Wageningen Economic Research | White paper

Towards a Future Research Agenda on Food System Resilience

Deborah Bakker, Emma Termeer and Bart de Steenhuijsen Piters

March 2021

The impacts of COVID-19, the effects of climate change, as well as other shocks and stressors, challenge the resilience of food systems at a global scale. While the world's population is expected to increase by 2 billion people in the next 30 years, the UN warns that global hunger is also on the rise. If food systems are not resilient, they might collapse in the face of new shocks and stressors. This means that the Sustainable Development Goals (SDGs) will not be reached. The UN already warns that without efforts to reform global food systems, its target of zero hunger by 2030 will be missed.[1]

This research agenda has been developed within the Wageningen University & Research Programme on "Food Security and Valuing Water" that is supported by the Dutch Ministry of Agriculture, Nature and Food Quality.

PLEASE CLICK ON THE SECTION OF YOUR CHOICE

1 'UN report sends 'sobering message' of deeply entrenched hunger globally', 13 July.

1 Introduction

How can we improve the resilience of food systems and ensure a sustainable food supply that feeds the world, both now and in the future? The Discussion Starter of the Resilience Action Track for the UN Food System Summit 2021 frames this resilience question as follows: How can we make sure *"that all individuals and institutions engaged in the functioning and governance of food systems are empowered to prepare for, withstand, and recover from instability and participate in a food system*

How can our research on resilience support transformation towards sustainable and equitable food systems?

that, despite shocks and stressors, delivers food and nutrition security and equitable livelihoods for all whist ensuring the healthy soil and water ecosystems for continued food system resilience"? We go even further by asking: how can we ensure that in the face of shocks and stresses, food systems can not only maintain functionality, but recover from the effects of harmful events, and improve to a better-off state? How can our research on resilience support transformation towards sustainable and equitable food systems?

Our ambition is to build a shared understanding of what determines the resilience of food systems, to understand the impact of different shocks and stressors, and to identify effective resilience strategies and leverage points for resilience building. What is still missing, however, is knowledge on the impacts of different shocks and stressors and how this interacts with activities in the food system, from agricultural production to processing, food supply and consumption. Here, it is important to take into account different food system outcomes, including safe, affordable and healthy food, remunerative employment and a living income, and biodiversity and environmental sustainability. The SDGs point to the interconnectedness of the resilience of food systems with balancing social, economic and environmental sustainability and the ambition to end all forms of hunger by 2030.

The objective of this white paper, as part of the KB Research Programme on Food Security and Valuing Water, is to create a mid- to-long-term perspective on research questions for Wageningen University and Research (WUR) on food system resilience. This research agenda should provide guidance to WUR research in the international domain, including Europe, Africa and with a global perspective. The aim of this paper is to present current and emerging research questions, dilemmas and consequences of improving resilience to shocks in food systems.

Finding ways to better understand food system resilience serves, in the end, a shared desire for strengthening the response and/or transformation capacity of global food systems. This implies that our quest for adequate methodology to study food system resilience, thus being capable of filling perceived knowledge gaps, will have to provide answers to questions regarding how higher levels of resilience can be promoted and, finally, how merits and trade-offs can be balanced.

2 Towards a new research agenda

WUR has conducted research on food system resilience for several years in a range of scientific domains, bringing together interdisciplinary expertise (for example, Dewulf et al. 2019; Buitenhuis et al. 2020). As part of the KB Resilience Strategic Investment theme of 2015–2018, many fundamental and applied research projects took shape and informed our knowledge of resilience in different contexts. Some research focused on climate and environmental resilience and its interactions with food security, such as pests and diseases, resilient cropping systems, climatic shocks to agricultural areas, or nature-based solutions for circular food systems. Other research focused on socio-economic aspects and their interrelations with resilience, such as the role of politics and institutions in the resilience of farming systems, vulnerabilities and bottlenecks in specific value chains and the role of data-driven innovations in agri-food sectors.

