University of Reading

Conflict, Livestock Assets, Nutrition and Health in Nigeria

Thesis submitted for the degree of

Doctor of Philosophy

School of Agriculture, Policy and Development

Olusegun Ayodeji Fadare

October 2022

Declaration of Original Authorship

I confirm that this is my own work, and the use of all the material from other sources has been properly and fully acknowledged.

October 2022

Olusegun Ayodeji Fadare

Abstract

There has been a growing interest in studying the impact of conflict on the well-being of affected populations, particularly in Sub-Saharan Africa and Nigeria. Agricultural livelihoods are especially vulnerable during conflicts, and as the conflict in Nigeria has been ongoing, there is a need to develop evidence-based strategies that can help agricultural households build resilience and improve their livelihood outcomes.

This study employs quantitative research methods to investigate the connection between livestock asset holdings, household nutrition, and health in the context of the Nigerian conflict. Three distinct research objectives were achieved using datasets from the Nigeria Living Standards Measurement Study and Armed Conflict Location and Event Data. These objectives are presented in individual chapters, which offer insights into the effects of conflict on livestock assets, nutrition and health, and the scope for building resilience to conflicts.

In Chapter II, this study finds that exposure to conflict leads to a reduction in livestock herds and an increase in livestock diversification. The access to agricultural land plays a mitigating role in the negative impact of conflicts on livestock production. Chapter III shows evidence that farmer-herder conflicts have a significant impact on household consumption of animal-source foods, which can be mitigated through livestock diversification. Finally, Chapter IV investigates the association between conflict, livestock assets, and farmers' mental health.

The study highlights the critical role that livestock assets play in promoting the well-being of Nigerian households, regardless of whether they are in conflict or non-conflict situations. Also, while livestock assets are susceptible to conflict risk, they possess dynamic qualities that enable them to mitigate the harmful effects of conflict and aid in building resilience among households. Therefore, advancing conflict-sensitive livestock production practices and strategies is vital for enhancing food security, nutrition, and key health indicators in Nigeria.

Acknowledgments

I am grateful for the support and kindness of many individuals who made my PhD journey and thesis completion possible. Firstly, I would like to express my sincere appreciation to my supervisors, Dr Giacomo Zanello and Prof. Chittur Srinivasan, for their selfless mentoring and significant contributions to my doctoral training. Secondly, I acknowledge the Institute for Food, Nutrition and Health at the University of Reading for providing funding to undergo some specialised training in quantitative methodologies.

I want to extend my deepest gratitude to my family, who have been unwavering in their support throughout my PhD journey. I thank my wife and best friend, Omotolani, for standing by me, as well as my children Ayomikun and Oluwashayomi, for their sacrifices. My father, Mr Olusegun Fadare, deserves a special thanks for being an inspiration. I also thank my mother, Mrs Racheal Fadare, for her unwavering support and daily prayers. Furthermore, I appreciate my siblings and in-laws for believing in me.

Lastly, I am thankful for my former supervisor, colleagues, and friends at the International Food Policy Research Institute (IFPRI), the University of Reading, and other Institutions. Specifically, I would like to thank Prof. George Mavrotas, Dr Dare Akerele, Dr Taiwo Aderemi, Dr Toritseju Begho, Kehinde Odeniyi, Oluwatosin Afeni, Adebayo Ogunniyi, and Kehinde Olagunju for their inspiration, encouragement, and support.

Table of Contents

Abstract iii

Acknowledgments iv

Table of Contents vi

List of Tables viii

List of Figures ix

Chapter I 1

1.1 Introduction 1

1.2 Background 6

Chapter II – The joint effects of terrorism and land access on livestock production decisions: Evidence from northern Nigeria 18

Abstract 19

2.1 Introduction 20

2.2 Background 23

2.3 Data and empirical strategy 26

2.4 Results and discussion 32

2.5 Conclusion 42

Chapter III – Livestock diversification mitigates the impacts of farmer-herder conflict on animal-source foods consumption in Nigeria 44

Abstract 45

3.1 Introduction 46

3.2 Background 50

3.3 Conceptual framework 55

3.4 Data and descriptive statistics 58

3.5 Empirical strategy 66

3.6 Results and discussion 70

3.7 Conclusions 79

Chapter IV – Examining the association between conflict, livestock assets, and farmers' mental health in Nigeria 82
Abstract 83
4.1 Introduction 84
4.2 Related literature 88
4.3 Conceptual framework for conflict, livestock assets, and depression 90
4.4 Conflict context, data, and empirical strategy 93
4.5 Results 99
4.6 Discussion 106
4.7 Conclusion 108
Chapter V 110
5.1 Concluding statement 110
5.2 Recommendations for policy considerations 110
5.3 Research contributions to knowledge 112
5.4 Strengths, limitations, and suggestions for future research 113
References 115
Appendix 132
Appendix A 132
Appendix B 133
Appendix C 141

List of Tables

Table 2.1. Description of variables used for analysis 31

Table 2.2. Summary statistics of variables used for analysis (2020 to 2016) 34

Table 2.3. Results of the relationship between terrorism, land access and cattle herd size 38

Table 2.4. Results of the relationship between terrorism, land access and small livestock herd size ... 39

Table 2.5. Results of the relationship between terrorism, land access and livestock diversification 40

Table 3.1. Summary statistics of variables used for analysis 63

Table 3.2. Summary statistics with the mean comparison between groups 64

Table 3.3. Impacts of farmer-herder conflict and covariate determinants on ASF consumption 72

Table 3.4. Impacts of farmer-herder conflict on ASF consumption (ATT) 74

Table 3.5. Impacts of livestock diversification on ASF consumption (ATT) 78

Table 4.1. Description of variables used for analysis 98

Table 4.2. Percentages of farmers that exhibited symptoms of depression in the last seven days 99

Table 4.3. Summary statistics 101

Table 4.4. Logit regression results of the association between conflict exposure, livestock assets, and depression (CES-D score ≥8) 101

Table 4.5. OLS regression results of the association between conflict exposure, livestock assets, and depression (CES-D score). 102

Table 4.6. Logit regression results of the association between conflict experienced, livestock assets, and depression (CES-D score ≥8). 103

Table 4.7. OLS regression results of the association between conflict experienced, livestock assets, and depression (CES-D score). 104

List of Figures

Figure 1.1. Global incidence of conflicts relative to food insecurity between 2010 and 2020 7

Figure 1.2. Health and nutrition outcomes by conflict status in Africa 7

Figure 1.3. Conceptual framework linking conflict, livestock assets, nutrition, and health status. 9

Figure 1.4. Map of Nigeria showing the 36 states and the Federal Capital Territory 12

Figure 1.5. Trend in violent conflict events in Nigeria from 2009 to 2019 15

Figure 1.6. Nigeria Map showing violent conflict events (right) by LGAs from 2009 to 2019 15

Figure 2.1. Violin plots of Livestock Diversity Index by terrorism exposure 34

Figure 2.2. Average Marginal Effects of the relationship between terrorism, land access and livestock production decisions 41

Figure 3.1. Trend in farmer-herder conflict events in Nigeria from 2009 to 20019 52

Figure 3.2. Nigeria Map showing farmer-herder conflict events by LGAs from 2009 to 2019 52

Figure 3.3. Conceptual framework linking farmer-herder conflict, livestock diversification, and animal-source food security. 56

Figure 3.4. Farmer-herder conflict events in Nigeria by month 57

Figure 3.5. Parallel trends test for the difference-in-differences (left) and event study (right) 75

Figure 3.6. Event study estimation of ASF consumption (Specific food groups) 76

Figure 4.1. Conceptual framework of the association between conflict exposure, livestock assets and depression. 92

Figure 4.2. Bivariate relationship between conflict and risk of depression 100

Figure 4.3. AME results of the estimates of the logit regression models for the association between conflict exposure/experienced, livestock assets, and the 10 depressive symptoms. 103

Figure 4.4. The association between conflict, livestock assets, and depression, based on column (7) in the result tables 105

Chapter I

1.1 Introduction

This chapter introduces the thesis' core chapters (Chapters II–IV) and it comprises two sections: the research problem statement and the background of the thesis. The research problem statement identifies the gaps in the literature, presents the research objectives, and the research relevance. The background extends the literature to conceptualise the framework linking the study objectives. It also highlights the study location, the conflict context, data sources, and the thesis structure.

1.1.1 Research problem statement

Violent conflict is undoubtedly a major challenge towards achieving some key targets of the 2030 Sustainable Development Goals (SDGs) as it concerns Sub-Saharan Africa (SSA). Global reports on international development consistently show that SSA countries in protracted conflict have the worse food security, nutrition and health indicators (von Grebmer et al., 2021). The slow pace and retrogression towards achieving SDGs 1-No poverty, 2-Zero hunger, and 3-Good health and well-being are key issues of concern in the region.

In Nigeria, the location of this study, conflict is protracted and largely manifested in the form of terrorism, farmer-herder conflict, and the activities of banditry and militias (ACLED, 2019). The protracted nature of the conflicts is destructive to agricultural assets, especially land and livestock. Livestock assets are particularly vulnerable as they are also rustled by conflict actors to partly fund further attacks (FATF-GIABA-GABAC, 2016; Okoli, 2019). Nevertheless, livestock assets remain crucial to many lives in the developing world (Randolph et al., 2007), where two in three households depend on them for income (Carletto et al., 2007).

The literature on conflict impact on agricultural production has grown in recent years with evidence showing that conflict is destructive to agricultural assets and disrupt the systems supporting them (Adelaja & George, 2019a). While the literature suggests that crop cultivation is a risky adventure in conflict situations (Dabalen, 2015), evidence is mixed on livestock production in conflict situations. Most studies indicate that livestock assets can demonstrate resilience capacity based on their dynamic characteristics (Cox, 2012). Yet, an important gap in the literature is the extent and context of the vulnerability of livestock species to conflict and their resilient nature.

Furthermore, food insecurity, malnutrition, and ill health (including mental health) are critical consequences of disrupted agricultural livelihoods arising from conflict. Mitigating the effects of conflict on these negative outcomes can be overwhelming for humanitarian assistance programmes. However, a sustainable approach for conflict mitigation is livelihood adjustment in response to conflict risk (Rockmore, 2020; Verpoorten, 2009). In the agricultural livelihood context, livestock diversification is important. However, there is limited evidence on the mitigating impact of livestock resilience capacity on key livelihood indicators. This needs to improve as the evidence will be valuable in designing conflict-sensitive nutrition policies and for peacebuilding in SSA.

Studies on conflict's effect on food security, nutrition and health are diverse in their indicators for measuring these well-being outcomes. One set of studies examined the effect of conflict on livestock and crop production, arguably measured food availability dimension of food security (Arias, Ibáñez, & Zambrano, 2019; George, Adelaja, & Awokuse, 2021; Verpoorten, 2009). Another theme of research directly examined the consequences of conflict on food and nutrition security measured in terms of calories intakes (D'Souza & Jolliffe, 2013; Fadare et al., 2019a), dietary diversity (Dabalen & Paul, 2014), and food insecurity access scale and coping strategies

(e.g., Nnaji et al., 2022). These studies can potentially influence policies on food security and nutrition in conflict situations. However, they provide limited information on the scope for resilience, especially nutrition resilience. Thus, are less sensitive to policy on salient nutritional needs of a vulnerable population who are primarily livestock-keeping households.

Furthermore, the health implications of conflict among agricultural households have been investigated (see Akresh, Lucchetti & Thirumurthy, 2012; Akresh, Verwimp & Bundervoet, 2011; and Minoiu & Shemyakina, 2014). These studies are more focused on children's health as measured by anthropometric indices and have paid little attention to the role of livestock in the designing of agricultural impact pathways. While it is acknowledged that children's health outcomes have long-term socioeconomic implications for attracting research interest in conflict situations, issues on parental (mental) health are also critical, and yet less investigated. This neglected research area is another focus of this thesis.

1.1.2 Research objectives

Given the identified gaps in the literature, this thesis aims to provide evidence of the impact of conflict on livestock assets, the nutrition and mental health of agricultural households in Nigeria and identify the scope for building resilience to conflict. The impact of different conflict measures and actors was examined on livestock assets and a range of nutrition and health indicators while assessing the mitigating effect of household resilience capacity using land and livestock assets. The following research questions are set to help achieve the aim of the thesis.

The first set of research questions are on livestock assets outcomes:

(i) What impact does terrorism have on livestock herd size and livestock diversification?

(ii) What role does land access play in livestock production decisions in conflict situations?

(iii) Do fatalities from terrorism cause households to adjust livestock production differently from terrorism incidents?

A key motivation for these questions is the limited evidence on land access' role in supporting livestock production in conflict situations. Using fatalities and incidents to measure conflict impact is intended to understand the household response to different degrees of conflict severity. The analytical approach employs a longitudinal data from agricultural households in northern Nigeria, a region characterised by agricultural activities, at the same time vulnerable to conflict risk. Thus, answering these questions provides evidence of terrorism's impact on livestock production decisions and the mitigating role of land access at different levels of conflict exposure. The study output is a self-contained chapter in Chapter II.

The second set of research questions relate to outcomes on nutrition and are framed as follows:

(i) What impact does farmer-herder conflict have on animal-source food consumption?

(ii) Does livestock diversification mitigate the impact of farmer-herder conflict on animal-source food consumption?

These questions are motivated by the dearth of evidence on the impact of conflict on nutrition and the mitigating role of livestock diversification strategy. At the same time, limited studies have identified the causal relationship between conflict and household nutrition, measured using ASF consumption. These research questions were addressed using a quasi-experimental design of difference-in-differences and event study estimation on a six-year longitudinal dataset of agricultural households in Nigeria. Chapter III of this thesis contains the research output with evidence on the impact of farmer-herder conflict on ASF consumption and the mitigating role of livestock diversification.

The third set of research questions uses farmers' mental health as the health outcome measure:

(i) Does conflict exposure increase depressive symptoms risk among Nigerian farmers?

(ii) Do livestock assets moderate the effect of conflict on farmers' depressive symptoms?

These research questions are motivated by the understanding that psychological well-being is an important outcome on which conflict effects can be more lasting and grievous than the effect on economic well-being (Friedman & Thomas, 2009). Yet, there is a paucity of evidence of conflict effect on the mental health of the farming population. Also, evidence that certain livestock species can provide psychosocial relief to their keepers in stressful situations is lacking in conflict contexts. Using logistic and OLS regression on a cross-sectional nationally representative dataset, Chapter IV provides evidence of a strong association between conflict, livestock assets and farmers' mental health as measured by depressive symptoms.

1.1.3 Research relevance

This research relevance can be positioned in the context of key targets of the 2030 SDGs 1, 2, and 3, including peacebuilding aspects of goal 16, "Peaceful, justice, and strong institutions". The livestock sector is often described as the pillar of the global food system (World Bank, 2022). In order words, it is pivotal for food security, nutrition and health improvement, which feed into peacebuilding and conflict prevention. Therefore, the evidence provided in this research will be relevant for designing policies to sustain small-holders livestock production in SSA to address issues bothering on the vulnerability of small-scale livestock keeping and related livelihood outcomes. Particularly, it is relevant in the short term for humanitarian assistance programmes for agricultural households in conflict situations in areas of livestock relief materials, micronutrient intakes from animal-source foods, and psychosocial support.

1.2 Background

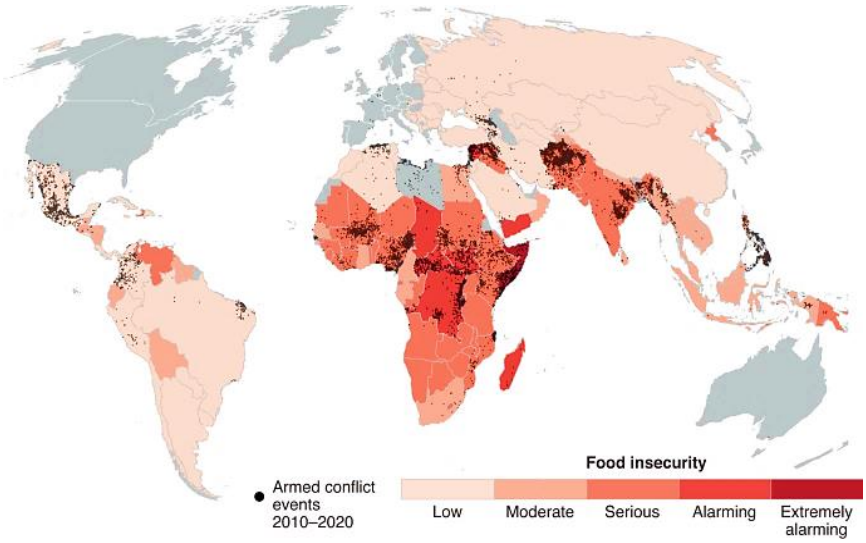
1.2.2 Conflict, food security, nutrition, and health linkages

Violent conflict and food insecurity are highly correlated (FAO et al., 2017). Conflict remains the 21st century's biggest challenge for SSA towards improving indicators on food security, nutrition, and health (Allison, 2020). Over the last decade, countries experiencing conflicts are concentrated in SSA and disproportionately vulnerable to food insecurity, as shown in Figure 1.1. Consequently, the report on the Global Hunger Index gives daunting statistics on key food security, nutrition and health indicators in Africa, as shown in Figure 1.2. Poor nutrition and health indicators are higher among SSA countries that are more exposed to conflict, with about 47% of these countries disproportionally exhibiting triple burden of malnutrition as compared to 7.4% in non-fragile and conflict-affected countries (von Grebmer et al., 2021).

In addition to conflict, socioeconomic, institutional, and environmental factors are known drivers of food insecurity, malnutrition, and poor health outcomes in Africa (FAO et al., 2017; IFPRI, 2021). The integration of these factors describes countries in fragility according to the International Monetary Fund (IMF). Countries in fragility are characterised by reduced institutional capacity, limited provision of services and limited ability to manage or mitigate social, economic, political, and security or environmental risks (IMF, 2022), resulting in strong links between fragility and conflict.

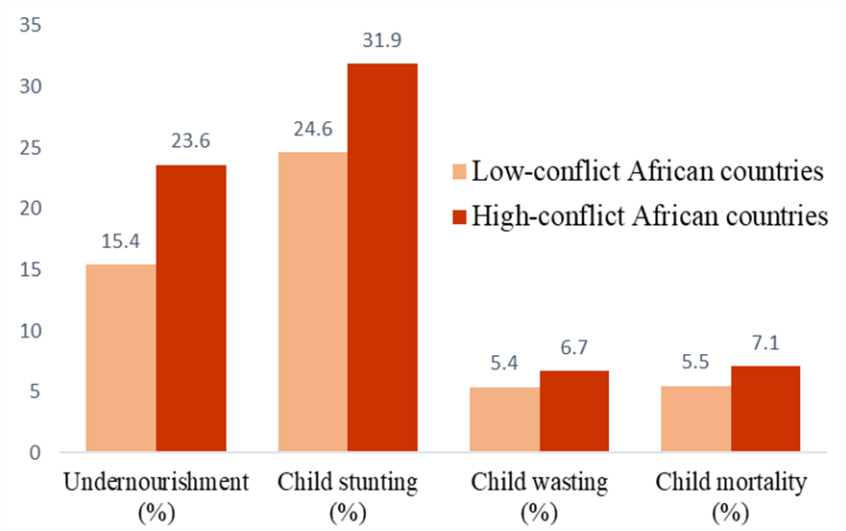
Conflict can be the cause and consequence of food and nutrition insecurity (Delgado, Murugani & Tschunkert, 2021; Hendrix & Brinkman, 2013). Factors that aggravate the contributions of food and nutrition insecurity to conflict are events of climate change, manifested through poor harvest or yield and competition for limited resources between farmers and herders. Others include socioeconomic, expressed through grievances from unemployment, perceived marginalization, inequalities, high cost of food and poor standard of living.

Figure 1.1. Global incidence of conflicts relative to food insecurity between 2010 and 2020



Source: Kuemmerle and Baumann (2021)
Reproduced with permission from Springer Nature

Figure 1.2. Health and nutrition outcomes by conflict status in Africa



Source: Adapted from von Grebmer et al. (2021)
Use is covered by a copyright exception

Similarly, malnutrition, especially micronutrient malnutrition and stunting, are potential risk factors for violent conflict (Alderman, Hoddinott, & Kinsey 2006). Childhood malnourishment can lead to poor cognitive development and school performance, and such individuals are less economically productive later in life and become poor (Alderman, Hoddinott, & Kinsey, 2006;

Haddad et al., 2014). Evidence shows that income poverty and poor health and nutritional status increase the risk of armed conflict (Pinstrup-Andersen & Shimokawa, 2008), as poor and hungry people have little regard for law and order and can easily be brainwashed and incentivised into joining gangs or terrorist groups (Brinkman & Hendrix, 2011).

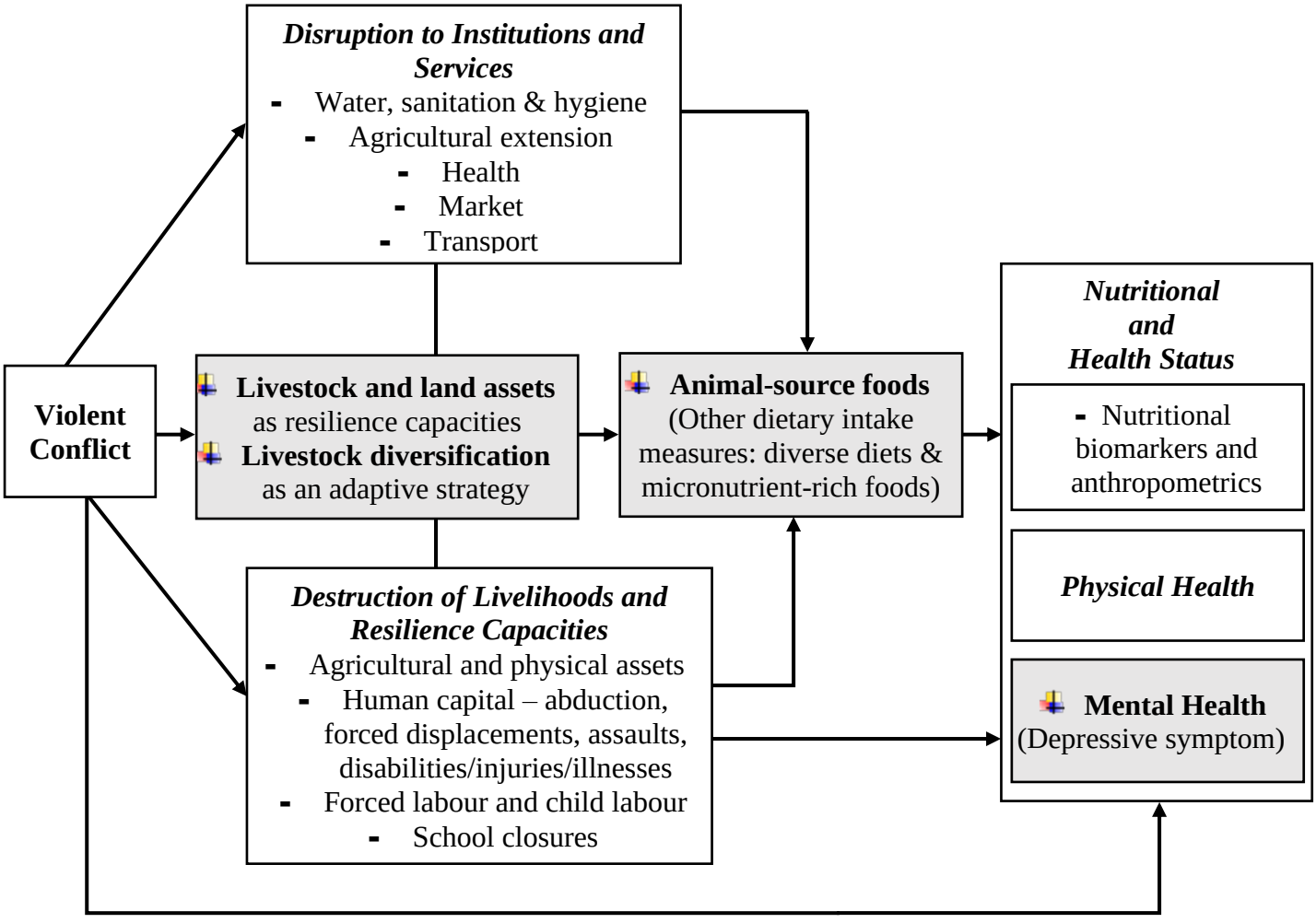
The relationship between food and nutrition security and violent conflict is less understood and remains complex as conflict simultaneously impacts multiple and interrelated well-being indicators (Brück & d'Errico, 2019). Empirically understanding the complexity and the causes and effects of the relationship will require obtaining longitudinal data that integrate household socioeconomic, food production and assets holdings, and household food consumption and expenditure data in a conflict context (Verwimp, Justino, & Brück, 2019), and addressing the issue of endogeneity in the relationship for causal inference (Brück et al., 2016).

While several studies are limited in failing to identify causality, some notable studies made an attempt to account for endogenous relationships in their estimations by employing a quasi-experimental design. The study by Hitzhusen and Jeanty (2006) employed an instrumental variable approach on panel data of 80 developing countries and found that exposure to conflict increases food insecurity using dietary energy consumption. Another study in Cote d'Ivoire uses propensity score-matching and found evidence that households in areas severely exposed to conflict and individuals who are the direct victims of the conflict have lower dietary diversity (Dabalen & Paul, 2014). Using panel data from South Africa and individual fixed effects, Alloush and Bloem (2022) found that neighbourhood violence is positively associated with depressive symptoms and increases the likelihood of being at risk of depression.

1.2.3 Conceptual framework linking conflict, livestock assets, nutrition and health

Following the argument and evidence from the literature, a conceptual framework to describe the link between conflict, livestock assets, nutrition and health is developed in Figure 1.3. The framework focuses on the effect of conflict on livestock assets and diversification strategy and how they impact nutrition and health outcomes. The grey boxes are the outcomes measured in this present research.

Figure 1.3. Conceptual framework linking conflict, livestock assets, nutrition, and health status.



Source: Author.

Violent conflict can destroy and disrupt livelihoods and resilience capacities, including agricultural assets, human capital, and institutions and services supporting them (Brück et al.,

2018). Households typically own different species of livestock as part of agricultural livelihood activities. However, some livestock species like cattle are more vulnerable to conflict risk than species like sheep and goats, and poultry. Households would often give up on cattle production and diversify into owning more of these other species to mitigate conflict risk. The dynamics in livestock production has both positive and negative effects on key livelihood outcomes in terms of food security, nutrition, and health of livestock-holding households.

Cattle are primarily the wealth figure of households and conflict can negatively impact the animal-source food security and, thus, the dietary quality and nutritional status of households that depend on them in some ways: (i) cattle destruction means reduced access to meat and dairy products, household income, and can lead to a reduction in food crop production if used as draught power, source of manure, and transportation to move inputs and outputs; and (ii) the disruption of access to veterinary services, extension services, pasture, and market may lead to distress sales, emaciation of cattle, diseases and death and thus negatively affect the benefits households derive from livestock assets. On the other hand, conflict can increase livestock diversification which may increase ASF consumption and health.

Furthermore, conflict events often leave exposed people with depression disorder through multiple channels. For households with large herds of cattle, the concern of losing cattle is a channel through which depressive symptoms for farmers can be reinforced. Similarly, the relationship between conflict and mental health can be mediated by livestock assets, as either a reinforcing factor or a mitigating factor.

1.2.4 Livestock development and its importance in Africa

Generally, the livestock sector in Africa is still developing and has been projected to become one of the most vibrant agricultural sub-sectors to add significantly to agricultural GDP in the coming decades. The sector accounts for 25% of agricultural value added in Africa as compared

to 55% in North America and 67% in Western Europe (FAOSTAT, 2018). However, livestock production in most developing countries is still dominated by smallholders, using basic management systems with limited access to technologies and services for improved productivity. For example, livestock production in Nigeria is subsistence and rudimentary, depending largely on open grazing on rangeland, thus increasing resource-use competition between farmers and herders. The Tropical Livestock Unit (TLU) in Nigeria is an average of 7.4, dominated mainly by cattle, goats and poultry (NBS/World Bank, 2016) and more than the average in Africa, which is 2.2 TLU (FAO, 2018).

The many roles of livestock assets in rural households are well recognised (Swanepoel, Stroebel, & Moyo, 2010). In the rural livelihoods context, keeping livestock transcends food but embraces a complex system capable of influencing the totality of household well-being (Banda & Tanganyika, 2021; Garmyn, 2021). Typically, livestock keeping is central to the social, cultural, and economic lives of most rural households as a source of finance, food, fertilizer, fuel, and farm labour, including mobility and social status or prestige.

