

CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES volume One

Edited by

Eteyen Nyong

Ijeoma Vincent-Akpu

Bassey Ekpo

Muhammad Hussaini

Udensi Ekea Udensi

Mansur Bindawa

Society for Agriculture, Environmental Resources & Management (SAEREM)

First published 2025

SAEREM World

Nigeria

C 2025 Eteyen Nyong

Typeset in Times New Roman

All rights reserved. No part of this book may be reprinted or reproduced or utilized in any form or by any electronic, mechanical, or others means, now, known or hereafter invented including photocopying and recording or in any information storage or retrieved system, without permission in writing from the copyrights owners.

CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES volume One

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-8-8

Printed at: SAEREM World

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-8-8 @ SAEREM World

TABLE OF CONTENTS

Preface

Editorial Note

Table of Contents

Acknowledgement

Dedication

Part one: The Concept of Climate Smart Agriculture (CSA)

Chapter One

Climate-Smart Agriculture (CSA) in Nigeria: An Examination of Successful Interventions, Challenges and Future Opportunities

**** Okwor, Uchechi Mercy¹, Ajuonuma, Edima Fidelis², and Oparaojiaku, Joy Obiageri³**

^{1,2,3} Department of Agricultural Extension, University of Agriculture and Environmental Sciences, Umuagwo

Chapter Two

Climate Smart Cropping Systems: Pathways to Agricultural Resilience and Environmental Sustainability

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-8-8 @ SAEREM World

Macsamuel Sesugh Ugbaa¹² and Christopher Oche Eche¹²

*Department of Environmental Sustainability, Joseph Sarwuan Tarka University Makurdi (formerly known as Federal University of Agriculture Makurdi) **Institute of Procurement, Environmental and Social Standards, Joseph Sarwuan Tarka University Makurdi (formerly known as Federal University of Agriculture Makurdi)

Chapter Three

Influence of Genotypes, Trash Mulching, and Weed Control Methods on Sugarcane (*Saccharum officinarum* L.) Productivity under a Changing Climate in the Southern Guinea Savanna of Nigeria

¹Bassey, M.S, ²Shittu, E.A* and ³Elemi, E.D

¹National Cereals Research Institute, P.M.B 8, Bida, Nigeria, ORCID: 0000-0002-9345-1112

²Department of Agronomy, Bayero University Kano, P.M.B 3011, Kano State, Nigeria
ORCID: 0000-0003-0639-009X

³Department of Crop Science, University of Calabar, Cross River State, Nigeria, ORCID: 0000-0002-8513-7457; seabarhm.agr@buk.edu.ng +2348024695219

Chapter Four

Climate Change and Adaptation Management Practices In Crop And Animal Production.

Idris, Rakiya Kabir and Suleiman, Akilu

Chapter Five

Climate-Smart Agricultural Extension: Strategies for Enhancing Farmers' Adaptation to Climate Change

¹Mbube, Baridanu Hope, ²Ameh, Daniel Anone & ³Kolo, Philip Ndeji
Federal College of Land Resources Technology, Kuru, P.M.B. 3025 Jos Plateau State
Department of Agricultural Extension and Management Technology
Email: hopenmbube@gmail.com & baridanu.mbube@fecorlart.edu.ng

Chapter Six

Influence of Climate Change and Soil Characteristics on the Performance of Upland Rice Varieties in the Kagoro Area, Kaduna State, Nigeria

Elisha Ikpe¹, Iliya Jonathan Makarau², Patrick Adakole John³

¹Department of Geography, Federal College of Education, Odugbo, Benue State

²Department of Geography and Planning, University of Jos, Plateau State

³Department of Agriculture, Federal College of Education, Odugbo, Benue State

elishaikpe@fceodugbo.edu.ng; Mobile: +2348065665954

Part Two: THE CONCEPT OF FOOD SECURITY

Chapter Seven

Climate-Smart Agriculture and Aquatic Toxicology: Balancing Food Security and Ecosystem Health

Victoria Folakemi Akinjogunla^{1*} and Aishat Ayobami Mustapha²

¹Department of Fisheries and Aquaculture, Bayero University Kano

²Department of Soil Science, Bayero University Kano.*vfakinjogunla.faq@buk.edu.ng

Chapter Eight

Empirical Evidence of Covariate Shocks and Lower Scale Agricultural Risk Interlock in Farming Systems Resilience

Sesugh Uker¹, Muhammad B. Bello² and Aminu Suleiman²

Institute of Food Security, Federal University of Agriculture Makurdi-Nigeria¹

Department of Agricultural Economics, Bayero University Kano-Nigeria²

Chapter Nine

Influence of Different Irrigation Regimes and Intervals on Mineral Content and Yield of Cucumber (*Cucumis sativus* L)

*^aIgbojionu, D.O., ^bIgbojionu, J.N.

^a*Department of Agricultural & Bio-environmental Engineering Technology,
Federal College of Land Resources Technology, Owerri, Imo State*

^b*Department of Soil Science & Technology,
Federal College of Land Resources Technology, Owerri, Imo State, Nigeria*

**a Corresponding author email: igbojionudonatus@gmail.com*

Chapter Ten

Integrating Agroforestry and Forest Gardens into Urban Greening for Food Security in Nigeria

Dr. Ogunsusi, Kayode

Department Of Forestry, Wildlife And Environmental Management, Olusegun Agagu
University Of Science And Technology, Okitipupa, Ondo State, Nigeria

Chapter Eleven

Climate Smart Agriculture, Food Security and Sustainable Development: Homegarden Agroforestry Perspective

*Eric, E.E., ** Ejizu, A.N. and *Akpan, U.F.

*Forestry Research Institutes of Nigeria, Ibadan, Swamp Forest Research Station Onne, Rivers State, Nigeria.

**Forestry Research Institutes of Nigeria, Ibadan, Federal College of Forestry, Ishiaghi, Ebonyi State, Nigeria.

*Corresponding author: estydavies@gmail.com

Chapter Twelve

Impact of Information Communication Technology (ICT) on Revenue Generation in Jalingo Local Government Area, Taraba State- Nigeria.

John Baling Fom, PhD¹ and Atiman Kasima Wilson, PhD²

Department of Political Sciences, University of Jos.

Department of General Studies, Federal Polytechnic, Bali

Chapter Thirteen

Role of Climate-Smart Agriculture in Addressing Challenges of Food Security and Climate Change in Africa

¹KAPSIYA JOEL*, ¹PETER ABRAHAM, ¹ADAMU WAZIRI, ¹DUNUWEL MUSA DANZARIA

¹*Department of Horticultural Technology, Federal College of Horticulture Dadin-kowa Gombe State Nigeria, *Corresponding author: jkapsiya.hort@fchdk.edu.ng*

Part Three: THE CONCEPT OF SUSTAINABLE DEVELOPMENT

Chapter Fourteen

The Political Economy of Renewable Energy Transitions: Implications for Fisheries

Victoria Folakemi AKINJOGUNLA^{1*} and Charity Ebelechukwu EJIKEME²

¹Department of Fisheries and Aquaculture, Bayero University Kano, Kano State, Nigeria.

²Department of Biology, Federal College of Education (Technical), Akoka, Lagos, Nigeria.

*vfakinjogunla.faq@buk.edu.ng

Chapter Fifteen

Sustainable Agriculture Practices in the Face of Climate Change

Fakuta, B. A, Ediene, V. F and Etta, O. I.

Faculty of Agriculture, University of Calabar, Calabar, Nigeria

Corresponding author: email balthiya1@gmail.com

Chapter Sixteen

Assessing the Challenges of Implementing Climate Change Adaptation Practices in Agricultural Communities of Benue State, Nigeria

Elisha Ikpe¹, Ugbede D. Omede² and Patrick A. John²

¹Department of Geography, Federal College of Education, Odugbo, Benue State

²Department of Agricultural Science, Federal College of Education, Odugbo, Benue State

Email: elishaikpe@fceodugbo.edu.ng

Chapter Seventeen

Climate Smart Agriculture

Muhammad Usman Mairiga

College of Agriculture and Animal Science

Ahmadu Bello University, Mando Kaduna

Chapter Eighteen

Climate Change and Food Production Threats in Nigeria: A Call for Action

Paul Temegbe Owombo

Department of Agricultural Economics and Extension, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria; owombopaul@gmail.com

Chapter Nineteen

Evaluating the Impact of Climate Change on Weed Dynamics, Sugar Quality, and Performance of Sugar cane hybrid clones in a Nigerian Savanna

¹Shittu, E.A*, ²Bassey, M.S, and ¹Buhari, F.Z

¹Department of Agronomy, Bayero University Kano, P.M.B 3011, Kano State, Nigeria
ORCID: 0000-0003-0639-009X

²National Cereals Research Institute, P.M.B 8, Bida, Nigeria ORCID: 0000-0002-9345-1112

*Corresponding Author email: seabarahm.agr@buk.edu.ng

Chapter Twenty

Integrating Crop Farmers Adaptation Strategies Against Climate Change In Ondo State, Nigeria

Emmanuel Olasope Bamigboye and Lateef Ayodeji Ola

Chapter Twenty One

Climate Change Mitigation Strategies Adopted by Palm Wine Tappers in Akwa Ibom State Nigeria

Eteyen Nyong and G. E. Okon

Department of Agricultural Economics, Akwa Ibom State University, Nigeria

eenyong16@gmail.com

Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It eschews pedantry and lays bare the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agriculture, Food Security and Sustainable Development** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate smart agriculture (CSA) food security, Sustainable Development issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate smart agriculture, food security, and sustainable development necessary in policy making process that will stimulate increase in food production and environmental sustainability.