To develop a common future research agenda on food system resilience, two brainstorm sessions with key WUR experts were conducted on 29 September and 1 October 2020. In two groups with eight to ten participants, we discussed the question: *what are important gaps in scientific knowledge about food system resilience and how are these linked to current concerns in society?* From the brainstorm sessions, we can broadly distinguish two debates. The first focuses on the conceptual and analytical understanding of food system resilience and reveals the need for a common language within (and beyond) WUR research domains. To do justice to this debate, the next section in this paper concerns methodological questions around the concept of food system resilience.

The second debate from the brainstorm sessions concerns questions relating to gaps in empirical and scientific knowledge around food system resilience. The result of the sessions was an extensive 'longlist' of relevant questions and suggestions for further research. This longlist of questions was distributed for internal consultation by additional WUR experts who did not participate in the brainstorm sessions. After this consultation round, the longlist was adapted into a conceptual shortlist of questions in its current form, with four key research areas:

1 shocks and stressors;
2 interactions and trade-offs;
3 leverage points for resilience building; and
4 governance of food system resilience.

The shortlist was then shared and discussed with leading, national and international experts outside WUR. This consultation round led to improved formulations of some of the key questions and useful insights into current debates around resilience. The final shortlist, which can be found in section 4 of this paper, is the result of extensive discussions and consultations with key experts and highlights pressing knowledge gaps and current concerns in international research on food system resilience.

3 Towards a common framework on food system resilience

We need a common analytical framework for the study of food system resilience in order to work across different domains and scientific disciplines within and beyond WUR. This section will outline some of the key concepts and methodological considerations that build common understanding.

According to the Enhancing Resilience in Food Systems research group at ETH Zürich, building food system resilience is an increasingly challenging task, as food systems are intrinsically complex and increasingly exposed to drivers of change, from natural disasters to economic and political crises and resource degradation.[2] It is therefore key to make food systems sustainable and adaptable to uncertain and, in some cases, unpredictable shocks and stressors.

In the literature, reference is made to strategies to improve resilience of food system outcomes: *robustness* (aim to resist disruption to existing outcomes), *recovery* (aim to return to existing outcomes after disruption), and *reorientation* (aim to accept alternative outcomes before or after disruption). All strategies involve *reorganisation*: making changes to system activities either directly or indirectly.

All strategies involve reorganisation: making changes to system activities either directly or indirectly.

