that works with governments towards a wellbeing economy, delivering human and ecological wellbeing. Its focus is fulfilling human rights whilst living within planetary boundaries.

Envisioning how we want things to be

Schwab's stakeholder economy is underpinned by the grand narrative of constant growth and modernisation through privatisation, science and innovation led by industry. The American social scientist Sheila Jasanoff described this grand narrative in this way: "As time's arrow points inexorably forward, so too do scientific discovery and its technological spinoffs, bringing only the possibility of gain and betterment" (Jasanoff 2002, p. 256). But we have many lessons that technology may instead bring unintended consequences resulting in great suffering and increased inequality.

To take care of people and our planet, we need a new narrative. New narratives are emerging; amongst them are the solidarity economy, care economy and one doubling down on business as usual. The latter was manifest in the publications of the Science Group of the UN Food System Summit of September 2021, which advocated for more research and technological innovation (von Braun et al. 2023).

Moving from the current vision to another requires a solid theory of change, beginning with a vision of the world we want to see. It requires a realistic assessment of current conditions, based on an astute power analysis, the preconditions and assumptions that are related to that change, strategic pathways of action and specific outcomes and impact.

The US nonprofit organisation HEAL Food Alliance is a multi-sector, multiracial coalition trying to build collective power to transform US food and farm systems. Its theory of change (HEAL Food Alliance 2022) begins with strategic assumptions about current conditions which set the scene for social change:

1 The root causes of our destructive food system are tied to the ideologies that place profit over people and the planet.
2 The transition that we really need is not currently politically feasible; we need to change the conditions and the structure.
3 No single organisation, alliance or sector can transform the system working on its own or in isolation.
4 Frontline and burdened communities have solutions for the systemic change that's needed and must lead their communities and all forces through transition.
5 To make the change we need, we need to work in and influence multiple areas.

Many of these assumptions apply globally, but people working on food system transformation need to assess current conditions in their own locales and formulate their own assumptions about what will be needed.

Looking at barriers to change

What has prevented transformation towards wellbeing from happening so far? I see three barriers.

First is the shift to authoritarian governments. The V-Dem Institute conducts research on democratisation of countries and paints a dismal picture. There are far fewer countries that are democratising than countries moving in an authoritarian direction. By 2022, 72% of the world's population – 5.7 billion people – lived in autocracies. In 2023, freedom of expression was deteriorating in 35 countries, government censorship of the media was getting worse in 47 countries, government repression of civil society organisations was worsening in 37 countries, and quality of elections was worsening in 30 countries. The slide towards autocracy in the last ten years wiped out advances towards democracy made in the last 35 years.

The decline is most dramatic in the Asia-Pacific region, which is back to levels last recorded in 1978. Eastern Europe, Central Asia, Latin America and the Caribbean are back to levels last seen around the end of the Cold War, even though Latin America has seen the election of progressive leaders (Papada et al. 2023). A political climate of authoritarianism presents intractable problems for the food system changes that we need. Food democracy is impossible if civic democracy has been destroyed.

The second barrier is global and domestic inequality and the intransigence of the economic elite. The richest 1% of the global population has captured almost two-thirds of all new wealth since 2020, and poverty has increased for the first time in 25 years (Christensen et al. 2023). The richest 10% of US households are responsible for 40% of the country's greenhouse gas emissions. The investment portfolios of the highest earning 1% of households (whose income is linked to 15%–17% of national emissions) account for 38%–43% of their emissions (Starr et al. 2023).

The V-Dem Institute states that disinformation, polarisation and autocratisation reinforce each other (Papada et al. 2023). The rise of disinformation, including about greenhouse gas emissions and who is most responsible for them, is one of the ways that autocrats are driving polarisation and preventing us from achieving the change that we want to see. It is also one of the ways that autocrats are rising in power.

The final barrier to transformation is lock-ins that exist within the food system preventing a transformation from extractive industrialised systems towards diversified, agroecological systems. Lock-ins are self-reinforcing trends that maintain the status quo of sociopolitical and economic systems. IPES-Food (2016) identified lock-ins of short-term thinking, compartmentalised thinking, the feed-the-world narrative, expectations of cheap food and using the wrong measures of success. In addition, path dependency and national orientations towards exports instead of feeding their own people on a local or regional level contribute to keeping business as usual in place. All these lock-ins are held together and perpetuated by the rapidly escalating concentration of the food system. The number of industries that are controlling every sector from inputs through retail is getting smaller and smaller, which means fewer and fewer people are involved. Consequently, the current food system is about as far from food democracy as one could imagine.

Creating a vision and theory of change

To overcome these barriers and to overcome the intransigence of the economic elite, we need a compelling vision that focuses on how life would improve for most people with a transformed food system under conditions of food sovereignty and food democracy. But where do we find vision? The Indian author Arundhati Roy wrote:

> The first step towards re-imagining a world gone terribly wrong would be to stop the annihilation of those with a different imagination. An imagination that is outside of capitalism

> as well as outside communism, an imagination that has an altogether different understanding of what constitutes happiness and fulfilment.
>
> (Roy 2011)

Indigenous people often hold such an imagination, and we can find inspiration in their writing and work. Examples are Black farmer Leah Penniman's *Black Earth Wisdom* (Penniman 2023) and Indigenous botanist Robin Wall Kimmerer's *Braiding Sweetgrass* (Kimmerer 2020).

Recurrent themes in Indigenous cosmologies include:

- Interdependence and respect for nature, instead of dominance;
- Taking only what is necessary, instead of exploitation and extractivism;
- Public stewardship of the commons of nature and food production, instead of private ownership of resources;
- Avoiding waste, instead of squandering what we have;
- Eating as a spiritual act embedded in values, rather than seeing food as just another commodity; and
- Sharing and solidarity, rather than individualism.

We must not forget that Indigenous and US Black wisdom (in the US) has been forged through immense suffering from genocide and slavery. Global Witness, which monitors violence against land offenders, reported that nearly 2000 land and environmental defenders were murdered between 2012 and 2022, and Indigenous people were victims of more than a third of global killings in 2022, even though they only make up around 5% of the world's population. These people were targeted for trying to protect their homes, lands, livelihoods and the ecosystems vital for biodiversity and for the climate. This political climate presents a stark problem for the food system changes that we need, as the people being murdered were defending precisely the values that need to be upheld.

Inspiring change through risk and action

Nelson Mandela reminded us that vision is only part of the theory of change: we also need pragmatic action. Fortunately, there are many examples of actions towards a better food system. People are taking risks – sometimes only beginning steps – but creating changes that benefit their communities and the natural world.

First, some communities are putting healthy food back into the commons rather than privatising it and making it available only to people with money. They understand food security as a public good that should be universally realised. Examples are land and seed commons, where land and seeds are shared by a collective, and making school meals free for all children.

Second, the science and practices of agroecology are increasing in visibility and popularity around the world. This is a food system with completely different premises than the industrialised extractive food system. Agroecological vision and practice:

- Encourage diversity in crops, nutrition and livelihood strategies;
- Enhance resilience to climate change;
- Improve soil health for long term productivity;
- Decrease or eliminate the use of synthetic fertiliser and pesticide use, which keeps farmers from going into debt;
- Build greater self-sufficiency, increase farmer autonomy; and
- Focus on marginalised people and small-scale farmers.

Agroecology is a productive and viable pathway to a transformed food system that will benefit all of us.

Third, people around the planet are demanding food sovereignty, which restores control of their food system. Food sovereignty is a growing call from people who are coping with imposed regulations, debt and impoverishment created by the global elite. It is explicitly recognised as a right in the UN Declaration of the Rights of Peasants and Other People Living in Rural Areas (UNDROP). Food sovereignty requires genuine food democracy to shift control from corporations to people.

Finally, people are trying to switch to wellbeing economies that place social welfare and environmental regeneration above profits by the few, whether this is at the scale of eco-villages and Transition Towns or for the entire nation. Scotland, New Zealand, Iceland, Wales, Finland and Canada have all joined the Wellbeing Economy Alliance, recognising that they need new indicators of wellbeing to measure success because GDP is not an adequate measure for progress.

Building coalitions – key to transformation

As the HEAL Food Alliance stated, no single organisation, alliance or sector can transform the food system working alone or in isolation. The food movement comprising people who are concerned about hunger and food access, local food, agroecology, food sovereignty, animal welfare and agricultural development is not strong enough alone to resist forces that are benefitting from current institutions and to create the transformation we want. To make the changes we need, we must work in and influence multiple arenas.

Our coalitions must be broad and inclusive to build political power. The food movement intersects many other movements including those for climate justice, racial equity, degrowth, the rights of people who have been put aside or marginalised, agrarian reform, labour rights, democratisation and the preservation of biodiversity. When we join forces with all these movements, we can create a transformed food system.

References

Benton T G, Bieg C, Harwatt H et al., 2021. *Food System Impacts on Biodiversity Loss: Three Levers for Food System Transformation in Support of Nature*. Chatham House and UNEP.

Borrelli P, Robinson D A, Fleischer L R et al., 2017. An assessment of the global impact of 21st century land use change on soil erosion. *Nature Communications*, 8:2013. https://doi.org/10.1038/s41467-017-02142-7

Chandrasekaran K, Guttal S, Kumar M et al., 2021. Exposing Corporate Capture of the UNFSS through Multistakeholderism. Food Systems 4 People. https://foodsystems4people.org/wp-content/uploads/2021/09/UNFSSreport2021.pdf

Christensen M-B, Hallum C, Maitland A et al., 2023. *Survival of the Richest*. Oxfam International. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621477/bp-survival-of-the-richest-160123-en.pdf

Crippa M et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2:198–209. https://doi.org/10.1038/s43016-021-00225-9

Fletcher S, Lu Y, Alvarez P and McOwen C, 2021. *Governing Coastal Resources: Implications for a Sustainable Blue Economy*. International Resource Panel (IRP) of the United Nations Environment Programme (UNEP).

Gleckman H, 2018. *Multistakeholder Governance and Democracy: A Global Challenge*. London: Routledge.

Gneiting U and Sonenshine J, 2018. A Living Income for Small-scale Farmers: Tackling Unequal Risks and Market Power. *Oxfam Discussion Papers*. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620596/dp-living-income-smallscale-farmers-151118-en.pdf?sequence=1&isAllowed=y

Godfray H C J, Beddington J R, Crute I R et al., 2010. Food security: The challenge of feeding 9 billion people. *Science*, 327:812–818.

GRAIN, 2016. The global farmland grab in 2016: how big, how bad? https://grain.org/article/entries/5492-the-global-farmland-grab-in-2016-how-big-how-bad

HEAL Food Alliance, 2022. Theory of change. https://healfoodalliance.org/theory-of-change/

IPES-Food, 2016. From uniformity to diversity. A paradigm shift from industrial agriculture to diversified agroecological systems. www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf

Jasanoff J, 2002. New modernities: Reimagining science, technology and development. *Environmental Values*, 11(3):253–276. www.jstor.org/stable/30301896

Kimmerer R W, 2020. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*. Minneapolis, MN: Milkweed Editions.