Climate Smart Agriculture, Food Security and Sustainable Development: Global Issues & Local Perspectives is organized in three parts. Part One deals with The Concept of **Climate Smart Agriculture**, Part Two is concerned with The Concept of **Food Security And** and Part Three deals with the Concept of **Sustainable Development**

Eteyen Nyong; October 2025

Chapter Eight

Empirical Evidence of Covariate Shocks and Lower Scale Agricultural Risk Interlock in Farming Systems Resilience

Sesugh Uker¹, Muhammad B. Bello² and Aminu Suleiman²

Institute of Food Security, Federal University of Agriculture Makurdi-Nigeria¹

Department of Agricultural Economics, Bayero University Kano-Nigeria²

Table of Content

1. Introduction

Empirical Method

Influence of Market Prices Fluctuation on Food Farming Systems

Extreme Weather Events as Integral Aspect of Covariate Shock

Farm Exit Factors Associated Lowe Scale Agricultural Resilience

2. Discussion and Global Context

Market Price Fluctuation as a Deterrent to Building Resilient Food System

Food Insecurity and Gender Disparity as an Intricate of Covariate Shock Associated Lower Scale Agricultural Risk

Dynamic Capabilities of Farmers in the Phase of Covariate Shocks

3. Policy and Decision-Making Measures for Averting Covariate Shocks Associated with Lower Scale Agricultural Risks

4. Conclusion

Introduction

Building farming systems resilience both at the household and farm levels would involve addressing several challenges experienced by farmers in the production and markets spaces. Without an understanding of how to build lower scale agricultural resilience at the farm and household levels which remains the bedrock of livelihood decision whilst also serving as a connector for the management of both social and physical resources (Wang *et al.*, 2021), it is difficult to create effective long-term management plans for agricultural development, and to assess the consequences of future environmental changes on different food production systems, and on farmer livelihoods in general (Duncan *et al.*, 2017). The information gap in terms of the cost implication of disaster impacts on agricultural livelihoods and food security of affected

population or local farming communities needs to be addressed by mobilizing proactive implementation partners with the needed financial resources towards disaster risk reduction of the agricultural sector so as to enhance local action and build resilience of the most vulnerable, which are often also the most food insecure (AU 2021 and FAO 2015).

Researchers have particularly stressed the importance of rebuilding post-disaster social relations, and that reconstruction should not only focus on restoration but should also improve resilience to deal with potential future disasters (Wilson *et al.*, 2018). Considering that farming systems overall are experiencing unmatched difficulties and risk outcomes, strikingly environmental change, heightened disasters, soil degradation, and shortages of farming assets. These difficulties have brought about limited diversity and reduced productivity, hence obstructing progress toward attaining some of the sustainable development objectives of ending hunger and improving livelihoods (Tao *et al.*, 2023). Risk associated with farming systems according to Komareka *et al.*, (2020) can result to covariate or idiosyncratic shock. This inherently involves adverse outcomes, including lower yields and incomes; and can also involve catastrophic events, such as financial bankruptcy, food insecurity and human health problems. Farmers therefore cope simultaneously with and manage multiple risks that can have compounding effects. Thus, risk outcomes can have cascading effects.

Going by the categorization of these risks, the lower scale (production risk, and market risk) and upper scale (unexpected change in government policy) agricultural risk intertwined to worsen the outcome experience. Specifically, covariate shocks occasioned by production and market risks can exacerbate lower-scale agricultural risks as such, they can interact, leading to compounding effects. For instance, a region hit by a covariate shock like a hurricane may also experience increased pest infestations in the aftermath due to the disruption of ecosystems and agricultural practices. Campbell (2021) also reported the interaction between lower scale risk as increase in growing temperature also led to the proliferation of pest such as coffee berry borer resulting to annual consequential crop damage among farmers.

Shocks are classified as either idiosyncratic or covariate (Nguyen *et al.*, 2018, Nguyena *et al.*, 2020). Idiosyncratic shocks are household specific and are uncorrelated with shocks to other households in a community, whereas; covariate shocks adversely affect a group of households at a time in a community (Nguyen *et al.*, 2018). Rural households are frequently hit by these shocks severely and in different forms causing setbacks in forms including illness, injury or unemployment of household members as applicable to idiosyncratic shocks or across households within a community (e.g. village) such as floods, droughts or epidemics as applicable to covariate shocks (Nguyena *et al.*, 2020). The combination of these risk factors affects farmers' economic ability and as a consequence the farming and food systems, food security and wellbeing is dwindled.

Often it is not the magnitude of a single event which determines whether a 'disaster' is considered to have occurred but a combination of circumstances, including conflict, poverty and environmental degradation, the protracted legacies of past events, or a cascade of events caused by interdependencies in a system, which have affected the capacity of a community to respond or recover (Wilson *et al.* 2018). Mondal *et al.*, (2023) infers that, despite the potential contribution of resilience thinking to lower scale agricultural risks that have direct implications on farmers and their livelihoods, the theoretical idea of resilience and its operationalisation remain under-explored. To address these challenges, strengthening agricultural resilience in the face of multiple risk is highlighted (Tao *et al.* 2023). The compounding effects of these risks may affect decisions and outcomes at scales well beyond the farmer or their household.

Empirical Method

Through a comprehensive literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A thorough examination of 217 agricultural resilience research articles was undertaken, with specific attention to covariate shock indicators for assessing agricultural risk at a lower scale. Findings were synthesized from peer-reviewed journal publications, following a literature matrix that was devised to streamline the selection process using key terms including agricultural resilience, covariate shocks, agricultural risk, and food system resilience.

After rigorous screening, 89 articles were chosen for further analysis. To operationalize the concept, an overview of covariate shocks and lower scale agricultural risk was provided, and an analytical framework consisting of five criteria including uncertainties, covariate shocks, scalar relationships, and temporal dynamics was applied. These criteria were based on Guedegbe *et al.*'s (2023) view on definition of resilience, which considers the economic unit, nature of shock, and development outcome as key aspects of resilience discourse.

Influence of Market Prices Fluctuation on Food Farming Systems

One initial cause of the 2007/08 world food price crisis was an interlock of production risk and severe droughts, but the impacts of the ensuing price spikes were exacerbated by some governments policies which was directed towards imposing export restrictions. During this crisis farmers faced production risk, market risk, and institutional risk all within a short period (Komareka *et al.*, 2020). Labour markets in low and middle-income countries are arguably more volatile than those in high-income countries; economic crises due to periods of rapid inflation, cycles of election violence, energy shortages, disease outbreaks, and extreme weather events are shockingly common. Underpinning this volatility is widespread acknowledgment and documentation of gender gaps in labour markets (Hardy *et al.* 2023). Rural households lead a more sedentary life and typically practice some form of seasonal or permanent crop production

alongside animal production and therefore interface more with food markets more regularly (Hussein *et al.* 2021). Similarly, Nakamura *et al.*, (2020) infer the availability of all-weather feeder roads, or rural roads, as prerequisite to raise living standards in poor rural areas by reducing transport costs between villages and markets and thereby generating market activity, affecting input and output prices, and enhancing agricultural production through the increased use of modern technologies and the changes in crop choice.

In the wake of significant volatility of global food prices and concerns about future global food security, there is renewed debate about the role and potential of smallholder production in the developing world (Eakin *et al.*, 2015). The growing number of studies that focus almost exclusively on the link between weather variability and crop yields provide only marginal increases in knowledge and by only studying one risk we only gain an inadequate picture of all the types of risk farmers encounter. The implication of this argument is that analyses of multiple concurrent sources of risks are likely to generate more useful insight (Komareka *et al.* 2020). Affirmatively, Droughts generate long-term social, economic and environmental impacts, affecting many people and regions, with about half of the world's land area at chronic risk of drought. While the influence process of drought is slow to materialize, it can cover extensive areas and last for many years, with devastating impacts on the agriculture sector, the environment and water management (Elusma *et al.*, 2022). In addition, the COVID-19 pandemic continues to impact global food supply chains, and black swan events such as the Russia-Ukraine conflict that have led to higher commodity prices and food shortages, and increasingly volatile, complex, and globally interconnected challenges are impacting human wellbeing (Tao *et al.*, 2023). These various nexus infers some critical interphase farmers can use as triggers to build their resilience in the phase of uncertainties.

Extreme Weather Events as Integral Aspect of Covariate Shock

Droughts for instance, have enduring consequences on social, economic, and the environment, aspects of farmers wellbeing which may have lasting effects on food production systems and the population. Approximately half of the world's land is consistently exposed to drought risk. Although the development of drought takes time, it can encompass vast regions and persist for extended periods, resulting in severe repercussions for agriculture, the environment, and water management (Elusma *et al.*, 2022). Farmers are traditionally caught with multiple risks related to climate, market fluctuations, financial challenges, and institutional changes leading to multi-vulnerability. Therefore, when we exclusively examine just one risk factor, we obtain an incomplete understanding of the full range of risks that farmers confront. In essence, studying only one risk does not provide a comprehensive view of the multifaceted challenges farmers must contend with.

Droughts have also been reported by Pourzand *et al.*, (2020) as the most damming covariate shock affecting agricultural livelihood world over. They inferred that the consequence of drought on livestock farming may lead to increasing expenditures on feed supplements for their livestock and consequent reduction in farm productivity and profitability, all due to reduced amounts of forage. As a consequence, farmers generate less income, diminishing their ability to service debt, and they may find it more difficult to replace capital items (e.g. machinery) and invest in recovery. Increased exposure to climate-change risks have disrupted agriculture supply chains and threatens food security. An estimated annual post-harvest loss of around 10% of value of domestic production due to the lack of adequate power supply, storage, transportation, and irrigation infrastructure has been reported by Villacis *et al.*, (2022) in Nigeria as a developing economy. Similarly, extreme climatic events such as precipitation extremes, storms, ocean surges, droughts and floods have been increasingly observed with extensive reoccurring peak flooding impact experienced in the north-central and coastal states between the period of September and mid-October every year as reported by Amaechina *et al.*, (2022) in Nigeria which indicates the impact climate change possess on sub-Saharan Africa.

Climate variability induced by high temperature, erratic rainfall regimes, (Amaechina *et al.*, 2022, Andatia *et al.*, 2022, Song *et al.*, 2018, Issahaku and Abdulai 2020) coupled with low adoption of modern technologies (Issahaku and Abdulai 2020) continues to be a major challenge to achieving sustainable food systems (Song *et al.*, 2018, Issahaku and Abdulai 2020) especially in Sub Saharan Africa (Issahaku and Abdulai 2020, Villacis *et al.*, 2022). The ability of households to insure against such vulnerabilities is limited by the inefficiency of insurance markets in the region and other developing countries (Akampumuza and Matsuda 2016). These climatic extremes affect ecosystem functioning, water availability, crop production, hence, food security of masses (Hossain *et al.* 2019). Weather shocks often disrupt food flows from rural areas to urban areas and result into reduced food security.