2 ETH Zürich, Enhancing Resilience in Food Systems.

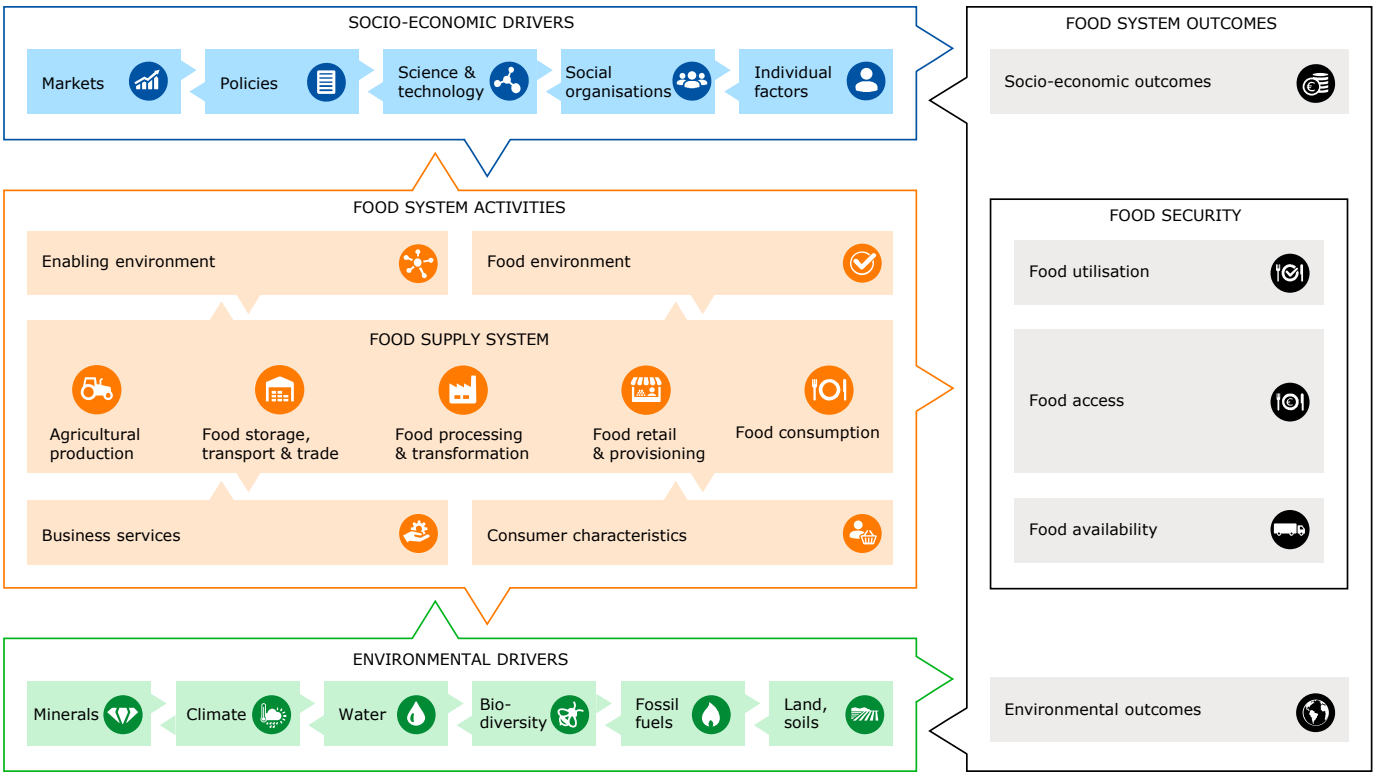

Figure 1: Mapping the relationships of the food system to its drivers (Van Berkum et al., 2018)

It is also recognised that resilience results from the combination of three capacities that lead to different short-term responses: 1) *absorptive* capacity leading to persistence, 2) *adaptive* capacity leading to incremental adjustments/changes and adaptation, and 3) *transformative* capacity leading to transformational responses (Béné et al., 2012).

For the purpose of building an empirical research agenda for food system resilience, we take the food system approach (FSA) as a starting point. This approach, as suggested by Van Berkum et al. (2018), is a useful interdisciplinary conceptual framework for research and policy aimed at securing or improving food system outcomes. A FSA analyses the relationships between the different parts of the food system and the outcomes of activities within the system in socio-economic and environmental/climate terms. Similarly, we are interested in resilience of food systems in the face of socio-economic shocks as well as climate resilience.

The food supply system encompasses multiple food value chains, which depend on the combined and interactive resilience of all actors and processes in the chain. We understand resilience as the readiness and capacity to deal with the consequences of vulnerabilities in the face of shocks and stressors. Not all actors or activities within food systems are equally vulnerable to different shocks and stressors. Hence, a systemic approach to food system resilience requires an understanding of the interaction of different shocks, stressors and components or activities, as well as the vulnerabilities and bottlenecks of a system. This enables the identification of leverage points for resilience building.

Policymakers can use a systemic perspective to elaborate a strategy or policy for reducing vulnerability or enhancing resilience. This can help identify where trade-offs between different forms of resilience are observed, and highlight relevant dimensions of resilience that are being neglected. It can help unpack what underpins resilience attributes: which forms of resilience are relevant, and how do they interact? What are the trade-offs and feedback loops? Who in the system will benefit, and who may be disadvantaged? Moreover, who and what can drive systems towards higher levels of resilience?