In terms of food production and consumption, the past 50 years have seen global meat production triple in response to increasing demands (Ritchie & Roser, 2017). It has also been projected that by 2050 the total demand for livestock products might double, and this will be significant in the developing world, especially in Africa. The driving forces for the development of livestock systems as projected for Africa are rising population, urbanization, production technological change, and consumers' preferences for high-value animal products (Thornton, 2010; Pica-Ciamarra & Otte, 2011). Even among the poor and rural households, livestock keeping is being promoted by many international development projects for women and youth empowerment and for households' nutritional improvement.

1.2.5 Study location – Nigeria

Located towards the edge of the Gulf of Guinea on the west coast of Africa, Nigeria has a total land area of 910,770sq.km covering 1,046km north-south and 1,127km east-west, with boundary length is 4,900 km, of which 853 km is coastline and is bordered by Chad and Niger to the north while to the south by Cameroon, the Gulf of Guinea, and Benin (Figure 1.4). Nigeria is divided into six (6) geopolitical regions (north-central, north-east, north-west, south-east, south-south, and south-west), 36 states and Federal Capital Territory, and 774 Local Government Areas (LGAs).

Figure 1.4. Map of Nigeria showing the 36 states and the Federal Capital Territory

Source: The Commonwealth Yearbook 2015, in Day and Caus (2020).
Use is covered by a copyright exception

By agroecological distinction, the country is divided into six (6) zones, including the Mangrove swamp, Rainforest, Derived savanna, Guinea savanna, Sudan savanna, and Sahel savanna zones. Annual rainfall ranges from the lowest 500 mm in the Sahel savanna to a peak of 3000 mm in the Mangrove Swamp. With an agricultural land area of about 84 million hectares,

agriculture remains the predominant employer of labour in Nigeria, absorbing up to 36% of the total labour force and contributing approximately 22% to Nigeria's GDP (Oyaniran, 2020). About 80% of Nigeria's farmers are smallholders, accounting for 90% of the nation's agricultural produce (Oyaniran, 2020). More than 70% of households in Nigeria are crop producers, and about 41% or 13 million households keep livestock (FAO, 2019), mainly chicken, goats, sheep, and cattle, with an average of 7.4 Tropical Livestock Unit (NBS et al., 2016). The main staple crops produced in Nigeria are cassava, yam, maize, sorghum, rice and millet, and these crops cover about 65% of the total area under cultivation.

Nigeria is the most populous country in Africa and 6th in the world, having a population of over 200 million people in 2020 with an annual growth rate of 2.5% (World Bank, 2021). More than 40% of the Nigerian population still leaves below the poverty line, and an average household spend approximately 60% of its expenditure on food items annually (NBS, 2020). The country is currently faced with significant socioeconomic and security challenges, including a high unemployment rate, income inequality, and social and economic marginalization. With regards to security challenges, Nigeria is mainly battling terrorism, climate-induced conflicts including those between farmers and herders, banditry and kidnapping, violent secessionism, and other political and social unrest from angry and unemployed youth. Given the share of Nigeria's population in Africa, its economic development and social stability is very strategic to the rest of the continent.

1.2.6 Contemporary conflicts in Nigeria

Following about four decades after the end of the Nigeria civil war that lasted for approximately two years (Sklar, 1976), another form of conflict described as guerrilla warfare started in July

2009 by the Boko Haram[1] after claiming responsibility for a series of attacks in the Northeast, Nigeria (ACLED, 2019). Conflict has since proliferated in different dimensions and has involved more groups and actors, including the arms-carrying gang of the Fulani herdsmen of West Africa and bandits with a heavy presence in the Northwest and Northcentral. There are reports of bandits forming an alliance with Boko Haram to reinforce terrorism in Nigeria.

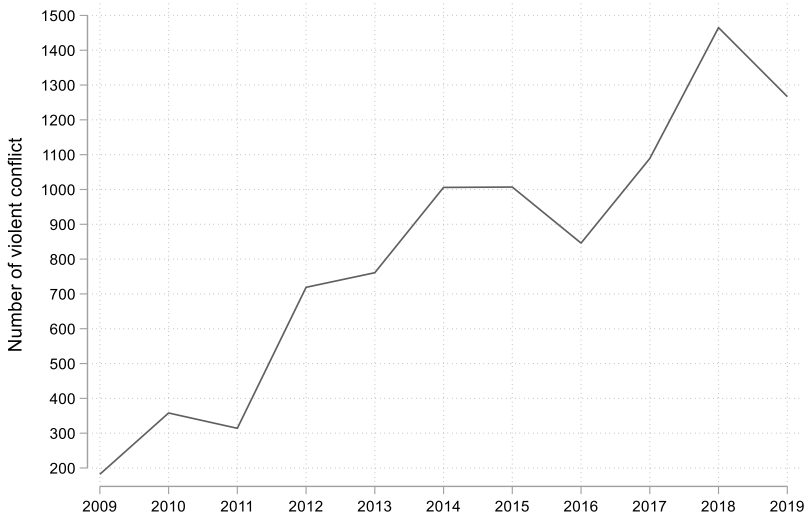
The act of terrorism is characterised by the strategic use of violence and intimidation of civilians to achieve a political or social objective (Enders & Sandler, 2012). Terrorists have varied objectives based on the ideology that established them. For instance, the word "Boko Haram" is a nickname that stemmed from the ideology of the group and literally means "Western education is a sin". Hence the group's objective includes the establishment of an Islamic state in Nigeria and an attack on western education through violence and intimidation (Walker, 2012). As of 2020, Nigeria is in the top three countries with the highest incidents of terrorist attacks and the largest terrorism-related fatalities (Institute for Economics & Peace, 2020). In Nigeria, terrorist events are largely perpetrated through the detonations of improvised explosive devices (IED) and gunfire in communities and public places, including mass kidnapping in schools and homes and cattle rustling (Chinwokwu & Michael, 2019).

The trend in armed conflicts in Nigeria have increased over the last decade (Figure 1.5). To date, Boko Haram has carried out over 3,000 attacks (UNDP, 2019), killing more than 27,000 civilians. Boko Haram alone has killed over 3 million internally displaced persons (IDPs) (UNHCR 2021). Just in 2020, over 1,000 students were kidnapped from schools, in addition

[1]With official name – *Jama'atu Ahlis Sunna Lidda'awati Wal-Jihad*, means "People Committed to the Propagation of the Prophet's Teachings and Jihad." They have affiliation with Al-Qaeda, the Islamic State of Iraq and Syria (ISIS), and the Islamic State's West Africa Province (ISWAP) (Walker, 2012).

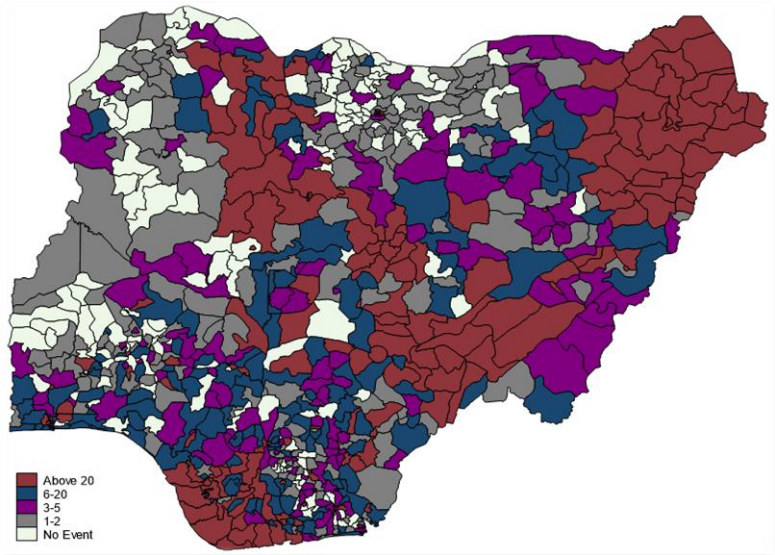
to the 377 schoolgirls abducted in 2014 and 2018 (VOX, 2021). In recent years, attacks from the arms-carrying gangs of the Fulani herdsmen of West Africa have skyrocketed and are often initiated by competition over pasture and water between farmers and herdsmen (ICON & PSJ, 2020). These attacks are prominent in the Northcentral and Northwest regions (Figure 1.6).

Figure 1.5. Trend in violent conflict events in Nigeria from 2009 to 2019



Source: Authors, from Armed Conflict Location and Event Data (2009-2019).

Figure 1.6. Nigeria Map showing violent conflict events (right) by LGAs from 2009 to 2019



Source: Authors, from Armed Conflict Location and Event Data (2009-2019).

1.2.7 Data overview

Two separate longitudinal datasets covering periods from 2010 to 2016 were used to analyse the objective of this thesis: (i) The Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) or otherwise known as the General Household Survey-Panel (GHS-Panel), and (ii) The Armed Conflict Location and Event Data (ACLED). The LSMS-ISA is part of a large Sub-Saharan Africa regional project that is conducted in eight countries, including Nigeria, being supported by the World Bank through funding from the Bill and Melinda Gates Foundation (BMGF). The objective is to strengthen the production of household-level data on agriculture to improve the understanding of agriculture in the region and its influences on household welfare and poverty reduction.

The ACLED dataset

The ACLED is the highest quality real-time data that reports on political violence and unrest around the world (Raleigh et al., 2010). Being a global georeferenced dataset, it enables users (e.g., Dabalen & Paul, 2014; Adelaja & George, 2019a) to merge the dataset with other survey datasets using unique identifiers such as the coordinates of events location and or administrative area code, and years of events. Basically, the techniques merge the event location, time, and type in the ACLED with the corresponding local government or administrative area code in another survey data. The ACLED also contain event type, sub-event type and information notes on the actual conflict events and number of recorded deaths.

The Nigeria LSMS-ISA sample design and detail on data collection

The sample is designed to be representative at the national and zonal levels using a two-stage probability sample. The first stage is the selection of the Enumeration Areas (EAs), the Primary Sampling Units (PSUs), based on the probability proportional to the size (PPS) of the total EAs in each of the 36 states and Federal Capital Territory (FCT), Abuja and the total households

listed in those EAs. At this stage, a total of 500 EAs were selected. The second stage involved the selection of households. The households were selected randomly using the systematic selection of ten (10) households per EA. This sample size selection was based on the previous General Household Survey, where ten households per EA are usually selected and give robust estimates. The selection led to a total of 5,000 households that were interviewed.

The LSMS-ISA is collected from households across the entire 36 states of Nigeria by the World Bank and the National Bureau of Statistics (NBS), Nigeria and a representative of six Nigeria geopolitical zones, covering both the urban and rural areas. The survey covers 5,000 households in the Wave 1, comprising data in post-planting (Round 1) and post-harvest (Round 2), with the last survey now reaching Wave 4 and Round 8 (see Table A.1 in the Appendix).

The LSMS-ISA data has detail information on livestock ownership, control, and management by households, and they are integrated with a wide range of household socio-economic indicators, making it suitable for analysis with an objective towards policies on livestock potential for household well-being. In terms of livestock ownership, goats (67.3%) and chickens (64.8%) are the most owned animals, followed by sheep (33.1%) and cattle (15.1%). More broadly, the LSMS-ISA also contains indicators to measure and monitor different aspects of livelihood choices, dietary consumption, and the mental health of the household head.

1.2.8 Thesis structure.

The remainder of the thesis is organised as follows. The next three chapters – Chapter II, Chapter III, and Chapter IV, are the core chapter, each structured as a journal article and addresses a set of research question investigated in the thesis. Next is the concluding chapter of the thesis, Chapter V and it summarises the core chapters, highlighting the connections between the objectives, the relevance of the findings to the body of research and policy, and implications for further research while discussing the limitations.

Chapter II

The joint effects of terrorism and land access on livestock production decisions: Evidence from northern Nigeria[2]

[2] This chapter was published in *World Development Perspective* journal on 28th July 2022: Fadare, O., Zanello, G., & Srinivasan, C. (2022). The joint effects of terrorism and land access on livestock production decisions: Evidence from northern Nigeria. *World Development Perspectives*, *27*, 100447. DOI: https://doi.org/10.1016/j.wdp.2022.100447

Authorship contribution statement:

Olusegun Fadare made substantial contributions which include conceptualization of research ideas, data curation and analysis, investigation, and methodology, and writing the original draft, review, and editing, including responding to reviewers' comments in the peer-reviewed process. **Giacomo Zanello** and **Chittur Srinivasan** made contributions in the areas of research conceptualization, funding acquisition, resources, supervision, validation, review, and editing.

Abstract

Livestock production is an integral part of the livelihoods of many households around the developing world and plays a significant role in farming households' food and nutrition security. However, conflict is a major challenge for livestock production in Africa and Nigeria in particular. We employ the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) panel data for Nigeria with a global georeferenced conflict dataset to examine the effect of terrorism on small-scale livestock production and the role of agricultural land access. Terrorism is an important factor that undermines livestock production. We find that increase in the incidents of terrorism reduces cattle herd size but does not reduce the herd size of households that manage larger area of land. Also, terrorism significantly increases livestock diversification independently and jointly with land access. However, higher fatalities from terrorism reduces herd size irrespective of the size of land managed by households but has no effect on livestock diversification. Our findings suggest a plausible land abandonment in areas where terrorism is severe. Curbing terrorism in Nigeria would ensure farmers have physical access to their land and sustain livestock production.

Keywords: Conflict mitigation; resilience; livestock assets; cattle; land access

2.1 Introduction

Livestock production is important for the food and nutrition security of countries around the world, with a more direct influence on the socioeconomic status of developing countries, especially in Sub-Saharan Africa (SSA), where it constitutes a significant source of livelihood. However, many challenges, including global climate change, regulatory policies, population increase, urbanization, and conflict, confront livestock production (Latino, Pica-Ciamarra, & Wisser, 2020; Simpkin et al., 2020; Thornton, 2010). More importantly and in recent years, armed conflicts have increased in some countries in SSA (ACLED, 2019). The immediate impacts are the destruction of lives, livelihoods, properties, and infrastructure. Furthermore, exposure to armed conflicts create a level of risk that influences agricultural production decisions, with attendant effects on the food and nutrition security of the affected population (FAO et al., 2017, 2019).

Empirical evidence on the impacts of armed conflicts on agricultural production – crops and livestock, including land use or access has grown in recent years (Adelaja & George, 2019a, 2019b; George, Adelaja, & Awokuse, 2021; Rockmore, 2020). Armed conflicts are shown to have a devastating effect on livestock production by direct destruction or indirectly through their effects on institutions and services that support livestock production (Adelaja & George, 2019a; Anne-Judith & Kinsumba, 2019; Gebreyes et al., 2016). Furthermore, armed conflicts' effects on agricultural land include farmland abandonment, reduced land use, and cultivation of previously uncultivated land (Baumann & Kuemmerle, 2016; Eklund et al., 2017; Gorsevski et al., 2012). However, some of the findings on the effects of armed conflicts on agricultural land are not empirically verified and lack contextual reality.

Evidence on the types of agricultural production farmers practice on agricultural land in conflict situations is mixed (Adelaja & George, 2019b; Chauveau & Richards, 2008). More

importantly, land use for small-scale livestock production during conflict has not received sufficient research attention despite land being an essential asset in livestock production. Further evidence from the study by Adelaja and George (2019b) in Nigeria shows that terrorism intensity increased the average size of plots farmed and the total area of land managed by households, albeit increasing the percentage of land left fallow. Though seems counter-intuitive, the study suggests that households might have claimed the management or control of lands belonging to neighbours, friends, and family members that fled their land to other locations.

There is evidence that increased land size managed by households in conflict situations encouraged farmers to produce crops that are less susceptible to conflict risk as farmers embraced crop diversification (Adelaja & George, 2019b). Such production decisions may be strategies for households to cope with conflict and mitigate its effects on agricultural livelihoods, as studies have shown that households learn to live with conflict over time by devising strategies to safeguard livelihoods and food consumption (Arias, Ibáñez, & Zambrano, 2019; Martin-Shields & Stojetz, 2019; Verpoorten, 2009). However, empirical studies suggesting that access to agricultural land may shape small-scale livestock production decisions in conflict situations are limited, especially in Nigeria. This paucity of evidence limits policy options toward mitigating conflict effects on livestock production. Our study is therefore motivated based on the need to understand land access's role in small-scale livestock production in conflict situations.

This study examines the effects of terrorism on livestock herd size and diversification and the role access to agricultural land plays in mitigating the effect of conflict on livestock production decisions. We focus our study on northern Nigeria as the region is home to a significant proportion of livestock-holding households in Nigeria, with vast hectares of land used for

agricultural activities and where the highest incidents of terrorism are recorded (ACLED, 2019). The northeast region of Nigeria started experiencing terrorism in mid-2009 following a series of attacks in the region by the Boko Haram Islamic sect, from where terrorism spread to other northern regions. Many of the attacks were targeted at communities where agricultural production is the main livelihood activity of about 80 per cent of the population (Kah, 2017).

We use nationally representative household panel data with global georeferenced conflict data to quantify the effects of terrorism from Boko Haram on livestock production. We use two dimensions of conflict, incidents of terrorism and fatalities from terrorism, to provide more insights into households' livestock production response to different degrees of terrorism exposure. We employ a random-effects Tobit regression estimation strategy and explore the time-varying information in the ongoing terrorism situation, an approach which has limited application in most empirical studies of this nature.

Our findings confirm the destructive effects of terrorism on livestock production in Nigeria, however, households diversify livestock production to cope with conflict. We find that terrorism reduces household herd size, but households with more access to agricultural land may increase cattle herd size only where attacks are associated with fewer fatalities. This study makes two significant contributions to the existing literature. First, it shows that access to agricultural land has a mitigating role in terrorism's effect on livestock production and may help households build resilience. Second, households are likely to build resilience in conflict situations where attacks are associated with fewer fatalities but are likely to abandon land assets and agricultural activities where and when attacks are fatal. This study shows, among others, the imperative of curtailing the severity of conflict among farming communities. It is relevant for designing conflict-sensitive interventions toward sustainable livestock production in Nigeria.

The rest of the paper is structured as follows. The second section provides a background on terrorism in Nigeria and explores existing literature to discuss small-scale livestock production and agricultural land access/use in conflict situations. The third section presents the data and empirical strategy. Results and discussion of findings are presented in the fourth section, while the fifth section concludes by summarizing key findings and drawing implications of the study for policy.

2.2 Background

2.2.1 Overview of terrorism in Nigeria

Nigeria has witnessed a significant rise in armed conflicts since 2009, majorly terrorism – a class of armed conflicts with a notable presence in northeast Nigeria. The act of terrorism from Boko Haram or the Islamic State West Africa stems from an ideology to establish an Islamic state in Nigeria using violence and intimidation to achieve their objectives (Walker, 2012). As of 2019, Nigeria was ranked third in the global terrorism index and recorded the second-largest terrorism-related fatalities worldwide (Institute for Economics & Peace, 2020). Terrorist attacks are often expressed through detonations of an improvised explosive device (IED) in communities and public places and gunfire at civilians by armed non-state actors such as Boko Haram. According to the monitoring estimates of Action on Armed Violence (2021), IEDs accounted for about 92 per cent of civilian deaths and injuries between 2011 and 2020. Terrorism constitutes the most significant threat to Nigeria's farming communities, with severe consequences for food production (Kaila & Azad, 2019).

Armed conflicts in Nigeria are ongoing and have taken different forms, including the activities of Fulani Ethnic Militia (FEM), bandits or "unknown gunmen", perpetrating mass kidnapping for ransom, cattle rustling, and killing of innocent citizens (Chinwokwu & Michael, 2019). Evidecne have shown that these acts of criminalities, abduction for ransom and cattle rustling,

in particular, are partly used by terrorist groups to finance arms purchases (FATF-GIABA-GABAC, 2016; Forest, 2012). For example, there is a high correlation between increasing incidents of cattle rustling in northern Nigeria and the rise in violent attacks from Boko Haram (Okoli, 2019).

Armed conflicts took a new turn in 2009 following a series of attacks by Boko Haram in the northeast, and subsequent clashes between the sect and the Nigerian military led to some government security forces losing their lives (Maiangwa et al., 2012; Walker, 2012). Terrorism and the rise in other forms of armed conflicts are also connected (Monteleone, 2016). These linkages are further reinforced in countries with high economic, political, and social fragility that are often exposed to a vicious circle of conflicts, given their weak institutional and social capacity to prevent reprisal attacks and protect livelihoods (McKay & Thorbecke, 2019).

2.2.2 Small-scale livestock production and agricultural land access/use in conflict situations

In Nigeria, livestock production is dominated by smallholders, mainly in the subsistence crop-livestock production system. The Tropical Livestock Unit (TLU) in Nigeria is 7.4 on average and mainly from cattle, sheep, goats, and poultry (National Bureau of Statistics & World Bank, 2016). Regarding the production system, cattle, sometimes with sheep and goats, are largely reared through pastoralism –free grazing and about 78 per cent of poultry birds are kept in free-range or semi-intensive production systems (FAO, 2018).

Land and livestock are essential assets upon which farmers make production decisions to maximize livelihood outcomes. In Nigeria, however, livestock production is most vulnerable to external factors, chief of which is the rising level of conflicts, including terrorism. Terrorism's effects on the agricultural sector can be classified as direct or indirect (Adelaja & George, 2019a) and transmitted through different channels (Arias et al., 2019), including

disruption to farming operations and supporting services and destruction of farm inputs or outputs. The direct effects of terrorism on cultivated land and livestock assets and labour use or access may cause households to alter their agricultural production behaviour. However, households in conflict situations often adjust production decisions to curtail losses, mitigate production risk, and build resilience (Arias et al., 2019; Rockmore, 2020).

Agricultural land is an essential input in livestock production, which can improve production as land can be used to grow hay or crop for livestock feed or leased out for income to increase farm investment. However, agricultural land use change in terms of abandonment in conflict situations (Baumann et al., 2015), and farmers cultivating previously uncultivated land in farther safer location are often suggested (Eklund et al., 2017). According to the study by Adelaja and George (2019b), household adjusted where and what is cultivated on land by engaging in mixed-farming or crop diversification and expanding farming activities in farther location that are less prone to conflict. Further evidence suggests that households living in conflict region allocate more land to the cultivation of crops like cassava or engage in agroforestry that requires less attention or management (Chauveau & Richards, 2008; Quandt & McCabe, 2017).

The consequences of conflict exposure for land use change are further explained in Adelaja and George (2019b). In their study, they show that households in regions with increased terrorist attacks manage more land size, suggesting that such land may belong to neighbours, friends, and family that have abandoned their farmland. Again, they show that there is fall in the value of land in conflict-prone regions as risk of investment on land increased, which to another plausible reason some households may have more areas of land in their possession. Evidence suggests that risk tolerant farmers may acquire more land, as victims of armed conflicts are more likely to take risks than nonvictims (Fatas et al., 2021), even though Adelaja

and George's study finds no significant relationship between conflict exposure and increase in land purchase in Nigeria.

The broad literature on risk and livelihood activities reveals that livelihood risk perception is associated with livelihood diversification (Block & Webb, 2001). Agricultural production diversification is often a risk mitigation strategy that helps spread risk among alternative production activities to sustain household income, ensure food access, and smooth consumption (Perry et al., 2002). For example, livestock-holding households may diversify livestock production in response to conflict risk. However, the degree of diversification as a strategy for mitigating risk may vary according to the risk-bearing capacities of households vis-à-vis their asset ownership, such as land assets, institutional support services, and perception of conflict risk (Mekuria & Mekonnen, 2018). Households with fewer assets (e.g., small landholders) and lower risk management capacity may be pushed to diversify livestock or settle for species less susceptible to shocks in response to limitations imposed on them by high conflict exposure (Gebreyes et al., 2016). Conversely, livestock diversification may be driven by higher risk-bearing capacity for households with more agricultural assets (Gebreyes et al., 2016).

2.3 Data and empirical strategy

2.3.1 Data

We use data from the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) for Nigeria with a corresponding global georeferenced conflict dataset, the Armed conflicts Location and Event Data (ACLED) covering period from 2010 to 2016. We merge the LSMS-ISA datasets with the ACLED dataset using the households survey

locations (the local government areas – LGAs[3]) and time (year) corresponding to the locations (LGAs) and time (year) of conflict events in the ACLED. The ACLED is the highest quality real-time data that reports on political violence and unrest worldwide (Raleigh et al., 2010). The data records fatalities from conflict, and types of conflict events as violent conflicts (battles, explosions/remote violence, violence against civilians) and non-violent conflicts (riots and protests). From the event types, sub-event types, including detailed information notes, one can distill events further into categories and perpetrators and compute the incidents of conflict events by actors, a method that has been widely used. See for example Dabalen and Paulm (2014), and Adelaja and George (2019). For this present study, we focused on events perpetrated by the Boko Haram terrorist group as the prevailing conflict events in northern Nigeria during the periods this study covers.

The LSMS-ISA is a panel data and nationally representative, being an effort by the World Bank and the Nigeria National Bureau of Statistics (NBS). The survey is in Waves[4]. Wave 1, which started in 2010 were collected in post-planting and post-harvest agricultural seasons, respectively in 2010 and 2011, and consisted of 5,000 households, comprising 66 per cent of agricultural households. We use the agricultural household[5] sub-sample for northern Nigeria with sample sizes of 2,023 in 2010/11 (Wave 1), 1,913 in 2012/13 (Wave 2), and 1,863 in

[3]LGAs are the third tier of government next to the states as administrative units in Nigeria. There are 774 LGAs in Nigeria across the 36 states including the Federal Capital territory in Abuja.

[4]We exclude Wave 4 (2018/2019) in this study, as insecurity in the locations and displacement of more households in the baseline necessitated a sample redesigning, returning less than 30 per cent of the base households in the panel.

[5]An agricultural household is a household with livestock and/or agricultural land with some under cultivation.

2015/16 (Wave 3). The LSMS-ISA has detailed information on livestock ownership and is integrated with a wide range of household socioeconomic characteristics.

2.3.1.1 Measurement of livestock production and the main determinants

Measurement of livestock production

We employ two dimensions of livestock production decisions as our outcome variables. First is the herd size, measured by the Tropical Livestock Unit (TLU), which describes livestock numbers across species and indicates the total livestock owned in kilograms. We measure the herd size of cattle and small livestock (sheep, goats, and poultry) separately. The TLU calculation involves assigning a score of 1.0 TLU to a single animal weighing 250 kg, thereby generating a weighting factor for each animal (Jahnke & Jahnke, 1982). The number of each species of animal owned by the household is multiplied by the animal TLU coefficient. Studies have shown that TLU is a valuable proxy for household economic status, food security and resilience in most shock situations (Ducrotoy et al., 2017).

The second dimension of livestock production is the livestock diversification index (LDI), which we derived using the Herfindahl Index (HI) as used by Pal and Kar (2012). The value of livestock species owned by the households is provided in the data, and the share in the total value of livestock own by each household is calculated as follow: $S_k = \frac{R_k}{\sum_{k=1}^{n} R_k}$, where S_k is the share for the k^{th} value of livestock species in the total for all value of livestock own by household. The value for the k^{th} livestock for a sample household represented as R_k; and $\sum_{k=1}^{n} R_k$ is the total value from livestock k=1, 2,…, n represents number of species own. Given the HI to be: $HI_L = \sum_{k=1}^{n} S_k^2$. From the HI_L we compute the Simpson Diversity Index (SDI) to represent our LDI as: SDI=1–HI_L., where HI_L is the computed Herfindahl Index. The LDI gives the extent of diversification with a high level of diversification tending towards one (1) and specialisation tending towards zero (0). Using this index provides a more accurate measure of

livestock diversification than the number of livestock species produced by the household (Murendo et al., 2019).

Measurement of terrorism

Terrorism from Boko Haram is measured using three indicators. First, households that live in the LGAs where at least one terrorist attack from Boko Haram happed within a year are exposed to terrorism, hence *exposure to terrorism* is a binary variable that takes the value of one (1) if a household is exposed to terrorism and zero (0) if not. We employ this variable in the descriptive analysis. Second is the *incidents of terrorism* variable, captured by the number of terrorist attacks within a year in an LGA, and measures conflict intensity. Third is the *fatalities from terrorism* variable which measures conflict severity, and it represents the number of casualties attributed to terrorism within a year in an LGA. The last two measures are employed in the empirical analysis as continuous variables. Employing these two conflict measures could provide additional insights into household livestock production response to different degrees of terrorism. Some other studies have used different measures of conflict to show their effect on agricultural production, but with mixed results (Adelaja & George, 2019a; Arias et al., 2019; Rockmore, 2011). However, employing these measures as determining factors in livestock production may yield different results.