As climate change remains a global challenge as extreme weather conditions are becoming more prevalent and agricultural seasons are becoming increasingly unpredictable. These shocks often reduce crop yields and food consumption, threatening food security especially among smallholder farming communities in developing countries. Climate change has been predicted to significantly and negatively affect productivity and efficiency of farming systems in low income countries. Climatic extremes damage crop farming causing a decline in the overall farm outcomes (Hossain *et al.* 2019) hence, the need to build resilience at the lower scale.

However, resilience cannot be built without understanding the root cause of shock and why it is needed in the first place. The development resilience approach explicitly emphasizes the importance of mitigating negative shocks because such shocks can dramatically alter the trajectories of low-income households in dynamic models with one or more thresholds (Yao *et*

et al., 2023). The working or applied definitions of resilience all have three common primary components: (1) economic unit considered (e.g., individual, household, or community), (2) type of shock investigated (e.g., natural disasters, armed conflicts, economic crises), and (3) development outcomes of interest (e.g., poverty, food security, and land expansion) (Guedegbe *et al.*, 2023). The ability of a household livelihood to function and persist after disturbances is determined by not only adaptive capacity, but also the extent of exposure and its resistance or sensitivity to disturbances (Wang *et al.*, 2021).

Considering that the afore attributes are not homogeneously applicable to the respective farming systems the farmers belong to due to individual resource base variations, measures must be developed to cross cut the individual abilities of farmers in understanding this normative concept. Walelign *et al.*, (2016) affirms that, households in developing countries especially in the rural areas are heterogeneous: their socio-economic characteristics and asset endowments differ as do their allocation of assets to income-generating activities. Further, rural households characterised by low incomes and high levels of dependence on agriculture are especially vulnerable to income shocks (Nguyen *et al.* 2018) as such, their resilience to these outcomes are of paramount importance.

Farm Exit Factors Associated Lower Scale Agricultural Resilience

Climate change is closely correlated to food insecurity. Poor households often cannot cope with shocks and this makes them more exposed to a loss of food security; quite often they need to adopt risk management strategies that can compromise their future income generating capacity (that is, assets smoothing). (d'Errico and Di Giuseppe 2018). Climate change is another factor that is predicted to increase the rate of farm exit over time in some areas, because of its effect on the severity and frequency of drought and changing rainfall patterns (Wheeler and Zuo 2017), Similarly, the 2019-20 bushfires experienced in Australia which claimed the lives of 33 people and over 3 billion animals; and the 2019 Monsoon event in Far North Queensland which killed more than 500,000 head of cattle. These events caused significant damage to critical infrastructure: roads, water, energy, and telecommunications including mobile, broadband, landline, and radio networks (Marshall *et al.* 2023). Indicating modern aspect of covariates shocks linked to technology adoption that may constitute similar challenges experience by climate variability and market changes.

The pressure to sell the farm may be highest during times of crisis periods such as drought (due to difficulties in farming, increase in costs and debt, availability of exit packages). But, at the same time, the presence of drought makes it less attractive to leave farming because the property market is often depressed (Wheeler and Zuo 2017). Critical scholarship on the intersection of development pathways and climate change responses highlights the roles of

power, agency, social difference, intersecting inequalities, and social justice in shaping people's resilience in a rapidly transforming world (Tschakert *et al.*, 2023).

This focus entails attention to the ways diverse stakeholders, ranging from individuals and communities experiencing marginalisation to influential corporations, share power in decision-making processes over adaptation and mitigation trajectories, disaster risk reduction, societal transformation, and the numerous contestations along the way. Multiple interlocking capitals which has been researched to enable coping and adaptation to mitigate loss and withstand damage has received criticism for not building anti-capitalist ethics, networks, and relationships that protect individuals where asset holdings and distributions might fail or be inadequate (Shah *et al.*, 2017). Net farm exit is associated with negative impacts on farming communities, as the loss of farmers leads to decreased community income, decreased education and health services, and continuing depopulation (Wheeler and Zuo 2017).

Case Studies and Global Context

Market Price Fluctuation as a Deterrent to Building Resilient Food System

Inconsistent commodity market price as an intricate of covariate shock hinders lower scale agricultural resilience and it has a significant effect on food systems that influences livelihood decisions. Furuoka *et al.*, (2023) examines the connectedness of energy and agricultural commodities using time-varying parameter vector auto regressions where they revealed that energy prices have significant explanatory power for the upward trend in agricultural and food price volatility. They acknowledged spillover effects, volatility, and the interconnectedness of commodity markets during global crises. Heltberg *et al.*, (2014) further described the impacts of food, fuel, and financial crises during 2008–2011. Their research uncovers hardships behind apparent resilience, highlighting gender and age differences in coping responses in their study on aggregates qualitative field research from 17 developing countries. There are emphases on the importance of informal safety nets and the need for better formal systems for coping with future shocks that affects food systems.

The short-term impacts of tropical storms on food prices as examined by Bao *et al.*, (2023) found that tropical storms lead to a 2.3% increase in food prices in developing countries including China, mainly on fresh vegetables, with limited evidence of demand-side shocks. Contrary, Gnutzmann *et al.*, (2019) investigates the resilience of syndicated markets, specifically focusing on the potash industry controlled by a syndicate. The study suggests that syndicates, by assigning market share based on production capacity, incentivize excess capacity investment, leading to market resilience against extreme events. The potash industry, despite capacity shocks from mine disasters shows resilience with no production shortfalls or price response. The approach of maintaining stable production levels and prices through mechanisms such as

market share allocation based on production capacity when employed in agricultural foods systems may prove to be a valuable innovation in building food system resilience but the resources to maintain such production levels may still remain a challenge in the developing countries due to under developed market share mechanisms and epileptic incentives available to the agricultural sector.

In a different context, Valdes and Jara-Rojas (2020) analyses the impact of shocks in copper prices on the economies of major copper-producing regions in Chile. Proposes a two-step method to estimate long-term copper prices and uses a general equilibrium model to simulate the effects of price cycles on regional economies. The study by Bao *et al.*, (2023) highlights the supply-side shock to the transportation and distribution system. Gnutzmann *et al.*, (2019) highlights the resilience of markets under syndicates but does not delve into potential drawbacks or challenges associated with this model. Further research could explore the long-term implications and potential downsides of relying on syndicates for market resilience.

Gnutzmann *et al.*, (2020), He *et al.*, (2021), and Hadachek *et al.* (2023) focus on market resilience but in different contexts (potash industry disasters, flash events in futures markets, and food supply chains under extreme events). A gap exists in understanding the specific mechanisms that contribute to market resilience, especially in different industries and under various extreme events or covariate shocks. There's a need for more research on the long-term impacts of external shocks on markets, agriculture, and food supply chains. Stevens and Teal (2023) examines the resilience of small and medium-sized firms in the U.S. agrifood supply chain to negative market shocks, particularly during the COVID-19 pandemic. The study evaluates the impact of vertical and horizontal diversification on firms' resilience, finding that vertical diversification decreases resilience, while horizontal diversification increases it. Reasonably this connotes that when risk is spread across different food systems as presented by vertical diversification there is more sustainability of building farmers' resilience irrespective of their enterprises.

The impact of the COVID-19 crisis on garment-making-firm owners in a Ghanaian district capital as investigated by Hardy *et al.*, (2023) finds that 80% of both male- and female-owned firms were operational by July 2020, but persistent closure is influenced by gender, with female-owned firms negatively selected on pre-pandemic sales. Stevens and Teal (2023) and Guedegbe *et al.*, (2023) both examine the resilience of economic entities (firms and households) in the context of the COVID-19 pandemic. Stevens and Teal (2023) focus on business resilience, while Guedegbe *et al.*, (2023) explore the resilience factors affecting farm and nonfarm incomes.

Stevens and Teal's (2023) examination of firms' resilience to market shocks, especially during a pandemic, aligns with the broader discussion on the resilience of coffee farmers in the context of socio-ecological changes discussed by Campbell (2021). Both highlight the importance of

understanding and strengthening adaptive capacities in the face of external challenges. Hardy *et al.*, (2023) and Stevens and Teal (2023) also contribute to the broader discussion on resilience, with Hardy *et al.*, (2023) exploring the resilience of garment-making firms during the COVID-19 crisis, complementing Stevens and Teal (2023)'s focus on small and medium-sized agrifood firms. Emphasis on the differential impacts based on gender and sector based resilience is highlighted in this finding which recognises the critical importance of adaptive capacities in enhancing resilience across various sectors facing external challenges, such as market shocks and socio-ecological changes. Additionally, there is an acknowledgment of the differential impacts of these challenges, including gender and sector disparities, highlighting the need for targeted interventions and support mechanisms to build resilience effectively.

The compatibility between market systems interventions and climate resilience, as studied by Kuhl (2018), poses challenges that require further exploration. Market systems interventions contribute to climate resilience but face tensions due to differing goals, target audiences, and approaches as presented by Kuhl (2018) who used the Feed the Future program as a case study in Ethiopia and Honduras. Morton (2020) discusses the potential impacts of COVID-19 on agriculture and agricultural trade in developing countries. Adopts a conceptual framework focusing on susceptibility, resistance, vulnerability, and resilience. This framework allows for formulating key questions related to the impacts of the pandemic on agriculture and rural livelihoods that if answered properly, could enhance resilience in several contexts.

Nordhagen *et al.*, (2021) and Kansime *et al.*, (2021) both focus on the impacts of the COVID-19 pandemic. The former assesses disruptions in agri-food Micro, Small, and Medium-sized Enterprises (MSMEs) globally, while the later explores household-level impacts in Kenya and Uganda. Sage (2013) discusses challenges in the global food system, including rising energy costs, climate change, and mal-consumption. Arguing against a productivist strategy and emphasizes the need to address the dominance of powerful economic interests in the global food system. Nordhagen *et al.*, (2021) investigates the impact of the COVID-19 pandemic on agri-food MSMEs in 17 countries. Findings reveal significant disruptions, decreased sales, and changes in production and pricing, with implications for food system resilience.

Exploring the resilience of markets to disasters using the example by Gnutzmann *et al.*, (2020) of potash mine disasters. Syndicates, a form of legal cartel, may contribute to market resilience by insulating it from external price control. The study focuses on the potash industry and observes market resilience despite significant capacity losses. He *et al.*, (2021) in their research, analyses the resilience of corn and lean hog futures markets during "flash events" associated with large intra-day price changes which found little evidence of liquidity provision fragility during these events; suggesting that active market making contributes to market stabilization. Hadachek *et al.* (2023) investigates the resilience of food supply chains under extreme events,

simulating the impact of various policy proposals. Policies like antitrust enforcement, subsidization of processing capacity entry, prevention of price spikes, and diversification have differing effects on resilience and economic welfare.