According to Discussion Starter of the Resilience Action Track for the UN Food System Summit 2021: *"Solutions need to be defined around cross cutting levers of joined-up policy reform, coordinated investment, accessible financing, innovation, traditional knowledge, governance, data and evidence, and empowerment of the most vulnerable".*[3]

3 Discussion Starter Paper (2020) Action Track 5: Build resilience to vulnerabilities, shocks and stress. UN Food Systems Summit 2021.

4 Emerging research questions on food system resilience

In the above sections we have explored a common framework for understanding food system resilience. After consultation and validation with experts within and outside WUR, we identified the following questions related to food system resilience in four key areas: *shocks and stressors, interactions and outcomes, leverage points for resilience building and governance of food system resilience.*

1 Shocks and stressors

We can imagine several shocks and stressors to have a potential impact on food systems, such as a zoonic health crisis (COVID-19), climate change, economic crises and political conflict. To be resilient is to anticipate these risks, which allows you to go from crisis management to prevention and preparedness.

We identify the following key questions:

1 *How do shocks and stressors relate to each other and what happens when they combine or overlap to create compounding shocks and stressors?*

Shocks and stressors to food systems often occur simultaneously, as seen with COVID-19: the health crisis has severe economic consequences, and in many countries overlaps with other ongoing crisis situations, such as political conflict, pests and diseases (desert locusts), and droughts. A framework to analyse these compounding shocks and stressors, and their interactions, contributes to understanding how food systems can be made more resilient, especially in contexts of protracted crisis, violent conflict or post-conflict situations.

2 *How do shocks and stressors affect actors, activities and food system segments differently?*

We need to create in-depth understanding into how different shocks affect different actors, activities and segments of the food system. In this way, risks can be managed and anticipated more efficiently and more specifically per actor group or value chain segment.

3 *What are the unique challenges for food systems as compared to other societal systems?*

We need to identify the key challenges for shocks to food systems specifically. For example, the COVID-19 crisis revealed some key risks associated with food systems, such as product perishability, bulkiness of commodities, transport challenges and the implications for human health if certain food products become unavailable. Insight into these specific challenges is necessary for adequate risk-management measures.

2 Interactions and outcomes

Measures and interventions to achieve resilient food systems are likely to create 'winners' and 'losers', as there are many competing interactions and interests within food systems. Desired outcomes, such as healthy diets, profits or sustainability, may contradict each other and thus create potential trade-offs. Identifying these potential trade-offs are key to understanding their implications for the way resilient food systems can be constructed.

We identify the following interactions that require further research on their implications for food system resilience.

a **Short-term and long-term gains:** the potential trade-off between economic livelihoods in the short term and sustainability in the long term provides a challenge for resilient design of food systems, as focusing on the resilience of one may jeopardise the resilience of the other. How can we best address this challenge?

b **Rural and urban demands:** rural resilience has long been central in resilience thinking, but recently most policy and academic focus has been on urban resilience-building to address infrastructure deficits, environmental degradation and climate change impacts. The perceived contradiction is also reflected in the question of whether food prices have to be kept low for urban consumers or whether farm gate prices have to be raised to provide farmers and workers with a living income. What is the best strategy to achieve desired outcomes for both rural and urban populations?

c **Diversifying and specialising functions:** biodiversity and landscape help to strengthen the resilience of ecosystems and local economies in rural areas. How can we translate this insight to the food system level, including social, political and economic dimensions? Diversification of food supply chains could increase resilience to shocks due to increased self-sufficiency. Alternatively, local specialisation could increase resilience of the value chain itself. What is the best balance between diversification and specialisation for desired outcomes?

d **Self-sufficiency and import** dependency: countries that are highly import-dependent are, in principle, more vulnerable to global market shocks. On the other hand, being well-connected to the global market for food supply can also be seen as a resilience strategy, especially for countries with limited abilities to produce food locally. Global or regional food supply also protects against local risks to food production such as droughts, pests, political crises, and so on. Localised (or regionalised) food production might have positive impacts on sustainability, with less pollution due to international transportation. What is the optimal balance between self-sufficiency and localised production on the one hand, and strong connections to global market supply on the other hand? This depends on the local and regional context as well as global trade infrastructure.

e **Intensified versus sustainable and regenerative use of natural resources:** in a context of growing demand for food, an important debate revolves around the intensification of land-use for agricultural production, and how to improve agricultural productivity in a sustainable way. There is a loud call for a circular, biobased economy. Are regenerative and circular food systems more resilient to different shocks as compared to other production modes? Even if these systems are more sustainable, what are the implications for economic livelihoods and food and nutrition security? What are the implications at the local and global level and across different geographical contexts?