Mateo-Sagasta, J, Zadeh S M and Turral H, 2017. *Water Pollution from Agriculture: A Global Review*. UN Food and Agriculture Organization and International Water Management Institute. https://www.fao.org/3/i7754e/i7754e.pdf

Papada E, Altman D, Angiolillo F et al., 2023. Defiance in the Face of Autocratization. Democracy Report 2023. University of Gothenburg: Varieties of Democracy Institute (V-Dem Institute).

Penniman L, 2023. *Black Earth Wisdom*. New York: Harper Collins Publishers.

Roy A, 2011. *Walking with the Comrades*. London: Penguin Books.

Schwab K and Mallaret T, 2020. *The Great Reset*. Zurich: Agentur Schweiz.

Starr J, Nicolson C, Ash M et al., 2023. Income-based U.S. household carbon footprints (1990–2019) offer new insights on emissions inequality and climate finance. *PLoS Climate*, 2(8):e0000190. https://doi.org/10.1371/journal.pclm.0000190

von Braun J, Afsana K, Fresco L O and Hassan M H A, 2023. Food systems: Seven priorities to end hunger and protect the planet. In: von Braun J et al. (Eds.), *Science and Innovations for Food Systems Transformation* (pp. 3–9). https://link.springer.com/book/10.1007/978-3-031-15703-5#toc

Webb P, Benton T G, Beddington J et al., 2020. The urgency of food system transformation is now irrefutable. *Nature Food*, 1:584–585. https://doi.org/10.1038/s43016-020-00161-0

WEF (World Economic Forum), 2010. Everybody's Business: Strengthening International Cooperation in a More Interdependent World. Report of the Global Redesign Initiative. https://www.weforum.org/publications/everybodys-business-strengthening-international-cooperation-more-interdependent-world/ - currently it seems to be linked to https://www.weforum.org/

WEF (World Economic Forum), 2018. Innovation with a purpose: The role of technology innovation in accelerating food systems transformation. https://www.weforum.org/publications/innovation-with-a-purpose-the-role-of-technology-innovation-in-accelerating-food-systems-transformation/

Yang B and He J, 2021. Global land grabbing: A critical review of case studies across the world. *Land*, 10:324. https://doi.org/10.3390/land10030324

31 The Earth will tell us

Ruud Zanders

Our food, our first necessity of life, has had its origins in agriculture for thousands of years. Following on from hunters and gatherers, as farmers we learned how to produce more and more food with our land. That urge to produce is now playing tricks on the Earth. No one will dispute that our current agricultural system needs change. Okay, almost no one then. But the big question is how we can and should proceed.

As Dutch farmers, we have been very successful in implementing the Mansholt vision:

> A convinced European federalist, Mansholt dreamt of a common agricultural policy for Europe. In 1950, he developed a plan for a common market for agricultural produce in Europe with a supranational governing structure. With a dire shortage of food and a crisis looming, Mansholt took a number of measures to restore food supplies quickly after World War II. He set minimum prices for the most important agricultural products combined with import taxes and support for exports. He was convinced that the whole of Europe needed to become self-sufficient and that a stable supply of affordable food should be guaranteed for all. Though it failed at the time, it was later revived and was the inspiration behind the agricultural policy of the European Economic Community. Mansholt got his chance to launch his plans for a common policy when he became Commissioner for Agriculture in the very first European Commission in 1958.
>
> (EC 2021)

In my view, Mansholt's plan contained the ingredients for large-scale production at the lowest possible cost. The farmer would be able to free up time by hiring workers, and at the same time, cheap food would become available to all so that the population would "never be hungry again". And especially after WWII, that was music to everyone's ears.

We Dutch farmers can farm cost-efficiently like no others, producing as much as possible at the lowest possible financial cost. After all, the entire agricultural world comes to see how "those Dutch" do that: how we convert all raw materials into high-quality food in such a price-efficient manner. However, as Mansholt himself eventually came to realise, we have gone far beyond our goal: the negative effects on people, animals, the environment and the climate are becoming painfully visible.

Moreover, agriculture is cost-efficient but not energy-efficient. In 1950, agriculture produced slightly more energy than was put into it; today, the energy input per hectare is more than six times greater than the output. And industrial food production in the US has been calculated to be even more inefficient. For every ten kilocalories put into food production, only one kilocalorie ends up on the consumer's plate. A structural change in the current system is necessary, where we switch to truly efficient food production in balance with animals, nature, the environment and climate.

DOI: 10.4324/9781032684369-41

How great would it be if Dutch farmers became leaders in this, so that in a few years the entire agricultural world would come to see how "those Dutch" do it; how we convert all raw materials into food as ecologically as possible without negative impact? However, a lot will have to happen to achieve this and we will have to dare to take radical decisions.

The long-awaited "Agricultural Agreement" between farmers and the government in the Netherlands ("het Landbouwakkoord") has turned out to be a disappointment for many. It failed and the largest farmers' organisation withdrew from the talks. So now we can ironically speak of a "Non-agricultural Agreement". When public scrutiny of the talks and this "Non-agricultural agreement" was revealed, it was also no more than continuing the status quo. It lacked the radical changes of policy and direction that are needed. It focused mostly on farmers and production. Important, but not enough. An "Agricultural Agreement" is not nearly enough for a sustainable food system. What we need is a Food Agreement in which both production and consumption are included as essential considerations.

The basic principle of a Food Agreement is that we would produce and consume within Earth's planetary boundaries. Circular thinking (re-using resources instead of discarding and therefore wasting them) is an important component. The former Minister Schouten of the Ministry of Agriculture, Nature and Food Quality had taken an initial step towards this in 2017. The idea was good, but its subsequent development in the hands of various government ministers was extremely poor. Dissatisfaction about this led to the establishment in 2019 of the organisation Caring Farmers, https://caringfarmers.nl.

We can't wait any longer and we really must get to work now. We have a "Non-agricultural Agreement", we have had new elections, we have rising food prices and we have farmers who no longer know where they stand. The latter, according to Jan Douwe van der Ploeg (2023), from his book, *Gesloten vanwege stikstof* ("Closed due to Nitrogen"), is because of the absolutist theory of optimal agriculture and because of failed government policies.

This theory of optimal agriculture implies that whilst there are emissions, they are lowest per unit of product. The more intensive the agriculture, the lower the emissions per unit of product. According to van der Ploeg, whilst that may seem cleaner, it leads to more pollution. Failing to include society and nature, including animal welfare, in this theory has ultimately created a monster that churns beyond the boundaries of society and has led to production and consumption that goes far beyond the planetary boundaries of our earth.

Even in government, "optimal agriculture" is and has been at the forefront of agricultural and environmental policy. Policy promotes and favours this form of agriculture and tries to mitigate or hide collateral damage from view. Nothing is done about the root of the problem and according to van der Ploeg, the central problem is no longer even seen.

We therefore need a new Food Agreement to give us a new direction. The Food Plan of the 2020s is the new Mansholt plan of the 1960s. We are waiting for the minister who will put their name to this.

Limburg, the province in the Netherlands where I live, is well known for its cakes. Just as a Limburg cake starts with the pastry base, a Food Agreement would also start at the base: the soil.

Soil is the basis for true circular agriculture. It needs to contain the right amount of organic matter, i.e., plant residues. This is essential for carbon storage and crop production.

In practical terms, what we grow will need to change. For example, more grains, leguminous plants and fewer harvested fruits. Growing perennial crops in a mixed, but otherwise easy to work and harvest, cultivation is also a well-known option. Less tillage should prevent carbon from entering the air as CO_2 (carbon dioxide), and other greenhouse gases. This means no or reduced ploughing, or a different method of ploughing or soil cultivation. Chemical pesticides have a major effect on soil life, the environment and biodiversity in and on the soil. They must therefore be used very carefully and ultimately phased out completely. The interaction between different crops can also assist in reduction in pesticide use – a broader cropping plan and greater crop differentiation contribute to better resistance of plants. The objective is to feed as many mouths as possible per hectare of land in an ecologically efficient manner.

The soil needs to be nourished. We can omit artificial fertiliser. Animal manure can be used beneficially for the soil. An arable farmer will then have to have the manure delivered according to his guidelines. To this end, the solid and wet fractions of the wastes of pigs and cows will have to be separated. The wet fraction, i.e., urine, can be used as a fertiliser substitute. The solid fraction is suitable for the organic matter in the soil. The manure can be separated even further, so that the requirements of arable farmers can be met even more specifically.

Furthermore, residual flows from the land and from the food industry can be used as a soil improver. This may also have an influence on the cultivation plan: not only the yield of the crop per hectare but also the residues of the crop that are needed for the soil are considered.

We talk a lot about cycles, but the cycle now ends with people themselves. There can be no real cycle if we flush our own waste down the toilet. A large part of what we put into our mouths comes out again. How many valuable raw materials are lost as a result? In the first half of the last century, it was very common in the Netherlands and currently still is in some cultures elsewhere in the world to return human excreta to the land. However, human manure is no longer used in many agricultural systems. Appropriately treated to reduce disease risk, it could be a good fertiliser for the soil and crops and could be returned to the soil to raise the next generation of plants.

New forms of agriculture are also worthwhile and contribute to a liveable planet. In arable farming and horticulture, the farmer starts anew every year by building the crop. With perennial crops and agroforestry however, you continue to build each year. Moreover, you create healthy soil, CO_2 storage and biodiversity at the same time. Trees and shrubs are also more resistant to the weather extremes that we will see much more often in the coming years. Food forests are the ultimate form because they allow climate and nature goals to be combined with food production and do not involve any manure.

Food forests can also contribute to varied, unsprayed, protein-rich plant food and healthier air, better water quality and more recreational areas. Healthier nature also ensures better health for us. And that in turn leads to savings in healthcare costs. Initial studies show that a food forest can provide a complete diet for a human. One hectare of food forest can feed six to eight people. For a natural system in such a forest, the food forest must be at least 20 hectares in size. Such new developments can be just as revolutionary as the emergence of intensive livestock farming.

Furthermore, a completely vegan arable farmer was named “Agricultural Entrepreneur of the Year” in the Netherlands in 2022 (Biocyclic Vegan International 2022). He no longer uses animals in his food system. This example demonstrates how soil can be fed by plants and deserves to be followed.

This automatically brings us to the animals. There should be no competition between humans and animals for crops on the land. We now use fertile land to produce food for animals and that is wasteful. Currently, 40% of all available fertile agricultural land is used to produce livestock feed. It is unfair and unimaginable that we would rather feed farmed animals for our own pleasure and profit than people who are hungry. This competition between humans and animals must therefore also be prevented. This means that we should only keep grazing animals on land that is not suitable for arable farming, the so-called marginal land. Farmed animals such as pigs and chickens should only be fed on leftovers from the land and from surplus food or food waste. It should not be a goal in itself to keep farmed animals just to eat them or their products. First, we must see what we can do with the land and the remains. Because marginal lands, such as peat meadow areas, may also be needed as natural CO_2 storage. Appropriately composted food waste can, for example, be used to fertilise the land.