Measurement of agricultural land access

The agricultural land access variable is proxied by the total agricultural land size (including plots cultivated, fallow, or pastureland) presently owned or managed by households. We adopt the definition of agricultural land access in Brück and Schindler (2009) which consider land access as the ability of a household to claim a parcel of land for current productive use or as fallow for future cultivation or usage. Therefore, in our definition, the more land size owned or managed by a household, the more land access the household has. However, this may not

necessarily mean physical access in conflict situations. Nevertheless, it is worth investigating whether such land access still influences farming household livestock production decisions through direct use of land for grazing or indirectly through crop/hay production for feed and capital accumulation.

Other control variables

As informed by literature, other variables that may influence livestock production decisions are added to our empirical estimations as controls. One of these variables is family labour supply, as proxied by the number of household members disaggregated by age categories (35 years and above, 18-35 years, below 18 years old). Other variables are access to extension advice, education of household head, women decision making on income and assets ownership computed as share of women in the household, and household economic status using wealth index[6]. We also include rainfall variable as livestock production could respond well to optimal rainfall as it increases the chances that livestock will have adequate access to water and feeds/folders. The geographical locations where households live are also controlled for. Household distance to the nearest population centre was used to proxy for household location in rural or urban, and the geopolitical regional dummies are used to control for geographical heterogeneity in livestock production. Variables used and descriptions are in Table 2.1

[6]The wealth index is measured as the first principal component of indicators of household assets (see Rutstein & Johnson, 2004). We compute wealth index using principal components analysis on variables such as the type of materials use for housing–wall material, roofing material, and flooring material; ownership of car, motor-bike, bicycle, sewing machine, furniture, generator, mattress, fan, radio, cassette recorder, television set, iron, DVD player, refrigerator, mobile phone, wheelbarrow, cutlass, and hoe; and the use of or access to public facilities like water, electricity, and refuse disposal.

Table 2.1. Description of variables used for analysis

Variable	Units	Description
Livestock production outcomes		
TLU of cattle	TLU	Tropical Livestock Unit (TLU) of cattle
TLU of small livestock	TLU	Tropical Livestock Unit (TLU) of small livestock (sheep, goat, and poultry)
Livestock diversification index	TLU	Livestock Diversification Index (LDI)
Explanatory variables		
Exposure to terrorism	Binary	1 if household lives in LGA that experienced at least 1 terrorist attack within the past 12 months preceding the survey month
Incidents of terrorism	Number	The total number of terrorist attacks in LGA within the past 12 months preceding the survey month
Fatalities from terrorism	Number	The total number of deaths attributed to terrorist attacks in LGA within the past 12 months preceding the survey month
Land size	Hectares	Total agricultural land available to a household in hectares (cultivated, fallow/pasture)
Control variables		
Access to extension services	Binary	1 if household received extension advice on animal care & diseases
Adult household members	Number	Number of household members above 35 years old
Youth household members	Number	Number of household members 18-35 years old
Children household members	Number	Number of household members less than 18 years old
Wealth index	Index	Wealth index calculated from durable assets owned, excluding livestock and land
Household head education	Year	Years of education completed by the household head
Women decide on income	Share	Share of women in the household that participated in decision on household income
Women own assets	Binary	1 if women own any of these assets – crop, animal, and household assets
Annual rainfall	Millimeters	The average 12-month total rainfall (mm) in Jan-Dec, starting January to December
Household distance to population center	Kilometers	Household Distance in (kms) to nearest population centre with +20,000
Northcentral region	Binary	1 if household is in Northcentral
Northeast region	Binary	1 if household is in Northeast
Northwest region	Binary	1 if household is in Northwest

Source: Author.

2.3.2 Empirical strategy

This section presents the empirical strategy for modelling the relationship between terrorism, land access, and livestock production decisions. The following hypotheses are tested. Hypothesis 1: terrorism decreases herd size of cattle, and small livestock, but the effect varies with land access. Hypothesis 2: terrorism increases livestock diversification, but the effect varies with land access. Hypothesis 3: incidents of terrorism cause households to adjust livestock production differently from fatalities from terrorism.

2.3.2.1 Regression model

Our hypotheses are tested using random-effects Tobit model. Tobit regression is appropriate for a corner solution outcome variable such as we have in our dependent variables, which have a censored distribution with a finite probability of a zero outcome and a normal distributed positive value. Also, due to the panel nature of our data, ordinary least squares and fixed effects estimation will fail to yield an unbiased estimation of the model. However, random-effects assumes that the unobserved time-invariant random component of the model is unrelated to the regressors, which is useful for estimating the values of the time-invariant coefficients in our model. The model is thus specified:

$$Y_{hlt} = \beta_0 + \beta_1 terrorism_{lt} + \beta_2 landsize_{hlt} + \beta_3 terrorism_{lt} * landsize_{hlt} + \beta_4 X_{hlt} + \mu_h + \varepsilon_{hlt} \dots (1)$$

where Y_{hlt} represents the three outcome variables; TLU of cattle (cattle herd size), TLU of small livestock (small livestock herd size), and LDI (livestock diversification index) of household (*h)* in LGA (*l*) at time (*t*), with each outcome regressed separately in the model. These outcomes are explained by $landsize_{hlt}$, and $terrorism_{lt}$, which entered the models as either fatalities from terrorism or incidents from terrorism. Other control variables include a set of household and regional characteristics captured in vector X_{hlt}. The household random effect is μ_h, and ε_{hlt} is the error term.

2.4 Results and discussion

2.4.1 Descriptive results

In Table 2.2, the summary statistics results of our variables show the mean comparison between households that are exposed to terrorism and those that are not. About 23 per cent of the households are exposed to terrorism, out of which 38 per cent are in the northcentral and 40 per cent are in the northeast. Households not exposed to terrorism own more cattle (average of

1.97 TLU) than households in locations that are exposed to terrorism, with an average of 0.99 TLU. The result further shows that households that are exposed to terrorism have an average of 0.63 TLU for small livestock, a little higher than the TLU in areas with no terrorism. There are some theoretical underpinnings to support the findings. For example, some studies suggest that livestock keepers diversify livestock production to species that are less susceptible to conflict shocks and constitute less burden to manage (Arias et al., 2019).

We present the violin plots (Figure 2.1) of livestock diversification of households that are exposed to terrorism and those not exposed to terrorism using a density plot function – a rotated and smoothed histogram. Violin plots show the shapes (density plot) of the LDI for the two categories of households, and the summary statistics. The width of the density plot shows how frequently the value occurs in the dataset. Thus, the broader regions represent values that occur more frequently which is between 0 and 0.1 and represents the first quartile regions, while values in the narrow regions occur less frequently, third quartile regions. The median is represented by the white dot in the centre of the box, while the length of the box is the interquartile range, and the line protruding outside the box is the range. The results show more skewness in the distribution of the median and quantiles of livestock diversification for population not exposed to terrorism toward high level of species specialization than those exposed to terrorism, and respectively having a mean of 0.13 and 0.17, as shown in Table 2.2.

Also, households that are exposed to terrorism have less access to agricultural land and extension services as compared to their counterparts in no conflict locations. There are also more educated heads, more adult members, and more women owning asset and deciding on income in locations under terrorist attacks than areas with no attacks.

Table 2.2. Summary statistics of variables used for analysis (2020 to 2016)

	Pooled		Not exposed		Exposed		Mean
	Mean	SD	Mean	SD	Mean	SD	difference
Dependent variables							
TLU of cattle (index)	1.75	9.04	1.97	10.00	0.99	4.32	-0.98***
TLU of small livestock (index)	0.61	0.96	0.60	0.97	0.63	0.94	0.03
Livestock diversification (index)	0.15	0.19	0.13	0.18	0.17	0.19	0.04***
Explanatory variables							
Exposure to terrorism (1/0)	0.23						
Incidents of terrorism (number)	0.59	2.13					
Fatalities from terrorism (number)	3.29	16.00					
Land size (hectare)	2.24	3.35	2.32	3.49	1.93	2.76	-0.39***
Access to extension services (1/0)	0.29		0.30		0.23		-0.07***
Adult household members (number)	1.48	1.05	1.46	1.03	1.54	1.11	0.08**
Youth household members (number)	1.48	1.18	1.45	1.12	1.58	1.37	0.14***
Children household members (number)	5.03	3.07	5.03	3.07	5.03	3.06	-0.00
Wealth index (index)	-0.77	1.93	-0.87	1.86	-0.44	2.15	0.43***
Household head years of education (year)	8.73	5.81	8.44	5.74	9.74	5.95	1.30***
Women decide on income (share)	0.09	0.14	0.08	0.14	0.11	0.15	0.02***
Women own assets (1/0)	0.57		0.55		0.62		0.07***
Annual rainfall (mm)	979.16	286.49	955.69	282.16	1059.81	286.70	104.13***
Household distance to population center (km)	31.05	21.17	31.26	21.32	30.32	20.66	-0.94*
North-central region (1/0)	0.29		0.26		0.38		0.12***
North-east region (1/0)	0.32		0.30		0.40		0.11***
North-west region (1/0)	0.39		0.44		0.21		-0.22***
Sample size	5,753 (4,487)		4,456 (3,532)		1,297 (955)		

Source: Author.

Note: The significance of the mean difference in characteristics between households that are exposed to terrorism and those not exposed are based on independent sample t-tests for continuous variables and Pearson chi-square test for categorical variables. Sample size in parentheses is for livestock holding households used for analysing livestock diversification. *** p<0.01, ** p<0.05, * p<0.1 denote significance at 1%, 5% and 10% levels respectively. SD is the standard deviation.

Figure 2.7. Violin plots of Livestock Diversity Index by terrorism exposure

Source: Author.

2.4.2 Regression results and discussion

In this section, we report the regression results of the joint effects of terrorism and land access on livestock ownership patterns in Tables 2.3, 2.4 and 2.5 which respectively represent the results with cattle herd size (TLU), small livestock herd size (TLU), and livestock diversification index as dependent variables. We also discuss key findings. The Tables present both the regression coefficients and the coefficients of the corresponding Average Marginal Effects (AME), results which we report and discuss. AME is estimated by calculating marginal effects for every observation in the sample and then averaging across the effects. In all the Tables, we first present models without the interaction of terrorism and land access (Models 1 and 2), before presenting our main model specification in Eq. (1) in Models 3 and 4, which estimates the joint effect of terrorism and land access on livestock production decisions. The Models are also distinguished by their choice of terrorism measure. Models 1 and 3 employ incidents of terrorism, while Models 2 and 4 employ fatalities from terrorism. Next, we graphically present in Figure 2.2 the results of the AME from Eq. (1) estimates for intuitive interpretation of the findings.

Results in Table 2.3 show that an increase in incidents of terrorism reduces the TLU of cattle by 0.281 (Model 1) and by 0.223 (Model 3) when households have access to land, but no significant effect on the TLU of small livestock as shown in Table 2.4. However, an increase in fatalities from terrorism significantly reduces cattle herd size (Table 2.3) and small livestock herd size (Table 2.4) regardless of whether households have access to land. In the study by George, Adelaja and Awokuse (2021) in Nigeria, fatalities from farmer-herder conflict have no significant effect on total livestock herd size but showed a negative effect on cattle herd size. Their finding is relatable as conflict between farmers and herders is an attack on cattle and may not affect small livestock species, unlike fatalities from the Boko Haram terrorist that have direct and indirect effects on livestock production (Adelaja & George, 2019a).

Some other studies also found that conflicts significantly reduced livestock herd size across livestock species (Anne-Judith & Kinsumba, 2019; Okafor, & Chikalipah, 2021; Rockmore, 2011; Verpoorten, 2009). However, these studies do not show how access to land may mitigate such an effect. We find that access to land remains positive in Table 2.3 after the interaction with incidents of terrorism and increases the TLU of cattle by 0.004 (Model 3). The statistically significant negative effect of terrorism on livestock herd size follows the direction of results in our descriptive analysis and the tested hypotheses. The results also show that fatalities from terrorism have more substantial adverse effects on cattle and small livestock herd size than incidents from terrorism.

We further understand from Figure 2.2 that the negative effect of incidents of terrorism (Panel A left) on cattle production attenuates in the positive direction as land access increases. In contrast, the negative effect of fatalities (Panel A right) on cattle production deepens as land access increases. Further in Panel B, access to agricultural land plays no significant role in mitigating the effect of terrorism on small livestock production. Even though small livestock may not require much land as cattle, access to land may indirectly contribute to small livestock production through crop residue.

In Table 2.5, the results of livestock diversification show that an increase in the incidents of terrorism increases livestock diversification index by 0.008 (Model 1) and 0.01 (Model 4) as household have more access to land, while there is significant relationship between increase in fatalities and livestock diversification. Our result agrees with past studies that show conflict exposure pushes households to diversify livestock production to multiple species of small livestock to spread risk (e.g., Perry et al. 2002). Furthermore, result in Figure 2.2 (Panel C left) shows that increased incidents of terrorism increases livestock diversification at increased land size, while increased fatalities from terrorism has no such effect on livestock diversification

(Panel C right). In other words, households' decision to diversify livestock production is predicated on their gaining more access to agricultural land in conflict situation.

Our findings suggest that households may have physical access to their land for livestock production only when the experience of terrorism is not fatal; otherwise, they have limited physical access to land. In addition, studies have shown that an increase in the severity of conflict resulted in land abandonment (Gorsevski et al., 2012). This result further suggests that increased fatalities from terrorism in our study locations made households abandoned land that could have supported livestock production. Thus, we posit that high fatalities from conflict is a better measure for understanding the severity of conflict rather than the number of events, as a single event may be more destructive and record more causalities than ten events.

Some other factors also determine livestock production decisions with statistical significance. Access to extension services, household members across age groups, and women participating in major household decisions are positively associated with livestock production. Location far away from population centre is associated with increased cattle production, while ownership of assets by women and rainfall positively determines small livestock production. Household durable assets (wealth index) are negatively associated with livestock production and diversification, which may be because of the exclusion of land and livestock assets that represent the main household wealth assets in the computation of the wealth index. Household locations in the north-central and those with educated head are negatively associated with livestock production. Furthermore, increased years of education of household head, household members across age groups, women's assets ownership and decision on household income, rainfall, and household distance to population centre are positively associated with livestock diversification. Whereas access to extension services and being in either northcentral or

northeast region as against locations in the northwest are negatively associated with livestock diversification.

Those variables exhibiting positive associations with livestock production decisions could help households build resilience for sustainable livestock production, which should be encouraged or protected. Likewise, the negative coefficients of access to extension services, and locations in the northcentral and northeast suggest that receiving extension services and being in the northcentral and northeast are associated with livestock species specialisation. Providing agricultural extension services to farmers is a crucial factor in agricultural production (Owens, Hoddinott, & Kinsey, 2003). The role of quality institutions in providing livelihood-enhancing services such as quality extension services to farmers cannot be over-emphasized in the light of some recent evidence linking institution quality to adequate food production in SSA (Cassimon et al., 2021; Ogunniyi et al., 2020). This argument is also valid for providing rural infrastructure and security to protect the lives and livelihoods of agricultural households.

Table 2.3. Results of the relationship between terrorism, land access and cattle herd size

	Random Effects Tobit estimates				Average Marginal Effects (AME)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Incidents of terrorism	-1.450**		-2.654***		-0.281**		-0.223*	
	(0.626)		(0.806)		(0.122)		(0.130)	
Fatalities from terrorism		-0.109***		-0.097**		-0.021***		-0.022***
		(0.040)		(0.049)		(0.008)		(0.009)
Incidents of terrorism*Land size			0.602***					
			(0.212)					
Fatalities from terrorism*Land size				-0.007				
				(0.019)				
Land size	0.178*	0.179*	0.075	0.186*	0.034*	0.035*	0.039*	0.033
	(0.108)	(0.108)	(0.114)	(0.109)	(0.020)	(0.021)	(0.021)	(0.021)
Access to extension services	6.178***	6.211***	6.281***	6.199***	1.196***	1.202***	1.215***	1.200***
	(0.813)	(0.813)	(0.814)	(0.814)	(0.161)	(0.161)	(0.161)	(0.161)
Adult household members	2.429***	2.439***	2.422***	2.439***	0.473***	0.475***	0.471***	0.475***
	(0.417)	(0.417)	(0.417)	(0.417)	(0.082)	(0.082)	(0.082)	(0.082)
Youth household members	1.947***	1.958***	1.917***	1.960***	0.378***	0.380***	0.372***	0.381***
	(0.380)	(0.381)	(0.381)	(0.381)	(0.075)	(0.075)	(0.075)	(0.075)
Children household members	0.456***	0.450***	0.441***	0.451***	0.089***	0.087***	0.086***	0.088***
	(0.147)	(0.147)	(0.147)	(0.147)	(0.029)	(0.029)	(0.029)	(0.029)
Wealth index	-2.114***	-2.085***	-2.073***	-2.086***	-0.408***	-0.403***	-0.400***	-0.403***
	(0.293)	(0.293)	(0.294)	(0.293)	(0.059)	(0.059)	(0.059)	(0.059)

Household head years of education	-0.582***	-0.584***	-0.585***	-0.583***	-0.113***	-0.114***	-0.114***	-0.113***
	(0.082)	(0.082)	(0.082)	(0.082)	(0.016)	(0.016)	(0.016)	(0.016)
Women decide on income	27.343***	27.534***	27.232***	27.527***	5.326***	5.360***	5.299***	5.359***
	(2.489)	(2.492)	(2.490)	(2.491)	(0.503)	(0.504)	(0.503)	(0.504)
Women own assets	0.328	0.378	0.361	0.376	0.056	0.066	0.062	0.065
	(0.791)	(0.792)	(0.791)	(0.792)	(0.154)	(0.154)	(0.154)	(0.154)
Annual rainfall	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to population center	0.061***	0.060***	0.061***	0.060***	0.012***	0.012***	0.012***	0.012***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.004)	(0.004)	(0.004)	(0.004)
North-central region	-3.618***	-3.569***	-3.565***	-3.571***	-0.686***	-0.677***	-0.675***	-0.677***
	(1.326)	(1.326)	(1.327)	(1.326)	(0.259)	(0.259)	(0.259)	(0.259)
North-east region	0.876	0.819	0.808	0.834	0.172	0.161	0.159	0.164
	(1.057)	(1.051)	(1.059)	(1.052)	(0.206)	(0.205)	(0.206)	(0.205)
Constant	-29.374***	-29.413***	-28.762***	-29.458***				
	(2.294)	(2.294)	(2.303)	(2.298)				
Observations	5,799	5,799	5,799	5,799				
Number of households	2,148	2,148	2,148	2,148				
Log likelihoods	-7408	-7406	-7404	-7406				
Chi-squared	428.5	429.1	432.8	429.3				

Source: Author.

Note: Standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 2.4. Results of the relationship between terrorism, land access and small livestock herd size

	Random Effects Tobit estimates				Average Marginal Effects (AME)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Incidents of terrorism	-0.015		-0.018		-0.009		-0.008	
	(0.020)		(0.024)		(0.013)		(0.014)	
Fatalities from terrorism		-0.002**		-0.002*		-0.002**		-0.002**
		(0.001)		(0.001)		(0.001)		(0.001)
Incidents of terrorism*Land size			0.002					
			(0.009)					
Fatalities from terrorism*Land size				-0.000				
				(0.000)				
Land size	0.015***	0.015***	0.014***	0.015***	0.008***	0.008***	0.009***	0.008***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
Access to extension services	0.331***	0.329***	0.331***	0.329***	0.199***	0.198***	0.199***	0.198***
	(0.034)	(0.034)	(0.034)	(0.034)	(0.021)	(0.021)	(0.021)	(0.021)
Adult household members	0.098***	0.098***	0.098***	0.098***	0.061***	0.061***	0.061***	0.061***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.010)	(0.010)	(0.010)	(0.010)
Youth household members	0.057***	0.058***	0.057***	0.058***	0.035***	0.035***	0.035***	0.035***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.009)	(0.009)	(0.009)	(0.009)
Children household members	0.027***	0.027***	0.027***	0.027***	0.016***	0.016***	0.016***	0.016***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)
Wealth index	-0.065***	-0.063***	-0.065***	-0.064***	-0.038***	-0.037***	-0.038***	-0.037***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.006)	(0.006)	(0.006)	(0.006)
Household head years of education	-0.004	-0.004	-0.004	-0.004	-0.002	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)

Women decide on income	2.196***	2.209***	2.195***	2.209***	1.350***	1.357***	1.349***	1.358***
	(0.107)	(0.107)	(0.107)	(0.107)	(0.066)	(0.066)	(0.066)	(0.066)
Women own assets	0.426***	0.428***	0.426***	0.428***	0.264***	0.265***	0.264***	0.265***
	(0.032)	(0.032)	(0.032)	(0.032)	(0.020)	(0.020)	(0.020)	(0.020)
Annual rainfall	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to population center	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
North-central region	-0.235***	-0.231***	-0.234***	-0.231***	-0.140***	-0.137***	-0.139***	-0.137***
	(0.049)	(0.049)	(0.049)	(0.049)	(0.030)	(0.030)	(0.030)	(0.030)
North-east region	-0.023	-0.016	-0.023	-0.016	-0.013	-0.008	-0.013	-0.008
	(0.043)	(0.043)	(0.043)	(0.043)	(0.027)	(0.027)	(0.027)	(0.027)
Constant	-0.777***	-0.777***	-0.775***	-0.778***				
	(0.086)	(0.086)	(0.087)	(0.086)				
Observations	5,799	5,799	5,799	5,799				
Number of households	2,148	2,148	2,148	2,148				
Log likelihoods	-7475	-7472	-7475	-7472				
Chi-squared	1059	1065	1060	1065				

Source: Author.

Note: Standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 2.5. Results of the relationship between terrorism, land access and livestock diversification

	Random Effects Tobit estimates				Average Marginal Effects (AME)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Incidents of terrorism	0.016**		0.008		0.008**		0.010**	
	(0.008)		(0.009)		(0.004)		(0.004)	
Fatalities from terrorism		-0.000		-0.000		-0.000		-0.000
		(0.000)		(0.000)		(0.000)		(0.000)
Incidents of terrorism*Land size			0.005					
			(0.003)					
Fatalities from terrorism*Land size				-0.000				
				(0.000)				
Land size	-0.002	-0.002	-0.003*	-0.002	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Access to extension services	-0.048***	-0.049***	-0.047***	-0.049***	-0.024***	-0.025***	-0.024***	-0.025***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.006)	(0.006)	(0.006)	(0.006)
Adult household members	0.025***	0.025***	0.025***	0.025***	0.012***	0.012***	0.012***	0.012***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
Youth household members	0.020***	0.020***	0.020***	0.020***	0.010***	0.010***	0.010***	0.010***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
Children household members	0.004**	0.004**	0.004**	0.004**	0.002**	0.002**	0.002**	0.002**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Wealth index	-0.021***	-0.020***	-0.020***	-0.020***	-0.010***	-0.010***	-0.010***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Household head years of education	0.002*	0.002*	0.002*	0.002*	0.001*	0.001*	0.001*	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Women decide on income	0.543***	0.549***	0.541***	0.549***	0.270***	0.273***	0.269***	0.273***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.018)	(0.018)	(0.018)	(0.018)

Women own assets	0.093***	0.093***	0.093***	0.093***	0.046***	0.046***	0.046***	0.046***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.006)	(0.006)	(0.006)	(0.006)
Annual rainfall	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to population center	0.001***	0.001***	0.001***	0.001***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
North-central region	-0.135***	-0.134***	-0.135***	-0.134***	-0.067***	-0.067***	-0.067***	-0.067***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.007)	(0.007)	(0.007)	(0.007)
North-east region	-0.066***	-0.060***	-0.067***	-0.060***	-0.033***	-0.030***	-0.033***	-0.030***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.006)	(0.006)	(0.006)	(0.006)
Constant	-0.252***	-0.251***	-0.247***	-0.251***				
	(0.029)	(0.029)	(0.029)	(0.029)				
Observations	4,487	4,487	4,487	4,487				
Number of households	1,947	1,947	1,947	1,947				
Log likelihoods	-2012	-2014	-2011	-2014				
Chi-squared	563.2	559.4	565.2	559.5				

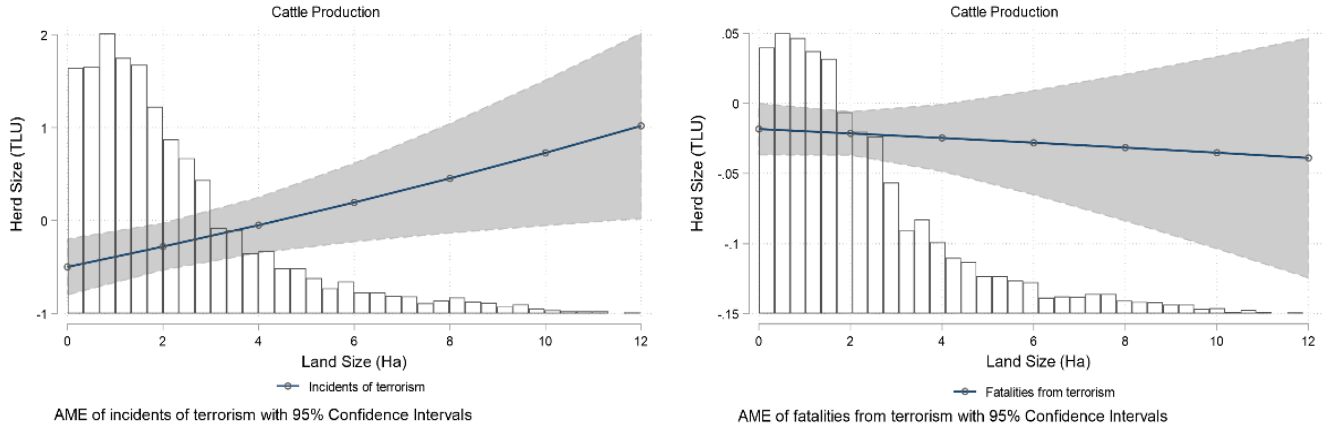
Source: Author.

Note: Standard errors in parentheses.

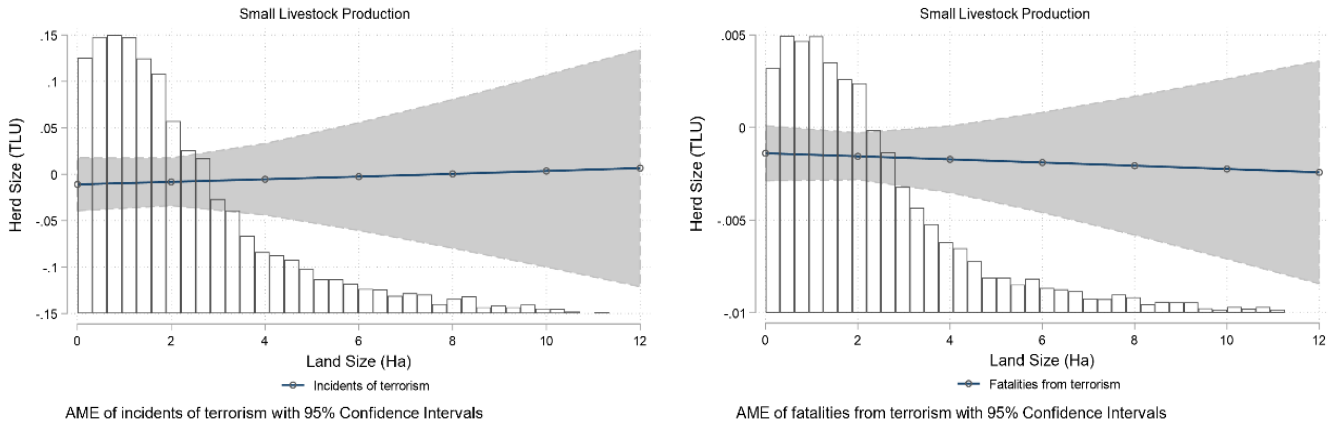
Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Figure 2.8. Average Marginal Effects of the relationship between terrorism, land access and livestock production decisions

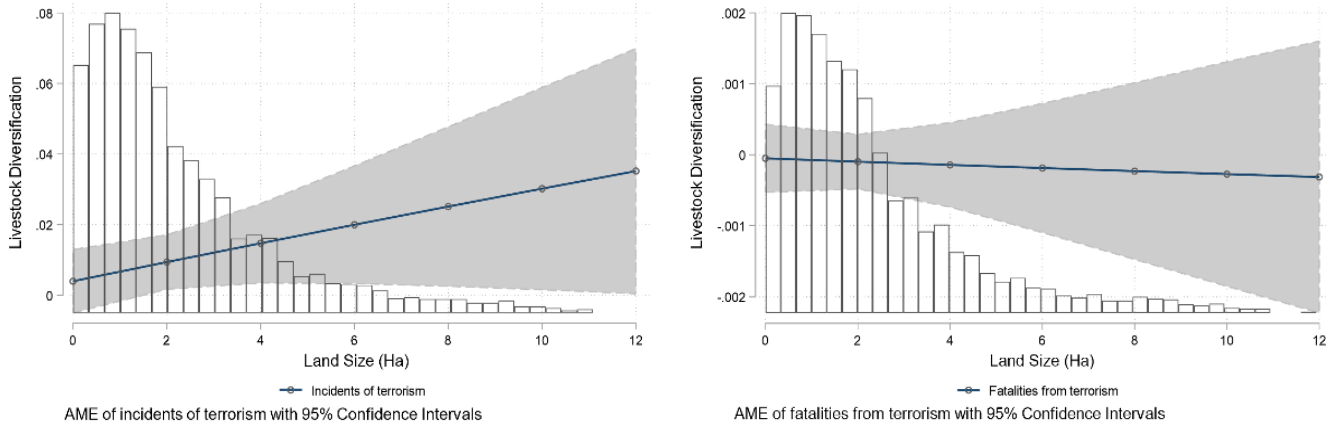
Panel A. Relationship between terrorism, land access and cattle herd size



Panel B. Relationship between terrorism, land access and small livestock herd size



Panel C. Relationship between terrorism, land access and livestock diversification



Source: Author.