3 Leverage points for resilience building

Interventions aiming to increase the resilience of food systems will have different impacts in different geographical contexts, depending on their agro-ecological and climatic setting, government policies, private sector engagement, community participation and institutional capacities. Initiatives should begin with an in-depth understanding of the socio-political, economic, cultural and environmental context of each locality. This includes analysis of food value chain weaknesses, system vulnerabilities, people's needs, as well as existing coping mechanisms. Only then can key leverage points for resilience building be identified in each context.

Initiatives should begin with an in-depth understanding of the socio-political, economic, cultural and environmental context of each locality.

We identify the following key questions:

1 *Which market failures leave food systems unprepared or ill-prepared for shocks and stressors?*

Once we can identify those market failures, it is possible to design targeted interventions for public government. For example, price fluctuations might directly impact many actors in the food value chain, from producers to retailers. In that case, an intervention that protects against the volatility of food prices might positively impact the resilience of an entire value chain and, by implication, support the delivery of desired outcomes such as economic livelihoods and food security.

2 How do interventions for food system resilience interact?

Some solutions might be most effective as 'stand-alone' interventions, while others are best combined. For example, an intervention to mitigate price risks and an intervention that focuses on the integration of a value chain: can they be substituted to solve the same problem? Or do they reach the best possible outcomes when combined? Which combination of interventions is most effective in the short- and long-term? Empirical evidence and a comparative analysis of different cases is needed to address these questions.

3 What is the potential role of digital solutions in resilience building?

We identify a growing interest in technical and data-driven solutions, for example to develop early warning systems. Policy recommendations in light of the COVID-19 crisis suggest that a shift to online platforms and 'digital agriculture' might have the potential to increase productivity, drive growth, as well as improve income levels, but empirical evidence on their applications across different food systems is lacking.

We identify a growing interest in technical and data-driven solutions, for example to develop early warning systems.

4 Governance of food system resilience

Food system governance reflects the priorities and power of different actors — in the public, civil society and private sectors. To date, most governance models have allowed food systems to evolve in unpredictable ways with often undesired outcomes. Effective governance is needed that mediates between the priorities of different stakeholders in food systems, and that draws on each group's necessary perspectives and capabilities.

Many of the experts that were consulted referred to the importance of understanding the governance of food

systems and processes to build resilience. This can be analysed with a political economy lens: who owns what, who does what, who gets what, and what do they do with it? Food systems already create 'winners' and 'losers' based on existing differences in access to assets, power and influence. Such inequalities are further reinforced when a shock or crisis occurs. This is also why simply 'bouncing back' to the old system is not necessarily the preferred option for every actor involved. We can identify different levels of governance, ranging from 'top-down' (United Nations, European Union, international organisations or national governments) to 'bottom-up' (local communities, associations of farmers or processors, worker unions, and other food system actors). Often, more informal power structures are overlooked, such as those defined by gender or generation.

So far, the food system resilience agenda has largely been donor-driven and centres around 'Western' agendas. Though there has been ample attention for strengthening food security, the priority of building food system resilience is not yet widely shared among governments in low- and middle-income countries. In building resilience, do we focus on the state and (formal) public institutions? What is the role and responsibility of the private sector, including small- and medium-sized enterprises? What is the role of NGOs?