From the beginning of the Mansholt era, we started breeding and keeping animals en masse to produce animal protein. Nowadays, however, we have a great deal of scientific ethological knowledge of and understanding about the emotional lives and intelligence of animals. This obliges us to treat animals with great care and not to equate the welfare of the (production) animal with only his or her physical health. That is why we must treat the animals we still use with as much respect as possible. This means at least plenty of daylight, fresh air, opportunities for natural behaviour and opportunities to exercise. Animals also just want to have a bit of fun. They're just like people sometimes!

The approach to using animals in circular agriculture is to get as much animal protein as possible from the "worthless" input. In other words, land which is not suitable for farming for human-edible crops is used to produce food for humans through animals. In that way, marginal land and residual flows are converted into high-quality food. It is clear that not all current forms of animal protein production are equally efficient. The first studies in this area show that animals that provide protein every day are particularly suitable. This includes laying hens and dairy cows. Keeping animals for meat appears to be much less efficient or even useless in this system. It should be noted that the pig is a real waste stream processor and is considered valuable in circular agriculture.

However, if we honestly look at what we do to other living beings, from that perspective we would come to no other conclusion than that keeping animals for our food is not justified in the first place. That seems like utopia in the short term, but worth investigating and striving for in the longer term.

A Food Agreement would contribute to healthy and tasty food within the borders of the planet. That is why we must focus on producing healthy products. Currently, 80% of supermarket foods do not fit into a healthy diet following the guidelines of "het voedingscentrum" (the Dutch Nutrition Centre, www.voedingscentrum.nl). This is unbelievable. Of course, there is no easy solution, but we must make healthy food more readily available and cheaper than unhealthy and unsustainable food.

Over the past ten years, short supply chains have been developing from the bottom up, with shorter routes and fewer links making locally produced food available to the consumer. There are already several examples of this. This has also resulted in various beautiful new companies and initiatives in which farmers and citizens work closely together, such as "Herenboeren" (farms jointly run by 200 families), Community Supported Agriculture and many others. An important advantage is the strengthened farmer–citizen connection. These short chain projects are all about this connection. Unfortunately, most consumers know little about the origin of their food and the side effects of their diet. Information and education about the farm or market garden of origin can make them more aware of the options for sustainably produced local food. Local supply chains also increase the vitality of communities.

"The consumer doesn't want to pay for it" never applies. My belief is that, in general, citizens and consumers are truly motivated to want to do the right thing. However, we must help them to ensure that they can do so. In other words, why should "bad" things even be available? A Food Agreement logically would influence the products we would make and therefore also the products for sale. As a result, consumption patterns will also have to change.

It's often claimed it's delusional to think that people will change their diets. Well, I disagree. Aren't we constantly changing our consumption patterns? For example, we once started eating more meat, then too much. At some point, we started eating too much fat, too much sugar, too much salt, etc. So why wouldn't we switch to an ecologically responsible diet? We need food systems that do not exploit the earth and that provide a "fair share" for everyone in the world. The Netherlands can become an example in this!

In essence, a Food Agreement would mean more plant-based and much less animal-based food. Until the time that we live completely without animal products, plant remains, treated food waste and human waste will serve as fertiliser.

In 2023, 25 billion euros were made available for food transition in the Netherlands. Never in our history has so much money been spent on this. However, food system change is not expensive if one considers the cost benefits of avoiding harmful impacts on climate, biodiversity, nature and our health (Ruggeri Laderchi 2024; see also Chapter 24 by Steven Lord et al.).

First steps towards a more holistic approach to food and farming have already been taken. For example, five farmer organisations produced the GroenBoerenPlan (Green Farming Plan) aimed at accelerating transition to food systems where nature and agriculture go hand in hand. Also, the Caring Movement has developed consisting of the Caring Farmers, the Caring Vets and the Caring Doctors organisations. This is a point of unity for farmers, veterinarians, doctors and consumers who want to move towards a sustainable and healthy food system.

We can expect to see savings in health care if we eat healthier and unsprayed food. It could form a part of preventive healthcare if consumers and healthcare providers could be informed and educated about this.

Is all this so difficult to achieve? Well, not actually. There are many practical things we can do now. These have been presented to ministers, who have been urged to look at the GroenBoerenPlan. They include increasing research budgets, arranging access to land, implementing fair prices that include the costs of production on the climate, providing information about sustainable food, anchoring sustainable food production in education and reducing VAT on fruit and vegetables.

However, when our Prime Minister in the Netherlands starts telling us that it is not that easy, that we need to define what exactly are fruit and vegetables and says: "Is a jar of pasta sauce a vegetable?" (Eerste Kamer 2022), yes, then it becomes difficult. It is easier to keep talking than to act. But there is a reason why there is a saying: "Where there's a will, there's a way". What we need is the real will to radically change our food system. It's exciting. We start walking and don't know exactly whether we are taking the right path. But there are several roads to Rome. However, we know one thing for sure: the current road is a dead end. Let's dare to choose a path and make a start.

If our food costs more as a result that is a social and political issue to address. We can't leave anyone behind. But the argument that it costs too much to keep production and consumption within the Earth's boundaries should not be used as an excuse for continuing to produce and consume beyond those limits.

References

Biocyclic Vegan International, 2022. Biocyclic Vegan farm Zonnegoed in the Netherlands named "Agricultural Entrepreneur of the Year 2022". https://www.biocyclic-vegan.org/2022/04/05/biocyclic-vegan-certified-farm-zonnegoed-in-the-netherlands-has-been-named-agricultural-entrepreneur-of-the-year-2022-boerderij-march-2022/

EC (European Commission), 2021. Sicco Mansholt: farmer, resistance fighter and a true European. https://european-union.europa.eu/system/files/2021-06/eu-pioneers-sicco-mansholt_en.pdf

Erster Kamer, 2022, 15 February. Report of the plenary meeting of Tuesday, February 15, 2022. https://www.eerstekamer.nl/verslag/20220215/verslag

Ruggeri Laderchi C et al., 2024. The Economics of the Food System Transformation. Food System Economics Commission (FSEC), Global Policy Report.

van der Ploeg J D, 2023. Gesloten vanwege stikstof ("Closed due to Nitrogen"). Gorredijk: Nordboek.

32 How to achieve national plant-based policies

The case of Denmark

Rune-Christoffer Dragsdahl

It all started in 2016, when one of our board members, Jeffrey, suggested we should start doing policy work. I am still deeply grateful to Jeffrey for initiating this. I am quite sure he didn't anticipate that this would eventually lead to political influence beyond what we could imagine at that time. Denmark being seen as a global champion for plant-based transition having launched. Including an internationally groundbreaking action plan for plant-based foods and a fund for plant-based foods with around 100 million Euros; and with these actions Denmark suddenly being seen as a global champion for the plant-based transition.

On the surface, it would indeed appear that Denmark is an unlikely place for this to happen. After all, Denmark has the largest animal production per capita in the world and is famous for exporting bacon and butter, whilst also having a high level of domestic consumption of animal products. And the lobby of the pork and dairy industries is notoriously strong. But this means that the case of Denmark gives hope to the rest of the world. Because if a transition can happen in Denmark, it can happen anywhere.

In this chapter, I will focus on some key principles in our policy work, and some concrete strategical collaborations that were crucial in the process leading to the major plant-based policy initiatives by the Danish Government. I will also reflect on two key issues, which I believe are crucial to ensure ambitious political action.

Laying the foundations: Establishing connections with policy makers

Looking back on the process, for the first several years, our policy work was about laying the foundation for the later work. I could write an entire book on laying the foundations! Here, I will only mention a few selected aspects of this work.

Over the years, we invited politicians to panel debates at festivals and conferences. Some rejected multiple invitations, before they eventually accepted. We surveyed all candidates ahead of elections, ensuring that most questions consisted of reasonable asks. Our aim was to demonstrate to politicians that there are many feasible plant-based policies.

Initially, back in 2016, only the greenest, most left-wing parties were interested in meeting with us. But gradually, we worked our way across the aisle, and by 2023, we had had meetings with 11 political parties. As more and more parties met with us, other parties heard about our pragmatic, fact-based approach and wanted to meet. To date, only one party has not accepted our meeting invitation.

We were fortunate as some key politicians were vegetarian or vegan and became official spokespersons on food and agriculture within their parties. But this was complemented by our ability to get to know other key spokespersons from other parties, who have publicly stated that we played a key role in opening their eyes to the importance of the plant-based agenda. They also

DOI: 10.4324/9781032684369-42

commented on the usefulness of our concrete policy inputs. These connections eventually meant that key politicians were in close contact with us during the negotiations. I am thankful that we, as an organisation with the plant-based agenda at the core of our hearts, found the right balance between idealism and pragmatism. Politicians rewarded this by trusting us and using our advice.

Our role as the trusted key organisation on plant-based development was further strengthened by strategic initiatives involving other stakeholders.

In 2016, a politician from the most left-wing party in the Parliament had brought us and Organic Denmark together in view of the synergies he saw between our two agendas. The core values of both movements relate to environment, health and animal ethics. It was regarding a policy proposal to fund training for kitchen professionals in organic values and plant-based skills. The funding didn't materialise at that time, but the process brought us closer to Organic Denmark, an established player in the Danish agriculture and food sector.

In 2019, a key stakeholder from the plant-based industry in Denmark, the company owning Naturli' Foods, took the initiative to start the Danish Plant-Based Business Association. Almost at the same time, a professional lobbyist approached us at the Vegetarian Society of Denmark and suggested that we should start a plant-based business association. However, we felt it would be much better to have an independent business association, as it would ensure our independence as an NGO, as well as give the business association more room to pursue business interests. We therefore decided to support the Danish Plant-Based Business Association as much as we could, providing contacts and networks and recommending it to other stakeholders.

This approach paid off well. Being a business association, the Danish Plant-Based Business Association could open some doors to stakeholders, who hesitated to engage with a vegetarian association. Over the years that followed, we developed a strong collaboration with the Danish Plant-Based Business Association and we complemented each other very well.

It should also be stressed that the Greta Thunberg-inspired climate demonstrations in Denmark, where more than 100,000 youth went to the streets to apply pressure on Danish politicians to act, played an important background role. This initiative eventually led to Denmark's target of reducing CO_2e (carbon-dioxide equivalent) emissions 70% by 2030 (Altinget.dk 2021). Whilst many initially didn't realise what the consequence of this target would be, it later became clear that to achieve such a dramatic reduction it would be necessary to transition agriculture towards fewer animals and more plants.

Strategic collaboration between stakeholders

In late 2019, whilst attending a conference abroad, we developed the idea of creating a plant-based network for professionals. Key stakeholders, including Organic Denmark, the Danish Plant-Based Business Association, some green organisations and the large retailer Coop, confirmed their interest, and we could therefore add their names to an application for government funding. We could get 50% government funding, if we provided the other 50% ourselves. This in practice was a trade-off: binding workloads corresponding to one existing employee to the network, in return getting funds for a new employee, and importantly also being required to use a government logo when communicating about the network, thereby increasing the legitimacy of the network.