Food Insecurity and Gender Disparity as an Intricate of Covariate Shock Associated Lower Scale Agricultural Risk

Food insecurity has tendencies of triggering other forms of shock including those resulting from violent conflict, theft and even low production thus affecting food systems. Husain *et al.*, (2022) examines the impact of the COVID-19 lockdown on dietary practices among women and children in Bihar, India. The study finds a deterioration in women's dietary practices, with ownership of ration cards and political contacts mitigating the crisis's effects. Hardy *et al.*, (2023), Tabe-Ojong *et al.*, (2023), and Husain *et al.*, (2022) collectively highlight the impact of the COVID-19 pandemic on different sectors including garment-making firms, food security, and dietary practices in Ghana, Africa, and India, respectively. Hardy *et al.* (2023) underscores the differential impact of the COVID-19 crisis on female-owned firms compared to male-owned firms. This echoes the broader theme of differential impacts based on gender and occupation. Addressing powerful economic interests in the global food system, pointing to a broader deficit research on the socio-political dimensions influencing food system dynamics identified in research by Sage (2013).

The impact of exposure to drought, flood, and pests on household consumption expenditure in the Teso sub-region of Uganda as analysed by Akampumuza and Matsuda (2016) reveals that weather shocks reduce consumption, particularly among female-headed households, leading to coping strategies such as non-farm employment and borrowing. Gahi *et al.*, (2020) suggests a need for gender-inclusive strategies, flood control mechanisms, and a standardized monitoring system. Hirvonen *et al.*, (2021) studies food security and consumption during the COVID-19 pandemic in Ethiopia. Despite income shocks, food consumption and dietary diversity remain largely unchanged or slightly increased. The study questions the adequacy of subjective income measures in reflecting the magnitude of shocks and suggests resilience in food value chains. Akoko *et al.*, (2019) examines food security strategies in a rapidly urbanizing area, Bolifamba-Buea, Cameroon. The study reveals a complex and diverse food security situation, with households facing challenges in maintaining a steady supply of adequate food. It emphasizes the need to understand urban household food environments and their outcomes.

Akoko *et al.*, (2019) raises awareness of the complex and diverse nature of urban food security but does not delve deeply into specific strategies. Future research could focus on developing effective strategies for ensuring food security in rapidly urbanizing areas. McArthur and Sachs (2019) constructs a model to explore the impact of foreign aid to agriculture on economic growth in Africa, using Uganda as an illustrative case. The model considers soil nutrient variation, minimum subsistence consumption, and other factors. Simulation scenarios demonstrate the

potential positive impacts of targeted aid on rural productivity and wages. Wang *et al.*, (2021) and McArthur and Sachs (2019) both focus on interventions such as foreign aid to agriculture and their consequences, with Wang *et al.* emphasizing unintended effects and the role of social networks, while McArthur and Sachs explore the potential economy-wide impacts of foreign aid in the context of soil nutrient variation.

While there is a focus on farm and nonfarm incomes and business resilience, the interconnectedness of these aspects and potential spillover effects on broader economic systems could be explored in future research as this was not exhaustive in the research by Guedegbe *et al.*, (2023) where they investigated the short-term impacts of COVID-19 containment measures on farm and nonfarm incomes of agricultural households in Nigeria. The study though highlights the mixed effects of these measures on incomes, emphasizing the role of resilience and vulnerability factors such as land size, wealth, income diversification, and reliance on hired labour.

Analyses by Haile *et al.*, (2022) on resilience capacity index and its effect on food and nutrition security in Ethiopia, focused on the twin-track approach of harmonizing humanitarian and development interventions. The study identifies assets ownership, access to social services, and adaptive capacity as core elements of resilience, emphasizing the need for comprehensive policies to reinforce resilience capacities. Birthal *et al.*, (2015) highlights improvements in adaptive capacity but does not delve into the specific mechanisms that contribute to these improvements, leaving room for more detailed exploration.

Haile *et al.*, (2022), Heltberg *et al.*, (2014), and Sinha *et al.*, (2022) all consider the impact of external shocks (pandemics, crises) on different aspects of resilience, such as food and nutrition security, coping strategies, and equitable resilience among marginalized communities. Sinha *et al.*, (2022) Explores the concept of 'equitable resilience' in the context of migrant workers from Scheduled Tribe or Adivasi communities in Bihar, India, amidst the COVID-19 pandemic. The study argues for a robust idea of resilience that considers social structures of power and subjectivities, emphasizing the need for lasting change through policies addressing structural conditions of inequality. Haile *et al.*, (2022) and Heltberg *et al.*, (2014) both highlight the role of assets (including social services and adaptive capacity) as core elements of resilience. Heltberg *et al.*, (2014) also stress the importance of informal safety nets, mirroring the concept of equitable resilience discussed by Sinha *et al.* (2022). The studies collectively emphasize the need for more targeted and region-specific measures, pointing to a potential hole in understanding how localized interventions can enhance resilience in the face of external shocks.

The microeconomic literature on the association between COVID-19 and food insecurity in Africa as researched by Tabe-Ojong *et al.*, (2023) suggests an increase in food insecurity due to COVID-19, and the study discusses coping strategies employed by households to build resilience.

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-8-8 @ SAEREM World

Ferguson and Ubilava (2022) analyses the impact of the war in Europe and the COVID-19 pandemic on cereal prices, testing the resilience of global commodity markets. The study provides historical context and assesses the consequences of the crisis, focusing on low- and middle-income countries.

Household-level food demand for Somalia post-civil war as analysed by Hussein *et al.*, (2021) revealed that, household food consumption is highly sensitive to income shocks, impacting diet diversification. Exogenous income shocks lead to less diversified diets, stressing the importance of improved food security for economic recovery. Examining the experiences of local food producers and meat processors in Iowa, U.S., during the early COVID-19 pandemic period. Nichols *et al.*, (2022) posits that small-scale producers show resilience in adapting to system shocks, but the uneven socio-emotional and economic 'costs' of resilience deserve increased attention in research and policy. The crucial link between food security and economic recovery need to address the unequal socio-emotional and economic burdens associated with resilience efforts in both research and policy making domains.

The association between smallholder farmers' food insecurity during climate shocks in Ethiopia and their subsequent aspiration levels was investigated by Girma *et al.*, (2023) and they found that severe food insecurity during climate shocks is associated with lower aspiration levels. Gutiérrez-Martín *et al.*, (2020) and BIRTHAL *et al.*, (2015) in their respective research, address water-related challenges in agriculture. Gutiérrez-Martín and cohort proposes a water reallocation strategy, while BIRTHAL *et al.*, (2015) explores the impact of droughts on rice production. Wheeler and Zuo (2017) examines farm exit intentions of irrigators in the Murray-Darling Basin, Australia, focusing on the impact of drought and water scarcity. Results suggest that water scarcity impacts farm exit intentions, with poorer-performing farms more likely to intend exit during drought periods. These assertions are similar to that of Pourzand *et al.*, (2020) where they quantify the impacts of droughts on the profitability of dairy, sheep, and beef farms in New Zealand. Droughts have moderate impacts on New Zealand dairy and sheep-beef businesses, with positive effects on revenue and profit for dairy farms attributed to increased export prices of milk solids.

The implications of the COVID-19 pandemic on household income and food security in Kenya and Uganda as assessed by Kansiime *et al.*, (2021) indicated income shocks, worsened food security, and dietary quality decline, with vulnerable groups relying on food-based coping strategies. Sage (2013) discusses broader challenges in the global food system, including energy costs, climate change, and mal-consumption. This perspective adds a systemic view, complementing the more specific studies on water management and pandemic impacts. Beckman and Countryman (2021) investigates the impacts of COVID-19 on agriculture, focusing on changes in Food Away from

Home (FAFH) expenditures. Agriculture's changes during COVID-19 had a significant effect on the overall U.S. economy, with a particular emphasis on the decline in FAFH expenditures.

Adong *et al.*, (2021) Explores the consequences of conflict exposure on food consumption in Northern Uganda, finding a reduction in consumption expenditure during post-conflict periods. Adelaja and George (2019) and Kurosaki (2017) both explore the impact of conflict on agriculture, focusing on the Boko Haram insurgency in Nigeria and the aftermath of floods in Pakistan, respectively.

Direct and indirect effects of conflicts have been underpinned by Adelaja and George (2019) to include market impacts on product and input prices. The study finds a significant reduction in total output and productivity due to increased Boko Haram attacks. Kurosaki (2017) however posits the interaction of productive and non-liquid assets in conflict-ridden situations, influencing recovery dynamics.

Further examination could seek to connect these findings to broader global contexts, especially in regions facing similar challenges. Hirvonen, *et al.*, (2021) investigates food consumption and food security during the COVID-19 pandemic in Addis Ababa, Ethiopia providing a contemporary perspective on global crisis. Despite concerns about increased food insecurity, the study finds that food consumption and household dietary diversity remained largely unchanged or slightly increased by August 2020. Bacon *et al.*, (2021) introduces a relational approach to joint assessment of household food and water security, considering climate variability and seasonality. This aligns with the broader systems approach advocated by Kawabata *et al.* (2020) for improving food security in Tajikistan.

Janssens *et al.* (2021), Girma *et al.* (2023), Ansah *et al.* (2023), and Marshall *et al.* (2023) all address the impact of shocks (COVID-19, climate shocks, weather shocks, and natural disasters) on households, economies, and resilience. Ansah *et al.*, (2023) however, went further to examines how resilience capacity mediates or moderates the relationship between weather shocks and household food security in northern Ghana. Resilience capacity is found to moderate the negative effects of heat stress and drought on food security. Ansah *et al.* (2023) and Marshall *et al.* (2023) on the other hand both focus on the role of resilience capacity in mitigating the negative effects of shocks on food security and disaster resilience. Empirical assessments of resilience capacity have been limited in terms of their direct effect on food security, and further research is needed to explore this relationship (Ansah *et al.* 2023).