5 Discussion and conclusions

In this paper, we explored common understandings of food systems and their resilience. After much consultation, we identified four areas of emerging questions that remain, to date, unanswered. A common denominator to these areas of investigation is that they refer to higher levels of complexity. Most of the resilience research done to date has been disciplinary in nature. While much is now known about the many individual compartments of the food system, much less is known about their interactions and trade-offs. To investigate these, we need to navigate between disciplines, and this requires a system perspective. Though some scientists still refer to such research as 'comparing apples and pears', much progress has been made over the past decades by interdisciplinary researchers addressing the challenge of understanding the interconnectivity of problems. As such, we are confident that all areas of the questions identified by our investigation can be answered. This was also confirmed by the respondents and participants in our research: a profound interest in the issue of building food system resilience and ambition to take on the challenge of exploring the unknown.

While much is now known about the many individual compartments of the food system, much less is known about their interactions and trade-offs.

We started our investigation while the COVID-19 pandemic had not reached its full scope and the impacts were still unclear. As our understanding of the impacts evolves, our attention broadens to broader debates and concerns in society. For example, the concerns voiced about resilience to shocks feed into existing debates about food security and the sustainability of food systems. It is our role and responsibility to research these questions and identify patterns that provide explanation, thereby creating leverage points for food system transformation.

References

Béné, C., Wood, R. G., Newsham, A., & Davies, M. (2012). Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. *IDS Working Papers, 2012(405)*, 1-61.

Berkum, S. van, Dengerink, J., & Ruben, R. (2018). *The food systems approach: sustainable solutions for a sufficient supply of healthy food* (No. 2018-064). Wageningen Economic Research.

Buitenhuis, Y., Candel, J. J., Termeer, K. J., & Feindt, P. H. (2020). Does the Common Agricultural Policy enhance farming systems' resilience? Applying the Resilience Assessment Tool (ResAT) to a farming system case study in the Netherlands. *Journal of Rural Studies*, 80, 314-327.

Dewulf, A., Karpouzoglou, T., Warner, J., Wesselink, A., Mao, F., Vos, J., ... & Hoang, L. (2019). The power to define resilience in social–hydrological systems: Toward a power-sensitive resilience framework. *Wiley Interdisciplinary Reviews: Water,* 6(6), e1377.

Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., ... & Six, J. (2015). Food system resilience: defining the concept. Global Food Security, 6, 17-23.

Annex

1 Table: Overview of WUR food system resilience research per domain.

Social sciences		
Wageningen Economic Research	Black swans and risks in agrifood chains (highly improbable shocks with potential extreme impacts)	KB-29
	Nourishing the world: urban challenges	
	Resilience and food security (NAPRO): resilience thinking in food and nutrition security	KB-29
	Data-driven resilience: data-driven innovations in the agrifood sectors	KB-29
	Data security for food security (cybersecurity as risk factors)	KB-29
	Transition Support System Approach	KB-29
	Food System Decision Support Tool	
	Consequences of COVID-19 for the Dutch agricultural sector	COVID-19
	Short chains and localisation	KB-35
	Rural transformation through food system development	
	Defining resilience in rural areas	KB-29
Wageningen Centre for Development Innovation	ISSD: increase productivity, resilience and income of households	
	Livelihood and resilience-based approach of least stable regions: building food system resilience in protracted crisis	
	Resilient Innovation System Approach: knowledge exchange and co-innovation networks	
	Resilient institutions and the role of institutions in the resilience of farming systems	KB-29
	Shocks and collapses in agrifood systems (natural and man-made stresses)	KB-29
	Tool to enhance regional resilience	KB-29
	Effects of COVID-19 on food systems: rapid sector and country assessments	COVID-19
	Power and politics: role and relations of power in food system transitions	KB-29
Prof. Gert-Jan Hofstede	System dynamics and agent-based modelling to enhance resilience of social-ecological systems	
Prof. Miranda Meuwissen	SURE-Farm: Towards sustainable and resilient EU farming systems	
Environmental sciences		
Wageningen Environmental Research	Climate resilient urban environments	
	Climate resilience of poor and vulnerable communities	
	Forest resilience against climate change	
	Strengthening international cooperation on climate change adaptation and mitigation policies	
	Climate shocks to delta areas	KB-29
	Relations between biodiversity and food security: trade-offs and feedbacks	KB-29
	Resilience indicators of forest resilience	KB-29
	Nature-based solutions for climate resilience and circular food systems	KB-29
	Food systems approach to track banana from production to consumption, identifying system bottlenecks	KB-35
Prof. Marten Scheffer	Tipping points in complex systems	
Plant sciences		
Wageningen Plant Research	Stress test to determine food security resilience in case of extreme events	KB-29
	Improving food systems in rural areas in East-Africa: securing food production and livelihoods	KB-29
	Diversity at the agro-ecosystem and farm level as strategy for resilient cropping systems and food chains	KB-29
	Resilient plants in resilient production systems	KB-29
	Sustainable solutions for diseases and pests in crops	
	Soil resilience for sustainable soil	
	Resilient cultivation systems	
	DriverIMPACTS: crop diversity as the foundation for sustainable European production chains	
Animal sciences		
Wageningen Livestock Research	Resilient livestock production: the animal as a complex dynamic system	KB-29
	Creating resilience in pigs through artificial intelligence	
	Resilience of dairy cattle	
	Early signs of decreased resilience in cows and pigs	
Wageningen Marine Research	Innovation in mangrove restoration by avoiding coastal flooding and erosion through sustainable land use	
Agrotechnology & Food sciences		
Prof. Vitor Martins dos Santos	Synthetic biology to increase plant resilience	

