

## Agricultural Resilience

Perspectives from Ecology and Economics

Agriculture as a social–ecological system embraces many disciplines. This book breaks through the silos of individual disciplines to bring ecologists and economists together to consider agriculture through the lens of resilience. It explores the economic, environmental and social uncertainties that influence the behaviour of agricultural producers and their subsequent farming approach, highlighting the importance of adaptability, innovation and capital reserves in enabling agriculture to persist under climate change and market volatility. The resilience concept and its relation to complexity theory are explained and the characteristics that foster resilience in agricultural systems, including the role of biodiversity and ecosystem services, are explored. The book discusses modelling tools, metrics and approaches for assessing agricultural resilience, highlighting areas where interdisciplinary thinking can enhance the development of resilience. It is suitable for those researching sustainable agriculture or those engaged in agricultural policy decisions and analysis, as well as students of ecology, agriculture, social science and economics.

SARAH M. GARDNER works at the interface of ecology and environmental economics. She has worked with agricultural policymakers, land managers and farmers for over 20 years as adviser, researcher and lecturer. Her current work at GardnerLoboAssociates involves the design of data management systems for the livestock sector.

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## Preface and acknowledgements

Agriculture is facing a time of significant change and uncertainty. In many countries, increased productivity, driven by technical developments during the twentieth century, has led to agricultural systems that are productive, but often very specialised, while reforms to agricultural policy have reduced the amount of protection provided by the state. Climate change is already increasing the probability of adverse weather-related shocks to farm systems and the likelihood of extreme events and their severity are predicted to increase. Concerns have been raised that modern agricultural systems are therefore vulnerable to increased levels of uncertainty across a range of environments – natural, market and political. Moreover, farmers are increasingly expected to produce food and other farm products with a lower environmental footprint. Faced with these demands, within increasingly uncertain external environments, how equipped are current agricultural systems to adapt and maintain production for a growing population? Do modern ‘efficient’ farm systems have sufficient buffering capacity to withstand future uncertainty and shocks? This book considers the adaptability of agriculture through the lens of *resilience*. It explores the economic, environmental and social uncertainties that influence the behaviour of agricultural producers and their subsequent choice of farming approach and considers the factors that foster resilience in agricultural systems, especially the role of biodiversity and ecosystem services.

The book arose from discussions and ideas that emerged during three interdisciplinary meetings organised by the Natural Capital Initiative, the British Ecological Society and the UK Agricultural Economics Society in 2012 and 2015. These meetings were designed to promote dialogue between ecologists and economists on the sustainable management of biodiversity and ecosystem services within agriculture and several of the themes developed in this book were highlighted at these meetings. Agriculture is a social-ecological system that embraces many disciplines. To reflect this, we have deliberately invited a diverse range of authors, including those with non-ecological backgrounds. As editors we were interested in determining

## xiv PREFACE AND ACKNOWLEDGEMENTS

whether the resilience concept might offer new insights on how agricultural systems should develop in the future, on the role that biodiversity and ecosystem services might play in enhancing the adaptive capacity of agriculture and on approaches that place greater emphasis on natural capital assets, such as soil, within agricultural production systems. In presenting a cross-disciplinary view of resilience, our aim was to consider the broad range of factors that influence decision-making in agriculture, to expose readers to the approaches and thinking adopted by different disciplines, e.g. to tackle questions of risk and sustainability in agriculture; and to identify areas where agriculture and the environment might benefit from future interdisciplinary collaboration.

The book is divided into two parts. After a brief review of the resilience concept, Part I sets out the context within which agriculture operates and its relationship with the global food system, before considering how this context influences the capacity of agricultural producers to adapt to change. The main chapters in this section focus on the contribution of biodiversity and ecosystem services to fostering resilience in agricultural systems and examine approaches for valuing and assessing this contribution. Part II considers different approaches for integrating biodiversity and ecosystem services into agricultural systems and sets out some of the challenges facing producers and policy-makers for building resilience in present-day agricultural systems. The book concludes by drawing together the lessons learned from the different economic and ecological approaches set out in each chapter and highlighting areas where research and policy development are needed to build agricultural resilience for the twenty-first century.

In examining the studies presented in this volume, we are reminded that resilience is an emergent property of complex adaptive systems which arises from the interactions and behaviour of many, diverse and independent, individual agents. It is the self-organising behaviour of these agents that facilitates adaptation and the emergence of resilience in systems. Within agriculture, the self-organising agents are the agricultural producers that build agricultural systems and the biological species that 'build' the agroecosystems and ecosystem services on which agriculture is founded. The dependence of agriculture on natural capital and ecosystem services highlights the importance of assigning 'values' to these assets to ensure that they are accounted for in agricultural production systems. Development of valuation approaches for natural capital is a flourishing area of dialogue between ecologists and economists. A more challenging area for dialogue focuses on exploring ways of balancing efficiency and resilience in agricultural production systems. These properties, while apparently promoting diametrically opposed system requirements – efficiency encourages uniformity among agents while resilience requires diversity – are both needed for growth and adaptive capacity in agricultural systems. Differences in economic and ecological approaches to this problem

can lead to divergent thinking and the implementation of trade-offs between agricultural production and ecosystem services, where in fact convergence and integration of objectives for agriculture and natural capital assets is needed – focusing, for example, on the multifunctional nature of agriculture, the value of the different goods arising from it and the maintenance of reserves of all types of capital. This is a critical area for discussion, argument and innovative thinking between ecologists and economists as the uncertainties surrounding agriculture and food production increase through the twenty-first century. Our outlook from this book is cautiously optimistic. Integrating resilience into agricultural systems is possible but requires policies and production paths that promote autonomy and heterogeneity and opportunities for self-organisation among agricultural producers and that incentivise the development of reserves of all types of capital. When viewed as complex adaptive systems, agriculture and the agroecosystems that underpin it possess many pathways to resilience. The key to these pathways is the multi-dimensional ecological, economic and social context within which agriculture operates. This context varies globally, both within and between nations. It is this variation that is the source of future adaptive ability for agriculture.

In presenting this volume, we are greatly indebted to all the authors of the chapters and to all the people who reviewed them. We especially thank Jenny van der Meijden at Cambridge University Press who has supported and guided us through the publishing process, the Editorial Board of Ecological Reviews and many friends and family who have supported us in the production of this volume. We hope that together we have been able to present a better understanding of the parameters that enhance and constrain resilience in agriculture and its co-existence with nature.

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