Dynamic Capabilities of Farmers in the Phase of Covariate Shocks

Resilience capacities, including adaptive and absorptive capacities, are positively associated with dietary diversity. The importance of interventions that enhance overall resilience capacity have been stressed in several research. Manyanga *et al.*, (2022) and Mutyebere *et al.*, (2023) both

address resilience in the context of food security. Manyanga *et al.*, (2022) focuses on resilience capacities in Zimbabwe, while Mutyebera *et al.*, (2023) considers resilience in the adoption of Disaster Risk Reduction measures. Gutiérrez-Martín *et al.*, (2020) introduces a water reallocation strategy, which aligns with the broader theme of resilience and adaptation, connecting with the exploration of the resilience of small and medium-sized agrifood firms in Stevens and Teal (2023). Both studies emphasize adaptive strategies in the face of challenges. Gutiérrez-Martín *et al.*, (2020) proposes a self-financed water bank in closed river basins to reallocate water within the agricultural sector and recover a share for the environment. Simulations in the Guadalquivir River Basin show potential water recovery benefits and increased economic efficiency. Birthal *et al.*, (2015) examines the impact of droughts on rice production in India, highlighting improvements in adaptive capacity due to irrigation expansion and availability of improved varieties, leading to a decline in drought-induced losses.

However, there is a gap in understanding the long-term implications of the proposed water reallocation strategy especially concerning the sustainability and scalability of the approach. These findings recognize the pivotal role of adaptive strategies in fostering resilience across various realms, including agriculture, resource management, and environmental sustainability. It affirms the importance of integrating adaptive approaches into policies and practices to effectively address challenges posed by environmental stressors other temporal dynamics associate with resilience. Additionally, it highlights the need for further research and evaluation to ensure the long-term sustainability and scalability of adaptive strategies in enhancing resilience and mitigating risks.

The focus on shocks, adaptation, and resilience aligns with the broader theme of understanding and addressing vulnerabilities in different sectors. Pourzand *et al.* (2020), Nichols *et al.*, (2022), and Morton (2020) all touch upon resilience and adaptation to shocks. Pourzand explores the resilience of New Zealand dairy and sheep–beef businesses to drought, Nichols assesses the resilience of local food producers during the early pandemic, and Morton discusses resilience in the context of COVID-19. Further examination is required to understand the nuanced socio-emotional and economic costs of resilience for small-scale producers. Nichols *et al.*, (2022) and Morton (2020) contribute to the discussion of the impact of the COVID-19 pandemic on food systems. Nichols focuses on local food producers in Iowa, while Morton provides a conceptual framework to analyse the pandemic's effects on agriculture and rural livelihoods.

Additional research could seek to understanding the long-term effects and recovery strategies in regions affected by conflict, as highlighted in the study by Adelaja and George (2019) and Kurosaki (2017). Kawabata *et al.*, (2020) infers that Tajikistan's food security situation is challenging despite progress in poverty reduction. The paper advocates for a systems approach involving policy interventions from different sectors to enhance access and affordability of

healthy diets, contributing to improved food security and nutrition. Bacon *et al.*, (2017) explores seasonal hunger in Central America, examining its relation to smallholder organizational affiliation, farm characteristics, and coping strategies. Findings indicate correlations between household capacities and shorter periods of seasonal hunger.

Nguyen *et al.*, (2018) explores the coping strategies of Vietnamese rural households in response to severe covariate and idiosyncratic shocks. The study finds support for Asset Smoothing Theory and Complete Market Hypothesis, indicating that households smooth productive assets and consumption against idiosyncratic shocks. Both Tabe-Ojong *et al.*, (2023) and Nguyen *et al.*, (2018) discuss coping strategies in response to shocks as they reported the essence for developing effective strategies for building farmers resilience diverse shocks bot at the household and farm levels. Alem and Tato (2023) explore the links between shocks, particularly the death of a family member, and mental health. Idiosyncratic shocks, especially unexpected deaths, are significantly associated with poor mental health. The study suggests the potential benefits of social support and insurance mechanisms.

Gunther and Harttgen (2009) discuss vulnerability to shocks, while Gahi *et al.*, (2020) highlight vulnerabilities in Burkina Faso's water sector. Both emphasize the need for adaptive strategies and information for resilience. Gunther and Harttgen (2009) discusses the vulnerability of households in developing countries to idiosyncratic and covariate shocks, emphasizing the limitations of static poverty measures in capturing poverty dynamics over time. The study proposes a method to assess the impact of shocks on vulnerability. Akampumuza and Matsuda (2016) discuss coping strategies to weather shocks in Uganda, similar to Gahi *et al.*, (2020), where stakeholders employ diverse options and water control mechanisms to adapt to climate threats. There is a gap in understanding how different sectors and regions cope with and recover from the impact of global crises, such as the COVID-19 pandemic and war in Europe. The need for research addressing the causal relationship between COVID-19, food insecurity, and resilience-building strategies in various contexts could be beneficial.

The research on Tajikistan's food security situation by Kawabata *et al.*, (2020) aligns with the theme of resilience and adaptation in Stevens and Teal (2023), emphasizing the importance of a systems approach and policy interventions for improved food security and nutrition. Bao *et al.*, (2023), Adong *et al.*, (2021), and Temesgen *et al.*, (2022) all examine the impact of shocks, albeit different types (tropical storms, conflict, covariate/idiosyncratic shocks) on food prices, consumption, and household vulnerability. Temesgen *et al.* (2022) investigates household vulnerability to covariate and idiosyncratic shocks in Ethiopia. Covariate shocks have a larger impact on consumption as compared to idiosyncratic shocks. Factors like livestock ownership and asset holding play a role in mitigating vulnerability.

Insights from different sectors and shocks provide a comprehensive perspective on the challenges and strategies for enhancing resilience in economic systems. Bao *et al.* (2023) and Beckman and Countryman (2021) both address external shocks (tropical storms, COVID-19 respectively) affecting food prices and agriculture. This also draws claims from the theme by Stevens and Teal (2023) which contribute to the understanding of resilience and adaptation in various contexts. Azong *et al.*, (2018) brings attention to the gendered nature of vulnerability, linking to the theme of understanding vulnerability and adaptation in rural settings. This aligns with the broader discussion initiated on the impact of various factors on vulnerability and resilience in different contexts.

Marshall *et al.*, (2023) explores the role of telecommunications infrastructure and services in rural communities in responding to natural disasters in rural Australia. The study adopts a socio-technical approach, highlighting both technical and social aspects of digital capability in disaster resilience. Sgroi and Sciancalepore (2022) analyses the competitiveness margins for small farms in developed economies using the Transaction Cost Theory. Cultivation contracts are identified as a valid tool for addressing marginalization problems of small agricultural enterprises. Valdes and Jara-Rojas (2020) and Sgroi and Sciancalepore (2022) explore the impact of shocks on specific economic sectors (copper production and small farms) and propose strategies for addressing challenges. A gap exists in understanding the dynamic nature of aspiration formation and reformation in relation to food insecurity during climate shock periods (Girma *et al.* 2023).

Villacis *et al.* (2022) and Bairagi *et al.* (2021) both focus on the impact of agricultural practices, with emphasizing productivity's role in food security and exploring the adoption of stress-tolerant rice varieties respectively. Villacis *et al.*, (2022) investigation infers that higher agricultural productivity in Nigeria is associated with improved food security indicators, including diversity in diets and reduced limitations in food variety and portion size. Warren *et al.*, (2015) in their exploration of urban agriculture (UA) and food security, dietary diversity, and nutritional status arrived at mixed findings; highlighting the need for a strengthened evidence base before confidently recommending UA as a strategy for improving urban food security.

Smallholder farmers' vulnerability to climate-related disasters in Sub-Saharan Africa is increasing due to land-use changes and poor adoption behaviour for Disaster Risk Reduction (DRR) measures (Mutyebera *et al.*, 2023). The Theory of Planned Behaviour (TPB) is applied to explain adoption behaviour, with Social Information Networks (SIN) playing a moderating role. Results suggest a need to build technical capacity in extension services and informal networks for effective DRR measures. On the other arm, Bairagi *et al.*, (2021) assesses the impacts of adopting submergence-tolerant (Sub1) rice varieties in northwest Bangladesh. Adoption of Sub1

rice is associated with higher yield, profit, and rice consumption. Factors influencing adoption include access to information through neighbours, farmer organizations, and training.

While Alem and Tato (2023) suggest potential mechanisms explaining the links between death of a household member and mental health, further research is needed to confirm causation and explore additional factors. The collective findings contribute to a broader understanding of resilience, shocks, and adaptation across different contexts, providing insights into strategies for enhancing food security and mental health. The studies collectively emphasize the importance of informed interventions and the complementary roles of formal and informal support networks.

The collective research emphasizes the dynamic nature of vulnerabilities and adaptive strategies in the face of climate variability, spanning water resource management, agricultural practices, and household resilience. Each piece contributes to a broader understanding of coping mechanisms and the importance of informed decision-making in the context of environmental and economic uncertainties. Gahi *et al.* (2020) focuses on stakeholder perceptions about agricultural water (AgWater) resource sustainability in Burkina Faso amidst climate variability. While stakeholders are aware of climate impacts, further work in adaptation strategies is required, including a lack of anticipation of climate effects on AgWater and limited hydro-climate services at the farm level. Issahaku and Abdulai (2020) examines drivers of individual and joint adoption of crop choice and soil and water conservation practices in Ghana. Adoption of these practices leads to higher crop revenues and reduced riskiness in crop production. Factors influencing adoption include education, access to extension services, and weather information.

Two models explored by Sgroi (2022) of value creation in mountain social farming, emphasizing the social aspects of social agriculture. Social agriculture integrates production for the market with social functions, promoting social inclusion, health improvement, and community well-being. The study highlights the diversity in social farming models and the principles of solidarity and reciprocity. There is no consensus regarding mainstreaming hydro-climate services at the farm level, particularly for dry-season crops.

In addressing the increasing vulnerability of smallholder farmers in Sub-Saharan Africa to climate-related disasters Mutyebera *et al.*, (2023) applies the Theory of Planned Behaviour (TPB) to explain adoption behaviour for Disaster Risk Reduction (DRR) measures. There's an emphasis on the role of Social Information Networks (SIN) in influencing adoption intentions. Miani *et al.*, (2023) focuses on designing a sustainable livelihood approach in the northern villages of Andar District, Ghazni province in Afghanistan. Highlights the significance of rural industrialization, solar energy, improved housing, and efficient production factors for sustainable livelihood. The study emphasizes the complementary role of social networks, particularly Social Information Networks (SIN), in sharing resources and information in mitigating risk.