2 Relevant recent publications by WUR

Brouwer, I. D., McDermott, J., & Ruben, R. (2020). Food systems everywhere: Improving relevance in practice. *Global Food Security,* 26, 100398.

Buitenhuis, Y., Candel, J. J., Termeer, K. J., & Feindt, P. H. (2020). Does the Common Agricultural Policy enhance farming systems' resilience? Applying the Resilience Assessment Tool (ResAT) to a farming system case study in the Netherlands. *Journal of Rural Studies,* 80, 314-327.

Dewulf, A., Karpouzoglou, T., Warner, J., Wesselink, A., Mao, F., Vos, J., Tamas, P., Groot, A., Heijmans, A., Ahmed, F., Hoang, L., Vij, S. & Buytaert, W. (2019). The power to define resilience in social–hydrological systems: Toward a power-sensitive resilience framework. *Wiley Interdisciplinary Reviews: Water,* 6(6), e1377.

Ge, L., Anten, N. P., van Dixhoorn, I. D., Feindt, P. H., Kramer, K., Leemans, R., Meuwissen, M., Spoolder, H. & Sukkel, W. (2016). Why we need resilience thinking to meet societal challenges in bio-based production systems. *Current Opinion in Environmental Sustainability,* 23, 17-27.

Lee, J. van, Kangogo, D., Özkan Gülzari, S., Dentoni., D., Oosting, S., Bijman., J., Klerkx, L. (2020 submitted). Resilience assessment in farming systems: a review. Agronomy for Sustainable Development.

Meuwissen, M. P., Feindt, P. H., Spiegel, A., Termeer, C. J., Mathijs, E., de Mey, Y., Finger, R., Balmann, A., Wauters, E., Urquhart, J., Vigani, M., Zawalinska, K., Herrera, H., Nicholas-Davies, P., Hansson, H., Paas, W., Slijper, T., Coopmans, I. & Reidsma, P. (2019). A framework to assess the resilience of farming systems. *Agricultural Systems,* 176, 102656.

Ruben, R., Verhagen, J., & Plaisier, C. (2018). The challenge of food systems research: What difference does it make?. *Towards Sustainable Global Food Systems,* 1.

Photo credits: Shutterstock

Contact & information

2021-031

Dr. Bart de Steenhuijsen Piters
Senior Research Coordinator
Wageningen Economic Research
PO Box 29703
2502 LS Den Haag
The Netherlands
www.wur.eu/foodsystemsapproach

The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 6,500 employees (5,500 fte) and 12,500 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.