Once the network was launched, in January 2020, it quickly gained large interest. The first network event was a conference, organised in collaboration with the Danish Plant-Based Business Association and held at the Danish Parliament, which became fully booked with 150 participants and a waiting list. The feedback from participants was very positive. Over the following years, the network grew to include some 200 professional members, thereby becoming the key forum for the plant-based agenda in Denmark. Some years later, other stakeholders also launched plant-based networks, typically focused on parts of the value chain, e.g., farmers or the processing industry.

The success of the network, which was characterised by a lively energy, inspired three other strategic initiatives that same year.

Firstly, we at the Vegetarian Society reflected on the need for a plant-based “knowledge centre”; a go-to place with science-based knowledge, but also practical solutions to implement. Ideally, we would love to have multiple stakeholders creating it together, but we also knew it would take a long time for multiple stakeholders to agree on a vision and direction, and we wanted something more agile. Eventually, we, the Vegetarian Society of Denmark, formed a strategic collaboration with Organic Denmark. We called it Plantebaseret Videnscenter; in English, we chose the name Centre for a Plant-Based & Organic Future and the website is https://plantebaseretvidenscenter.dk/. It is not a physically separate centre, but a centre anchored at the two existing offices of the two organisations.

The creation of this centre was received positively by several politicians and the Government, which responded by creating a small fund for organic plant-based projects. The fund was competitive and other stakeholders had the opportunity to apply and benefit. This gave the Centre for a Plant-Based & Organic Future the possibility to quickly grow to include more than a dozen projects, all working to develop the plant-based value chain.

Secondly, the main farmers’ association, the Danish Agriculture & Food Council, which also includes pork giant Danish Crown and dairy giant Arla, got inspiration from participating in our first network event. So did the organisation Frej, a youth-led think-tank founded by students within agriculture and food studies, which had good connections to the farmers and their association. Eventually, the farmers’ association invited us and Frej to write and publish a joint research and development strategy for plant-based foods (Vegetarian Society of Denmark et al. 2020). Whilst some green NGOs were a bit sceptical about this collaboration, fearing it would be used to greenwash the farmers’ association, to this day I remain convinced that it was a good move. The collaboration achieved further mainstreaming of the agenda and had important political influence: right-wing parties became more neutral towards the plant-based agenda, and key parties in the centre of Danish politics became slightly positive.

Thirdly, the buzz surrounding the network events and the agenda in general inspired the Danish Plant-Based Business Association and Greenpeace to explore the possibility of publishing a joint business and NGO vision for the Danish agricultural and food system. They invited Green Transition Denmark, Animal Protection Denmark, the Conservation Society of Denmark and us at the Vegetarian Society of Denmark to join this collaboration. After months of work in good faith from all the organisations involved, the vision report *From Feed to Food* (Vegetarian Society of Denmark 2020) was published. An important compromise, suggested by the Danish Plant-Based Business Association, was to start the report with the market potential, to follow with concrete policy suggestions, and only at the end include a review of all the problems with the current food system. Whilst the latter are of course very serious and provide the motivation for the NGOs in the collaboration, putting business opportunities first in the report was a new move for NGOs. The publication of the report was presented at meetings with various officials at the Ministry of Food and Agriculture as well as several parties in Parliament. All received the report with interest: the collaboration between businesses and NGOs made them curious.

The three initiatives were launched within a few months, whilst the Network for Plant Proteins continued to organise successful conferences and networking events. In combination, these initiatives generated strong political interest across several parties. They were all mentioned in an internal Government document summarising the possibility of setting up a fund to support plant-based foods.

These activities helped establish the Vegetarian Society of Denmark as a key player to whom politicians from multiple parties reached out for policy advice.

The four key initiatives: Dietary guidelines, funding, action plan and eco-scheme for farmers

Denmark now has four key policy initiatives to promote plant-based foods. The first happened independently of the above work but should nonetheless be mentioned, as it was a very important move. The four initiatives are:

- **Dietary guidelines**. In January 2021, Denmark launched new official dietary guidelines (Ministry of Food, Agriculture and Fisheries of Denmark 2021), which emphasise "plant-rich" as the new keyword, whilst specifically recommending eating less meat and more pulses. The guidelines were developed by scientists at the Technical University of Denmark, which recommended a Danish slightly adjusted version of the EAT-Lancet Commission's "planetary diet". The Government followed the recommendations of the scientists.
- **Subsidies for farmers**. The agricultural deal of October 2021 included a new plant-based subsidy for farmers under the Common Agricultural Policy of the European Union (EU). The scheme means that farmers get an additional subsidy if they grow foods suitable for human consumption (Danish Agricultural Agency 2024). In practice, if they can't sell their produce for human consumption, they are allowed to feed it to animals. Therefore, to make this subsidy a success, consumption and exports of plant-based foods will have to increase.
- **Funding for development of the sector**. The agricultural deal also established a fund, the Plant-Based Food Grant (Danish Agricultural Agency 2023), with 100 million EUR to be granted over eight years (2023–2030). The fund, half of which is for organic plant-based foods, was formally set up in March 2023, and the first round of applications saw 97 applications worth a total of approximately 27 million EUR, which was almost four times the amount available in the first round. The fund will support all kinds of projects, stimulating plant-based development, ranging from increasing consumption (through professional kitchens and amongst citizens in general) to product development and strengthening collaboration throughout the value chain.
- **Action Plan**. The agricultural deal also included the creation of a Danish national action plan for plant-based foods. The action plan was launched in October 2023 (Ministry of Food, Agriculture and Fisheries of Denmark 2023), as a groundbreaking initiative – no country had done this before. Whilst the action plan lacks measurable targets, it does involve the entire food system, including professional kitchens, the education system, processing, farming, research and innovation. It stresses that "plant-based foods are the future" and that Denmark wants to contribute to the "necessary global transition" towards more plant-based production and furthermore wants to "inspire the rest of the world".

The role of businesses versus civil society

In many countries, there is a tension between business interests and NGOs. There are good reasons for this, since many businesses have making money as their primary purpose, whilst NGOs are mission-driven. However, things are not always that black and white.

Some NGOs can get caught up in securing funds for their own survival, focusing on campaigns to get donations, rather than creating actual change. Paving the way for major policy initiatives may require NGOs to play down their own role and victories. For example, if I could share more details of the dialogue between us and key politicians leading up to the plant-based deal, I would expect a huge influx of donors and members to our organisation. But by doing so, we would damage our future influence. In my view, too many NGOs are too focused on campaigning to get donations.

Vice versa, some businesses are indeed mission-driven. For example, start-ups may spend years of sweat and tears with no salary or a very low salary, whilst taking major risks. Even some of the larger companies may be driven by genuine idealism.

However, some companies, particularly the larger ones, may tend to have a patronising view of NGOs as something that is nice, rather than seeing NGOs as fundamental to drive societal transition and complementary to what the businesses can achieve on their own. For instance, in many countries (including all the EU), companies are strictly limited regarding health claims. This hinders their communication of one of the key strengths of plant-based foods, which is that they are, generally, healthier. However, NGOs can use such health claims.

To maximise political influence, NGOs and businesses need to collaborate more. It is my experience that many politicians listen intently to businesses because they must. However, they are often unsure about how to use the information they receive because business lobbyists rarely give neutral advice.

NGOs tend to give more neutral advice. But I have heard politicians lament that NGOs bring forward proposals that are wildly unrealistic, or that are taking too much departure in campaign objectives.

In my view, ideally, NGOs should ask for input from businesses on what is needed to advance plant-based developments. They should then seriously reflect on what is objectively needed before they then advise politicians. Complete objectivity doesn't exist, of course, but aiming for it, as well as one can, surely is possible.

NGOs should of course remember that business and NGO interests are not always aligned. NGOs need to be honest when products are of bad quality, whether health- or taste-wise. And as with other businesses, there will be disingenuous players, who will mainly be in the game to attract capital for fake projects, or investors who are only in it to speculate, and who don't care about the plant-based agenda.

Highly processed imitations or healthy foods?

A major weakness in the plant-based movement is what sometimes appears to be a deep divide between proponents of highly processed imitation products and proponents of healthy wholefoods cooked from scratch.

The concept "plant-based" does have a health origin, as the term was coined in the 1980s to denote a healthy diet; that is, a diet that takes point of departure in whole plants (Campbell 2019). Some decades later, the term became popular within the industry, because it seemed to be free of any ideological connotations with the terms "vegan" and "vegetarian". Today, the term is also used to refer to highly processed products to such an extent that many consumers now associate the term with "processed". This leads to criticisms of plant-based foods as highly processed. What a sad irony.

In my view, the term now has a life of its own with a dual meaning, where it can refer to a healthy wholefoods diet, as well as any processed products made with plants.

Such ambiguity can cause confusion and conflict, and it certainly does arise. However, when I was an anthropology student, I learned that ambiguity is also powerful, as it allows people with different perspectives to project their own visions into a concept. In my view, this is exactly what makes the "plant-based" concept so powerful. I believe a key to further advancing a global transition to plant-based is to insist on including many different types of foods under the plant-based umbrella.

We do need to keep teaching kids to cook healthy foods from scratch. And we should encourage kitchen professionals to create delicious dishes made from raw ingredients such as vegetables and pulses. But the need for a global dietary transition is so urgent that we don't have time to wait for utopia, where everyone has the skills (and the time!) to do this every day at every meal. We need to develop lots of healthy convenience foods that people can grab on the go, or just buy and heat up at home. We also need imitations that can make the transition easy for the majority, who like the tastes and textures they associate with meat and dairy. And it should be possible to find some common ground in between. For example, we need healthier (but still tasty!) versions of processed meat imitations, where the fibres, minerals and vitamins are retained, not lost, which can be used by professional kitchens as well as ordinary citizens.

A major strength of Denmark's Plant-Based Food Grant is that it has been established with this holistic mindset. It will support all the above and half of the funds will go to organic plant-based foods. The holistic approach is also reflected in the composition of board members, where agricultural, industry and civil society interests and expertise are well balanced. When other countries hopefully follow suit and create their own similar funding mechanisms, they should ensure that the strategy and board composition have a similarly broad scope.

Conclusion

In this chapter, I have shared some key aspects of the road to Denmark's plant-based policy initiatives. Some of the key insights are:

- Patience is needed. It takes years to build up connections and trust within policy circles. During those years, many smaller strategic steps can be taken.
- Strategic collaboration between stakeholders is crucial. Different alliances can be made between NGOs and the industry, organic farmers and conventional farmers.
- NGOs and businesses should appreciate the value of collaborating with each other; but keep in mind their respective strengths.
- Plant-based policy initiatives should embrace healthy wholefoods as well as processed imitations of animal products; and solutions in between, which combine health and convenience, whilst emphasising the use of organic ingredients. The agenda is far too important to be hindered by a conflict between, on the one hand, unrealistic idealism and, on the other hand, industry interests without values.

Each country is different. And within larger countries, regions will be different. However, I believe that this chapter can be of value to many distinct parts of the world. Stakeholders may selectively try to apply the insights they find valuable in their own contexts.