2.5 Conclusion

Livestock production is an integral part of the livelihoods of many households around the developing world. It plays a major role in food and nutrition security and the general well-being of farming households. However, rising armed conflicts, especially in SSA presents a significant threat to the sustainability of livestock production in the region. In this paper, we employ a panel data econometric strategy to examine the effect of terrorism on livestock production decisions and the role access to agricultural land play in sustaining livestock production in conflict situations. This study confirms previous findings on the destructive effect of conflict on livestock production. It, however, further shows that access to agricultural land is an essential factor that needs to be maintained to sustain livestock production in conflict

situations. We also demonstrate that larger land availability is not associated with increased livestock production when the households are in LGAs where there are high fatalities due to terrorism. A plausible explanation for this may be the abandonment of land in such areas or lack of physical access to land in conflict affected LGAs. Evidence presented in this study is limited in the literature and may be of interest to policy researchers to substantiate. Among other contributions, this study shows the imperative of curtailing the severity of conflict among farming communities.

Government should make an effort toward curtailing the spread of conflicts, given their negative impact on livestock livelihoods, as highlighted in the study. This study also suggests designing conflict-sensitive livestock-related interventions in protracted conflict. One of such could be the promotion of small livestock production such as family poultry, rabbitry, and other livestock species that are less vulnerable to destruction during conflict. In addition, specific humanitarian intervention should be prioritized for livestock-holding households who may be unable to bounce back due to the severity of conflict on their livestock assets. With the rising middle-income class and African population, the demand for animal source foods has increased. Nigeria, being the most populous country in Africa, is a critical player in the demand and supply of livestock products. Hence, strategies for sustaining livestock production will position Nigeria to leverage the substantial livestock market for its economic growth.

Chapter III

Livestock diversification mitigates the impacts of farmer-herder conflict on animal-source foods consumption in Nigeria[7]

[7] This chapter was summited to *Food Policy* on 22nd October 2022 and now under Required Reviews Completed status.

Authorship contribution statement:

Olusegun Fadare made substantial contributions which include conceptualization of research ideas, data curation and analysis, investigation, and methodology, and writing the original draft, review, and editing, including responding to reviewers' comments in the peer-reviewed process. **Giacomo Zanello** and **Chittur Srinivasan** made contributions in the areas of research conceptualization, funding acquisition, resources, supervision, validation, review, and editing.

Abstract

The agricultural production and livelihood outcomes in Nigeria are threatened by the ongoing farmer-herder conflict. However, households that possess resilient capacities may be able to mitigate the negative impacts of this conflict. In this study, we explore the impacts of farmer-herder conflict on the consumption of animal-source foods and investigate the extent to which livestock diversification can serve as a mitigating factor. Using longitudinal data from Nigeria and a global georeferenced conflict dataset, we utilize difference-in-differences and event study design approaches to establish a causal relationship. Our findings indicate that exposure to the farmer-herder conflict leads to a reduction in the quantity of animal-source foods consumed by households and an increase in the number of days in which households exclude animal-source foods from their diets. However, we also find that livestock diversification has a positive impact on the quantity of animal-source food consumed by households. By shedding light on the role of livestock diversification in mitigating the impacts of the farmer-herder conflict on household nutrition, our research provides policymakers and practitioners with important insights into potential strategies for building nutrition resilience in conflict-affected areas.

Keywords: Conflict mitigation, livestock assets, climate shocks, seasonality, coping strategies, nutrition security

3.1 Introduction

Nutrition indicators globally are slowly improving owing to the commitments of the Sustainable Development Goals 2030 (FAO et al., 2019). However, there is a significant decline in food consumption and nutrition quality in the developing world, partly attributed to concurrent shocks from climate change, the recent covid-19 pandemic, and resultant conflicts with limited resilience capacity (Jayne et al., 2021; Brück, d'Errico, & Pietrelli, 2019). For example, conflict-affected countries are homes to about 75% of the world's malnourished children and are concentrated in Africa (FAO et al., 2019). The region where improvements in nutrition indicators, particularly child stunting and anaemia in women of reproductive age (WRA), have been stalled since 2015 (Micha et al., 2020). The retrogression in these nutrition indicators is suggestive of the negative impacts of the escalating conflict situations in Africa (Raleigh, 2019).

In recent years, the rise in conflicts between settled farmers and nomadic herders in West and Central Africa, resulting primarily from competition for scarce land and water resources for both parties' interests, is also of significant importance (Brottem, 2021; ICG, 2017). Growing exploratory literature suggests farmer-herder conflict's destructive impacts on the food systems. A few empirical studies have also emerged in recent times, investigating farmer-herder conflict impact on agricultural production (George, Adelaja, & Awokuse, 2021; Nnaji et al., 2022a), food security (Nnaji et al., 2022b), and household welfare in general (Kaila & Azad, 2019). Evidence from these studies is important in quantifying the destructive impacts of farmer-herder conflict on food security and nutrition. However, it is limited in scope to advance policy on the nutritional needs of the exposed households, a gap also identified in studies employing conflict perpetrated by other actors.

In a broader view of armed conflicts, only a few studies have analysed conflict impacts on such indicators as dietary diversity (e.g., Baliki, Brück, & Stojetz, 2018; Dabalen & Paul, 2014; George, Adelaja, & Weatherspoon, 2020; Tranchant, Gelli, & Masset, 2021), a good proxy for household nutrition. Nevertheless, a thoughtful focus on specific food groups of high nutritional value for women and children, such as animal-source food (ASF), is perhaps more relevant for nutrition programming, especially in the farmer-herder conflict context. Also relevant in this context is the nutritional importance of small-scale livestock production in improving household ASF consumption in many countries in Africa (Kumar et al. 2015).

Animal-source food contains the best micronutrients needed by WRA and the child's optimal growth from conception to second year birthday (World Health Organization, 2004). Limited intakes of micronutrients have long-term negative consequences for the child's cognitive development (Black, 2003). Hence, evidence from this study will throw light on the depth of nutritional deprivation for women and children in conflict situations and accentuate ASF as an essential pathway linking conflict to poor child health outcomes (Bageant, Liu, & Diao, 2016; Kim, 2019; Le & Nguyen, 2020; Le, 2021; Acharya et al., 2020).

Furthermore, the extant literature on conflict and food security nexus is limited in providing evidence on strategies for mitigating conflict's effect on food security and nutrition. More importantly, in understanding the role of livestock diversification. This evidence needs to be developed to improve policy recommendations for conflict mitigation, food security, and nutrition resilience. Based on these identified gaps in the literature, we set our research objectives using data from Nigeria, a country with the highest number of fatalities from farmer-herder conflict globally (Brottem, 2021) with significant challenges for women and children nutrition (FAO et al., 2019; Micha et al., 2020). We examine the impact of farmer-herder

conflict on ASF consumption while examining the mitigating impact of livestock diversification.

Understanding the relationship of concern in this study is important for several reasons. First, conflict actors are driven differently, and their impact on various well-being indicators, including food security and nutrition, may vary by the perpetrators (Kaila & Azad, 2019). Second, the rise in farmer-herder conflict may disproportionately affect livestock-holding households (see Fadare, Zanello, & Chittur, 2022; George, Adelaja, & Awokuse, 2021) and disrupt the animal-source food systems. Thus, increasing the number of people who would exclude ASF from their diets. Lastly, livestock diversification is shown to increase resilience for food security and nutrition of agricultural households around the developing world (Khonje et al., 2022). This evidence is important in conflict context for policy action (Kray et al., 2018). This study will provide such evidence to advance studies that have suggested livestock diversification as conflict mitigation strategy (Fadare, Zanello, & Chittur, 2022).

Empirically investigating conflict impact on food security and nutrition presents significant methodological challenges in identifying causal effects (Brück et al., 2016). Also, given the limited availability of longitudinal household-level conflict data, many studies employed cross-sectional data (e.g., Dabalen & Paul, 2014; Nnaji et al., 2022b). The drawback of such analysis is not being able to account for household-level heterogeneity, which to an extent, makes recommendations for policy difficult (Martin-Shields & Stojetz, 2019). Our study overcomes these challenges in several ways. The first is by using a nationally representative household longitudinal dataset with global georeferenced conflict data, covering periods from 2010 to 2016. Essentially, the household level data are collected seasonally, leaving scope for exploring the seasonality dimension in our relationship and for employing a quasi-experimental impact evaluation design with difference-in-differences (DD) and event study estimation strategy.

Using the ACLED dataset for Nigeria from 2009 to 2019, we find patterns that show farmer-herder conflict events peak in post-harvest season and dissipate in post-planting season. Following this outcome, we matched the conflict data with the household-level data, and the post-planting season is pre-treatment, and the post-harvest season is post-treatment. The treatment group are farmer-herder conflict-exposed households and those not exposed are the control group. We then estimate a series of regression models within the framework of DD and event study estimation strategy to isolate the effect of farmer-herder conflict on ASF consumption and the mitigating impact of livestock diversification.

We find a causal relationship between farmer-herder conflict and ASF consumption measured as quantity consumed and ASF consumption coping strategies. Essentially, exposure to farmer-herder conflict reduces ASF consumption by 0.10 and increases the number of days households engaged in ASF consumption coping strategies by between 0.1 and 0.2 days. The results further show that livestock diversification significantly buffers the impact of farmer-herder conflict on the quantity of ASF consumed by 0.096 but has no effect on ASF consumption coping strategies. Our findings have significant implications that suggest farmer-herder conflict-exposed households with limited livestock diversification strategy may experience seasons of malnutrition and micronutrient deficiency. This situation might result from a shortfall in the household food supply associated with the post-planting season. At the same time, the post-harvest season is characterised by high incidents of farmer-herder conflict, which undermine the expected harvest.

This study has important implications for nutrition policy, conflict prevention, and peacebuilding. This is the first study to provide evidence on the nutritional implication of conflicts in the context of farmer-herder conflict and seasonality and provide evidence on livestock diversification mitigating effect using nationally representative data. The evidence

presented will be relevant for strategic humanitarian response and policy on food and nutrition resilience to conflict and agricultural seasonality. This study highlights the need to improve nutrition intervention towards critical months of low ASF consumption for farmer-herder conflict-exposed households. Also suggested is for government to show more commitment towards reducing climate change's effect drivers of farmer-herder conflict. Such commitment may include promoting conflict-sensitive agricultural production systems such as cattle ranching systems and irrigation systems to reduce the effect of prolonged dryness on crop production. Finally, there is evidence to support livestock diversification as a critical pathway in building resilience for nutrition in conflict situations.

The remainder of this paper is organised as follows. Section two provides background on farmer-herder conflict in Nigeria and reviews the empirical literature on the relationship between livestock diversification and household nutrition. Section three presents a conceptual framework for understanding the link between farmer-herder conflict, seasonality, livestock diversification and household nutrition. Section four presents and describes the data. Section five describes the empirical strategy for isolating conflict impact and specifies the empirical models. The results and discussion of key findings are presented in section six. Finally, section seven summarises and concludes the study with some policy implications.

3.2 Background

3.2.1 Farmer-herder conflict development in Nigeria

Evolving exploratory studies have described the farmer-herder conflict as violent competitions between nomadic herders and settled farmers over land and water resource access and use, resulting from trespasses or encroachments destructive to crops and livestock assets and the community resources. Interestingly, farmers and herders in Nigeria have a long history of

harmonious relationships in coordinating resource use and access in mutually beneficial ways (Adigun, 2019; ICG, 2017). However, such mutual understanding is no longer in place.

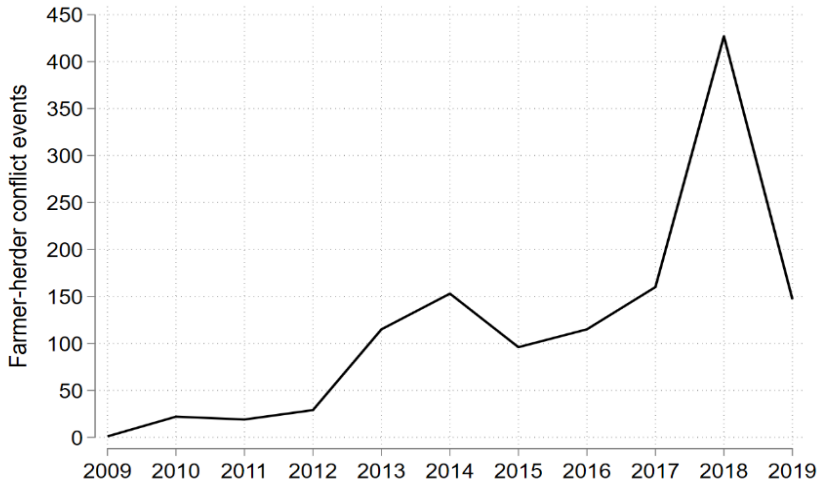
Essentially, in the wake of several interrelated factors, such as population increase and climate change effects, including desertification and land and water resources scarcity, farming has seen expansion along ancient-established grazing routes in recent years. At the same time, herders migrating southward have been in full spate than usual in the past few decades (IOM, 2021). Migrant herders, as a result, engage in violent strive with settled farmers in host communities for land and water for their herds (Olaniyan, Faleye, & Moyo, 2021). This development is a consequential failure on the part of the government to review the established land policy and strengthen land institutions for climate-sensitive land tenure policies.

Containing farmer-herder conflict is significantly mired and complicated by Nigeria's prevailing social and political insecurity and terrorism. For example, the insurgency in the north-east and banditry in the north-west regions of Nigeria, regions characterised by extreme temperature, intersecting with the impacts of climate change, have increased the rate of herders migrating southward in recent times, fueling conflict (United Nations, 2021). On the other hand, the conflict is exacerbated by politically fueled ethnoreligious differences as migrant herders, mostly the Fulanis, are predominantly Muslims, while settled farmers are mostly Hausa Muslim majority in the north and mixed ethnic groups Christian majority in the south and middle-belt regions (Benjaminsen & Ba, 2021; Ajala, 2020).

The pace of farmer-herder conflict-related events in Nigeria in the past few years is significant, destructive to the food systems and retrogressive to socioeconomic development. As shown in Figure 3.1, farmer-herder conflict incidents increased from less than 25 in 2010 to more than 425 events in 2018. The spike in the conflict in 2018 was preceded by the introduction of anti-open grazing laws to reduce farmer-herder conflict in 2017-18 by the Benue and Taraba state

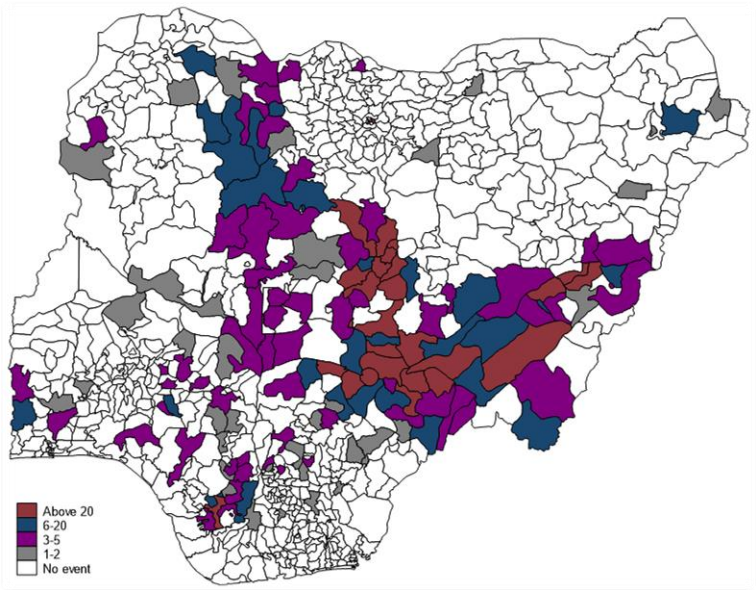
governments (International Crisis Group, 2018). While the laws have limited effects in these states, they resulted in a significant shift of herding activities to neighbouring southern states, expanding the conflict in other states. The laws were later suspended following the increase in conflict, yet the tensions continued, and affected southern governments started to enact laws against open grazing in their states.

Figure 3.1. Trend in farmer-herder conflict events in Nigeria from 2009 to 20019



Source: Authors, from Armed Conflict Location and Event Data (2009-2019).

Figure 3.2. Nigeria Map showing farmer-herder conflict events by LGAs from 2009 to 2019



Source: Authors, from Armed Conflict Location and Event Data (2009-2019).

Figure 3.2 also shows that farmer-herder conflict incidents are dispersed along the north-western and southern regions and concentrated in the north-central region, which has a predominantly Christian population and multi-ethnic group. According to a sub-national household survey coordinated by the world bank in 2019, about 55% of all reported conflict events in the north-central were caused by competition over land and water scarcity (Azad, Crawford, & Kaila, 2018). The peak of the incidents in 2018 resulted in over 2,700 fatalities (Brottem, 2021), doubling casualties recorded due to Boko Haram attacks in the same year, while more than 10,000 fatalities have occurred from 2009 to 2018 (ACLED, 2019). Even though farmer-herder conflict events are relatively fewer, they are associated with more fatalities than attacks from Boko Haram in recent times, with a more severe consequence for food security.

3.2.2 Livestock diversification and household nutrition in shock situations

The role of agricultural production in household food security and nutrition is well documented (Mosha et al., 2018; Hetherington et al., 2017; Ayenew et al., 2018). In particular, homestead livestock production is proven to increase consumption of ASF and micronutrient intakes (Pica-Ciamarra et al., 2011; Azzarri et al., 2015; Fadare et al., 2019b) and can complement staples and improve household dietary diversity. In shock situations, however, livestock production may be an imperfect buffer for food consumption smoothing, especially in poorly integrated markets (Lange & Reimers, 2014). This is because shock situations generally reduce the resilience capacity of households as food availability and access become strained. Many households engage in risky coping strategies such as selling off livestock assets when faced with food shortages and economic hardship (Lange & Reimers, 2014). Therefore, promoting agricultural diversification may be necessary for building resilience for food security and nutrition in shock situations (Kray et al., 2018).

Agricultural production is increasingly vulnerable to covariate shocks like conflict (Rockmore, 2020; Adelaja & George, 2019a; Kaila & Azad, 2019) and extreme weather events (Ickowicz et al., 2012; Sewando et al., 2016). However, evidence shows that many agricultural households in developing countries respond to shock situations by diversifying agricultural production (Arslan et al., 2018) as risk mitigation to stabilise income and smooth food consumption and nutrition (Ngigi, Mueller, & Birner, 2021; Megersa et al., 2014a). In such situations, households may engage in crop-livestock diversification (Mortimore & Adams 2001), diversify production within crop types (Arslan et al., 2018; Bellon et al., 2020; Paul, Shonchoy, & Dabalen, 2015), or diversify livestock species production (Fadare, Zanello, & Chittur, 2022; Megersa et al., 2014b; Rockmore, 2020). While it is possible for households in conflict situations to diversify livestock towards less susceptible livestock species, crop diversification may be challenging as it may predispose farmers to attacks. For example, Paul, Shonchoy and Dabalen (2015) in Cote d'Ivoire suggest that militia control of land made crop diversification a risky option.

Studies from African countries have shown that agricultural diversification can positively affect children's nutritional status through the consumption of diverse diets (e.g., Kumar et al., 2015). Most studies linking agricultural diversification to food security and nutrition are mainly in the context of climate shock mitigation or in no specific context, like the study by Kumar et al. (2015). Nevertheless, these studies are instructive in understanding the effect of agricultural diversification on household food security and nutrition, and their contextual dynamics. While there is consistent evidence of the positive effect of livestock diversification or crop-livestock diversification on food security and nutrition, such evidence is inconsistent with crop diversification. The study by Kray et al. (2018) suggests why the impact of crop diversification on nutrition may be inconclusive evidence, except when integrated with livestock diversification.

In a recent study by Habtemariam et al. (2021) in Tanzania, only crop-livestock diversification shows a significant relationship with dietary diversity and not crop diversification. Another similar finding showed no statistically significant relationship between crop diversification on dietary diversity in a conflict situation (Paul, Shonchoy, & Dabalen, 2015). In the context of seasonality in Afghanistan, Zanello, Shankar and Poole (2019) found that market access improved dietary diversity in the lean season. However, livestock diversification increased dietary diversity in both lean and regular seasons and crop diversification only improved dietary diversity in the regular season. Similarly, Ayenew et al. (2018) in Nigeria show that crop-livestock diversification only increased dietary diversity in post-harvest season and not post-planting. These set of findings suggest seasonal shock effects on food security and nutrition. Further study in Ethiopia's climate risk context shows that livestock diversification reduced the number of months of food deficit experienced by households and improved household dietary diversity (Megersa et al., 2014a). The study also suggests that the sale of livestock assets is an important pathway through which livestock diversification improves food security, supporting the vital role of market access in shock situations.

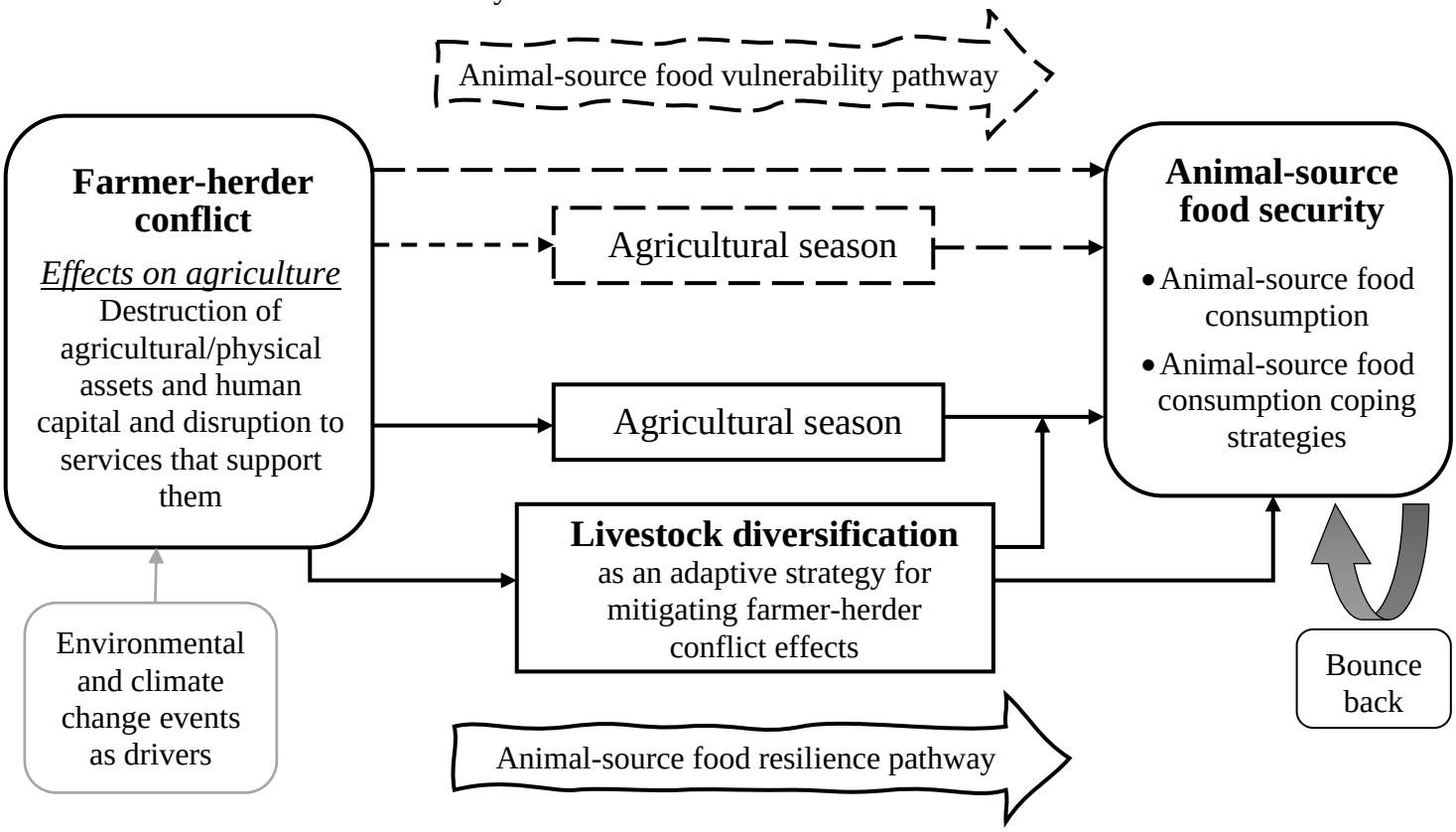
3.3 Conceptual framework

In Figure 3.3, we present a conceptual framework that shows the pathways linking farmer-herder conflict, livestock diversification, and animal-source food consumption, mediated by agricultural season. The impact of farmer-herder conflict on animal-source food security is first transmitted through its destructive and disruptive effects on agricultural assets, human capital, and supporting services such as extension services and the food commodity market, as represented by the dash arrow. However, unlike other types of conflicts, farmer-herder conflict is highly seasonal (Figure 3.4) and exhibits rhythms with climate change events like drought (Brottem, 2021; Landis, 2014). Therefore, the second dash line through agricultural season is important in the impact pathway from farmer-herder conflict to ASF consumption. The

vulnerability context describes the situation where households do not have adaptive strategy, such as engaging in livestock diversification. Conversely, the resilience pathway suggests that adopting livestock diversification strategy increase household resilience for ASF consumption.

A study conducted by FAO and Tufts University (2019) is probably the only study that has examined the relationship between climate-induced conflict, seasonality, and nutritional outcomes in Africa and provides important insights into the conceptual understanding of the relationship examined in this present study. The study shows that contemporary conflicts in Africa are associated with the seasonal cycle of farming and herding activities and are linked with child malnutrition in Chad, South Sudan, and Sudan. Evidence from these countries shows that the end of the lean season is associated with the peak of child wasting, with the first and larger peak of acute malnutrition occurring at the end of the dry season.

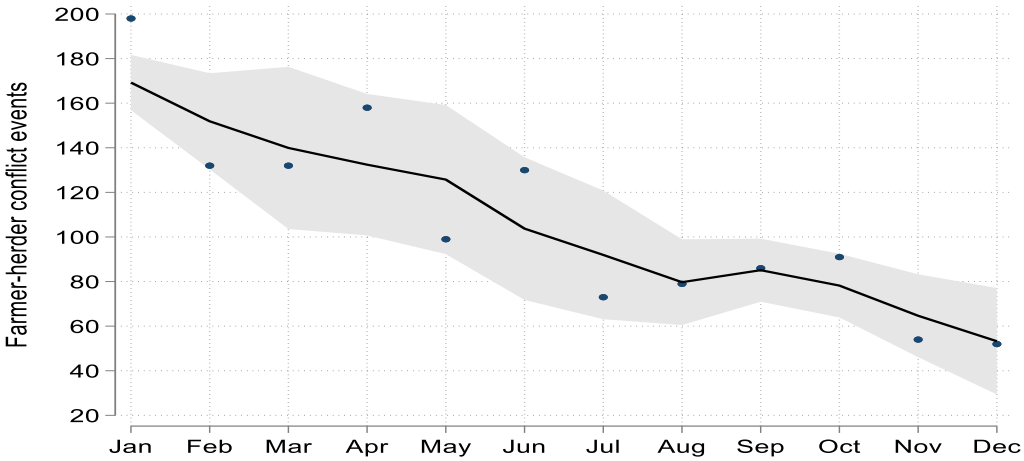
Figure 3.3. Conceptual framework linking farmer-herder conflict, livestock diversification, and animal-source food security.