Li *et al.*, (2022) and Nicholas-Davies *et al.*, (2021) both touch upon resilience in rural livelihoods. Li *et al.*, (2022) identify capacities that promote resilience, while Nicholas-Davies *et al.*, (2021) explore how farmers respond to challenges through adaptive strategies. The study analyses personal narratives from family farms in five European countries, emphasizing the importance of internal pressures within the family and farming business in driving management changes over time. Wuepper and Sauer (2016) suggest that self-efficacy and social capital are still shaped by historical variables, indicating slow changes or changes only in the absence of policy intervention. Understanding the long-term effects and dynamics of historical factors needs to be studied further.

Nicholas-Davies *et al.*, (2021) highlight the need for more flexible, tailored farm support. This stresses another area in research on developing and implementing adaptive support strategies that consider individual capacities, farm resources, and contextual settings. These studies continue the exploration of factors influencing rural development, resilience, and socio-economic approaches. The emphasis on historical factors, capacities, climate change, and adaptive strategies aligns with the themes explored in the previous pieces. The studies enrich the narrative by providing insights from diverse contexts, interventions, and challenges, contributing to a comprehensive understanding of the dynamics shaping livelihoods and well-being. The collective research reinforces the importance of considering historical, social, and economic factors in designing effective policies for sustainable development.

Policy and Decision-Making Measures for Averting Covariate Shocks Associated with Lower Scale Agricultural Risks

Behavioural aspects that aims towards addressing risk and uncertainty have been researched by Araujo *et al.* (2022) and Mutyebera *et al.* (2023). Araujo focuses on economic behaviours influenced by Prospect Theory, while Mutyebera employs the Theory of Planned Behaviour to understand adoption behaviour for DRR measures, considering social networks. Slijper *et al.*, (2022), discusses the interlinkage of financial and natural frameworks globally, presenting exploration topics in ecological and resource economics that aims to identify key challenges, trends, and research gaps to drive future research in achieving efficient, impartial, and sustainable use of natural resources.

The studies collectively contribute to a comprehensive understanding of decision-making, risk management, and sustainable livelihood. Araujo *et al.* (2022) adds a behavioural economics perspective, Mutyebera *et al.* (2023) integrates social networks into risk management, and Miani *et al.*, (2023) explores sustainable livelihood strategies. Together, these researches enlightens on the economic behaviours, risk mitigation, and sustainable development, forming a cohesive narrative in understanding adaptive strategies in different contexts. Further studies explore the analysis of economic behaviours like ambiguity loving and Prospect Theory in general

equilibrium contexts. Further research could explore the implications and applications of these behaviours in broader economic settings. Mutyebera *et al.* (2023) points out limitations in the Theory of Planned Behaviour (TPB), particularly its failure to account for the intention-behaviour gap. Future research could focus on refining and expanding behavioural theories to better capture the complexities of decision-making.

The studies by Abay *et al.*, (2022), Otchere and Handa (2022), Alik-Lagrange *et al.*, (2023), and Yao *et al.*, (2023) all contribute to the understanding of factors that enhance family resilience, with a focus on social security programs, cash transfers, workfare, and mobile cash. Abay *et al.*, (2022) focuses on the Useful Security Nets Program (PSNP) in Ethiopia, evaluating its impact on rural families' resilience. Findings indicate that PSNP moves, especially when consistent are associated with increased resilience. Combining security nets with income-generating or asset-building activities enhances resilience, suggesting the need for sustained interventions.

Otchere and Handa (2022) on the other hand utilizes the FAO resilience index in a cash transfer assessment in Malawi. They confirmed the index's validity in predicting positive adaptive behaviour and resilience. Unconditional cash transfers significantly increase the resilience index, emphasizing the role of regular and predictable cash transfers in safeguarding consumption and building resilience against future shocks. Yao *et al.* (2023) in their own research, examines the impact of mobile cash on family resilience in Kenya. Mobile cash access increases resilience among families facing severe shocks, indicating its role in helping families stay above the resource poverty line. The study suggests that digital payments have long-term effects on resilience and advises cautious consideration of taxation policies to ensure the technology's potential benefits are not undermined.

Abay *et al.* (2022) suggests that short-term government assistance programs may not be very effective in improving family resilience. This raises an area for further research exploration in understanding the optimal duration and design of social security programs. Alik-Lagrange *et al.*, (2023) evaluates the Londö public works program in the Central African Republic. The program leads to a lasting increase in monthly earnings and a gendered response, with women diversifying income sources and men strengthening agricultural production. The study emphasizes the need to consider gender-specific impacts in assessing the effectiveness of workfare programs. Habimana and Haughton (2022) analyses the impact of Rwanda's anti-poverty program, Vision 2020 Umurenge (VUP), specifically focusing on credit provision. Borrowing from VUP leads to increased livestock, farm input purchases, higher consumption, reduced poverty, and greater secondary school enrolment. The study highlights the program's effectiveness in addressing various aspects of household well-being.

Financial services contribute to poverty reduction by facilitating investments and helping manage financial emergencies. The Global Findex database is highlighted as a tool for

understanding and measuring financial inclusion globally to foster resilience even at the farming household level. Collectively, these studies contribute to the broader understanding of strategies and interventions aimed at improving family well-being, resilience, and livelihoods. The focus on social security programs, cash transfers, workfare, and digital payments forms a cohesive narrative on the diverse approaches to address poverty and vulnerability in different socio-economic contexts. The studies add to a nuanced insight into the effectiveness and sustainability of interventions designed to enhance resilience at the farm and farming household levels. Yao *et al.*, (2023) notes limitations in the study's external validity, emphasizing the need for further research in different contexts to understand the impact of digital payments on farming household resilience.

Both Wang *et al.*, (2021) and Hirvonen *et al.*, (2021) touch upon resilience in different contexts. Wang *et al.*, (2021) discuss the resilience of rural households in response to Payments for Ecosystem Services (PES) interventions, while Hirvonen *et al.*, (2021) highlight the resilience of food value chains during the COVID-19 pandemic. Wang *et al.*, (2021) in their investigation of the unintended consequences of Payments for Ecosystem Services (PES) on the socio-ecological system in China explores the role of social networks in building resilience in response to PES interventions, highlighting the importance of considering both environmental and socio-cultural conservation for rural development. Atkinson and Ovando (2022) explores the significance of land ownership in natural capital accounting, focusing on how ownership affects the distribution of ecosystem services. The study, set in Scotland, emphasizes the importance of private land for certain ecosystem services and raises questions about wealth disparities related to natural capital.

Larsen and Lilleør (2017) investigates the impact of an agricultural intervention on child nutrition in Africa. The intervention, providing smallholder farmers with new technology options, resulted in increased level-for-age measures among children from participating families, indicating improved nutrition. These studies collectively contribute to the broader understanding of interventions and phenomena shaping socio-economic outcomes. The focus on unintended consequences, economic behaviours, resilience, and distributional impacts aligns with the themes explored, providing a comprehensive view of diverse factors influencing development, economic decision-making, and well-being. The studies enrich the ongoing narrative by adding insights from varied contexts and interventions, building on the foundation laid by earlier research.

Bretschger and Pittel (2022) identifies twenty key challenges in environment and resource economics, emphasizing the interconnectedness of monetary and natural systems globally and regionally. The paper aims to guide future research in developing theories, observational applications, and policy strategies for sustainable resource use. Buitenhuis *et al.*, (2020) in their

research also examines the relationship between the Common Agricultural Policy (CAP) post-2020 and the resilience of farming systems, focusing on a Dutch case study. Introduces the Resilience Evaluation Tool (ResAT) to assess how CAP influences vigor, resilience, and variability in farming systems. Buitenhuis *et al.*, (2020) and Knoke *et al.*, (2023) contribute to the understanding of resilience in different systems that could enhance farmers' decision making models.

Knoke *et al.*, (2023) develops an analytical framework to study economic resilience in different forest management systems. The framework focuses on post-disturbance economic recovery as an indicator of resilience. The study compares the economic resilience of continuous cover forestry and clear-fell systems in Central Europe. Marshall *et al.*, (2015) explores the potential impacts of shifting regional water balances on U.S. field crop production under climate change. Examines biophysical and economic impacts, including the effects of irrigation shortages. Considers the adaptability of agricultural systems to changing production conditions.

While Buitenhuis *et al.*, (2020) assesses the influence of CAP on farming system resilience, the broader impact of agricultural policies on resilience remains an open research area. Exploring how different policies affect the adaptive capacity of farming systems is essential. The interconnectedness emphasized by Bretschger and Pittel (2022) resonates with the holistic view presented in previous research. Understanding the interplay between economic, social, and environmental factors is crucial for sustainable development, aligning with the overarching narrative of this study. The exploration of resilience in farming systems (Buitenhuis *et al.*, 2020) and forest management (Knoke *et al.*, 2023) complements the broader discussion on resilience. These studies add depth to the understanding of how diverse systems respond to challenges and the role of policies in enhancing or constraining resilience.

Conclusion

Understanding and tending to the intricacies of market fluctuations as an intricate for managing lower scale agricultural risk is crucial for moderating covariate shocks on food systems and livelihoods. Insights bits of knowledge from research feature the interconnectedness of product markets, the differential effects of shocks on sectors, socioeconomics, and the need for targeted interventions and support mechanisms. Holes in knowledge persist, especially with respect to the particular components driving market resilience and the compatibility between market interventions and climate resilience. Overall, further examination is expected to illuminate compelling approaches and systems pointed toward improving flexibility across different areas notwithstanding developing difficulties.

Drawing from the synthesis of different investigations, the diverse idea of food insecurity and its interconnectedness with different shocks, including violent conflict, climate-related disasters,

and economic crises features the differential effects of covariate shocks on vulnerable populations, including women, children, and marginalized communities, stressing the requirement for gender-inclusive strategies and region-specific interventions. Also, the importance of resilience-building measures to mitigate the adverse effects of shocks on food security, livelihoods, and economic recovery has been emphasized. There is likewise a call for additional examination to extend how we might interpret resilience capacities and their role in enhancing food security and disaster resilience across various settings.