References

Altinget.dk, 2021. Valgforskere afblæser generationskampen: Folketingsvalget var et klimavalg for både unge og ældre. https://www.altinget.dk/energi/artikel/valgforskere-afblaeser-generationskampen-folketingsvalget-var-et-klimavalg-for-baade-unge-og-aeldre

Campbell C T, 2019. History of the term 'whole food, plant-based'. https://nutritionstudies.org/history-of-the-term-whole-food-plant-based/

Danish Agricultural Agency, 2023. Multi-year strategy for the Plant-Based Food Grant. https://plantefonden.lbst.dk/fileadmin/user_upload/Plantefonden/Dokumenter/Strategy__Plant-Based_Food_Grant.pdf

Danish Agricultural Agency, 2024. Bio-ordning: Varieret planteproduktion. https://lbst.dk/tilskud-selvbetjening/tilskudsguide/varieret-planteproduktion

Ministry of Food, Agriculture and Fisheries of Denmark, 2021. The Danish Official Dietary Guidelines. https://en.foedevarestyrelsen.dk/food/nutrition-and-health/the-official-dietary-guidelines

Ministry of Food, Agriculture and Fisheries of Denmark, 2023. Danish Action Plan for Plant-based Foods. https://en.fvm.dk/Media/638484294982868221/Danish-Action-Plan-for-Plant-based-Foods.pdf

Vegetarian Society of Denmark, 2020. Fra Foder til Føde (From Feed to Food). https://vegetarisk.dk/english/#background-on-plant-based-foods-in-Denmark

Vegetarian Society of Denmark, Frej, and the Danish Agriculture and Food Council, 2020. Plant-Based Foods: R&D Strategy for a New Area of Growth in Denmark's Food Production System. https://vegetarisk.dk/wp-content/uploads/2023/04/plant-based-foods_rd-strategy-november-2020.pdf

33 The Conscious Food Systems Alliance

Inner capacities for regenerative food systems

Thomas Legrand and Noemi Altobelli

> Creating regenerative systems is not simply a technical, economic, ecological or social shift: it has to go hand-in-hand with an underlying shift in the way we think about ourselves, our relationships with each other and with life as a whole.
>
> Daniel Christian Wahl, Author of Designing Regenerative Cultures (2016)

Time for a complementary approach to food systems transformation

Food connects us with one another, our cultures and our planet. Rather than nourishing our collective health and well-being, however, food systems are at the heart of the social and environmental crises we face (Kopittke et al. 2019; Shukla et al. 2019; FAO and UNEP 2021). Despite significant investment and effort towards transforming food systems, the solutions emphasised so far are not delivering the necessary impact. This impasse calls us to examine more deeply the root causes of our crises and the structural barriers to transformation.

Progress is hindered by entrenched power structures that severely limit agency ("power" or "influence") to create change at individual and collective levels. These structures maintain and are themselves maintained by a pervasive cultural narrative of separation. This narrative underpins a dominant paradigm of unfettered economic growth, deprioritises care in policymaking, depresses stakeholder collaboration and manifests in a widespread inability to think and act systemically.

Whilst these barriers are embedded in structural inequities and the lack of agency of the most marginalised stakeholders, they are also fundamentally rooted in our consciousness, particularly in cultural patterns of disconnection from self, others and nature. Consciousness refers to our awareness of inner and outer phenomena, which influences the lens through which we see and relate to ourselves, and the world around us: others, nature and future generations. Cultivating consciousness leads to an increasing circle of identity, care and responsibility (Wamsler et al. 2021).

In the field of sustainability, the importance of deepening consciousness, and cultivating inner capacities – individual and collective awareness, mindsets, beliefs, values, worldviews and associated transformative cognitive, emotional and relational qualities and skills – that support it, is increasingly recognised (Ericson et al. 2014; Edwards 2015; Parodi and Tamm 2018; Wamsler et al. 2021; Woiwode et al. 2021).

Accordingly, the latest IPCC (Intergovernmental Panel on Climate Change) reports on climate change mitigation and adaptation highlight for instance the role of "inner transitions" and inner capacities of individuals, organisations and societies as a lever for accelerating the transition in the context of sustainable development (IPCC 2022a, 2022b).

DOI: 10.4324/9781032684369-43

Overcoming structural barriers to food systems transformation requires investments in building and cultivating the inner capacities of individuals, groups and institutions that comprise them. This implies fostering reconnection with nature, others and self and cultivating specific transformative qualities and skills. Integrating the cultivation of inner capacities with ongoing investment in existing external solutions represents an untapped opportunity to unlock food systems transformation. To transform food systems, we must work not only on policy, research and project implementation but also on the inner drivers of individual, collective and institutional behaviours. Increased connection to ourselves, each other and nature can activate the transformative qualities and skills needed to support the transition to regenerative food systems.

Launched in late 2022 after two years of incubation with partners, the Conscious Food Systems Alliance (CoFSA), https://consciousfoodsystems.org, convened by the United Nations Development Program (UNDP), supports the cultivation of inner capacities of food systems stakeholders as a key complementary approach for food systems transformation.

CoFSA originates in a decade's work by the UNDP's Green Commodities Programme that addresses the sustainability challenges of highly traded agricultural commodities (such as coffee, cocoa and palm oil) through multi-stakeholder cooperation and dialogue. The challenges faced during this time led Andrew Bovarnick and his team to understand that external solutions are not by themselves enough to bring about systemic change. Even where programmes seek to enable cooperation, the inner human aspects of food and agriculture systems (e.g., lack of trust, mindsets) are too often overlooked, with the result that appropriate structural and policy solutions are not sufficiently adopted, implemented and scaled. The team set out to address this blind spot in collective efforts to achieve sustainable food systems.

CoFSA's journey has been an emergent process supported by the commitment of a diverse set of members and the quality of relationships they have built. The initial concept was developed in late 2020. In 2021, the "Breathing Room" – a dedicated online space of 27 core members – was launched with the purpose of co-creating the Alliance. This led to the production in 2022 of foundational documents including its Manifesto (UNDP 2022a), the Rationale for Action report (Legrand et al. 2022), the Theoretical Foundations Report (Wamsler et al. 2022) and Collection of Case Studies (UNDP 2022b). It also allowed identification of CoFSA core values: bringing our whole selves to this work (emotional, embodied and authentic); willingness to undertake inner work; equity, inclusivity and acknowledgement of power dynamics; deep listening; valuing diverse points of view; embracing complexity and working with emergence. Key challenges have also been identified early on such as the need for inclusion and diversity and the balance to be found between a common vision and the diversity of contexts, experiences, which should inform how to implement this agenda.

The Alliance was launched in late 2022, together with the establishment of a governance framework (an "interim inner council" and a Community of Practice and Learning).

Unlocking food systems transformation through consciousness approaches

CoFSA applies consciousness approaches, which integrate the consideration and cultivation of inner capacities into interventions, across all levels. Consciousness approaches can leverage certain practices which actively support the cultivation of inner capacities. These consciousness practices include a vast range of contemplative mind-body practices, often rooted in a variety of wisdom-based traditions (e.g., nature connection and mindfulness), as well as psychological and cognitive behavioural-based practices (e.g., self-reflection and-inquiry practices), transformative spaces and communication practices (e.g., deep listening and non-violent communication) and transformative education and leadership practices (e.g., experiential learning). CoFSA is committed to working with a diversity of consciousness approaches and practices that support the cultivation of inner capacities, according to their relevance in different cultural contexts, in particular local traditional wisdoms.

CoFSA's principles[1] to cultivate inner capacities emphasise the need for context-specific and culturally relevant interventions, founded on respect and equity, as well as awareness of power dynamics.

CoFSA approaches food systems transformation by working with all relevant stakeholder groups across food systems, including consumers, companies, governments, development agencies, academia, global and local NGOs, local communities and farmers and food producers, at three interconnected levels:

- Individual: through trainings, educational programmes and retreats, as well as coaching activities;
- Group (collective): by building safe, connecting and transformative spaces and networks for conscious multi-stakeholder dialogues and platforms; and
- Institutional: by supporting the cultural transformation of organizations, as well as dedicated public and private policies.

This means that CoFSA interventions can support certain practices or learning environments that support individuals and/or groups to tap into their inner potential and nourish transformative inner capacities. In addition, CoFSA interventions can leverage the current political and institutional landscapes by systematically mainstreaming the consideration of inner capacities into existing institutions, structures and systems. The aim of the latter is to support the structural and political conditions required for the emergence of a more regenerative food system from the inside-out (Wamsler et al. 2021).

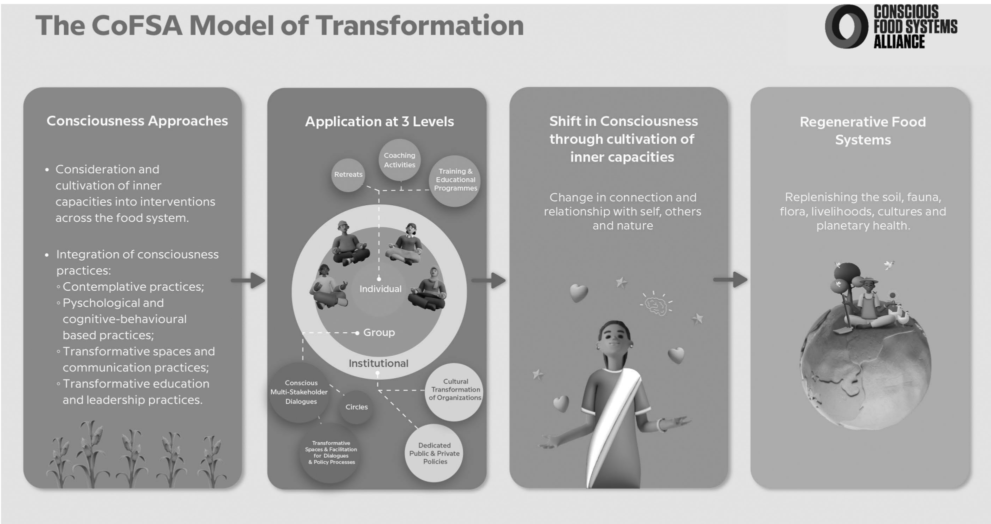

Figure 33.1 The CoFSA model of transformation. This linear model over-simplifies the process of change for the sake of clarity. In practice, systems change is a complex process characterised by multiple causations, interactions, feedback loops and inevitable uncertainty and unpredictability. CoFSA's model draws on the Model of Inner-Outer Transformation (Kopittke et al. 2019; Shukla et al. 2019; FAO and UNEP 2021) and the Inner Development Goals framework, www.innerdevelopmentgoals.org.

CoFSA Interventions focus on working with governments, companies, farmers and development practitioners to support food systems transformation across three main areas:

Food systems policy and pathways

- *Food policy reform:* to improve the quality of interaction of policymakers and to support them in designing policies that integrate a more "compassionate" and systemic approach.
- *Multi-stakeholder dialogues:* to create safe, connecting and transformative spaces for conscious multi-stakeholder dialogues in food systems contexts.