Source: Authors.

According to the Nigerian agricultural seasonal calendar, as shown by FEWS NET (2013), the dry season can be categorised into the peak of the dry season and the onset of the dry season. The dry season begins in October in the north and from November to December in the south, and peaks from January through the end of February in the south and to the end of April in the north. Concomitantly, as shown in Figure 3.4, farmer-herder conflict events show seasonal patterns with a peak at the peak of the dry season and a fall from the onset of the dry season. In addition, the data employed for this study were collected seasonally; in the post-harvest season (peak of the dry season) between February and April and in the post-planting season (the onset of the dry season) between August and October (See Table B.1 in the Appendix for details). Thus, it presents an opportunity to test the hypothesis that the relationship between farmer-herder conflict and ASF consumption and coping strategies is mediated by the agricultural season.

Figure 3.4. Farmer-herder conflict events in Nigeria by month



Source: Authors, from ACLED Jan. 2009 to Dec. 2019.
Note: The shaded region represents 95% Confident Intervals.

Furthermore, the seasonal nature of farmer-herder conflict also means that it is predictable to a large extent, thus, providing an opportunity for livestock-holding households to plan and

adapt rather than being reactive with short-term coping strategies. As highlighted previously, livestock diversification is important strategy households employ in mitigating the effect of conflict on livelihood outcomes. We hypothesise that livestock diversification mitigates the impact of farmer-herder conflict on ASF consumption across agricultural seasons.

3.4 Data and descriptive statistics

In this section, we describe the dataset used for analysis as aggregated from two sources: a longitudinal dataset from the Living Standard Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) for Nigeria (NBS, 2016), and a global georeferenced dataset from the Armed Conflict Location and Event Data (ACLED) (Raleigh et al., 2010).

3.4.1 Data

The ACLED is regarded as the highest quality and real-time data and analysis source on political violence and protest globally. The quality and precision of the data have been verified (Eck, 2012). More importantly, the methodology for gathering conflict data employs modern communication technology to access accurate information on violence directly from eyewitnesses and locals without relying exclusively on a press release from the public or government (Croicu & Kreutz, 2017). The ACLED has fatalities records from conflict events and types of conflict events, categorised as violent conflicts such as battles, explosions/remote violence, violence against civilians, and non-violent conflicts, including riots and protests. In addition, the data contain detailed notes on the actual conflict events, which can be further distilled and coded into different conflict categories and perpetrators not explicitly captured. We employed such granular information to isolate farmer-herder conflict events and quantify their incidents.

The LSMS-ISA is an effort by the World Bank in conjunction with the Nigeria National Bureau of Statistics (NBS). The survey covers 5,000 households, representative of Nigeria's six (6) geopolitical zones and the urban and rural areas. Data are collected in waves, and two survey rounds or visits complete a wave. The first round in a wave happens in the post-planting season, while the second in the post-harvest season. The post-planting visit usually takes place in September through October, followed by a post-harvest visit in February through April and no two rounds in a year. We use six survey rounds covering periods from 2010, when the survey started to 2016[8], and we focus on agricultural households[9] which constitute about 60% of the survey. The sample size for analysis by survey year is 3,256 (2010), 3,314 (2011), 3,160 (2012), 3,087 (2013), 3,015 (2015), and 3,010 (2016), representing 18,842 pooled observations. The LSMS-ISA contains information on a wide range of indicators, including household socioeconomic, livelihoods, and food consumption. We harmonised the farmer-herder conflict variable from the ACLED with the household level dataset from the LSMS-ISA to locate households exposed to farmer-herder conflict.

3.4.1.1 Animal-source food consumption outcomes measurement

We use three main outcomes to measure household ASF consumption. First is the quantity of ASF consumption as an aggregated and as disaggregated into four outcomes – meats, milk, poultry, and fish consumption. The survey asked an adult household member responsible for food preparations or food purchases made by the household in the past seven days to recall food consumption and the quantity of each food item consumed during the last seven days prior

[8]This survey was not conducted in 2014. Also, this study excludes Wave 4 (2018/2019), as insecurity and displacement of some households in the baseline necessitated a sample redesigning, thus retaining only less than 30 per cent of the base households in the panel.

[9]An agricultural household is a household with livestock and or agricultural land with some under cultivation.

to the interview. The quantity of animal-source food items[10] reported in non-standard units was standardised, and we quantified ASF consumption in 100grams of consumption per day per adult-equivalent unit. Adult-equivalent unit accounts for variation in household composition and individual consumption requirements by adjusting household size, age, and sex. We employ an adult-equivalent conversion factor as used by Desiere et al. (2018). Less than 10% of the households did not consume an ASF in the past seven days prior to the survey. Such observations were dropped, including a few unrealistic outliers of less than 1%, followed by *winsorising* the distribution of the outcomes at 1% and 99%.

The other two ASF consumption indicators are originally from the tools used for assessing household food consumption coping strategies as provided in the LSMS-ISA questionnaire. We use two questions from a set of questions administered to an adult female household member who is knowledgeable about household food consumption or another member with such knowledge. The two questions are the number of days in the past 7 days any member of the household had to: (i) rely on less healthy and nutritious/preferred foods, and (ii) limit the variety of foods eaten. These two indicators show a higher negative correlation with ASF consumption than the other coping strategies and a positive correlation with fruit and vegetables (see Table B.2 in the Appendix). Thus, the indicators can be a good proxy for ASF consumption coping strategies as they measure the extent to which households can sacrifice nutritious foods for calorie-dense foods and diverse foods for less diverse foods. Finally, these

[10]ASF captured in the LSMS-ISA include chicken, duck, other domestic poultry, beef, mutton, pork, goat, wild game meat, canned meat, other meat, fish (fresh), fish (frozen), fish (smoked), fish (dry), snails, seafood, canned fish, other fish or seafood, fresh milk, milk powder, milk tinned (unsweetened), cheese (wara), Other milk and dairy products. These are categorised into four groups: i) meat (all meat, except poultry products), ii) milk (all milk and dairy products), iii) poultry (all poultry products), and iv) fish (all fish and seafood)

indicators also measure short-term ASF consumption deprivation, as they are sensitive to short-term changes such as seasonality or the effects of conflict shocks (Maxwell et al., 2003).

3.4.1.2 Farmer-herder conflict exposure and exposure period measurement

Farmer-herder conflict is measured as the total number of events that occurred within the household LGA in the past 12 months prior to the survey. We use this measure for descriptive statistics. However, we use a binary treatment indicator for the empirical analysis. Households are categorised as conflict-exposed (treatment group) if they are in LGA that experienced at least one farmer-herder conflict event within 12 months preceding survey and non-exposed (control group) if their LGA did not experience any conflict event within the same period. Our seasonality indicator is a binary variable representing one (1) for survey in post-harvest season (post-treatment) and zero (0) for survey in post-planting season (pre-treatment).

3.4.1.3 Livestock diversification measurement

We construct the livestock diversification index (LDI) as derived from the Herfindahl Index (HI) applied in Woerheide and Persson (1992). The LDI is calculated as follows: $S_k = \frac{R_k}{\sum_{k=1}^{n} R_k}$, where S_k is the share for the k^{th} value of livestock species in the total for all value of livestock owned by household, R_k represents the value for the k^{th} livestock for a sample household, and $\sum_{k=1}^{n} R_k$ is the total value from livestock k=1, 2,…, n represents the number of species own. Given the HI to be $HI_L = \sum_{k=1}^{n} S_k^2$, our LDI=1–$HI_L$. The LDI takes a value ranging from 0 to 1, with species specialisation tending towards zero value while a high level of diversification tends towards one. Households with an average LDI greater than or equal to the sample mean are indicative of a higher degree of adopting livestock diversification strategies and are assigned a code of 1. Conversely, households whose LDI falls below the sample mean engage in relatively less diverse livestock production practices and are assigned a code of 0.

3.4.1.4 Control variable measurement

We control for livestock ownership status, the value of crop produced by households over a year in Naira, the highest year of education attained by household, household size, and wealth index, which was computed from durable household assets, excluding ownership of livestock assets. Also, parts of the control variables are distance to market (km), distance to population (km), annual rainfall (mm), and annual mean temperature multiplied by 10°C (degree Celsius), which were used as provided in the dataset. The rainfall and temperature data were collected at the household level using georeferenced household locations with geospatial climate data.

3.4.2 Descriptive statistics

Table 3.1 shows the summary statistics variables used for analysis, including the control variables, while Table 3.2 presents the mean comparison between the treatment group and the control group in post-planting and post-harvest seasons. Table 3.1 shows that farmer-herder conflict incidence was about 10%. Also, the mean aggregated ASF consumption in Nigeria was 0.742 (100g/day/aeq), meat, milk, poultry, and fish were respectively 0.345, 0.532, 0.286, and 0.354 (100g/day/aeq), and an average household experienced at least one day of ASF consumption coping strategies. The difference in the means of ASF food consumption and household characteristics between the treatment and control groups in post-planting and post-harvest are particularly instructive.

Table 3.1. Summary statistics of variables used for analysis

Variable	Units	*N*	Mean	Std. Dev	Minimum	Maximum
ASF consumption	100g/day/aeq	16,970	0.742	0.794	0.009	10.76
Meat consumption	100g/day/aeq	9,794	0.345	0.254	0.001	1.40
Milk consumption	100g/day/aeq	2,206	0.532	0.317	0.01	1.13
Poultry consumption	100g/day/aeq	2,655	0.286	0.258	0.001	1.08
Fish consumption	100g/day/aeq	11,769	0.354	0.298	0.001	1.45
Days HH relied on less-preferred food	Number of days	18,842	1.126	1.737	0	7
Days HH limits the variety of foods eaten	Number of days	18,838	0.961	1.579	0	7
FH conflict incidents	Number	18,842	0.045	0.326	0	9
FH conflict	Binary	18,842	0.099	0.299	0	1
PH season	Binary	18,842	0.503	0.500	0	1
Livestock diversification	Binary	12,827	0.353	0.478	0	1
Own livestock	Binary	18,842	0.679	0.467	0	1
Value of crop produced	Naira (multiplied by 10,000)	18,842	12.902	15.416	0	85.94
Average years of HH education	Year	18,842	9.984	5.660	0	18
HH size	Number	18,842	6.273	3.262	1	31
Wealth index	Index	18,842	-0.003	2.344	-3.53	6.12
Distance to market	Kilometres	18,842	71.543	39.880	0.28	214.36
Distance to population	Kilometres	18,842	24.883	19.251	0.06	130.5
Annual rainfall	Millimetres	18,842	1258.777	458.388	378	2574
Annual mean temperature	Degree Celsius (multiplied by 10)	18,842	263.665	9.751	210	288

Source: Author.

The results in Table 3.2 show that the average number of farmer-herder conflict events was 0.19 in the post-planting season and almost doubled (0.35) in the post-harvest season. ASF consumption in the two seasons is not significantly different, while conflict-exposed households reduced ASF consumption significantly by 0.08 (100g/day/aeq) in post-planting, and by 0.17 (100g/day/aeq) in post-harvest, mainly from milk and fish consumption. However, poultry product consumption among the exposed group increased significantly in the post-harvest season compared to post-planting. The results further reveal that conflict-exposed households significantly had fewer days of coping strategies than the non-exposed households across the seasons. Interestingly, more households exposed to conflict owned livestock (about

95%), produced more crops and engaged in livestock diversification than non-conflict areas. This may not be surprising as some studies have shown evidence that armed group tends to attack location where food production is in abundance (Koren, 2018), underscoring the importance of disaggregating conflicts into actors, drivers, and motives. This situation may explain why conflict-exposed households had fewer days of ASF consumption coping strategy than the non-exposed. However, the impact of farmer-herder conflict on these outcomes is subjected to further empirical testing using empirical modelling for policy inferences.

The consumption patterns observed in this data show that consumption of ASF at a low level in post-planting is further dampened in post-harvest season for households that are exposed to farmer-herder conflict. By implication, there may be year-round animal-source food (nutrition) insecurity for a significant number of agricultural households in Nigeria as they primarily rely on rain-red agricultural practices, worsening by extreme weather events. On the other hand, conflict-exposed households may remain in perpetual severe food insecurity and malnutrition situations since the incidents of farmer-herder conflict are significantly high in the dry or post-harvest season. This consumption pattern further lends credence to the notion that extreme weather events and conflicts are in synergy against food security and nutrition in countries with significant vulnerability to conflict and climate change.

Table 3.2. Summary statistics with the mean comparison between groups

	Post-planting (2010, 2012, 2015)			Post-harvest (2011, 2013, 2016)		
	Non-exposed group (control)	Exposed group (treatment)	Difference in means	Non-exposed group (control)	Exposed group (treatment)	Difference in means
ASF consumption (100g/day/aeq)	0.741	0.664	-0.077***	0.767	0.600	-0.168***
Meat consumption (100g/day/aeq)	0.339	0.354	0.015	0.347	0.357	0.009
Milk consumption (100g/day/aeq)	0.549	0.512	-0.037	0.515	0.511	-0.004
Poultry consumption (100g/day/aeq)	0.267	0.298	0.031	0.295	0.341	0.046*
Fish consumption (100g/day/aeq)	0.353	0.298	-0.055***	0.365	0.304	-0.062***
Days HH relied on less-preferred food	1.172	1.032	-0.140**	1.094	1.087	-0.007
Days HH limits the variety of foods eaten	1.054	0.811	-0.243***	0.913	0.711	-0.201***

FH conflict incidents	0.000	0.185	0.185***	0.000	0.349	0.349***
Livestock diversification	0.329	0.514	0.185***	0.332	0.466	0.133***
Own livestock	0.645	0.977	0.332***	0.622	0.982	0.360***
Value of crop produced	12.397	18.206	5.809***	12.239	18.200	5.961***
Average years of HH education	10.016	9.690	-0.326	10.036	9.528	-0.508***
HH size	6.131	7.284	1.153***	6.202	7.205	1.003***
Wealth index	0.034	-0.373	-0.407***	0.058	-0.509	-0.567***
Distance to market	71.599	69.983	-1.616	71.252	74.806	3.553***
Distance to population centre	24.345	29.789	5.444***	24.185	31.091	6.907***
Annual rainfall	1274.041	1112.735	-161.306***	1271.302	1149.307	-121.994***
Annual mean temperature	264.040	260.171	-3.868***	264.015	260.542	-3.473***

Source: Author.

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Furthermore, some households' characteristics exhibit remarkable differences between conflict-exposed households and non-exposed. Conflict-exposed households had an average of one household member more than those not exposed, which is expected as they actively engaged in agricultural production. Also, while there is no significant difference in the average years of educational attainment between exposed and non-exposed households in the post-planting season, there is a significant reduction in education attendant for exposed households in the post-harvest season by about half a year. A study by Kaila and Azad (2019) shows evidence of a decrease in the household budget for education due to the farmer-herder conflict in Nigeria and an increase in health expenditures, suggesting that children may drop out of school as conflict incidents intensify. Farmer-herder conflict-exposed households are significantly poor and poorer in the post-harvest season, which corroborates studies suggesting that poor households are more likely to remain poor following exposure to conflict attacks (Kaila & Azad, 2019).

Notable also is the observed differences in the mean distance from households to the nearest market among the exposed group and non-exposed group. While distance to market is less

among the exposed group in post-planting, we observe a significant increase of about 3.6 kilometres between the two groups in the post-harvest season. It is possible that farmer-herder conflict also disrupts market structure or displays some households farther from market locations. Distance between conflict-exposed households and the nearest population of 20,000 plus is significantly farther than non-exposed households but comparable across the two seasons. Annual rainfall and annual mean temperature, respectively, were about 140mm and 3.6°C lower in areas exposed to conflict than those not exposed to conflict.

3.5 Empirical strategy

Violent conflicts are reasonably argued as endogenous in the model estimating the relationship between conflict and food security. The primary sources of endogeneity are unobserved confounders and reverse causality or simultaneity (Martin-Shields & Stojetz, 2019; Brinkman & Hendrix, 2011; Collier et al., 2003). In the case of farmer-herder conflict, it is correlated with extreme climate events or, broadly, events of environmental change (Brottem, 2016; Turner et al., 2011; Eberle, Rohner, & Thoenig, 2020; Hendrix & Salehyan, 2012; Moritz et al., 2019). Thus, making it difficult to isolate its impact on food security and nutrition from that of extreme weather events. More importantly, we cannot rule out the possibility of endogeneity arising from omitted variables bias and selection bias. According to Eberle, Rohner and Thoenig's (2020) study, farmer-herder conflict mainly occurs in agropastoral communities, especially at the border between rangeland and farmland suitable for herding and farming, areas particularly vulnerable to climate shocks. Thus, the locations of farmer-herder conflict are not randomly determined in a population, which is a potential problem for identifying the causal effects of farmer-herder conflict on food security and nutrition.

For nonexperimental data, as we have, several approaches have been used in dealing with selection bias in empirical studies of this nature, including the matching method, instrumental

variables, and difference-in-differences. Another approach is to control for climate shocks variable or seasonality and account for the likely correlation between conflict and extreme weather events such as drought while controlling for household fixed effects as used in the study by Tranchant, Gelli and Masset (2021). We employ the latter approach in the first instance by controlling for seasonality to account for time-varying temporal and seasonal shocks that can influence the outcome variables while also taking advantage of the longitudinal nature of our data which captures pre-conflict and post-conflict across seasonal time periods to employ the Difference-in-Differences (DD) and event study estimations.

The DD strategy assumes that the treatment and control group both follow a similar parallel trend of the outcome variable during the pre-treatment period for an exogenous treatment (Wing, Simon, & Bello-Gomez, 2018). However, in order to increase the internal validity of this estimation strategy, we follow three few steps. First, we base our analysis on agricultural households, which to a more considerable extent, share similar characteristics, both observable and unobservable. Second, we validate our use of DD by conducting the parallel trends assumption tests, employing a local nonparametric regression of ASF consumption, the numbers of days rely on less-prefer foods, and the number of days limits the variety of foods eaten on seasonal year trend in treatment group and control group.

However, pre-treatment parallel trends are not enough to guarantee parallel counterfactual trends (Kahn-Lang & Lang, 2019); thus, we add further robustness and sensitivity checks by employing an event study estimation for all the outcome variables. The event study model is suitable for estimating staggered intervention; for example, in our case, there is differential timing in which households were exposed to conflict at different points. While the event-study model is useful in establishing the DD identifying assumption, it also avails for assessing the evolution of relative outcomes over time as it evaluates the pre-treatment dynamics between a

treatment and control group with differential timing by including treatment leads and lags as used by Miller, Johnson and Wherry (2021).

$$Y_{hlt} = \beta C_{lt} + \sum_{s=1}^{S} C_{l,t+s}\varphi_s + \sum_{m}^{M} C_{l,t-m}\lambda_s + \rho \boldsymbol{X}_{hlt} + \gamma_t + \vartheta_h + \varepsilon_{hlt} \quad (1)$$

where Y_{hlt} represents ASF consumption (aggregate), meat consumption, milk consumption, poultry consumption, fish consumption, days relied on less-preferred foods, and days household limits the variety of food eaten for household *h* in LGA *l* in the time period *t*. C_{lt} is the treatment indicator which equals 1 if a household was exposed to conflict at LGA *l* at period *t* and 0 if a household was exposed to the control condition at LGA *l* at period *t*. β captures the immediate effect of conflict, while s is the leads or anticipatory effects, and *m* is the lags or post-treatment effects. Under the strict exogeneity assumption, $\varphi_s = 0$ for $s = 1 \ldots S$. While λ_m measures any additional effects of the conflict that occur in *m* periods after exposure. If the initial effect of the conflict is positive, then the negative values of λ_m imply that the initial effect of the conflict dissipates over time, and the positive values of λ_m suggest that the conflict has larger effects over time. Vector $\boldsymbol{X}_{hlt}$ includes ownership of livestock, the value of crop produced, education of household, household size, wealth index, distance to market, distance to population, temperature, and rainfall variables, while γ_t is season year trend (seasonality), ϑ_h is the household fixed effects, and ε_{hlt} is the idiosyncratic error term which captures other unobserved factors that may affect ASF consumption.

Next, we model the relationship between ASF consumption, coping strategies (days relied on less-preferred foods, and days household limits the variety of food eaten), and the explanatory variables. We specify a fixed effects regression equation to account for the unobserved household and geographical location characteristics that may simultaneously influence both ASF consumption and farmer-herder conflict exposure as follows:

$$y_{hlt} = \alpha + \beta C_{lt} + \rho \boldsymbol{X}_{hlt} + \gamma_t + \vartheta_h + \varepsilon_{hlt} \quad (2)$$

Here we model our outcome variables as a function of conflict exposure C_{hl}, household control variables captured in vector $\boldsymbol{X}_{hlt}$, and seasonal year trend γ_t while estimating two alternative models: one with no time control and another with survey year trend control. Following these estimates and the fulfilment of the parallel trend assumption of the DD as shown in the nonparametric regression result (Figure 3.5 left) and event study results (Figure 3.5 right), we specify the following pooled OLS regression equation to estimate the DD strategy:

$$y_{hlt} = \alpha + \beta C_{lt} + \pi P_t + \delta C_{lt} \text{ x } P_t + \rho \boldsymbol{X}_{hlt} + \gamma_t + \varepsilon_{hlt} \quad (3)$$

We introduce interaction terms between our treatment indicator C_{lt}, conflict exposure and the treatment period P_t indicator, which equals 1 if post-harvest season and 0 if post-planting, where δ is the estimated coefficient of the average treatment effect on the treated (ATT). We also estimate alternative models with no year control and model with survey year trend control.

Also central to our objective is to investigate whether and the extent to which the impact of farmer-herder conflict on ASF consumption is mitigated by household livestock diversification strategy. Hence, we modify Eq. 3 by including interaction terms between livestock diversification indicator L_{hlt} which equals 1 if household diversified livestock species and 0 if no, and the treatment C_{lt} and treatment period P_t indicators as specified below:

$$y_{hlt} = \alpha + \beta C_{lt} + \pi P_t + \delta C_{lt} \text{ x } P_t + \theta C_{lt} \text{ x } P_t \text{ x } L_{hlt} + \partial_1 L_{hlt} + \partial_2 C_{lt} \text{ x } L_{hlt} + \partial_3 P_t \text{ x } L_{hlt} + \gamma \boldsymbol{X}_{hlt} + \gamma_t + \varepsilon_{hlt} \quad (4)$$

Where ∂_2 is the coefficient of the effect of livestock diversification on ASF consumption before exposure to conflict, while θ captures the mitigating effect of livestock diversification, i.e., the ATT. As in Eqs. 2 and 3, we also estimate alternative models with no year control and another with survey year trend control. The estimated OLS regression in Eqs. 3 and 4 is with the

assumption that our treatment (farmer-herder conflict) is exogenous, and if the treatment is endogenous, then the parallel trends assumption is violated since OLS will always estimate an effect size using the slope of the control group as the counterfactual, regardless of whether or not the slope is correct (Goodman-Bacon, 2021; Kahn-Lang & Lang, 2019). Hence, we replicate the models in Eqs. 3 and 4 by specifying models in Eqs. 5 and 6 where we control for household fixed effects and seasonal year trend while estimating the model with no year trend control and model with survey year trend controls in alternative specifications.

$$y_{hlt} = \alpha + \beta C_{hl} + \pi P_t + \delta C_{hl} \text{ x } P_t + \rho \boldsymbol{X}_{hlt} + \gamma_t + \vartheta_h + \varepsilon_{hl} \quad (5)$$

$$y_{hlt} = \alpha + \beta C_{lt} + \pi P_t + \delta C_{lt} \text{ x } P_t + \theta C_{lt} \text{ x } P_t \text{ x } L_{hlt} + \partial_1 L_{hlt} + \partial_2 C_{lt} \text{ x } L_{hlt} + \partial_3 P_t \text{ x } L_{hlt} + \gamma \boldsymbol{X}_{hlt} + \gamma_t + \vartheta_h + \varepsilon_{hlt} \quad (6)$$

3.6 Results and discussion

In this section, we present the results of the estimations of model specifications in equations (Eqs.) 1 to 6 and discuss the findings. Figure 3.5 (right) and Figure 3.6 present the results of the event study estimation of Eq. 1 for all the outcome variables (see Table B.6 in the Appendix for the regression results table). Table 3.3 reports the fixed effects regression results from the estimates of Eq. 2 for the impact of farmer-herder conflict and confounding factors on ASF consumption and coping strategies, respectively, in models 1 to 3. Table 3.4 reports the results of the ATT in models 1 and 2 (pooled OLS, Eq. 3) and in models 3 and 4 (fixed effects, Eq. 5) for the impact of farmer-herder conflict on ASF consumption and coping strategies. Similarly, Table 3.5 presents the results of the ATT in models 1 and 2 (Pooled OLS, Eq. 4) and models 3 and 4 (fixed effects, Eq. 6) to quantify the mitigating effects of livestock diversification on ASF consumption and coping strategies. We discuss the results in each table one after the other.

3.6.1 Farmer-herder conflict and covariate determinants on ASF consumption

In Table 3.3, we report three models for each outcome variable: model 1 has no year trend control, model 2 controls for survey year trend, and model 3 controls for seasonal year trend. While the three models' results are for comparison, we base our analysis on model 3, which shows more internal validity and consistency with our hypotheses. We find that exposure to farmer-herder conflict has a statistically significant negative relationship with ASF consumption; it leads to a reduction of 0.05 100g in ASF consumption. Also, exposure to farmer-herder conflict statistically increases the number of days households rely on less preferred foods by 0.14 and the number of days households limit the variety of foods eaten by 0.08, while the results in model 2 are not significant for all the outcome measures.

We also find that the seasonal year trend is negative and statistically significant with ASF consumption and positive with days relied on less preferred foods. However, no such significance is observed with the outcome 'days limit the variety of foods eaten'. In comparison with model 1, the seasonal year trend mediates the effects of farmer-herder conflict on the two outcomes, suggesting a spurious association between farmer-herder conflict and the outcome variables that needs to be adequately accounted for. The negative effect of the seasonal year trend on our outcome variables indicates a seasonal shock effect increasing from post-planting to post-harvest seasons. Some covariates also show a statistically significant association with ASF consumption and coping strategies.

Table 3.3. Impacts of farmer-herder conflict and covariate determinants on ASF consumption

	Animal-source food consumption (100g/day/aeq)			Animal-source food consumption coping strategies					
				Number of days households had to rely on less-preferred foods			Number of days households had to limit the variety of food eaten		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
FH conflict	-0.061***	0.009	-0.047**	0.158***	0.049	0.144***	0.079*	-0.027	0.079*
	(0.021)	(0.021)	(0.021)	(0.054)	(0.054)	(0.054)	(0.045)	(0.045)	(0.045)
Survey year trend		-0.062***			0.098***			0.096***	
		(0.004)			(0.009)			(0.009)	
Seasonal year trend			-0.019***			0.020***			0.001
			(0.003)			(0.007)			(0.006)
Own livestock	0.042*	0.027	0.038*	0.082*	0.106**	0.086*	0.040	0.063	0.040
	(0.023)	(0.022)	(0.023)	(0.044)	(0.043)	(0.044)	(0.043)	(0.042)	(0.043)
Log of value of crop	0.001	0.004*	0.002	0.007	0.002	0.007	0.006	0.001	0.006
produced	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Average years of HH	-0.001	0.002	-0.000	-0.007	-0.010*	-0.007	0.001	-0.002	0.001
education	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
HH size	-0.021***	-0.015***	-0.019***	0.039***	0.028**	0.037***	0.043***	0.033***	0.043***
	(0.005)	(0.004)	(0.004)	(0.012)	(0.012)	(0.012)	(0.010)	(0.010)	(0.010)
Wealth index	0.043***	0.036***	0.041***	-0.075***	-0.064***	-0.074***	-0.074***	-0.063***	-0.074***
	(0.009)	(0.009)	(0.009)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)
Distance to market	-0.006*	-0.002	-0.005*	0.007	0.002	0.006	0.003	-0.002	0.003
	(0.003)	(0.002)	(0.003)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Distance to population	0.001**	0.002***	0.002**	-0.000	-0.001	-0.000	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Annual rainfall	0.002***	0.000	0.002***	-0.003***	0.000	-0.002***	-0.002***	0.001	-0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Annual mean temperature	0.010	0.004	0.009	0.002	0.014	0.003	0.017	0.028	0.017
	(0.009)	(0.006)	(0.008)	(0.012)	(0.014)	(0.012)	(0.015)	(0.018)	(0.015)
Constant	-4.328*	-0.162	-3.662	3.092	-3.640	2.397	-1.120	-7.697	-1.158
	(2.442)	(1.566)	(2.303)	(3.335)	(3.877)	(3.334)	(3.983)	(4.927)	(3.994)
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	16,970	16,970	16,970	18,842	18,842	18,842	18,838	18,838	18,838
Number of households	3,671	3,671	3,671	3,708	3,708	3,708	3,708	3,708	3,708
R-squared	0.015	0.038	0.018	0.007	0.017	0.007	0.007	0.019	0.007

Source: Author.