Further examination is expected to understand the long-term implications of adaptive strategies and to ensure their sustainability and scalability. Cross-sector collaboration is vital to draw out vulnerabilities holistically, and tailored support for rural development is crucial for building adaptive capabilities. This will enable policymakers enhance farming and food systems resilience and adaptation across different scales, promoting sustainable development in the face of environmental and economic uncertainties.

Behavioural economics and risk mitigation strategies, may also enhance how we might interpret adaptive behaviours of farmers. The nexus between financial and natural frameworks, featuring key difficulties in adding to shape a strong story that highlights the significance of economic behaviours, social networks, and sustainable livelihood strategies in fostering decision making process for food systems resilience.

Additionally, policy programmes including, cash transfers, and workfare initiatives, demonstrate the multi-layered approaches to enhancing farming resilience. While featuring the viability of certain interventions, such as unconditional cash transfers and public works programs, these studies also underscore the importance of sustained interventions and gender-sensitive approaches. By and large, these examinations add to a nuanced comprehension of strategies for improving resilience across various socio-economic contexts and feature the requirement for additional exploration to address existing gaps and challenges.

Acknowledgement: The authors wish to express their gratitude to the World Bank Centre of Excellence - Centre for Dryland Agriculture, Bayero University Kano-Nigeria for facilitating the dissemination of this research findings.

Reference

- Abay, K. A., Abay, M. H., Berhane, G. and Chamberlin, J (2022). Social protection and resilience: The case of the productive safety net program in Ethiopia. *Food Policy* 112 (2022) 102367.
- Adelaja, A., George, J., Fox, L., Fuglie, K., Jayne, T. (2021). Shocks, Resilience and Structural Transformation in Sub-Saharan Africa. *Sustainability*. 13:13620.

- Adong, A., Kornher, L., Kirui, O. K., von Braun, J. (2021). Conflict exposure and food consumption pathways during and after conflict: Evidence from Northern Uganda. *World Development* 147 (2021) 105636.
- Alem, Y. and Tato, G. L. (2023). Shocks and mental health: Panel data evidence from South Africa. *World Development* 168 (2023) 106270.
- Alik-Lagrange, A., Buehren, N., Goldstein, M. and Hoogeveen, J. (2023). Welfare impacts of public works in fragile and conflict affected economies: The Londö public works in the Central African Republic. *Labour Economics* 81 (2023) 102293
- Akampunguza, P. and Matsuda, H. (2016): Weather Shocks and Urban Livelihood Strategies: The Gender Dimension of Household Vulnerability in the Kumi District of Uganda, *The Journal of Development Studies* 2016
- Akoko, R. M., Monono, E. N. and Pčolinská, L (2019). Urbanization and food security in Buea: an appraisal of household food security situation and resilience in Bolifamba-Buea Cameroon. *International Journal of Modern Anthropology*. 2(12): 173 – 187.
- Andatia, P., Majiwaa, E., Ngigib, M., Mbechea, R. and Ateka, J. (2022). Determinants of adoption of climate smart agricultural technologies among potato farmers in Kenya: Does entrepreneurial orientation play a role? *Sustainable Technology and Entrepreneurship* 1 (2022) 100017.
- Amaechina, E. C., Anugwab, I.Q., Agwub, A.E., Ifeluninic, A.I., Umeonuora, T.G. and Okwor, C. A. (2022). Assessing climate change-related losses and damages and adaptation constraints to address them: Evidence from flood-prone riverine communities in Southern Nigeria. *Environmental Development* 44(2022)100780.
- Ansah, I. G. K., Kotu, B. H., Manda, J., Muthoni, F. and Azzarri, C. (2023). Mediation and Moderation Roles of Resilience Capacity in the Shock–Food–Security Nexus in Northern Ghana. *Ecological Economics* 211 (2023) 107894.
- Ansah, I. G. K., Gardebroek, C. and Ihle, R. (2019). Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. *Food Security* (2019) 11:1187–1203.
- Atkinson, G. and Ovando, P. (2022). Distributional Issues in Natural Capital Accounting: An Application to Land Ownership and Ecosystem Services in Scotland. *Environmental and Resource Economics* (2022) 81:215–241
- Azong, M., Kelso, C. J. and Naidoo, K. (2018). Vulnerability and resilience of female farmers in Oku, Cameroon, to Climate Change. *African Sociological Review*. 22(1):31–53.

- Bacon, C. M., Sundstrom, W. A., Stewart, I. T., Maurer, E. and Kelley, L. C. (2021). Towards smallholder food and water security: Climate variability in the context of multiple livelihood hazards in Nicaragua. *World Development* 143 (2021) 105468.
- Bairagi, S., Bhandari, H., Das, S. K. and Mohanty, S. (2021). Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh. *Food Policy* 105 (2021) 102183.
- Bao, X., Sun, P. and Li, J. (2023). The impacts of tropical storms on food prices: Evidence from China. *American Journal of Agricultural Economics*. 105(2):576–596.
- Beckman, J. and Countryman, A. M. (2021). The Importance of Agriculture in the Economy: Impacts from COVID-19. *American Journal of Agricultural Economics*. 103(5):1595–1611.
- Birthal, P. S., Negi, D. S., Khan, T. and Agarwal, S. (2015). Is Indian agriculture becoming resilient to droughts? Evidence from rice production systems. *Food Policy* 56 (2015) 1–12.
- Bretschger, L. and Pittel, K. (2022). Twenty Key Challenges in Environmental and Resource Economics. *Environmental and Resource Economics* (2020) 77:725–750.
- Buitenhuys, Y., Candel, J. J. L., Termeer, K. J. A. M. and 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 (2020) 314–327.
- Campbell, D. (2021). Environmental change and the livelihood resilience of coffee farmers in Jamaica: A case study of the Cedar Valley farming region. *Journal of Rural Studies* 81 (2021):220–234.
- d'Errico, M. and Di Giuseppe, S. (2018). Resilience mobility in Uganda: A dynamic analysis. *World Development* 104 (2018) 78–96.
- Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S. and Hess, J. (2020). The Global Findex Database 2017: Measuring Financial Inclusion and Opportunities to Expand Access to and Use of Financial Services. *The World Bank Economic Review*, 34(Supplement), 2020, S2–S8.
- Duncan, J. M., Tompkins, E. L., Dash, J. and Tripathy, B. (2017). Resilience to hazards: rice farmers in the Mahanadi Delta, India. *Ecology and Society* 22(4):3.
- Eakin, H., Appendini, K., Sweeney, S. and Perales, H. (2015). Correlates of Maize Land and Livelihood Change Among Maize Farming Households in Mexico. *World Development*. 70:78–91.

- Elusma, M., Tung, C. and Lee, C. (2022). Agricultural Drought Risk Assessment in the Caribbean region: The case of Haiti. *International Journal of Disaster Risk Reduction*. 83(2022)103414.
- FAO (2015). The Impact of Natural Hazards and Disasters on Agriculture and Food Security and Nutrition. A Call for Action to Build Resilient Livelihoods. FAO, Rome.
- Furuoka, F., Yaya, O. S., Ling, P. K., Al-Faryan, M. A. S. and Islam, N. M (2023). Transmission of risks between energy and agricultural commodities: Frequency time-varying VAR, asymmetry and portfolio management. *Resources Policy* 81 (2023) 103339.
- Gahi, Z. N., Kablan, M.K.A., Kpan, O.J.G., Dongo, K. and Badolo, M. (2020). Analysis of Stakeholder Perceptions and Practices Related to Climate Change Adaptation in Burkina Faso. *African Crop Science Journal*. 28(4):543 – 553.
- Girma, M., Jerneck, A. and Dejen, A. (2023). Food Insecurity Experience during Climate Shock Periods and Farmers' Aspiration in Ethiopia. *Environmental Development* 46 (2023) 100868.
- Gunther, I. and Harttgen, K. (2009). Estimating Households Vulnerability to Idiosyncratic and Covariate Shocks: A Novel Method Applied in Madagascar. *World Development*. 37(7): 1222–1234.
- Gnutzmann, H., Kowalewski, O. and Spiewanowski, P. (2019). Market Structure and Resilience: Evidence from Potash Mine Disasters. *Amer. J. Agr. Econ.* 102(3): 911–933.
- Guedegbe, T., Adelaja, A. and George, J. (2023). Resilience, endogenous policy responses to COVID-19, and their impacts on farm performance. *World Development*. 168 (2023):106254.
- Gutiérrez-Martín, C., Gómez-Limón, J. A. and Montilla-López, N. M. (2020). Self-financed water bank for resource reallocation to the environment and within the agricultural sector. *Ecological Economics* 169 (2020) 106493.
- Habimana, D. and Houghton, J. (2022). Does Rwanda's flagship microcredit programme boost agriculture and incomes? *African Journal of Agricultural and Resource Economics*. 17(3):239–254.
- Hadachek, J, Ma, M, and Sexton, R. J. (2023). "Market Structure and Resilience of Food Supply Chains under Extreme Events." *American Journal of Agricultural Economics* 1–24.
- Haile, D., Seyoum, A. and Azmeraw, A. (2022). Food and nutrition security impacts of resilience capacity: Evidence from rural Ethiopia. *Journal of Agriculture and Food Research* 8 (2022) 100305.
- Hardy, M., Litzow, E., McCasland, J. and Kagy, G. (2023). Gender Differences in Informal Labor-Market Resilience. *The World Bank Economic Review*, 37(1), 2023, 112–126.