Sustainable landscapes

- *Conscious farming and local community development*: to improve the well-being and resilience of farmers and their communities and help them cultivate regenerative mindsets and agricultural practices.
- *Revitalising and strengthening traditional wisdom*: to promote traditional cultural practices and knowledge that support regenerative food systems.

Supply chain transformation

- *Cultural transformation of organisations*: to support the cultivation of regenerative mindsets, values and skills that catalyse supply chain transformation.
- *Conscious consumption*: to support the adoption of more healthy, sustainable and local diets and strengthen traditional food cultures.

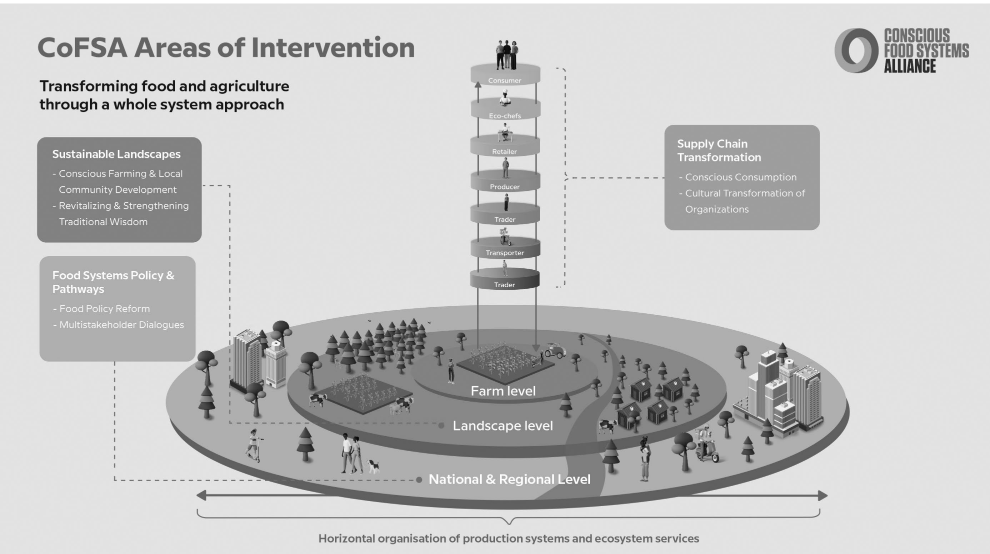

Figure 33.2 CoFSA areas of intervention. This figure shows CoFSA areas of interventions at three levels: supply chain transformation, sustainable landscape and food systems policy and pathways.

Our work – convening and pioneering

Community of learning and practice

CoFSA brings together an intentional community of peers, which fosters connections, knowledge exchange and collaboration for building conscious food systems. Offering CoFSA members a space to connect with each other, find peer support, as well as language, methodologies and tools to implement this agenda has proved instrumental, allowing to break the sense of isolation that they often feel. The fact that a UN agency convenes such community has also proved important to bring legitimacy to this field and we have noticed there are more people than we think who are ready to step up into this agenda when they feel entitled to do so.

In 2023, the CoFSA Community launched a series of activities amongst which are: a Collective Inquiry series on core areas of intervention for conscious food systems (e.g., Conscious Local Communities and Cultures for Regeneration, Farmers' well-being and psychological resilience, Conscious Consumption, etc.), Consciousness Practice Sessions (e.g., mindfulness, nature connection, non-violent communication, etc.) and monthly meditations for farmers and food producers with the internationally renowned "peace-pilgrim", Satish Kumar. In April 2023, CoFSA convened its community and held its first three-day strategic retreat at Schumacher College, UK, which allowed members to experience the role of consciousness practices in transforming food systems, build connections and collaborations and frame the next stage of the Alliance's development. Some participants described this experience as profoundly transformative at both personal and professional levels. This made us appreciate the importance of in-person gatherings, though which our work really comes alive and tangible.

Implementation

Additionally, CoFSA pioneers the application of consciousness approaches and practices across food systems, through a global portfolio of interventions, including the delivery of training, coaching and facilitation services, supported by research and learning frameworks.

In July 2023, we launched a Call for Proposals, offering up to US$20,000 in funding for four CoFSA member-led initiatives. These initiatives aim to demonstrate how consciousness-based approaches can strengthen inner capacities, accelerating the transformation of food systems towards regenerative, sustainable and equitable models. Furthermore, they contribute to creating a repository of learning resources, including case studies and training materials, which can be used to scale up the integration of consciousness-based practices in food systems transformation.

In 2023, in partnership with the Inner Green Deal (https://innergreendeal.com), CoFSA developed and successfully tested a Conscious Food Systems Leadership, combining six online modules with a collaborative online platform and practice app. It introduces participants (food systems stakeholders) to CoFSA's consciousness approaches and help them develop insights on how to incorporate these practices into their work and organizations for food systems transformation. This will be an important resource to empower CoFSA members in the future.

Finally, CoFSA, in collaboration with a global Network of Local Hubs, is developing a globally distributed learning curriculum, to facilitate an equitable exchange of knowledge and experience for food systems practitioners of diverse backgrounds to develop the inner capacities needed to build regenerative and conscious food systems at grassroots level. The program will be built of a series of dynamically interlinked modules offered both online and facilitated at site-based practice centres in locations around the world. The curriculum development and design will be led by Schumacher College.

To find out more about CoFSA early stories of change, see Box 33.1.

Box 33.1 CoFSA early stories of change

In late 2023, we conducted a CoFSA community survey to assess the value and impact of our work so far. 70% of respondents said that they have already been able to integrate CoFSA's practices and agenda into their work. For example, one individual highlighted COFSA as a profound source of inspiration, resulting in

a Introducing mindfulness and consciousness-based methods to her team and organisation and
b Establishing a conscious consumption programme to encourage mindful consumption practices in communities and schools.

85% of them found CoFSA to be instrumental in this process, thanks to four dimensions through which CoFSA impacted members and their work:

- **Community**: Multiple responses underscored the sense of belonging to a like-minded community (tribe) and overcoming isolation, finding peer support and networking opportunities. Notably, CoFSA's coffee chats served as a catalyst, fostering connections amongst some members that now launched a programme "Being More", which uniquely combines 15 resilience and empathy-building techniques to help food system teams master sustainability.
- **Inner development and inspiration**: CoFSA has contributed to personal growth and well-being, as well as inspiration that leads to transformative actions. For example,
  - An individual underwent a life-changing experience with CoFSA that led to significant personal transformation. By connecting with their soul and adopting a new mindset, they managed to address their bulimic tendencies and experienced a shift from "doing" to "being". As a result, they lost 20kg from April to July by applying stress management techniques learned during the experience of the CoFSA Strategic Retreat in Devon.
  - Another individual highlighted feeling more calm and less stressed about climate change after engaging with CoFSA. They reported adopting a more measured approach, focusing on tackling one issue at a time. This change in mindset allowed them to feel more connected and part of a community, providing essential tools to understand the world in ways that fostered a deeper connection with others.
  - In one organisation, CoFSA influenced a shift in meal practices during land-based learning events. Moving away from catered meals, the organisation introduced participatory and meditative meal experiences, where participants are made aware and guided through the process from harvesting to meal preparation and consumption, emphasising a more engaged and mindful approach to meals. This has fostered amongst the invitees a deeper understanding of emotional connections and beliefs linked to food.

- **Learning**: Engaging with CoFSA work and events leaves individuals full of hope; at the same time, it increases empathy and shifted perspectives, fostering a better understanding of complex challenges. Many respondents mentioned feeling inspired by discussions, speakers and the learning environment created by CoFSA. Quotes from members include: "CoFSA has been a space of constant learning, peer support and searching for new ways to transform our food systems".
- **Confidence and legitimacy:** The respondents highlight the importance of CoFSA in bringing legitimacy to this agenda, especially with a UN organisation convening. Practical guidelines, references, examples give them the confidence to step into this agenda. Members said: "CoFSA is giving me the confidence to be bolder" or "It is no longer taboo to talk about consciousness practices and spirituality".

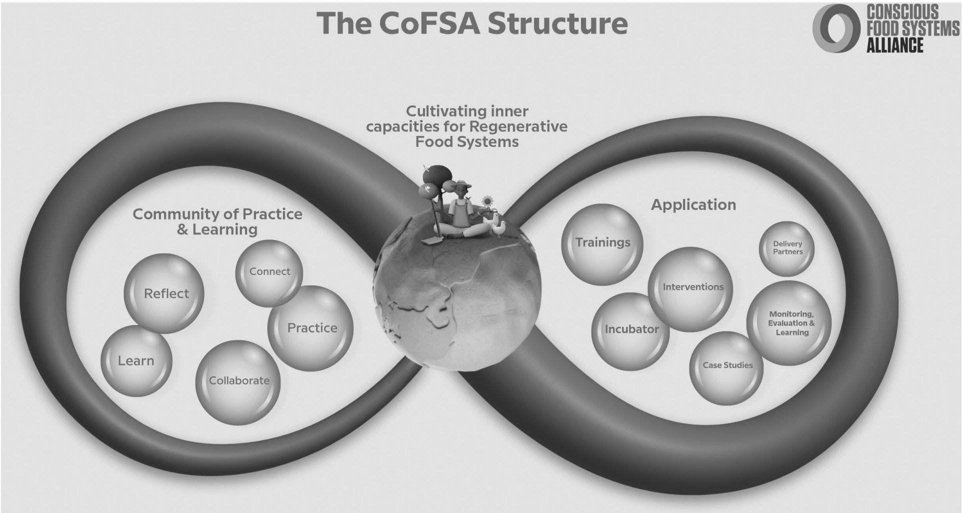

Figure 33.3 CoFSA structure.

Conclusion and learning

The CoFSA has already built a solid basis for work. It has framed a new narrative on food systems transformation highlighting the complementary role of inner capacities and consciousness practices, as well as a clear agenda for action. A movement of more than 250 members dedicated to this agenda, and with more than 1,500 people following this work, has been initiated. Throughout this transformative process, deep bonds have been created amongst core members, a community of practice and learning built and implementation through training and pilot interventions has started.

The priority is now to grow this work, in particular through fundraising and strategic partnerships, and build a movement, through empowering our members and enhancing the Alliance's governance.

Note

1 CoFSA's principles for cultivating inner capacities were developed through a series of co-creative workshops in 2021–2022. We recognise the need to keep this approach alive, constantly evolving and maturing.

- Context-specificity: CoFSA interventions, whether at global, national or local levels, must be tailored to specific challenges at hand and the needs and wants of change agents.
- Respect and Equity CoFSA: The application of consciousness practices and approaches must respect everyone's own path of evolution, and not treat people as objects to be changed. Rather, CoFSA offers the tools to support greater individual and collective awareness and flourishing, trusting, based on the emerging science, that these interventions will ultimately support systemic transformation towards regenerative food systems.
- Power dynamics: CoFSA aims to create safe, connecting and transformative spaces and conditions for systemic change and regeneration. If these spaces and conditions don't include explorations of power and bias, they may not lead to the deeper mindset shifts needed, furthermore they may reinforce a dominant group's values.
- Cultural relevance: CoFSA interventions must be locally relevant in terms of language, techniques, frameworks, religions, philosophies, and other cultural considerations. Supporting locally led initiatives which harness local resources, and traditional wisdom, is crucial to enacting this principle.
- Working with a variety of consciousness practices and approaches: CoFSA is committed to working with a diversity of consciousness approaches and practices that can support the cultivation of inner capacities, according to their relevance in different cultural contexts, in particular local traditional wisdoms. CoFSA acknowledges both the spiritual origin of many consciousness practices and approaches and welcomes the role that faith and religious organisations and perspectives can have in supporting development of inner capacities for the transformation of food systems. At the same time, it recognises the opportunity in many contexts to promote secular practices to respect the beliefs and values of stakeholders across food systems.
- Evidence-based approaches and plurality of knowledge.