Note: Robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Specifically, we find that livestock assets ownership, household wealth, distance to population centre, and rainfall positively influence ASF consumption, while household size and distance to market have a reducing influence on this outcome. The positive association between ASF consumption and livestock asset ownership conforms with previous studies (Azzarri et al.,

2015; Hetherington et al., 2017). However, the significance of livestock ownership in our model is weak (10%) and may result from the vulnerability of livestock assets to conflict and climate shocks, which could explain a positive and statistical association with days relied on less preferred foods. Additionally, household size is positively associated with an increase in the number of days households adopt coping strategies, while higher wealth status and higher rainfall statistically reduce the number of days households adopt coping strategies.

3.6.2 Impacts of farmer-herder conflict on ASF consumption

Table 3.4 reports the ATT results for the impact of farmer-herder conflict on ASF consumption and coping strategies in models 1 and 2 from OLS estimates and models 3 and 4 from fixed effects estimates. However, pooled OLS results from DD estimation are subject to bias, as discussed under the empirical strategy; as such, we report from model 4, which shows more robustness in establishing a causal effect. Results in Table 3.4 are reported along with the event study results in Figure 3.5 (right) and Figure 3.6. We find a significant reduction of 0.1 100g (Table 3.4, Panel A) in the consumption of ASF attributed to farmer-herder conflict exposure with a decrease of between 0.11 and 0.18 100g during each exposure year (Figure 3.5 right, Panel A), as compared to when there was no exposure. We discuss these findings later under this subsection, along with the results of the disaggregated ASF consumption in Figure 3.6.

Furthermore, the results of the coping strategies show that, on average, exposure to farmer-herder conflict increases by 0.19 (Table 3.4, Panel B) additional day of relying on less preferred foods or 0.49 (Figure 3.5 right, Panel B) additional days at the end of the survey year, relative to years with no exposure. Similarly, exposure to farmer-herder conflict results in, on average, 0.12 (Table 3.4, Panel C) additional days of limiting the variety of food eaten and up to 0.72 (Figure 3.5 right, Panel C) in later years estimates.

Table 3.4. Impacts of farmer-herder conflict on ASF consumption (ATT)

	(1)	(2)	(3)	(4)
Panel A: *ASF consumption (100g/day/aeq)*				
FH conflict*PH season	-0.091***	-0.095***	-0.092***	-0.100***
	(0.027)	(0.026)	(0.023)	(0.023)
Constant	0.741***	0.085	0.739***	-4.412*
	(0.011)	(0.199)	(0.005)	(2.426)
R-squared	0.003	0.106	0.002	0.015
Number of Observations	16,970	16,970	16,970	16,970
Panel B: *Number of days households relied on less-preferred foods*				
FH conflict*PH season	0.134*	0.094	0.176**	0.189***
	(0.070)	(0.070)	(0.070)	(0.070)
Constant	1.172***	1.355***	1.147***	3.190
	(0.022)	(0.461)	(0.011)	(3.343)
R-squared	0.001	0.047	0.002	0.008
Number of Observations	18,842	18,842	18,842	18,842
Panel C: *Number of days households limit the variety of food eaten*				
FH conflict*PH season	0.041	0.006	0.101*	0.117*
	(0.059)	(0.059)	(0.060)	(0.061)
Constant	1.054***	-0.234	1.024***	-1.027
	(0.020)	(0.383)	(0.010)	(3.997)
R-squared	0.004	0.078	0.004	0.011
Number of Observations	18,838	18,838	18,838	18,838
Household controls	No	Yes	No	Yes
Household fixed effects	No	No	Yes	Yes

Source: Author.

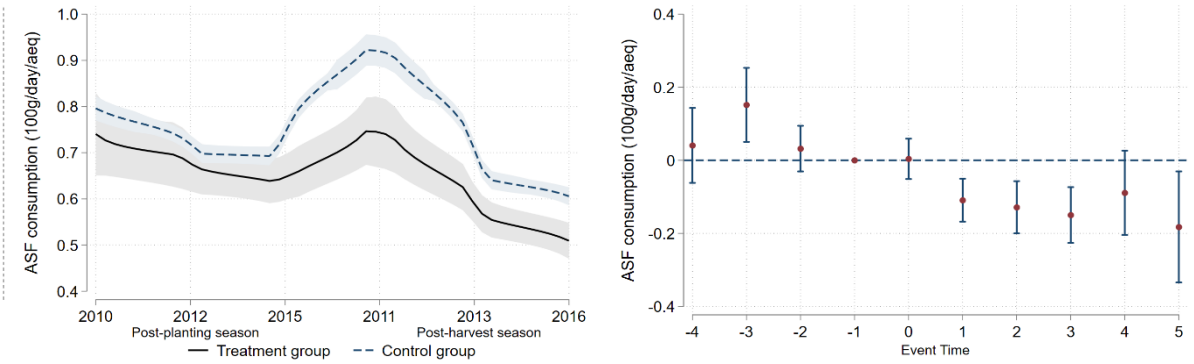
Note: ATT is average treatment effect on the treated. Robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

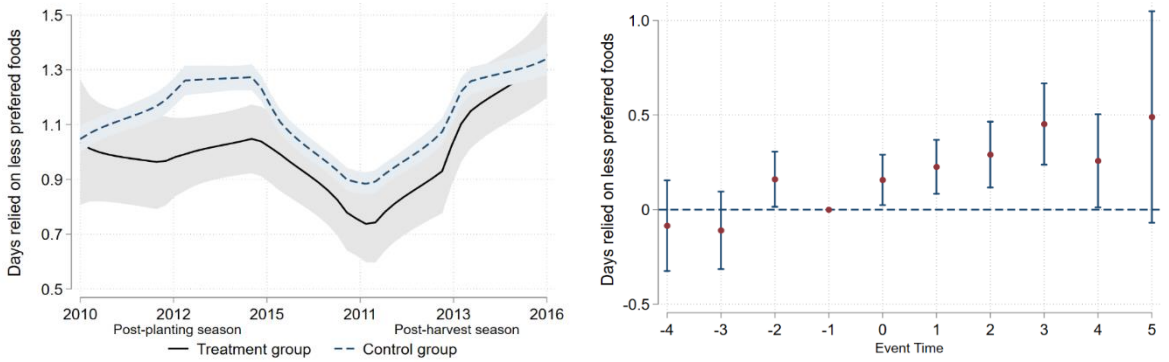
The positive association between farmer-herder conflict and coping strategies is expected and conforms with previous findings from Nigeria (e.g., George, Adelaja, & Weatherspoon, 2020; Kaila & Azad, 2019; Nnaji et al., 2022b). However, our study advances previous evidence by showing that estimates of later years have larger and more significant coefficients, revealing the cumulative strains farmer-herder conflict has on the number of days households would have to exclude ASF consumption in their diets. This evidence improves our understanding of the short-term impact of conflict shock on ASF consumption for better nutrition programming.

Figure 3.5. Parallel trends test for the difference-in-differences (left) and event study (right)

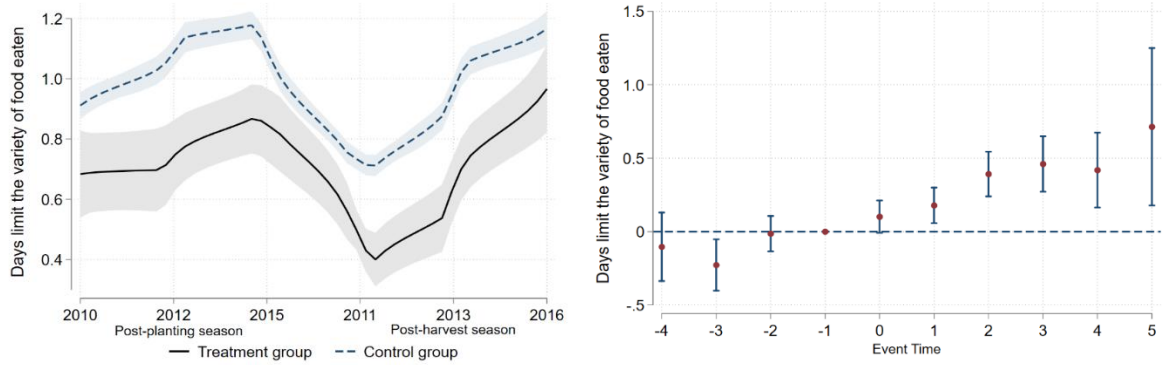
Panel A: *ASF consumption (100g/day/aeq)*



Panel B: *Number of days households relied on less-preferred foods*



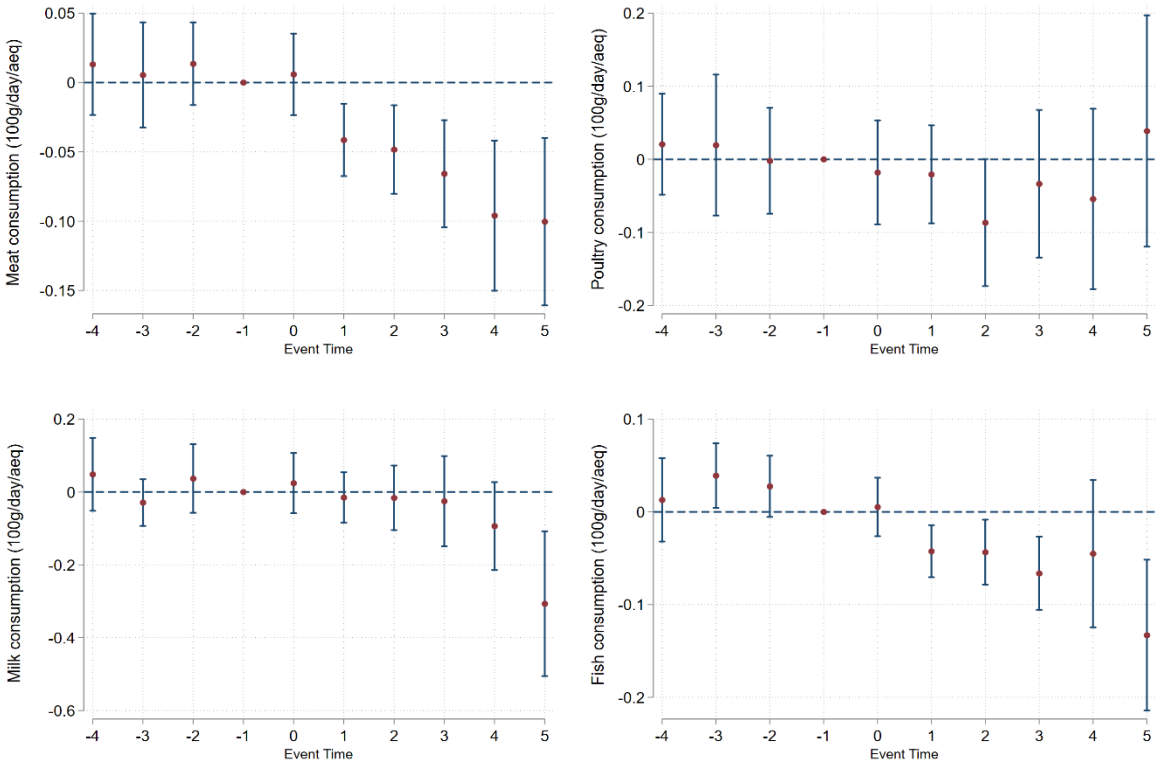
Panel C: *Number of days households limit the variety of food eaten*



Source: Author.

Note: A local nonparametric regression of ASF consumption by seasonal trends on treatment and control group (left) with 95% confidence intervals represented by the shaded region, and event study estimation results with point estimates of each time period before and after exposure (right) with the confidence intervals of 95%.

Figure 3.6. Event study estimation of ASF consumption (Specific food groups)



Source: Author.

Note: Event study estimation results with point estimates of each time period before and after exposure (right) with the confidence intervals of 95%.

From the event study estimation, the results of the disaggregation of ASF consumption into their food components are presented in Figure 3.6. The results reveal that, compared to years with no exposure, meat, milk, poultry, and fish consumption respectively reduced by up to 0.10, 0.32, 0.09, and 0.13 (100g/day/aeq) in the later year, except for poultry with a non-significant positive sign of the coefficient, suggesting an apparent shift in ASF consumption towards poultry products. Some studies have suggested that the shift may result from households diversifying livestock production to small livestock species in response to conflict risk (Arias, Ibáñez, & Zambrano, 2019; Fadare, Zanello, & Chittur, 2022). Furthermore, in peacetime, poultry ownership has been shown to improve ASF consumption significantly more than other livestock species (Azzarri et al., 2015; Fadare et al., 2019b., Hetherington et al.,

2017). Hence, our results suggest that increasing the share of poultry holdings through diversification may improve poultry consumption in conflict situations.

Furthermore, the negative impact of farmer-herder conflict on meat and dairy consumption is not surprising since cattle are the most targeted for destruction in conflict situations which may disrupt the supply chain of meat and milk and consumption from owned production. A few studies that examined this relationship found a reduction in household expenditure on meat and milk in Côte d'Ivoire post-conflict (Dabalen & Paul, 2014). Also, Tranchant, Gelli and Masset (2021) report a reduction in the likelihood of meat, milk, and fish consumption due to increased fatalities in Mali conflict situations. Also, the study by Bageant, Liu, & Diao (2016) in Nepal reports a significant negative relationship between conflict and the quantity of milk consumed by livestock-holding households. While livestock-holding households are expected to increase ASF consumption, finding from Nepal is attributed to livestock productivity declines and milk price increases, with more effects on households with fewer herd size. It is also not surprising that fish consumption is negatively affected by farmer-herder conflict. The effect can be explained through a decrease in household expenditure on fish as between 23 and 54% of fish consumed in rural Nigeria are imported frozen fish, while the rest are farmed or captured (Liverpool-Tasie et al., 2021), which may also be disrupted by farmer-herder conflict.

3.6.3 Mitigating impacts of livestock diversification on ASF consumption

Table 3.5 presents the ATT results for the mitigating impact of livestock diversification on ASF consumption and coping strategies following the layout set in Table 3.4 and similar justification for reporting only the fixed effects results in model 4. We find that livestock diversification increases ASF consumption by 0.094 100g in post-planting and by 0.096 100g following exposure to farmer-herder conflict in post-harvest, hence the identified mitigating impact. However, livestock diversification has a negative non-statistically significant

relationship with days relied on less preferred foods but reduces the number of days households limit the variety of foods eaten by 0.21 in post-planting and by no significant number of days in post-harvest following exposure to farmer-herder conflict.

Table 3.5. Impacts of livestock diversification on ASF consumption (ATT)

	(1)	(2)	(3)	(4)
Panel A: *Animal-source food consumption (100g/day/aeq)*				
FH conflict*PH season	-0.150***	-0.129***	-0.132***	-0.140***
	(0.042)	(0.040)	(0.034)	(0.034)
FH conflict*Livestock diversification	-0.032	-0.014	0.102**	0.094*
	(0.049)	(0.046)	(0.050)	(0.050)
FH conflict*PH season*Livestock diversification	0.167***	0.119**	0.091*	0.096**
	(0.055)	(0.052)	(0.048)	(0.048)
Constant	0.731***	0.434**	0.729***	-1.988
	(0.014)	(0.215)	(0.008)	(2.246)
R-squared	0.015	0.107	0.019	0.029
Number of observations	11,373	11,373	11,373	11,373
Panel B: *Number of days households relied on less-preferred foods*				
FH conflict*PH season	0.071	0.063	0.134	0.157
	(0.098)	(0.098)	(0.097)	(0.097)
FH conflict*Livestock diversification	-0.003	-0.015	-0.145	-0.125
	(0.128)	(0.128)	(0.124)	(0.124)
FH conflict*PH season*Livestock diversification	0.077	0.012	0.057	0.045
	(0.149)	(0.148)	(0.146)	(0.146)
Constant	1.175***	1.994***	1.074***	-1.763
	(0.031)	(0.531)	(0.023)	(4.264)
R-squared	0.002	0.045	0.010	0.014
Number of observations	12,827	12,827	12,827	12,827
Panel C: *Number of days households limit the variety of food eaten*				
FH conflict*PH season	-0.004	0.004	0.109	0.133
	(0.083)	(0.084)	(0.084)	(0.085)
FH conflict*Livestock diversification	-0.121	-0.129	-0.229**	-0.207*
	(0.111)	(0.112)	(0.112)	(0.111)
FH conflict*PH season*Livestock diversification	0.049	-0.031	-0.002	-0.011
	(0.124)	(0.123)	(0.125)	(0.125)
Constant	1.021***	-0.201	0.894***	-2.066
	(0.028)	(0.435)	(0.020)	(4.812)
R-squared	0.004	0.080	0.014	0.020
Number of observations	12,824	12,824	12,824	12,824
Household controls	No	Yes	No	Yes
Household fixed effects	No	No	Yes	Yes

Source: Author.

Note: ATT is average treatment effect on the treated. Robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

These findings suggest that livestock diversification also mitigates the impact of other non-conflict shocks on ASF consumption and days household limits the varieties of foods eaten in post-planting season and mitigates ASF consumption in post-harvest conflict situations. As hinted earlier, there are limited studies on the mitigating effects of livestock diversification on ASF consumption in conflict situations. However, some related studies' findings show that livestock diversification plays an important role in improving household nutrition across seasons. For example, in Afghanistan, Zanello, Shankar and Poole (2019) found that livestock diversification increased dietary diversity across seasons, suggesting a buffer for household nutrition during the lean season. Another study by Ayenew et al. (2018) in Nigeria shows that the positive effect of crop-livestock diversification on dietary diversity is only captured in post-harvest season and not in post-planting. In Nigeria, harvested foods are more in the post-harvest season. At the same time, livestock production may decline due to water and pasture scarcity and farmer-herder conflict, a feature of the post-harvest season. This situation may undermine livestock production and food consumption for households in conflict-prone regions during critical months and seasons of heightened conflicts.

3.7 Conclusions

Generally, the global nutrition indicators have improved yet are pervasive in the developing world owing to multiple shocks, mainly from climate, the recent Covid-19 pandemic, and conflict aggravated by the former. Conflict has become one indicator strongly correlated with the dire state of food insecurity and malnourishment in Africa (FAO et al., 2019, von Grebmer et al., 2021). To advance the commitments of the 2030 Sustainable Development Goal 2, "end hunger, achieve food security and improved nutrition and promote sustainable agriculture", more robust evidence on how conflict impacts food security and nutrition and the mechanism for building resilience to mitigate conflict impact in Africa is required.

Examining the nutritional impact of conflict has been subsumed in household dietary diversity and child anthropometric indicators. Such a perspective to understanding conflict's impact on nutrition may limit evidence for policy action on specific nutritious food groups such as ASF for the population most at risk of nutritional consequences of conflict. Also, given the evidence on the destructive impact of conflict on livestock assets which may disproportionately disrupt animal-source food systems, an important pathway to women and children's nutrition, we find compelling reasons to examine the objective of this study and advance the discussion on this important nexus.

This is the first study to provide evidence on the impact of conflict on ASF consumption and introduce new indicators that capture the short-term impact of conflict shock on ASF consumption. In addition, this study provides the first evidence on the mitigating impact of livestock production diversification on ASF consumption in conflict situations. Our approach combines a georeferenced conflict events dataset from Nigeria with a longitudinal dataset from a Nigerian household survey covering the period from 2010 to 2016 to identify a causal relationship between conflict, livestock diversification and ASF consumption using a quasi-experimental impact evaluation design.

The patterns of food production and consumption observed across the seasons reveal evidence that farmer-herder conflict-exposed households are those with significant stakes in crop and livestock production and have the potential to consume ASF. The regression results, however, show that farmer-herder conflict significantly reduces the quantity of ASF consumed by households and increases the number of days households sacrifice consumption of ASF. Essentially, farmer-herder conflict statistically reduces the consumption of meat, milk and fish, while poultry consumption is not negatively affected.

However, we find that livestock diversification has a buffering effect on ASF consumption and can reduce households' days to exclude ASF from their diets. These findings suggest that livestock diversification is a sustainable adaptive strategy for household resilience to shocks and helps mitigate conflict effects, thus lending support to policies and programmes promoting livestock production and diversification strategy. An important implication of this evidence is that conflict-exposed households with limited capacity to diversify livestock production are at higher risk of year-round micronutrient deficiency, which has long-term consequences for women and children.

This study has some important implications for nutrition policy, conflict prevention, and peacebuilding. There is a need to improve nutrition intervention towards critical months of low ASF consumption for households exposed to farmer-herder conflict. Also important is for government to show more commitment towards reducing climate change's effect drivers of farmer-herder conflict. Such commitment may include promoting conflict-sensitive agricultural production systems such as cattle ranching and irrigation systems and land tenure policies. While this study focuses on Nigeria, findings are equally relevant for African countries experiencing farmer-herder conflict. Subsequent research is encouraged to expand on nutrition indicators used in assessing the impact of conflict on household nutrition to improve evidence for policy action.

Chapter IV

Examining the association between conflict, livestock assets, and farmers' mental health in Nigeria[11]

[11] This chapter was published in *Economics and Human Biology* journal on 16th February 2023: Fadare, O., Zanello, G., & Srinivasan, C. (2023). Stressor or succour? Examining the association between conflict, livestock assets, and farmers' mental health in Nigeria. *Economics & Human Biology*, 49, 101234. DOI: https://doi.org/10.1016/j.ehb.2023.101234

Authorship contribution statement:

Olusegun Fadare made substantial contributions which include conceptualization of research ideas, data curation and analysis, investigation, and methodology, and writing the original draft, review, and editing, including responding to reviewers' comments in the peer-reviewed process. **Giacomo Zanello** and **Chittur Srinivasan** made contributions in the areas of research conceptualization, funding acquisition, resources, supervision, validation, review, and editing.

Abstract

Farmers are disproportionately vulnerable to violent attacks in the conflict situation in Nigeria, with potential traumatising effects due to the destruction of agricultural livelihoods. In this study, we conceptualise the links between conflict exposure, livestock assets, and depression, using a cross-sectional nationally representative survey of 3,021 Nigerian farmers to quantify the relationships. We highlight three main findings. First, conflict exposure is significantly associated with farmers exhibiting depressive symptoms. Second, holding higher herds of livestock, more cattle, and more sheep and goats while exposed to conflict is associated with higher risk of depression. Third, keeping more poultry is negatively associated with depressive symptoms. Finally, this study accentuates the significance of psychosocial support for farmers in conflict situations. The relationships between different livestock species and farmers' mental health may interest further research in strengthening the evidence.

Keywords: Violent conflict; livestock assets; depressive symptoms; psychosocial support; Africa.

4.1 Introduction

The farming population is disproportionately vulnerable to violent attacks in contemporary conflict situations in Africa, as attacks on food systems are also a weapon of war used by conflict actors (Kemmerling et al., 2022). Particularly in Nigeria, terrorism and conflict between farmers and herders are more concentrated among the farming communities and of-ten lead to the destruction of human capital and livelihood assets such as livestock. While the economic impact of conflict on agricultural livelihoods has been quantified (e.g., Adelaja & George, 2019; Fadare et al., 2022), the psychological effect of conflict among the farming population, especially in low- and middle-income countries (LMICs), has not received adequate research attention. This study will expand the evidence on this neglected topic while highlighting key risk and protective factors associated with depression among farmers in Nigeria.

Unarguably, exposure to conflict has a negative psychological effect on the general population, as it leaves one in five people with one or more symptoms of mental disorders such as depression, anxiety, or post-traumatic stress disorder (PTSD) (Charlson et al., 2019). However, the psychological effect of conflict exposure may be severe for the farming population. This is because farming, more than many occupations, involves working in a hazardous and stressful environment (Olowogbon et al., 2019; Reed & Claunch, 2020), including exposure to pesticides, which is associated with depressive symptoms among farming households (Fuhrimann et al., 2022; Petarli et al., 2022). Additionally, perceived stress from uncertainty around financial strain, lack of social support, and threat to sources of livelihood are strong risk factors for depression for farmers (Hagen et al., 2021; Wang et al., 2019).

Exposure to conflict poses a significant threat to farmers' livelihoods and may reinforce mental stress through critical channels. First, conflict may lead to a significant financial shock to

farmers and disengage them from social ties (Andersen et al., 2020). Especially given that farmers have limited access to insurance schemes or any form of social protection from the government to mitigate conflict risk (Agarwal et al., 2022; Bierbaum et al., 2021). Second, many farmers' store of wealth is their livestock assets, and there is a high likelihood of losing them. For example, in the prevailing conflict between farmers and herders and the targeting of cattle by terrorist groups to finance arms purchases in Nigeria (FATF-GIABA-GABAC, 2016; Okoli, 2019).

Consequently, farmers with more herds of livestock may be more psychologically stressed due to perceived threats to their livestock assets than those with less herd size. At the same time, fewer livestock holdings may correlate with poverty (Ellis & Mdoe, 2003; Randolph et al., 2007), while poor people may be more inclined to poor mental health (Haushofer & Fehr, 2014; Lund et al., 2010). However, holding more herds of livestock can improve farmers' mental health (Nuvey et al., 2020) owing to the many benefits livestock provide (Hidoto, 2015; Maass et al., 2012). Additionally, farmers with more herds of livestock in conflict situations may diversify livestock assets to smaller species as a risk mitigation strategy and to reduce psychological stress (Rockmore, 2020; Fadare et al., 2022). Given also that different livestock species have peculiar characteristics, farmers may leverage these to increase resilience.

Evidence suggests that small livestock species are more resilient to conflict risk (Cox, 2012; Maass et al., 2012) and may have psychological benefits beyond the income they pro-vide in distressing situations (Glass et al., 2014, 2017). There are some additional insights from the studies by Alders et al. (2021) and Cacciatore et al. (2020) on the therapeutic benefits of keeping livestock. However, understanding the links between conflict exposure, live-stock assets, and the psychological well-being of farmers is crucial. More importantly, there is a need

for research to improve evidence of farmers' mental health state and their determinants in LMICs, where stressful events among the farming population have significantly increased.

In this study, we examine the association between conflict, livestock assets and depression among farmers in Nigeria, a country where attacks from terrorism and farmer-herder conflict have increased significantly in the recent decade. Using cross-sectional agricultural household data and georeferenced conflict data, we measure conflict exposure (objective measure) as a binary variable, which classifies farmers as living in conflict locations or not. Additionally, we employ self-reported conflict experienced (subjective measure) binary variable to capture farmers that relocated to non-conflict locations. The livestock variables are measured using the livestock diversification index, total livestock herd size, and three categories of livestock species – cattle, sheep and goats, and poultry. Needless to say, the cross-sectional nature of our data presents significant challenges for causal identification in our empirical models. In particular, we cannot adequately account for biases resulting from omitted variables, sample selection, and simultaneity. However, we include a rich set of control variables and employ objective and subjective measures of conflict to reduce biases.

We find that two in five farmers (41%) in Nigeria fall in the probable depression category or are at risk of depression, that is, have the 10-item Center for Epidemiological Studies-Depression Scale (CES-D) score greater or equal to eight. The regression results show that exposure to conflict has a significant association with farmers exhibiting depressive symptoms or being at risk of depression, evidence strongly supported by a recent study among the general adult population in Nigeria (Sato et al., 2022). However, among the farming population, closely related to our findings are results in the studies by Hagen et al. (2021), Nuvey et al. (2020), and Olff et al. (2005). The authors found a significant association be-tween livestock farmers' exposure to disease outbreaks and poor mental health.

Our findings further show that conflict-exposed farmers with more herds of livestock, particularly cattle, are at a higher risk of depression. However, such an association may not be generalised for some adverse events farmers face. For example, a study conducted by Nuvey et al. (2020) in Ghana revealed a positive correlation between the number of cattle herds possessed by farmers and their mental well-being in the context of disease outbreaks. This association may be due to the fact that farmers with a larger number of livestock assets have greater capability to mitigate the adverse effects of disease outbreaks by accessing veterinary services and purchasing necessary drugs. The ability to control such adverse situation can lead to improved mental health, as farmers are able to continue to derive social and economic benefits from their livestock. Additionally, this study also finds evidence supporting the hypothesis that keeping more poultry birds can have a negative impact on farmers' depressive symptoms. The coefficient of livestock diversification is negatively associated with depression. However, this relationship was not statistically significant, suggesting that the trend towards diversification into smaller livestock species may not induce stress among farmers in conflict situations.