- Heltberg, R., Hossain, N., Reva, A. and Turk, C. (2013). Coping and Resilience during the Food, Fuel, and Financial Crises. *The Journal of Development Studies*. 49(5):705–718.
- Hirvonen, K., de Brauw, A. and Abate, G.T. (2021), Food Consumption and Food Security during the COVID-19 Pandemic in Addis Ababa. *Amer. J. Agr. Econ.*, 103 (3): 772–789.
- Hossain, M. S., Arshad, M. Qian, L., Zhao, M., Mehmood, Y. and Kachele, H. (2019). Economic impact of climate change on crop farming in Bangladesh: An application of Ricardian method. *Ecological Economics* 164 (2019) 106354.
- Husain, Z., Ghosh, S. and Dutta, M. (2022). Changes in dietary practices of mother and child during the COVID-19 lockdown: Results from a household survey in Bihar, India. *Food Policy* 112 (2022) 102372.
- Hussein, M., Law, C. and Fraser, I. (2021). An analysis of food demand in a fragile and insecure country: Somalia as a case study. *Food Policy* 101 (2021) 102092.
- Issahaku, G. and Abdulai, A. (2020). Adoption of Climate-smart Practices and its Impact on Farm Performance and Risk exposure among Smallholder Farmers in Ghana. *Australian Journal of Agricultural and Resource Economics*, 64:396–420.
- Janssens, W., Pradhan, M., de Groot, R., Sidze, E., Donfouet, H. P. P. and Amanuel Abajobir (2021). The short-term economic effects of COVID-19 on low-income households in rural Kenya: An analysis using weekly financial household data. *World Development* 138 (2021) 105280.
- Kansiime, M. K., Tambo, J. A., Mugambi, I., Bundi, M., Kara, A. and Owuor, C. (2021). COVID-19 implications on household income and food security in Kenya and Uganda: Findings from a rapid assessment. *World Development* 137 (2021) 105199.
- Kawabata, M., Berardo, A., Mattei, P. and de Pee, S. (2020). Food security and nutrition challenges in Tajikistan: Opportunities for a systems approach. *Food Policy* 96 (2020) 101872.
- Knoke, T., Paul, C., Gosling, E., Jarisch, I., Mohr, J. and Seidl, R. (2023). Assessing the Economic Resilience of Different Management Systems to Severe Forest Disturbance. *Environmental and Resource Economics* (2023) 84:343–381.
- Komareka, A. M., De Pinto, A and Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems*. 178 (2020) 102738.
- Kuhl, L. (2018). Potential contributions of market-systems development initiatives for building climate resilience. *World Development* 108 (2018) 131–144.
- Kurosaki, T. (2017). Household-Level Recovery after Floods in a Tribal and Conflict-Ridden Society. *World Development*. 94:51–63.

- Larsen, A. F. and Lilleør, H. B. (2017). Can Agricultural Interventions Improve Child Nutrition? Evidence from Tanzania. *The World Bank Economic Review*, 31(3):767–785.
- Li, E., Deng, Q. and Zhou, Y. (2022). Livelihood resilience and the generative mechanism of rural households out of poverty: An empirical analysis from Lankao County, Henan Province, China. *Journal of Rural Studies* 93 (2022) 210–222.
- Manyanga, M., Murendo, C., Pedzisa, T., Mutyasira, V. and Ndou, R. (2022). Resilience capacities and implications for food security in Zimbabwe. *African Journal of Agricultural and Resource Economics* 17(4):298–312.
- Marshall, A., Wilson, C. and Dale, A. (2023). Telecommunications and natural disasters in rural Australia: The role of digital capability in building disaster resilience. *Journal of Rural Studies* 100 (2023) 102996.
- McArthur, J. W. and Sachs, J. D. (2019). Agriculture, Aid, and Economic Growth in Africa. *The World Bank Economic Review*, 33(1), 2019, 1–20.
- Miani, A. M., Dehkordi, M. K., Siamian, N., Lassois, L., Tan, R. and Azadi, H. (2023). Toward sustainable rural livelihoods approach: Application of grounded theory in Ghazni province, Afghanistan. *Applied Geography* 154 (2023) 102915.
- Mondal, M., Biswas, A., Mandal, S., Bhattacharya, S. and Suman, P. (2022). Developing Micro Level Resilience Index for Indian Sundarban Adopting Resilience Indicators for Measurement and Analysis (RIMA) Methodology. *Geosystems and Geoenvironment*. 2 (2023):100129.
- Morton, J. (2020). On the susceptibility and vulnerability of agricultural value chains to COVID-19. *World Development* 136 (2020) 105132.
- Mutyebere, R., Twongyirwe, R., Sekajugo, J., Kabaseke, C., Kagoro-Rugunda, G., Kervyn, M. and Vranken, L. (2023). Does the Farmer's Social Information Network Matter? Explaining Adoption Behavior for Disaster Risk Reduction Measures using the Theory of Planned Behaviour. *International Journal of Disaster Risk Reduction* 92 (2023) 103721.
- Nakamura, S., Bundervoet, T and Nuru, M. (2020): Rural Roads, Poverty, and Resilience: Evidence from Ethiopia, *The Journal of Development Studies*.56(10):1838-1855
- Nguyen, G. T. H., White, B. and Ma, C. (2018). When Faced with Income and Asset Shocks, Do Poor Rural Households in Vietnam Smooth Food Consumption or Assets? *The Journal of Development Studies* 9(2018):2008-2023
- Nguyena, T., Nguyena, T. T. and Grotea, U. (2020). Multiple Shocks and Households' Choice of Coping Strategies in Rural Cambodia. *Ecological Economics* 167 (2020) 106442.

- Nichols, C., Janssen, B., Beamer, C. and Ferring, C. (2022). Pivoting is exhausting: A critical analysis of local food system resilience. *Journal of Rural Studies* 96 (2022) 180–189.
- Nicholas-Davies, P., Fowler S., Midmore, P., Coopmans, I., Draganova, M., Petitt, A. and Senn, S. (2021). Evidence of resilience capacity in farmers' narratives: Accounts of robustness, adaptability and transformability across five different European farming systems. *Journal of Rural Studies* 88 (2021) 388–399.
- Nordhagen, S., Igbeka, U., Rowlands, H., Shine, R. S., Heneghan, E. and Tench, J. (2021). COVID-19 and small enterprises in the food supply chain: Early impacts and implications for longer-term food system resilience in low- and middle-income countries. *World Development* 141 (2021) 105405.
- Otchere, F. and Handa, S. (2022). Building Resilience through Social Protection: Evidence from Malawi. *The Journal of Development Studies*, 58:(10):1958–1980.
- Pourzand, F., Noy, I and Sağlam, Y. (2020). Droughts and farms' financial performance: a farm-level study in New Zealand. *Australian Journal of Agricultural and Resource Economics*. 64:818–844.
- Sage, C. (2013). The interconnected challenges for food security from a food regimes perspective: Energy, climate and mal consumption. *Journal of Rural Studies*. 29:71–80.
- Sgroi, F. and Sciancalepore, V. D. (2022). Dynamics of Structural Change in Agriculture, Transaction Cost Theory and Market Efficiency: The case of Cultivation Contracts between Agricultural Enterprises and the Food Industry. *Journal of Agriculture and Food Research* 10 (2022) 100396.
- Shah, S. H., Angeles, L. C. and Harris, L. M. (2017). Worlding the Intangibility of Resilience: The Case of Rice Farmers and Water-Related Risk in the Philippines. *World Development*. 98:400–412.
- Sinha, S., Narain, N., Bhanjdeo, A. (2022). Building back better? Resilience as Wellbeing for Rural Migrant Households in Bihar, India. *World Development* 159 (2022) 106031
- Slijper, T., de Mey, Y., Poortvliet, M. P. and Meuwissen. M. P. M. (2022). Quantifying the resilience of European farms using FADN. *European Review of Agricultural Economics*. 49 (1):121–150.
- Song, C., Liu, R., Oxley, L. and Ma, H. (2018). The Adoption and Impact of Engineering-Type Measures to Address Climate Change: Evidence from The Major Grain-Producing Areas in China. *Australian Journal of Agricultural and Resource Economics*. 62:608–635.

- Stevens, A. W. and Teal, J. (2023). Diversification and resilience of firms in the agri-food supply chain. *Amer J Agr Econ.* 2023;1–40.
- Tabe-Ojong, M. P., Nshakira-Rukundo E. and Gebrekidan, B. H. (2023). COVID-19 and Food Insecurity in Africa: A review of the Emerging Empirical Evidence. *European Review of Agricultural Economics.* 00(00):1.26.
- Tao, T., Ma, L., Wang, X., Wu, S, Shia, Z. and Cui, X. (2023). Resilience or Efficiency? Strategic Options for Sustainable Development of Agricultural Systems in Ecologically Fragile Areas of China. *Science of the Total Environment.* 881(2023)163411.
- Temesgen, Y., Ketema, M. and Ademe, A. (2022). Rural Households Vulnerability to Covariate and Idiosyncratic Shocks using Multilevel Longitudinal Model: Evidence from Ethiopia. *Heliyon* 8 (2022) e10968.
- Tschakert, P., Parsons, M., Atkins, E., Garcia, A., Godden, N., Gonda, N., Henrique, K. P., Sallu, S., Steen K. and Ziervogel, G. (2023). Methodological lessons for negotiating power, political capabilities, and resilience in research on climate change responses. *World Development* 167 (2023) 106247.
- Valdes, R. and Jara-Rojas, R. (2020). The impact of commodity price shocks among regional economies of a developing country. *Australian Journal of Agricultural and Resource Economics.* 64:920–939.
- Villacis, A. H., Mayorga, J. and Mishra, A. K. (2022). Experience-based food insecurity and agricultural productivity in Nigeria. *Food Policy* 113 (2022) 102286.
- Walelign, S. Z., Pouliot, M., Larsen, L. O. and Smith-Hall, C. (2016): Combining Household Income and Asset Data to Identify Livelihood Strategies and Their Dynamics, *The Journal of Development Studies.* 53(6):1-19
- Wang, Y., Zhang, Q., Li Q., Wang, J., Sannigrahi, S., Bilsborrow, R., Bellingrath-Kimura, S. D., Li, J. and Song, C. (2021). Role of social networks in building household livelihood resilience under payments for ecosystem services programs in a poor rural community in China. *Journal of Rural Studies* 86 (2021) 208–225.
- Wheeler, S. A. and Zuo, A. (2017). The impact of drought and water scarcity on irrigator farm exit intentions in the Murray–Darling Basin. *Australian Journal of Agricultural and Resource Economics.* 61:404–421.
- Wilson, G. A., Hu, Z. and Rahman, S. (2018). Community resilience in rural China: The case of Hu Village, Sichuan Province. *Journal of Rural Studies* 60 (2018) 130–140.

Wuepper, D. and Sauer, J. (2016). Explaining the performance of contract farming in Ghana: The role of self-efficacy and social capital. *Food Policy* 62 (2016) 11–27.

Yao, B., Shanoyan, A. Schwab, B. and Amanor-Boadu, V. (2023). The role of mobile money in household resilience: Evidence from Kenya. *World Development* 165 (2023) 106198.