References

Edwards A R, 2015. *The Heart of Sustainability*. New Society Publishers. ISBN: 9780865717626.

Ericson T, Kjønstad B G and Barstad A, 2014. Mindfulness and sustainability. *Ecological Economics*, 104:73–79. https://doi.org/10.1016/j.ecolecon.2014.04.007

FAO and UNEP, 2021. Global Assessment of Soil Pollution. www.fao.org/documents/card/en/c/cb4894en

IPCC, 2022a. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III Contribution to the Sixth Assessment Report of IPCC.

IPCC, 2022b. Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of IPCC.

Kopittke P M, Menzies N W, Wang P et al., 2019. Soil and the intensification of agriculture for global food security. *Environment International*, 132. https://doi.org/10.1016/j.envint.2019.105078

Legrand T, Jervoise A, Wamsler C et al., June 2022. *Cultivating Inner Capacities for Regenerative Food Systems: Rationale for Action*. UNDP. https://consciousfoodsystems.org/wp-content/uploads/2023/03/CoFSA-Rationale-for-Action-Report_2022.pdf

Parodi O and Tamm K (Eds.), 2018. *Personal Sustainability: Exploring the Far Side of Sustainable Development*. London: Routledge. https://doi.org/10.4324/9781315159997

Shukla J et al., 2019. IPCC, 2019: Summary for Policymakers. In: Climate Change and Land: An IPCC Special Report.

UNDP, 2022a. The Conscious Food Systems Alliance Manifesto. consciousfoodsystems.org/wp-content/uploads/2022/10/COFSA-Manifesto.pdf

UNDP, 2022b. The Conscious Food Systems Alliance Collection of Case Studies. Annex-I_CoFSA-Case-Study-Collection1.pdf (consciousfoodsystems.org)

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. *Global Environmental Change*, 71:102373. https://doi.org/10.1016/j.gloenvcha.2021.102373

Wamsler C, Bristow J, Cooper K et al., 2022. Theoretical foundations report: Research and evidence for the potential of consciousness approaches and practices to unlock sustainability and systems transformation.

Woiwode C, Schäpke N, Bina O et al., 2021. Inner transformation to sustainability as a deep leverage point: Fostering new avenues for change through dialogue and reflection. *Sustainability Science*, 16(3):841–858. https://doi.org/10.1007/s11625-020-00882-y

34 Native American regenerative food and land management systems

Lyla June Johnston

I remember a dream I had as a teenager. When I awoke, I immediately and vividly recounted every detail. I was standing in a forest and could hear the gnashing teeth of tractors. They were slowly nibbling away at the forest's edge with their clear-cutting machinery.

I went and asked them, "What are you doing?"

"We're clearing the forest to make more space to farm", they responded. I saw in their wake rows and rows of planted seeds. I felt the vastness of life and edible plants and animals in the forest I stood in. I could feel the vibrance, the beauty, the diversity of beings all around me. I could feel cycles of life turning in real time. I could see how it would be possible to prune, cut, burn, select, curate and cultivate the natural food bearing capacity of that forest.

I turned to them and said, "The forest is already a farm".

Looking back, it's shocking that I could have said such a thing in a dream as a teenager. I had no idea a decade later my elders would point me towards my research topic. I had no idea I'd be reading every article on regenerative Indigenous land management I could get my hands on. I had no idea I'd be looking into the grandiose, landscape-scale gardening practices of my Native American ancestors and the ways in which they farmed the forest with great skill and intent. I had no idea I'd be contributing to the monumental effort of myriad scientists to dispel the myth that America was "virgin land", "terra nullius" or "pristine wilderness" before Europeans made landfall. Who knew I would be part of an army of authors to compile and present all the ways Indigenous Peoples cultivated this place, like a vast garden, for thousands and thousands of years?

In the "developed world", when we think of food, we think in a very narrow box: it must be grown in monocrop fashion. Farms must supplant "nature" instead of being part and parcel of nature. It has to come in a plastic package with a barcode and nutritional facts label on the back. Food has ironically become denatured, de-spirited and de-valued into an object rather than a living, breathing being, that gives its very life so that we could have life. It is now something we buy, carry and throw to our yelling toddler in the back of the car instead of a sacred gift culminated by the convergence of an immeasurable number of breathtaking biological processes.

In many Indigenous languages, food is not an object, nor is it a noun. It is either a verb or derived from a verb. Perhaps our words for food are verb-based because food is not seen as a static instant, but an ever-moving exchange of life and love. From rainfall to soil microbes, from rhizome networks to xylem routes, from deer teeth to grassland meristems, from prairie fire to acorn nutrients, from herring migrations to bear bellies, from kelp forests to urchin shells and from abalone meat to otter paws, "food" is more than a thing – it is a miracle. Food goes into our mouths just as prayers of gratitude flow out for the life we receive and give back to the land through careful management and maintenance.

I believe Indigenous Peoples were able to – and in many cases still do – tap into the food systems that were and are already burgeoning all around them. We noticed what was already

DOI: 10.4324/9781032684369-44

going on and fan the flames of that movement. For example, millions of stampeding buffalo were nourished by our human-set fires that burned the prairies, replenished it with ash and gave rise to nutrient dense grasses to munch on. Clam gardens augmented along pacific northwest coastlines through the construction of human-made, intertidal rock walls. Chestnut groves from Maine to Georgia sustained by routine thinning of mast trees, lest they become overcrowded, undernourished and more prone to blight. Bolivian floodplain feasts created by anthropogenic dirt walls that funnelled, slowed and captured receding waters during the dry season to produce perennial supplies of fish, fruit, escargot and game animals.

Furthermore, the word "food" does not encapsulate the non-human-centric nature of the universe. In other words, the word "food" usually designates nutrition that is "just for humans". Many Indigenous societies work to produce food for the earth just as much as it produces food for us. We work to monitor how much food is available to the robins, to the antelope, to the butterflies, as much as we monitor how much food is available to us. In many Native Nations, it is believed to be our duty to care for and feed other lifeforms as part of our sacred responsibility to the land. Thus, food and food systems are not just "for" humans but for all life. When this is our goal (to feed all the life around us), clearly our design goals and principles will look different than a society that seeks to feed only their own mouth. For the former case, we will seek to spread the nourishment and energy of food evenly in all directions to all life. In the latter case, we will resemble a leech to the system, slowly sucking all nourishment and all energy into our own mouths, our own species and depriving the whole. Thus, the very underlying *goal* of our food systems (to feed humans or line the pockets of an agricultural corporation CEO) is directly responsible for the damaging and unsustainable nature of our food systems.

This is all to say, within Western society, we desperately need to break out of the constricting and limiting preconception of what food is and could be. Whilst Indigenous societies may not have all the answers, they show us there are vastly different ways to think about and cultivate "food". Just like a painter who realises there are a dozen more colours to paint with than she ever knew existed, so, too, must we as a hegemonic culture learn new ways that food can be understood and co-created.

Towards this end, I would like to run through four case studies of ways Indigenous Nations in North and South America would care for their food systems for thousands of years. Hopefully, these stories will bend and break open our way of seeing food, water and sustenance for the 21st century. Ironically, sometimes by looking back deep in time, we can find solutions for the future ahead.

I will first start with the chestnut groves of a place we now call Kentucky, USA. This specific area has much older names than this and is home to the ancestors of the Shawnee Nation and other Indigenous groups. In the 1990s, scientists removed a soil core from Cliff Palace Pond, Kentucky, which held thousands of years worth of information. By examining the fossilised pollen therein, we can reconstruct the forest composition of this area across time. In this particular case, we can see that around 3,000 years ago it transforms from a cedar and hemlock forest to a chestnut, hickory nut and black walnut forest (Delcourt et al. 1998). We see the introduction of domesticated edible species such as goosefoot, sunflower and sumpweed. Strikingly, we also see fossilised charcoal enter the record and continue steadily. Altogether this mast and fire balance is maintained for 3,000 years! It is only interrupted in about 1930 when the American chestnut was almost completely wiped out by a parasitic fungus known as Chestnut blight (due to colonial mismanagement of American forests).

Scientists interpret that around 3,000 years ago ancestors of the Shawnee began to curate a biodiverse food forest and managed it with routine burning of the forest floor, a common management practice of Indigenous Peoples throughout the Americas (Stewart 2002). Burning helps to keep the trees far apart because it continually clears the area of saplings, shrubs and other competing vegetation that could overcrowd the trees you want. Overcrowding of forests can lead to extreme competition for limited nutrients, sunlight and water within the forest system, which can weaken tree immune systems. The result of non-burning is you can have many sick, malnourished trees, instead of a few strong and healthy trees. By burning in between old growth trees, moreover, we can also open meadow and travelling spaces. This attracts herbivores such as deer, antelope, bison, elk, etc., who feast on the grasslands that spring up in the wake of fire and ash and correspondent soil vitality. Furthermore, routine fire can prevent catastrophic fires because it keeps fuel loads down and prevents trees from getting dried out from too much competition over limited ground water. Without proper burning and spacing, forests can become a tinder box waiting to catch fire. Perhaps this is why colonists always noted and marvelled at the "park-like" nature of Indigenous forests they came upon. Indeed, these were not "wild" forests, but heavily curated spaces, shaped and co-created by human beings. This ancient and famous chestnut belt spanned from Maine to Georgia and was tragically decimated in the early 20th century.

This system teaches us that we do not need to settle for tiny orchards, nor do we have to simply let nature take its course. We can be active agents and participants in the way the land looks and tastes on massive, regional scales. It also teaches us that without human pressure and presence, many land-based food systems (whose chestnuts can feed a whole host of species) collapse and go into disrepair. Perhaps this signals to us as humans that we indeed have an ecological purpose in this world if we simply wield our energy in a regenerative manner.

Next, I'd like to share a story of pacific northwest clam gardens in a place some call Quadra Island, Canada. These are the ancestral homelands of the We Wai Kai, We Wai Kum, K'omoks, Xwemalhkwu, Kwakwaka'wakw and Klahoose First Nations. Human-made clam gardens are established by tracing the coastline with intertidal rock walls. As the tide rises and recedes, the wall holds back water and sediment. Over time, this generates calmer, shallower and warmer waters, excellent for clam proliferation, including littleneck, gaper and butter clams (Lepofsky et al. 2021). This is done not only to augment a predictable food supply for humans but will also end up feeding racoons, minks, river otters, sea ducks and geese. These clams are seen by Indigenous Nations, "as having families and societies equivalent to those of humans, and with their own abilities and needs" (Deur et al. 2015, p. 206). These walls are at least 3,500 years old and span some 15 kilometers around Quadra Island alone!