Our study extends the current knowledge on the factors associated with depression among the farming population by examining the mental health of livestock owners in conflict context. We provide new evidence to suggest that livestock holdings may serve as both protective and risk factors for depression among farmers depending on the circumstances at play, a significant contribution to the literature in LMICs. More importantly, in Nigeria, this is the first attempt to quantify the mental health state of farmers using a nationally representative data. Evidence can serve as a reference for policy interventions and programmes on the mental health of farmers in Nigeria, especially those exposed to traumatic events such as conflict. Finally, this study also strengthens our understanding of the link between agriculture and a less studied

dimension of human health (mental health) in LMICs, and the findings can motivate further research in this area.

4.2 Related literature

Studies on the mental health of farmers have long been an important research theme but have gained significant interest in recent years. This is because farmers across the world are increasingly being exposed to stressors that often lead to mental disorders and suicide at the extreme. While the majority of the studies on farmers' mental health are carried out in developed countries, as evidenced by the recent systematic review of the literature (see Liang et al., 2021; Reed & Claunch, 2020; Santos et al., 2021), studies on the mental health of farmers in LMICs, particularly, Sub-Sharan Africa are just emerging. According to a systematic review of the literature on key risk factors affecting farmers' mental health globally from 1979 to April 2019, only a few studies contributed to the literature in Africa (Daghagh et al., 2019).

Unlike workers in most occupations, farmers are more exposed to stressors and distressing events such as crop pest and livestock disease outbreaks, extreme weather events, price shocks, and violent conflict, often resulting in losses of agricultural products and assets. According to the study conducted in 70 farming communities in Nigeria, almost all the farmers interviewed could identify stressors in farming, and 80% thought they had been affected by agricultural stressors in several ways (Olowogbon et al., 2019). Studies have also shown that experiences of adverse events such as disease outbreaks, cattle theft, and land-related conflict resulted in farmers' poor mental health (Nuvey et al., 2020; Olff et al., 2005). A recent study among 6,413 beneficiaries of mental health and psychosocial support programme in the Democratic Republic of the Congo (DRC), Mali, and Nigeria reveals that 49% of the conflict victims were farmers (Andersen et al., 2022).

Conflict situations can be traumatising for farmers as their livestock assets become vulnerable to attacks. Evidence in northern Nigeria shows that livestock rustling, emaciation, disease, death, and distress sale are ways farmers lose livestock in conflict situations (Anne-Judith & Kinsumba, 2019). Further studies suggest a significant relationship between increased cattle rustling and farmer-herder conflict (George et al., 2021) or terrorist attacks in Nigeria (Okoli, 2019). Thus, farmers living in areas prone to farmer-herder conflict may be apprehensive and lose control over managing big livestock. Coping with conflict is also challenging as farmers may be displaced from their homes and livelihood activities, e.g., from accessing farmland or pasture. According to Sweetland et al. (2019), farmers' inability to cope with farming-related stressors hurts their livelihood outcomes – food security, income, asset accumulation, and by extension, their physical and mental health.

4.2.1 The role of livestock assets in the social and economic lives of households

Livestock assets play significant roles in human societies, the complexity of which is increasingly gaining recognition (Alders et al., 2021). The literature suggests that for many livestock-holding households in Africa, cattle herds signify a store of wealth and play many other roles in households' social and economic lives. They serve as a means of land exchange and can function as draught animal power for ploughing, harvesting, transportation and hauling, including providing organic fertiliser for crop production. In some African cultures, cattle are used as payment for bride price, and social prestige is associated with the size of cattle holdings (Hidoto, 2015). Additionally, income from cattle sales and daily earnings from milk sales can meet the food and non-food need of households for smoothing consumption in most shock situations (Islam & Maitra, 2012), conflict situations being an exception since cattle are highly vulnerable to conflict.

Furthermore, sheep, goats, and poultry, even though they may not command a high monetary value per unit herd as cattle, are part of most households' social and economic lives. Poultry

ownership can ensure households have regular access to animal-source food consumption and daily income from selling eggs. Similarly, small livestock requires less land and capital to rear and are mostly used for humanitarian support for the victims of conflict or extreme climate events (Watson & Catley, 2009). In addition, they have the advantage of generating income quickly. Studies have shown that in the long run, livestock species such as poultry and small ruminants could help boost and rebuild household wealth in conflict and post-conflict situations (Maass et al., 2012). These species are primarily relied upon for income generation, food, and other needs in the event cattle assets become susceptible to attacks, thus playing substituting or supplementary roles and helping households build resilience to conflict (Cox, 2012).

In Nigeria, livestock keeping, largely practised as subsistence and complementary to other non-farm activities, contributes significantly to food security and the general well-being of farming households. About 13 million households, or approximately 70% of agricultural households in Nigeria, own and manage at least one species of livestock (FAO, 2019), mostly chicken, goats, sheep, and cattle, as these are in high demand for meeting different human needs with no cultural barrier to their production. More importantly, the sales of livestock assets are the most important coping strategy in shock situations, next to assistance from family and friends (NBS, 2016). Even though livestock assets are vulnerable to conflict risk, their dynamic characteristics mean they can be used to build resilience).

4.3 Conceptual framework for conflict, livestock assets, and depression

While the aetiology of depression remains complex (Kessler & Bromet, 2013), epidemiologic studies of depression show that 40% to 50% of depression risk is genetic. The study by van den Bosch and Meyer-Lindenberg (2019) depicts how exposure to environmental stressors can alter brain structures and functioning to induce depression or depressive symptoms through a biological pathway called chronic stress. Furthermore, chronic stress induces a state of chronic

inflammation in the brain and triggers depressive symptoms and, subsequently, depression (Slavich & Irwin, 2014). According to Cohen and Wills (1985), stress is triggered when an individual considers a situation, such as protracted adverse situations, as threatening or demanding without an appropriate coping response, including feelings of helplessness.

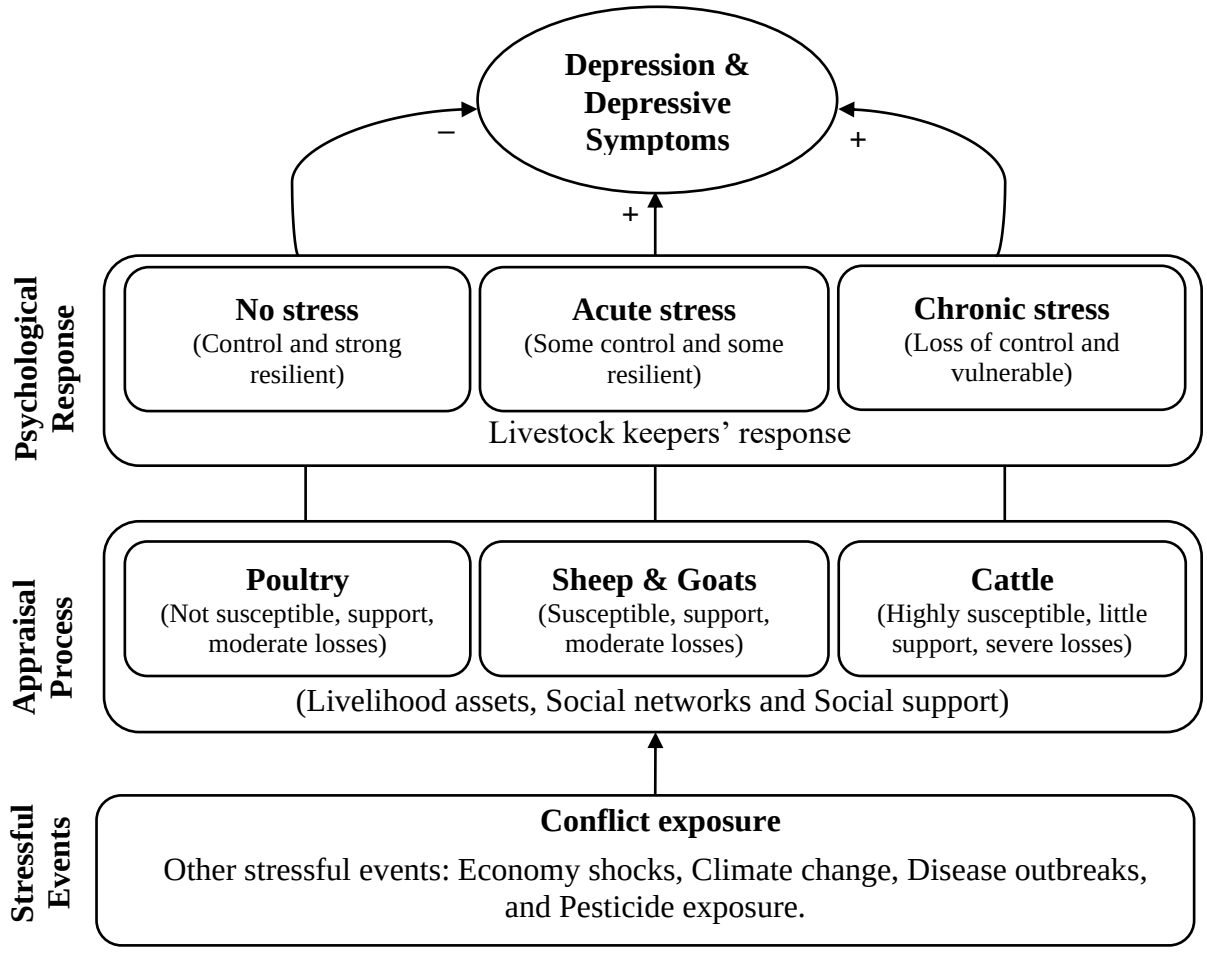
We draw on the works of Cohen and Wills (1985) and van den Bosch and Meyer-Lindenberg (2019) to develop a conceptual framework for understanding the pathways through which conflict may induce depression among farmers. In Figure 4.1, we show that following conflict exposure, a stressful event, livestock keepers undergo a situation appraisal process based on the different livestock assets they own, the perceived hazards, and the likely social support available from family and friends and community members. The outcome of such appraisal is a psychological response that determines the level of stress farmers develop.

In adverse situations, such as conflict, livestock assets may not guarantee positive well-being outcomes (Kazianga & Udry, 2006) except through another support system, including friends and family or social networks (Kutek et al., 2011), which provides financial aid, material resources, and needed services (Cohen & Wills, 1985). Cattle, in particular, are most vulnerable to attacks and cumbersome to manage in conflict situations because of their size, pastoralism production system, and economic and social-cultural value. They are also less likely to be given as a restocking relief in humanitarian programmes. Instead, cattle destocking is encouraged as a strategy to help households convert them to cash and minimise losses to events of conflict or drought (Watson & Catley, 2009). In the absence of intervention or support mechanisms, cattle holders may suffer huge losses and build up chronic stress and depression. Thus, we posit that holding more cattle in conflict situation can increase psychological stress for farmers.

While holdings of sheep and goats may subject farmers to a level of mental stress as cattle holdings if raised in the pastoralism production system, nevertheless, evidence shows that small

livestock, including poultry, are more resilient in conflict situations. Hence, they may maintain a support system for farming households based on their peculiar characteristics and can be used in rebuilding stocks in the long run (Cox, 2012). Farmers may have a level of control in minimising their losses and appraise conflict situations as less stressful, especially if they diversify livestock holdings to smaller species to mitigate conflict risk. We posit that in conflict situation, sheep and goats owners with larger herd sizes may experience acute stress, while keepers of more poultry birds may not experience stress.

Figure 4.1. Conceptual framework of the association between conflict exposure, livestock assets and depression.



Note: Other stressful events listed are non-exhaustive but as captured in the literature review.
Source: Authors.

4.4 Conflict context, data, and empirical strategy

4.4.1 Conflict context in Nigeria

During the time of the survey, terrorism from Boko Haram and farmer-herder conflict are the prevailing violent conflict events in Nigeria. Terrorist attacks by the Islamic State and al-Qaeda-linked Boko Haram jihadist sects are directed mainly at civilians and vulnerable people. As of 2019, the group has carried out over 3,000 attacks (UNDP, 2019) and has killed more than 27,000 civilians since 2009 (ICON & PSJ, 2020). Likewise, clashes between farmers and herders over pastureland and water often result in significant casualties. Since 2009, conflict in Nigeria has resulted in over 3 million internally displaced persons (IDPs) (UNHCR, 2021), and many households have suffered abuses and lost assets, livelihoods, and family members. Violent conflict negatively impacts agricultural livelihoods in Nigeria, with major consequences for livestock assets. Key channels of attacks on livestock result from the pastoralism system of livestock production, which escalates land and water use conflict between farmers and herders and cattle rustling by terrorists to finance arms purchases.

4.4.2 Data

We use data from two sources: (i) agricultural household-level data from the 2016 survey round of the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) for Nigeria (NBS, 2016) and (ii) a global georeferenced conflict data collected from the Armed Conflict Location and Event Data, ACLED (Raleigh et al., 2010). The data were merged based on event time (year) and location (Local Government Area code, LGA) (ACLED, 2019). The LSMS-ISA is a nationally representative longitudinal data collected from 5,000 households, out of which about 65% are agriculture households, with about 70% owning at least one livestock species. The agricultural household sub-section of the data collected in the 2016 round of the survey contains mental health questionnaire and captures 3,021 households, which we employ in the analysis. The respondents for the mental health questionnaire were the heads

of households or most senior members whom we identified as livestock keepers and managers of farmland. Hence, our primary unit of analysis is a farmer per household.

Measurement of depression symptoms

The LSMS-ISA adopted the 10-item Centre for Epidemiological Studies-Depression (CES-D) scale developed by Andresen et al. (1994) from the original 20-item CES-D scale developed by Radloff (1977). The 10-item CES-D scale has shown robust psychometric properties, predictive accuracy, and high correlations with the 20-item CES-D scale in community populations and has been validated in Africa (Baron et al., 2017). CES-D questionnaires are used as screening tools for detecting depression in general populations and are meant to identify symptomatic persons who may not otherwise be recognised and show the probability that they should ideally be referred to for psychosocial support.

The CES-D screening tool is composed of 10 questions on symptoms of depression. Respondents were asked the number of days during the last seven days they felt or behaved in a particular way to suggest they exhibited any of the symptoms (Table C.1 in the Appendix contains the questions and the scoring procedures). A binary variable was generated for each of the depressive symptoms to categorise respondents as having depressive symptoms or not, and a CES-D score that ranges from 0-30 was generated by aggregating the ten depressive symptoms. A score of 30 on the 10-item CES-D score signifies a high risk of depression. Going by the cut-off point of the CES-D, a CES-D score ≥ 8[12] indicates probable depression category. We employ both the binary and the continuous outcome variables in our regression analysis for robustness checks to assess the sensitivity and reliability of the results under different specifications. Table 4.2 shows the proportion of farmers exhibiting depressive symptoms.

[12] This cut-off point has shown good sensitivity and specificity and high internal consistency across age categories (Lewinsohn et al., 1997)

Measurement of conflict

The conflict exposure variable is an objective measure and is defined as households in LGA that experienced at least one violent conflict attack in the last 12 months preceding the survey. This measure is used against a subjective measure where there may be a possibility of biased reporting of violence experienced by victims of traumatising events if talking about the situations will bring back pain. However, we capture farmers who have relocated to non-conflict areas by using subjective measure, conflict experienced variable, defined as self-reported violent conflict experienced by households between 2014 and 2016 (see Table C.2 in the Appendix). This measure also serves as a robustness check for our analysis. In addition, incidents of conflict experienced within the LGA and by households are used for the bivariate analysis of the relationship between risk of depression (CES-D score) and conflict incidents.

Measurement of livestock assets

We employ the Tropical Livestock Unit (TLU) to measure the total livestock holdings and, separately, the sizes of cattle, sheep and goats, and poultry holdings. TLU is used to describe livestock numbers across species to quantify the total livestock holdings (see Rothman-Ostrow et al., 2020). Using TLU against the count of species also enables us to capture other minor species into the category of livestock they fit based on their sizes and management characteristics. In the data, cattle holdings are made up of a few donkeys, horses, and camels (5.2%), sheep and goats include 2% pigs, while poultry includes 3% rabbits and other smaller species (see Table C.3 in the Appendix for the livestock species composition). The livestock diversification index (LD Index) was calculated using the share of the value of livestock species in the total value of livestock owned by households, following the computation approach in Fadare et al. (2022). The LD Index takes values from 0 to 1, with zero (0) representing high level of species specialisation while high level of diversification tends towards one (1).

4.4.3 Empirical strategy

The empirical analysis of the relationship between conflict, livestock assets, and mental health is not straightforward. Theoretically, conflict is endogenous in the mental health econometric model. Specifically, in the context of this study, conflict incidents are not random as there may be endogenous targeting for attack agropastoral communities with more livestock assets holdings or active farming activities (Eberle et al., 2020), subjecting the model to selection bias. There is also the possibility of omitted variables bias, measurement error, and simultaneity in the model. Examining the relationship using cross-sectional data limits the extent to which we can adequately account for possible biases. Against the complexity of the relationship examined, some steps were taken to ameliorate the biases. Aside from taking the sample from the farming population, which to a larger extent shares similar characteristics, we include several control variables in the models. We also test different models' specifications, using an objective and subjective measure of conflict. Nevertheless, we avoid making causal inferences from the findings and interpret results as association.

We employ both the logit and OLS regression models in estimating the relationship between conflict, livestock assets and depression symptoms. The models are specified as follows. Model (i) contains no interactions of livestock and conflict variables, while model specification (ii) contains conflict and livestock variables interaction terms.

$$D_{il} = \beta_0 + \beta_1 Conflict_{il} + \beta_2 \boldsymbol{L_{il}} + \beta_3 \boldsymbol{X_{il}} + \beta_4 \boldsymbol{Y_{il}} + \beta_5 \boldsymbol{Z_l} + u_{il} \quad \text{(i)}$$

$$D_{il} = \beta_0 + \beta_1 Conflict_{il} + \beta_2 \boldsymbol{L_{il}} + \gamma Conflict_{il} * \boldsymbol{L_{il}} + \beta_3 \boldsymbol{X_{il}} + \beta_4 \boldsymbol{Y_{il}} + \beta_5 \boldsymbol{Z_l} + u_{il} \quad \text{(ii)}$$

Here, D_{il} represents depression variables; as binary outcomes, it takes the value of 1 if individual *i* in LGA *l* exhibited one of the depressive symptoms or has CES-D score ≥8 (i.e., is in probable depression), and 0 otherwise, while as a continuous outcome, it captures CES-D

score, which ranges from 0 to 30. The main risk factor examined is conflict exposure or experienced, $Conflict_{il}$, with the value of 1 if individual *i* in LGA *l* is exposed to conflict or had experienced conflict, and 0 otherwise. Vector $\boldsymbol{L_{il}}$ contains livestock variables, which include the TLU of cattle, the TLU of sheep and goats, and the TLU of poultry of individual *i* in LGA *l*. While in alternative model specifications, livestock variable is entered as either TLU of all livestock species or as livestock diversification index.

We control for other factors that may determine depression in all the models. Vector $\boldsymbol{X_{il}}$ includes individual-level control variables, which are respondents' years of education, age categories, gender, marital status, health status, and shocks experienced, i.e., idiosyncratic and covariate shocks experienced by respondents' households (Table C.4 in the Appendix contains the list of shocks experienced), religious affiliation, and cooperative society membership. Vector $\boldsymbol{Y_{il}}$ represents household-level control variables, including the total value of annual household crops produced, total annual household salary income and income from other sources, household size, food consumption in the past seven days – household dietary diversity, household wealth index, computed using principal components analysis on durable household assets, and rural or urban location. Lastly, $\boldsymbol{Z_l}$ is a set of regional dummies representing the six geopolitical regions in Nigeria where a household is located. β_0 is the intercept, while β_{1-5} and γ are the estimated coefficients of the parameters, with γ being for the interaction terms, and u_l is the random-error term. Variables description and measurements are in Table 4.1.

Table 4.1. Description of variables used for analysis

Variable	Units	Description
CES-D score	Score	Centre for Epidemiological Studies-Depression (CES-D) score
CES-D score≥8	Binary	1 if probable depression (CES-D score ≥8)
Main determining factors		
Conflict experienced	Binary	1 if respondent experienced at least one form of conflict between 2014 and 2016
Conflict exposure	Binary	1 if respondent lives in LGA that experienced at least one violent conflict attack within the past 12 months preceding the survey
Poultry	TLU	Tropical Livestock Unit (TLU) of poultry
Sheep-goats	TLU	Tropical Livestock Unit (TLU) of sheep and goats
Cattle	TLU	Tropical Livestock Unit (TLU) of cattle
All livestock	TLU	Tropical Livestock Unit (TLU) of all livestock species
Livestock diversification index	Index	Livestock Diversification Index (LDI)
Individual level factors		
Years of education	Year	Years of education completed by respondents
Aged below 35 years	Binary	1 if respondent is below 35 years, 0 if otherwise
Aged between 35-64 years	Binary	1 if respondent is between 35 and 64 years, 0 if otherwise
Aged above 64 years	Binary	1 if respondent above 64 years, 0 if otherwise
Female	Binary	1 if respondent is female
Married	Binary	1 if respondent is married
Ill-health	Binary	1 if respondent suffered an illness/injury in the past 4 weeks
Experienced shocks	Binary	1 if respondent experienced at least one idiosyncratic or covariate shock between 2014 and 2016
Christianity	Binary	1 if respondent practices Christianity, 0 if other religions
Cooperative society member	Binary	1 if respondent is a member of a cooperative society
Household level factors		
Value of crops produced	Naira	Total value of crops produced by households over the last cropping season in Naira
Salary income	Naira	Total household annual income from salary in Naira
Other income sources	Naira	Total household annual income from other sources in Naira
HH dietary diversity	Score	Household dietary diversity score measured using a 7-day recall period
Wealth index[a]	Index	Household wealth index calculated from a set of durable assets excluding livestock assets
Household size	Number	Number of household members
Rural location	Binary	Household is in rural area
Regional level factors		
North-central	Binary	Household is in North-central
North-east	Binary	Household is in North-east
North-west	Binary	Household is in North-west
South-east	Binary	Household is in South-east
South-south	Binary	Household is in South-south
South-west	Binary	Household is in South-west

Source: Author.

[a]Household durable assets employed in computing the wealth index are type of materials used for housing wall, roofing, and flooring; ownership of car, motor-bike, bicycle, sewing machine, furniture, generator, mattress, fan, radio, cassette recorder, television set, iron, refrigerator, phone, wheelbarrow, cutlass, and hoe; and use of or access to public facilities.

4.5 Results

4.5.1 Descriptive results

The descriptive results are reported in Tables 4.2 and 4.3, and in Figure 4.2 (Panel A and B). Table 4.2 shows that '*restless sleep* (56%), '*not getting going*' (53%), and '*unhappy*' (51%) are the top prevailing symptoms of depression exhibited by farmers, while '*burdened*' (38%), '*afraid*' (36%), and '*lonely*' (34%) are the least. Some studies have likewise reported a high prevalence of a few of these depressive symptoms among farmers. Particularly, high prevalence of restless sleep has been reported among farmers in Nigeria (Olowogbon et al., 2019), Uganda (Fuhrimann et al., 2022), and America (Chengane et al., 2021). Restless sleep or sleep deprivation is also shown to be associated with exposure to pesticides (Fuhrimann et al., 2022) and musculoskeletal pain and discomfort (Chengane et al., 2021). Furthermore, while farming population in many developed countries is mostly lonely (Wheeler et al., 2022), most farmers in Nigeria are not lonely. It is not surprising that loneliness is the least of the depressive symptoms in Nigeria. The reasons may be that farm locations are less isolated from the general population, and farmers still largely employ farm labourers for farming activities, with the advantage of social interaction, unlike in the developed countries where farming is technology-driven and farms are in isolated areas from the general population (Wheeler et al., 2022).

Table 4.2. Percentages of farmers that exhibited symptoms of depression in the last seven days

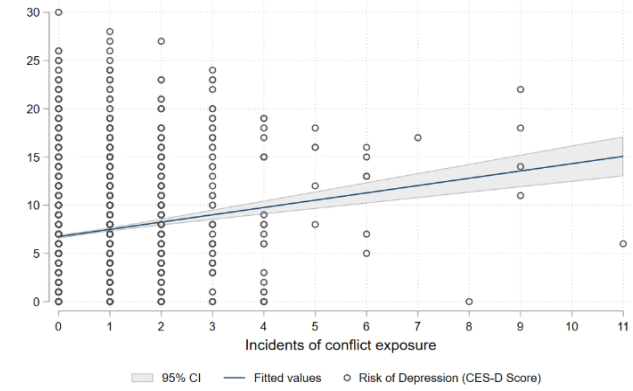
Depressive symptoms	Symptoms code	Yes (%)
Was disturbed by things that do not normally bother me	Disturbed	42
Had trouble keeping my mind on what I was doing	Troubled	41
Felt depressed	Depressed	49
Felt that everything I did was a burden	Burdened	38
Felt hopeful about the future	Hopeless	48
Felt afraid	Afraid	36
Had restless sleep	Restless sleep	56
Was unhappy	Unhappy	51
Felt lonely	Lonely	34
Did not feel like getting up in the morning	Not getting going	53

Source: Authors

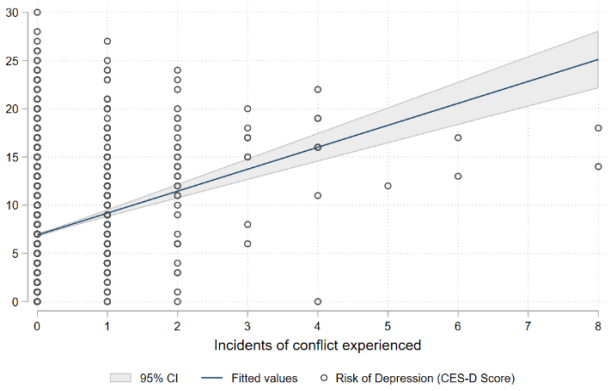
In Figure 4.2, we show a positive linear relationship between risk of depression and incidents of conflict exposure (Figure 4.2, Panel A), and incidents of conflict experienced (Figure 4.2, Panel B). The results suggest that relative to conflict-exposed farmers, farmers who were directly affected by conflict may exhibit more depressive symptoms.

Figure 4.1. Bivariate relationship between conflict and risk of depression

Panel A. Bivariate relationship between incidents of conflict exposure and risk of depression.



Panel B. Bivariate relationship between incidents of conflict experienced and risk of depression.



Note: The shaded region represents 95% confidence intervals.

Source: Author.

In Table 4.2 shows that 41% of farmers have a CES-D score ≥8 (i.e., the prevalence of farmers with probable depression), while the prevalence of probable depression among conflict-exposed farmers was 45%. About 33% of farmers are exposed to conflict, and 7% reported experiencing conflict. Among the farmers not exposed to conflict, 5% have experienced conflict, suggesting they relocated to non-conflict areas. A study in Uganda shows that the prevalence of depression among people exposed to war was as high as 52% (Njenga et al., 2006). In Nigeria, the prevalence of depression among victims of violent conflict in the North-Central region was 38.5% and 45% among heads of households (Taru et al., 2018), the same as the prevalence obtained using national representative data in this study.

We further show in Table 4.3 that poultry, and sheep and goat holdings are not significantly different between farmers in conflict locations and those in non-conflict locations. However, conflict-exposed farmers owned less livestock and cattle, and diversified livestock less than

farmers not exposed to conflict. This result suggests losses of cattle to conflict in conflict locations, as evidenced in the study by Fadare et al. (2022), which found a reduction in cattle herd size as conflict increases in Nigeria. Furthermore, conflict-exposed farmers relative to non-exposed are more educated, within the 35-64 age brackets, experienced more shocks, are more among the Christians, produced more crops, earned more salary and other income, owned more durable assets, had more members, and are more in the rural areas, the north-central, north-east, and south-south regions. On the other hand, conflict-exposed farmers are less among young farmers aged below 35 years, less in households consumed more diverse diets, and locations in north-west south-west regions.