What we can gather from this case study is that we do not have to own the land to cultivate it. It also teaches us that we can and should share the bounty of our creations with other lifeforms as part of our way of giving back. It also teaches us to have respect for even the smallest creatures, such as clams. In other words, just because something isn't a human, doesn't mean it's not a person. This system also shows us that Indigenous Peoples were not merely "hunter-gatherers" or victims of circumstance but actively co-created a world that worked for them over the millennia and worked for all the life around them. It demonstrates how by tapping into the kinetic energy of the moon, the tide and the massive presence of the ocean, we can create a workable system in partnership with all these things. Lastly, and perhaps most connected to the overarching message of this paper, is that our food systems do not have to be separate from the natural ecosystems around us but can be seamlessly integrated so that they are one and the same.

Thirdly, I'd like to discuss the "Amazonian Dark Earths" of the Indigenous Peoples of South America. The Mebêngôkre (colonially known as Kayapó People) – an Indigenous Nation of present-day Para and Mato Grosso, Brazil – are one of many expert soil managing societies of Amazonia (Lima et al. 2002). They and others are well-known for their ability to create thick and fertile A-horizons through a variety of soil amendment and maintenance practices.

Their resultant soil systems are known interchangeably as Terra Preta de Índio, Amazonian Dark Earths and Anthropogenic Black Earths (Cunha et al. 2009).

Mebêngôkre agroforesters cultivate many food items including but not limited to sweet potato, yams, cassava, plantains, bananas, maize, beans, squash, groundnut, various tubers, papaya, mango and pineapple. Soil amendments are as diverse as the crops planted. The things Mebêngôkre People add to their soil systems include but are not limited to: ash from in-field cooking activities, termite species, along with their nest soils and organic material, nearby forest litter, a variety of manure and dung, previously enriched soils, crop residues such as peelings, leaves and vines and ash from in-field burning (Posey 1985).

In a comparative study, over a five-year period, the production of all crops was 61,750 kilograms/hectare, whereas a nearby colonist agricultural system produced 21,800 kilograms/hectare (Hecht 1992). Moreover, it was found that soils from a single swidden plot could continue to yield food for up to 11 years due to wise timing and selection of crops and a wide variety of continual soil amendment practices. Neighbouring colonial agricultural soils could rarely make it past five years before needing rest.

These soils have been found to be several thousands of years in the making, with one area of settlement estimated to have 500 hectares of human-made Amazonian Dark Earths (Maezumi et al. 2018). This is equivalent to over 900 football fields worth of anthropogenic soil! As Hecht (1992) has written, “The Kayapó and other rural populations don’t just manage agricultural fields, they manage whole landscapes”.

This story teaches us that we can influence the world immensely in positive ways. We often view humans as a pest or a problem in the world. We also see the human population explosion as a curse for the earth. But it really matters what kind of behaviour these humans are engaging in. If they are simply consuming plastics and unsustainable supply chains, then yes, this population explosion is a problem. However, if these humans are actively engaging in applying field amendments to the world around them, and giving more than they take from the surrounding system, they might be able to create 900 football fields worth of loamy topsoil per city as well. Indeed, if guided by the right goals and values, and equipped with the right skills, human beings can be an incredible asset to the earth.

The fourth and final story I’d like to share is that of American grasslands pyro-management. This large-scale and often overlooked Indigenous soil and food management system involves the upkeep of native grasslands on the Great Plains and in the Midwest. These once-extensive grasslands stabilised vast tracts of soil and supported a host of large herbivores who in turn supported the cultural, spiritual, nutritional and material needs of Native Nations. The upkeep of these grasslands was not solely for human benefit, however. An ethic of ecocentrism and stewardship underpinned these practices, intended for the benefit of all life. Many estimate that these soils were generated over a scale of thousands of years (Christy 1892).

These grasses were managed, in large part, by routine, low intensity burns set by a variety of Indigenous Plains Nations. This fire activity had profound and intentional effects on soil microbiological processes. Light, patchy burning in dormant seasons can increase overall soil health through the addition of nutrients through ash, heating of soil organic matter, increased nitrogen and phosphorus mineralisation rates, increased species richness and increased pH levels of soils (Wan et al. 2001). Depending on a number of factors – including time of year, fire intensity and ecosystem type – fire can positively hasten the chemical conversion of expired plant tissues into bioavailable nutrients and stimulate soil macro- and microbiological processes.

In fact, burning the grasslands and meadows was so important that many native nations name certain moons within their lunar calendars for the times when we burn. The Myaamia Nation of the Ohio River Vally name two moons for human-set fires: *saašaakayolia kiilhswa* (the Grass

Burning Moon) and *kiiyolia kiilhswa* (the Smokey Burning Moon). In a recent publication from the Myaamia Center at Miami University in Ohio, they explain how in

> *saašaakayolia kiilhswa* (the Grass Burning Moon), we see fire as something that restores and gives new life to the prairie. Fire helps clear the land of old grass and brush and opens seed pods that have fallen to the ground. Because of fire, new flowers and plants emerge in the spring.
>
> (McCoy et al. 2011)

These seasonal burns and other practices also attracted a variety of species that worked to support the ecosystem as well, such as buffalo, deer and antelope. People often envisage Indigenous Nations chasing bison herds with bows and arrows, but there is increasing evidence that the bison herds followed us – they followed our fire and the nutrient dense grasslands it created. This would logically follow given the ample evidence suggesting that tallgrass is pyro-adapted.

These stories show us that there are incredibly creative ways to feed our food. By simply applying fire to the land, Indigenous Nations created lush grasses for herbivores to munch on. It also teaches us that we do not necessarily have to cage our chickens and fence our cattle. If you simply create the environments that these animals appreciate, then they will come to you. In this sense, it is a fenceless farm, a world where we honour and make a home for our life and in return life gives its life to our mouths and bellies so we may live. This is the value and the technique of ecological reciprocity. A little bit of care and appreciation for what sustains us goes a long way.

As you can see, the world of Indigenous foods is expansive. It is beyond plastic packages, beyond monocrop farms and beyond the de-spirited designation of sacred plants and animals as mere “food”. I frankly think we will have a hard time breaking out of the mental box we’ve been born into, which parcels the land into small pieces for extraction instead of managing whole landscapes holistically and reciprocally. Nevertheless, I believe this is our task. I hope these stories have bent and broken open our way of seeing food, water and sustenance for the 21st century. Ironically, sometimes by looking back deep in time, we can find solutions for this uncertain future ahead. Together, when guided by the proper goals and principles, we can become a gift to the earth once again. Indeed, this is not a “Native American” thing – it is a human thing. It is our nature, our design, our purpose and our birthright as *Homo sapiens*: to be the hands and feet of the Creator, an emissary of Her love and care for the earth.

References

Christy M, 1892. Why are the prairies treeless? *Proceedings of the Royal Geographical Society and Monthly Record of Geography*, 14(2):78–100.

Cunha T J F, Madari B E, Canellas L P et al., 2009. Soil organic matter and fertility of anthropogenic dark earths (Terra Preta de Índio) in the Brazilian Amazon Basin. *Revista Brasileira de Ciência do Solo*, 23(1):85–93.

Delcourt P, Delcourt H, Ison C et al., 1998. Prehistoric human use of fire, the eastern agricultural complex, and Appalachian Oak-Chestnut forests: Paleoecology of Cliff Palace Pond, Kentucky. *American Antiquity*, 63(2):263–278. https://doi.org/10.2307/2694697

Deur D, Dick A, Recalma-Clutesi K et al., 2015. Kwakwaka’wakw “Clam Gardens”. *Human Ecology*, 43, 201–212. https://doi.org/10.1007/s10745-015-9743-3

Hecht S B, 1992. Indigenous soil management in the Latin American tropics: Neglected knowledge of native people. In Altieri M A and Hecht S B (Eds.), *Agroecology and Small Farm Development*, pp. 129–142. Boca Raton, FL: CRC Press.

Lepofsky D, Toniello,G, Earnshaw J et al., 2021. Ancient anthropogenic clam gardens of the Northwest coast expand clam habitat. *Ecosystems*, 24(2):248–260.

Lima H N, Schaefer C E R, Mello J W V et al., 2002. Pedogenesis and pre-Columbian land use of "Terra Preta Anthrosols" ("Indian black earth") of Western Amazonia. *Geoderma*, 110(1–2):1–17.

Maezumi S Y, Robinson M, De Souza J et al., 2018. New insights from pre-Columbian land use and fire management in Amazonian dark earth forests. *Frontiers in Ecology and Evolution*, 6:111.

McCoy T, Ironstack G, Baldwin D et al., 2011. *Myaamionki: Ašiihkiwi Neehi Kiišikwi, The Place of the Miami: Earth and Sky*. Miami Tribe of Oklahoma.

Posey D A, 1985. Indigenous management of tropical forest ecosystems: The case of the Kayapó Indians of the Brazilian Amazon. *Agroforestry Systems*, 3:139–158.

Stewart O C, 2002. *Forgotten Fires: Native Americans and the Transient Wilderness*. Norman: University of Oklahoma Press.

Wan S, Hui D and Luo Y, 2001. Fire effects on nitrogen pools and dynamics in terrestrial ecosystems: A meta-analysis. *Ecological Applications*, 11(5):1349–1365.

Conclusion

Moving from extinction to securing regeneration: The mission of a movement

Joyce D'Silva and Carol McKenna

The evidence is clear. Food systems change has transformative potential for human, animal and planetary health. As the authors in this book have informed us there is no more time for business-as-usual. Climate and biodiversity goals will not be achieved without food system transformation, including reducing the production and consumption of animal-sourced foods.

To choose regeneration over extinction, our diets must be more plant-based and our farms – on land and in water – must become regenerative.

The purpose of a future-fit global food system should be to produce sufficient, accessible, affordable nourishing food for people within planetary boundaries whilst providing decent livelihoods for people and good lives for farmed animals.

The question is how to make these changes happen with urgency.

The authors in this book have shared a myriad of pathways to change. Cooperation and collaboration across many policy areas and sectors are needed. We need to live with respect for the earth and all the beings who share this home with us. To aim for harmony with them. To cherish the soil and the waterways. To restore the wildlife, forests and grasslands we have devastated.

No one can achieve all this alone, although we can make personal lifestyle choices to support the transformation.

We need above all to work together to maximise our impact on governments, on international bodies and on agribusinesses and food businesses. The larger our voice, the louder it will sound and the sooner the responses will come.

So, we the editors of this book end with an invitation – please work with and support Compassion in World Farming, our actions, our partners and like-minded organisations. To find out more visit www.ciwf.org or email us at officeofceo@ciwf.org.

DOI: 10.4324/9781032684369-45

Index

Note: **Bold** page numbers refer to tables, *italic* page numbers refer to figures and page numbers followed by "n" refer to end notes.