Table 4.3. Summary statistics

Variable	Full Sample		Conflict Exposed (33%)		Non-exposed (67%)		Mean
(minimum/maximum of the full sample)	Mean	SD	Mean	SD	Mean	SD	difference
Outcome variables							
CES-D score (0/30)	7.13	5.13	7.57	5.39	6.92	4.99	-0.65***
CES-D score ≥8 (0/1)	0.41	0.49	0.45	0.50	0.39	0.49	-0.06***
Main determining factors							
Incidents of conflict exposure (0/11)	0.53	0.92	1.53	1.38	0.0	0.0	-1.53***
Incidents of conflict experienced (0/8)	0.10	0.48	0.16	0.64	0.07	0.37	-0.09***
Conflict experienced (0/1)	0.07	0.25	0.10	0.30	0.05	0.22	-0.05***
Poultry TLU (0/0.71)	0.08	0.12	0.08	0.12	0.08	0.13	0.003
Sheep-goats TLU (0/5.2)	0.52	0.86	0.50	0.87	0.53	0.86	0.03
Cattle TLU (0/21)	1.42	8.04	0.83	4.56	1.71	9.26	0.88***
All livestock (0/25)	1.85	4.95	1.45	4.95	2.04	5.44	0.59***
Livestock diversification index (0/0.70)	0.12	0.18	0.11	0.17	0.13	0.18	0.02**
Individual level factors							
Years of education (0/18)	5.94	6.28	6.31	6.43	5.77	6.20	-0.55**
Household head age in year (16/93)	53.32	14.32	53.29	13.79	53.34	14.58	0.04
Aged below 35 years (0/1)	0.08	0.28	0.07	0.26	0.09	0.29	0.02**
Aged between 35-64 years (0/1)	0.68	0.47	0.70	0.46	0.67	0.47	-0.03*
Aged above 64 years (0/1)	0.23	0.42	0.23	0.42	0.24	0.43	0.01
Female (0/1)	0.16	0.37	0.17	0.38	0.16	0.37	-0.01
Married (0/1)	0.77	0.42	0.76	0.43	0.77	0.42	0.01
Ill-health (0/1)	0.20	0.40	0.21	0.41	0.20	0.40	-0.01
Experienced shock (0/1)	0.35	0.48	0.38	0.49	0.34	0.47	-0.05***
Christianity (0/1)	0.51	0.50	0.60	0.49	0.47	0.50	-0.13***
Cooperative society member (0/1)	0.09	0.28	0.08	0.27	0.09	0.29	0.01
Household level factors							
Value of crops produced ’10,000 (0/76)	15.46	17.00	17.38	18.78	14.53	15.98	-2.85***
Salary income ’10,000 (0/904)	51.18	1,280	96.36	2,130	29.16	471.24	-67.2

Other income sources ’10,000 (0/162)	2.97	54.97	6.32	95.11	1.33	8.93	-4.99**
Household dietary diversity score (1/12)	7.93	1.91	7.80	1.95	7.99	1.89	0.19***
Wealth index (-4.14/5.01)	-0.53	2.17	-0.46	2.17	-0.56	2.17	-0.10
Household size (1/34)	7.74	3.61	7.96	3.60	7.63	3.61	-0.34**
Rural location (0/1)	0.86	0.34	0.90	0.31	0.85	0.36	-0.05***
Regional level factors							
Northcentral (0/1)	0.18	0.38	0.23	0.42	0.16	0.36	-0.07***
Northeast (0/1)	0.17	0.38	0.25	0.43	0.14	0.35	-0.11***
Northwest (0/1)	0.25	0.43	0.14	0.35	0.30	0.46	0.16***
Southeast (0/1)	0.19	0.39	0.19	0.39	0.19	0.40	0.01
Southsouth (0/1)	0.13	0.34	0.17	0.37	0.11	0.32	-0.06***
Southwest (0/1) (base category)	0.08	0.27	0.03	0.18	0.10	0.30	0.07***
Sample size	3,021		990		2,031		

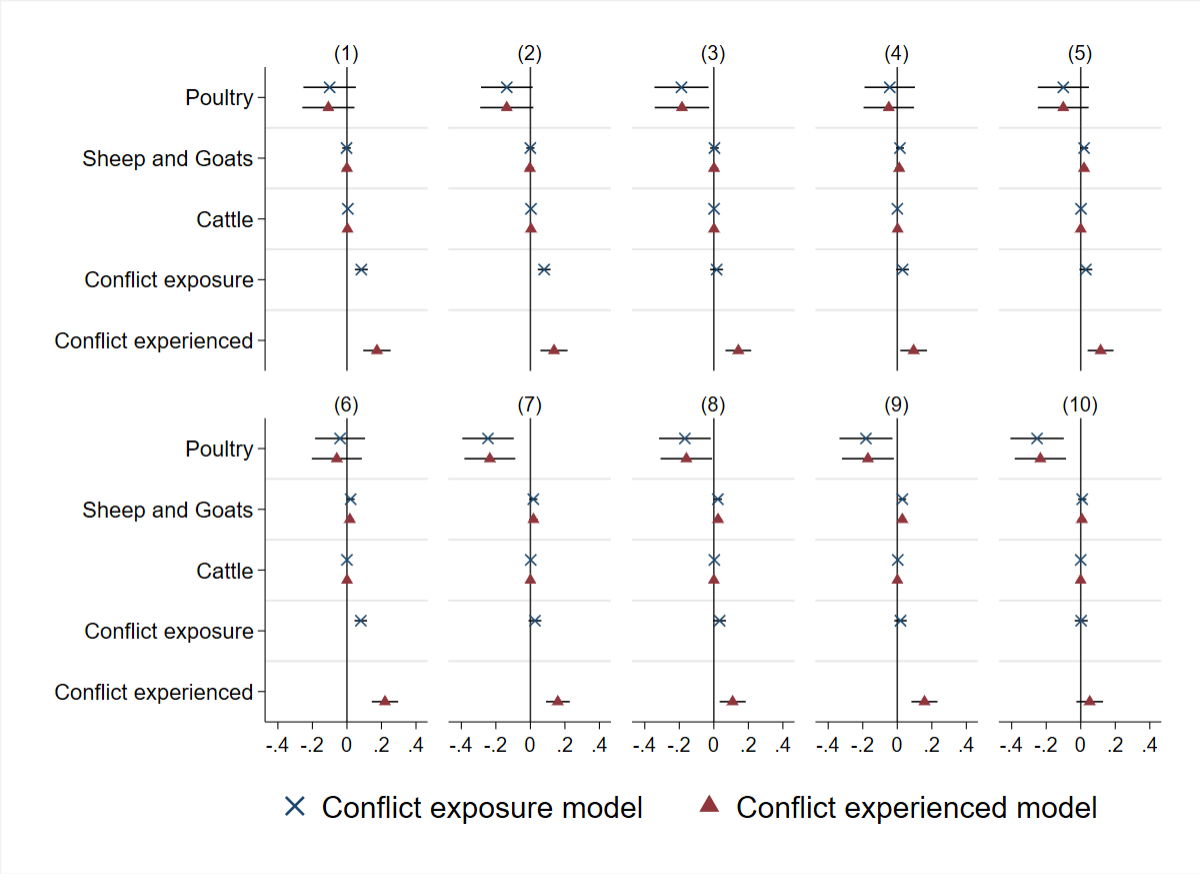
Note: The mean difference in the characteristics of conflict-exposed and non-exposed farmers, based on independent sample t-tests for continuous variables and Pearson chi-square test for categorical variables. SD = standard deviation. *** p<0.01, ** p<0.05, * p<0.1 denote significance at 1%, 5% and 10% levels respectively.

4.5.2 Regression results

4.5.2.1 The association between conflict events, livestock assets, and depression

We first present the results of the association between conflict, livestock assets, and the 10 depressive symptoms in Figure 4.3 as Average Marginal Effects (AME) estimates of logit model specification (ii). Figure 4.3 shows that conflict exposure has a significant association with farmers being ‘*disturbed* (1)’, ‘*troubled* (2)’, and ‘*afraid* (6)’, while conflict experienced has a positive association with all the depressive symptoms except ‘*not getting going* (10)’. Having more poultry while exposed to or having experienced conflict is negatively associated with all the depressive symptoms except ‘*disturbed* (1)’, ‘*burdened* (4)’, ‘*hopeless* (5)’ and ‘*afraid* (6)’. Conversely, there is a positive association between having more herds of sheep and goats in conflict situations and ‘*unhappy* (8)’ and ‘*lonely* (9)’, while having more cattle in conflict situations is associated with ‘*disturbed* (1)’ and ‘*troubled* (2)’.

Figure 4.2. AME results of the estimates of the logit regression models for the association between conflict exposure/experienced, livestock assets, and the 10 depressive symptoms.



Note: (1) Was disturbed by things that don't normally bother me, *(2)* Had trouble keeping my mind on what I was doing, *(3)* Felt depressed, *(4)* Felt that everything I did was a burden, *(5)* Felt hopeful about the future, *(6)* Felt afraid, *(7)* Had a restless sleep, (8) Was unhappy, *(9)* Felt lonely, and *(10)* Did not feel like getting up in the morning. Confidence intervals (CIs) are set at 95%. The stars and triangles with their CIs represent coefficients at different significant levels. Coefficients with CIs outside the vertical lines, at the edge, and on the vertical line are statistically significant at 1%, 5%, and 10% levels, respectively. Coefficients with CIs across the vertical lines are insignificant. Tables C.6 and C.7 in the Appendix contain full results.

Next, we present the results of model specifications (i) and (ii) for the aggregated depression symptoms in Table 4.4 (logit models) and Table 4.5 (OLS models), while the robustness checks results are in Table 4.6 and 4.7, logit and OLS models respectively. In all the results tables, column (1) presents the results of the model specification (i), and columns (2) and (3) are the alternative models. Similarly, column (4) presents the results of model specification (ii), while

columns (5) and (6) are the alternative models. However, we report the results of model specification (ii) as AME in column (7) and the alternative models in columns (8) and (9). The results in column (7) are further represented in Figure 4.4 as predicted probability for intuitive interpretation.

Results across all the models specified in the results tables show that conflict exposure or experienced is statistically associated with probable depression or risk of depression at 5% level. Also, having more poultry is negatively and statistically associated with probable depression and risk of depression across the models specified at 5% level of significance. However, the association is stronger (at 1% level) in the OLS models. Furthermore, Table 4.4 shows a significant association between holding more livestock and cattle in conflict-exposed locations and farmers exhibiting depression symptoms at 5% level of statistical significance, with the robustness checks' results in Table 4.6 showing similar significance. However, our descriptive statistics show that farmers not exposed to conflict have more livestock assets and cattle than their conflict-exposed counterparts. Therefore, to underscore our hypothesis that more herds of cattle may increase mental stress for farmers due to perceived threats to cattle, it may be possible that farmers with more cattle in locations not exposed to conflict also feel apprehensive on account of the tragic news of livestock losses suffered by farmers in non-conflict locations.

In addition, Table 4.5 shows that higher livestock, and sheep and goats holdings while exposed to conflict have a significant association with the risk of depression. The association between livestock assets and mental health of farmers has been reported in different contexts. A study by Majbauddin et al. (2020) in rural Ethiopia found a non-statistically significant association between higher livestock units and farmers' mental health in no specific shock context. However, Hagen et al. (2021), Nuvey et al. (2020), and Olff et al. (2005) in Canada, Ghana,

and United Kingdom, respectively, show a significant association between livestock farmers' exposure to disease outbreaks and farmers exhibiting poor mental health.

Furthermore, we find a non-statistically significant association between livestock diversification and depression across all the models specified, even though the coefficients are mostly negative. While a positive correlation between livelihood/income diversification and food security or better physical health has been reported (Adem et al., 2018; Manlosa et al., 2019; Majbauddin et al., 2020), we find no study on the association between livestock diversification and mental health. Close to reporting on this association is the work of Majbauddin et al. (2020) in rural Ethiopia, which shows no significant association between livelihood diversification, consisting of farm and non-farm income-generated activities, and farmers' mental health.

Further depiction of the results in Figure 4.4 shows that the predicted probability of farmers being at risk of depression when not exposed to conflict or experienced conflict is 40% on average, regardless of the size of livestock holdings (represented by the blue dashed lines). Also, the probability of farmers being at risk of depression when exposed to conflict is approximately 45% on average (represented by the maroon lines). However, the probability decreases to less than 25% for farmers with higher poultry flocks, while it increases beyond 60% for farmers that own more herds of sheep and goats, and cattle.

4.5.2.2 Other determinants of depression

Some of the covariates are statistically significant as risk or protective factors of depression (see Tables C.4 and C.5 in the Appendix). The results show that farmers with more years of education, more farm produce, and more durable assets, Christians against those practising other religions, and farmers whose households consume diverse diets are at a lower risk of exhibiting depressive symptoms. However, farmers in the age bracket of 36 to 64 years, those with physical ill health,

and who have experienced shocks, reside in the northern region, south-east, and south-south as against residents in the south-west are at a higher risk of being depressed. It is not surprising to see that some important well-being indicators, such as education, asset ownership, and adequate dietary consumption, are protective factors for depression. The finding that farmers in their active years are more at risk of depression is instructive and has implications for food security.

Table 4.4. Logit regression results of the association between conflict exposure, livestock assets, and depression (CES-D score ≥8).

	Models with no interaction terms			Models with interaction terms			Average Marginal Effects of models with interaction terms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Conflict exposure	0.183**	0.184**	0.171**	0.232**	0.172*	0.150	0.043**	0.042**	0.039**
	(0.085)	(0.085)	(0.085)	(0.105)	(0.091)	(0.101)	(0.019)	(0.019)	(0.019)
Poultry	-0.688**			-0.207			-0.162**		
	(0.347)			(0.418)			(0.077)		
Conflict exposure*Poultry				-1.571**					
				(0.755)					
Sheep-Goats	0.089*			0.048			0.017		
	(0.053)			(0.065)			(0.012)		
Conflict exposure*Sheep-Goats				0.087					
				(0.107)					
Cattle	0.013**			0.012**			0.005**		
	(0.006)			(0.006)			(0.002)		
Conflict exposure*Cattle				0.031					
				(0.028)					
All livestock		0.021***			0.020**			0.005***	
		(0.008)			(0.009)			(0.002)	
Conflict exposure*All livestock					0.008				
					(0.020)				
LD Index			-0.078			-0.139			-0.017
			(0.236)			(0.282)			(0.053)
Conflict exposure*LD Index						0.183			
						(0.466)			
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.0627	0.0611	0.0596	0.0640	0.0612	0.0612			
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

Note: Numbers in parenthesis are robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 represent significance at 1%, 5% and 10% level respectively. Control variables are education, age, sex, marital status, physical health status, the experience of shocks, religious affiliation, cooperative society membership, value of crops production, salary income, other income, dietary diversity, wealth index, household size, rural-urban location, and geopolitical zone binary variables. Full results are in Table C.4 in the Appendix.

Table 4.5. OLS regression results of the association between conflict exposure, livestock assets, and depression (CES-D score).

	Models with no interaction terms			Models with interaction terms			Average Marginal Effects of models with interaction terms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Conflict exposure	0.414**	0.426**	0.409**	0.440*	0.313	0.352	0.430**	0.448**	0.413**
	(0.197)	(0.198)	(0.197)	(0.244)	(0.211)	(0.236)	(0.198)	(0.198)	(0.197)
Poultry	-2.310***			-1.911**			-2.338***		
	(0.724)			(0.826)			(0.729)		
Conflict exposure*Poultry				-1.304					
				(1.653)					
Sheep-Goats	0.279**			0.237			0.262**		
	(0.127)			(0.149)			(0.128)		
Conflict exposure*Sheep-Goats				0.079					
				(0.260)					
Cattle	0.012			0.009			0.021		
	(0.010)			(0.011)			(0.014)		
Conflict exposure*Cattle				0.036					
				(0.038)					
All livestock		0.030			0.017			0.041*	
		(0.020)			(0.022)			(0.021)	
Conflict exposure*All livestock					0.073				
					(0.047)				
LD Index			0.040			-0.121			0.041
			(0.519)			(0.594)			(0.520)
Conflict exposure*LD Index						0.494			
						(1.058)			
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.114	0.111	0.110	0.114	0.111	0.110			
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

Note: Numbers in parenthesis are robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 represent significance at 1%, 5% and 10% level respectively. Control variables are as used in Table 4.4. Full results are in Table C.4 in the Appendix.

Table 4.6. Logit regression results of the association between conflict experienced, livestock assets, and depression (CES-D score ≥8).

	Models with no interaction terms			Models with interaction terms			Average Marginal Effects of models with interaction terms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Conflict experienced	1.054***	1.052***	1.061***	0.769***	0.919***	0.837***	0.215***	0.230***	0.231***
	(0.170)	(0.169)	(0.170)	(0.230)	(0.189)	(0.219)	(0.039)	(0.037)	(0.038)
Poultry	-0.705**			-0.690*			-0.155**		
	(0.351)			(0.365)			(0.077)		
Conflict experienced*Poultry				-0.331					
				(1.489)					
Sheep-Goats	0.068			0.031			0.013		
	(0.053)			(0.057)			(0.012)		
Conflict experienced*Sheep-Goats				0.438**					
				(0.201)					
Cattle	0.013**			0.014**			0.003**		
	(0.006)			(0.006)			(0.001)		
Conflict experienced*Cattle				-0.005					
				(0.048)					
All livestock		0.019**			0.016*			0.004**	
		(0.008)			(0.008)			(0.002)	
Conflict experienced*All livestock					0.064				
					(0.044)				
LD Index			-0.128			-0.229			-0.031
			(0.239)			(0.249)			(0.053)
Conflict experienced*LD Index						1.452			
						(0.925)			
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.0690	0.0718	0.0702	0.0696	0.0731	0.0708			
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

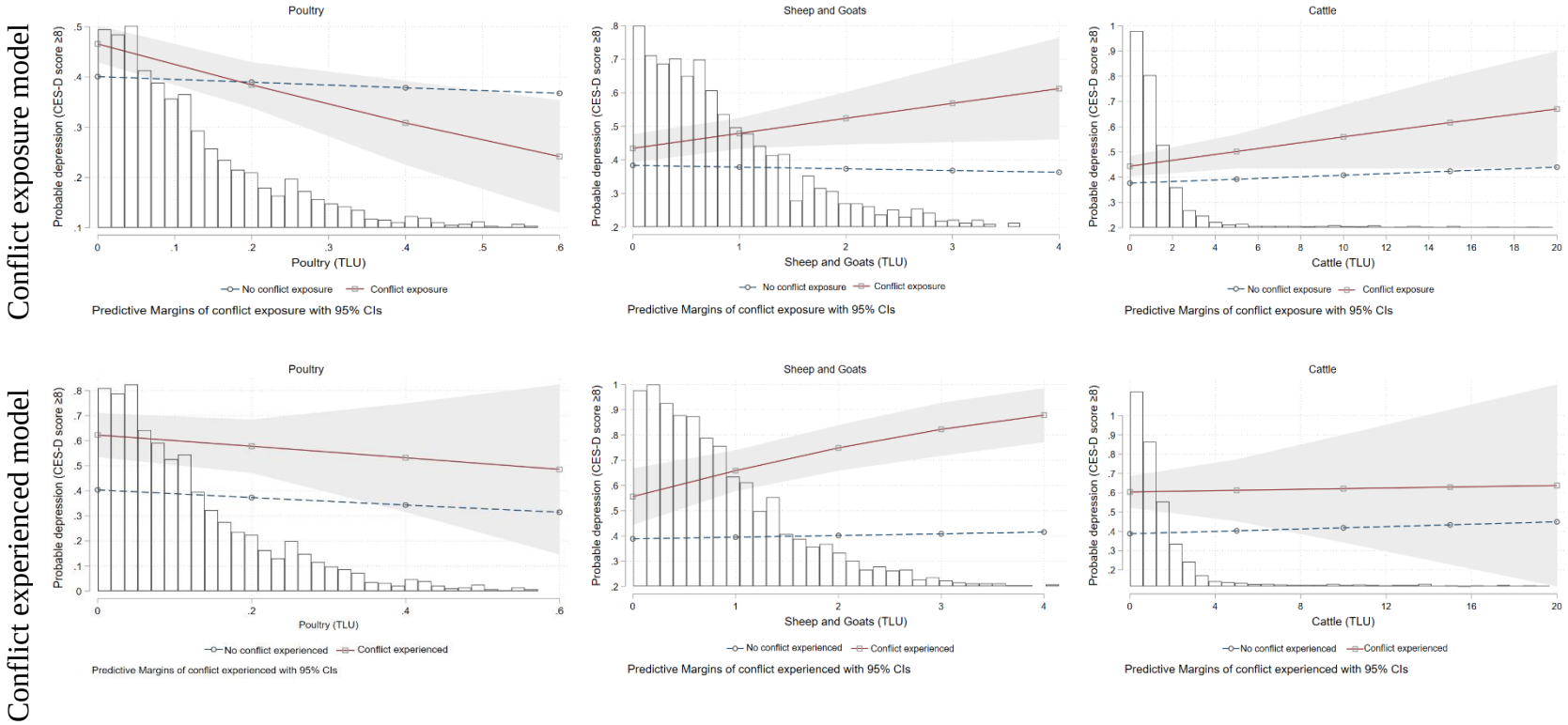
Note: Numbers in parenthesis are robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 represent significance at 1%, 5% and 10% level respectively. Control variables are as used in Table 4.4. Full results are in Table C.5 in the Appendix.

Table 4.7. OLS regression results of the association between conflict experienced, livestock assets, and depression (CES-D score).

	Models with no interaction terms			Models with interaction terms			Average Marginal Effects of models with interaction terms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Conflict experienced	3.310***	3.321***	3.334***	3.242***	3.019***	3.174***	3.284***	3.220***	3.298***
	(0.436)	(0.434)	(0.435)	(0.633)	(0.479)	(0.588)	(0.487)	(0.444)	(0.456)
Poultry	-2.306***			-2.184***			-2.350***		
	(0.712)			(0.731)			(0.715)		
Conflict experienced*Poultry				-2.465					
				(3.253)					
Sheep-Goats	0.208*			0.160			0.170		
	(0.122)			(0.128)			(0.123)		
Conflict experienced*Sheep-Goats				0.143					
				(0.441)					
Cattle	0.014			0.012			0.020*		
	(0.010)			(0.010)			(0.011)		
Conflict experienced*Cattle				0.112					
				(0.070)					
All livestock		0.024			0.012			0.020	
		(0.019)			(0.020)			(0.019)	
Conflict experienced*All livestock					0.109**				
					(0.044)				
LD Index			-0.109			-0.187			-0.119
			(0.513)			(0.526)			(0.512)
Conflict experienced*LD Index						1.009			
						(1.948)			
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.132	0.136	0.133	0.133	0.137	0.134			
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

Note: Numbers in parenthesis are robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 represent significance at 1%, 5% and 10% level respectively. Control variables are as used in Table 4.4. Full results are in Table C.5 in the Appendix.

Figure 4.3. The association between conflict, livestock assets, and depression, based on column (7) in the result tables



Source: Author.

Note: Shaded regions represent 95% confidence intervals.

4.6 Discussion

There are about 300 million people in the world suffering from depression, and 5% of the world's adult population is depressed (WHO, 2021), making depression a major public health concern. More importantly, the world is more exposed to traumatic events such as the recent covid-19 pandemic, droughts or floods, and conflict, which disproportionately affect the livelihoods of many people in LMICs. The livelihoods of the farming population, in particular, are mostly affected by the contemporary conflict situations in Africa, with significant implications for their psychological well-being. Evidence on the mental health effects of violent conflict across different demographic and socio-cultural settings is well-documented. However, this study extending the evidence to the farming population fills important gaps in the literature.

We provide evidence of the vulnerability to conflict, an important livelihood asset, livestock, and how it may affect farmers' mental health. The evidence is important for improving psychosocial support and resilience for the farming population. This study shows that conflict exposure leaves about 45% of farmers at risk of depression, 6% higher than farmers not exposed to conflict, suggesting that farmers are faced with other risk factors for depression. Exposure to pesticides, diseases outbreak, financial loss, poor physical health, and sustained injuries are identified risk factors for depression in developed and developing countries (Hagen et al., 2019; Reed & Claunch, 2020; Olff et al., 2005). Our study further shows that exposure to conflict is associated with a higher risk of depression and holding more herds of livestock, cattle in particular, in conflict situations is a major reinforcing factor for an increased likelihood of depression symptoms.

Similar to our study are studies that found a significant association between exposure to disease outbreaks as a traumatic event and poor mental health of farmers (Hagen et al., 2021; Nuvey et al., 2020; Olff et al., 2005). However, these studies do not examine the association between farmers' mental health and the size of livestock holdings or the different livestock species owned by the exposed farmers, except for the study by Nuvey et al. (2020) that shows that more herds of cattle improve mental health for the Ghanaian farmers. Holding more cattle can boost farmers' social and economic status, resulting in psychological well-being if the nature of adverse events farmers face is controllable.

However, unlike in conflict situations, where there is a disruption to the systems that support livestock production, increased risk and uncertainty for cattle owners can trigger stress. Thus, holdings more cattle can be cumbersome to manage as they can be directly attacked or indirectly destroyed through emaciation and diseases due to lack of access to pasture, water, other inputs and supporting services such as market and extension services. A salient finding in our result is that holding more herds of cattle in conflict situations produces similar psychological responses as exposure to conflict, supporting the positive relationship between more cattle herds and higher risk of depression in conflict situations.

The weak association between holding more herds of sheep and goats while in conflict situations and depression conforms with the conceptual understanding of the characteristics of these livestock species and the extent of their vulnerability to conflict. An inverse relationship with depression may be expected based on their income generation and resilience capability as they are not in the extreme case of 'high-valued' but vulnerable cattle and 'low-valued' but resilient poultry. The strong association between higher poultry assets and lower risk of depression aligns with the conceptual understanding that poultry birds demonstrate more

resilience to conflict and may possess some characteristics that maintain good mental health for the keepers.

There are anecdotes about poultry keeping being associated with a reduced risk of depression symptoms which may be further validated through experimental evidence. For example, available grey literature suggests that poultry keeping can have a calming effect on their keepers and may reduce depression. Also, a recent study suggests white meat reduces the risk of depression symptoms (Kazemi et al., 2021), and poultry meat consumption may represent another potential pathway through which poultry can reduce the likelihood of depression. Evidence from Nigeria shows that poultry meat is often consumed in farming households more than meat from cattle, sheep and goats (Fadare et al., 2019). This evidence may interest further research and intervention promoting small-scale livestock production for human nutrition and health.

4.7 Conclusion

There is a growing recognition of the need to monitor and ensure farmers have good mental health, as also imperative in the fight against hunger, food insecurity and malnutrition in LMICs (Sparling et al., 2021). Our study extends the current knowledge on the risk and protective factors of depression among the farming population. The key points from this study include the appreciation of the magnitude of mental health challenges the Nigerian farmers are subjected to by factors such as conflict. Another is the scope for building resilience using livestock assets to mitigate the potential effect of conflict on farmers' mental health. More importantly, this study informs the need for psychosocial support for farmers in conflict situations as an essential input in peacebuilding, livelihoods recovery, and food security and nutrition (Hertog, 2017; Sparling et al., 2021; UNDP, 2022).

The primary aim of the CES-D screening tool used in this study is to identify the population at risk of depression that may require psychosocial support, which is an important policy implication of this study. Given the limited information on mental health in Nigeria, policy options in this direction may include awareness creation and re-orientation on the mental health issue, especially among the farming population. Additional support for victims of conflict may include mental health evaluation, and psychosocial support, among others. Moreover, people clinically diagnosed with depression may be referred for mental health treatment and psychoeducation. Recent evidence in some African countries suggests that mental health and psychosocial intervention for victims of conflict have been effective (Andersen et al., 2022).

Finally, this study provides additional evidence for humanitarian intervention on the typology of livestock that may be used as relief in protracted conflict situations. However, more research is required to generate sufficient evidence on the pathways from livestock assets to depression in conflict contexts or similar shock situations. More importantly, more study should employ the CES-D score to measure depression to increase it validation in Africa. Also, as previously highlighted, the empirical analysis is limited to using cross-sectional data, which precludes us from investigating the temporal relationship between depression, conflict, and livestock assets. However, the study, being the first in Nigeria to quantify the prevalence of depression symptoms among farmers and their risk factors using a nationally representative data, is significant and could motivate future investments in a cohort study on the mental health of farmers in Nigeria.

Chapter V

5.1 Concluding statement

The 21st-century conflicts in SSA are protracted and have seasonal dimensions as they are also being fueled by climate change. Being protracted opens the discussion on the strategies for sustaining agricultural livelihoods, particularly livestock production in conflict situations. A strong argument is made for livestock as a vehicle that could drive household resilience (Glass et al., 2014; Ngigi, Mueller, & Birner, 2021; Megersa et al., 2014a; Maass et al., 2012). Even though livestock assets are vulnerable to conflict shocks, they can be resilient in specific contexts. The evidence provided in this thesis is informative for adapting livestock portfolios to build nutrition and health resilience in protracted conflict situations.

More evidence on the destructive impact of conflict on agricultural livelihoods is contextualised on livestock assets while validating the dynamic characteristics of livestock assets in building resilience to conflict shocks. The multiple benefits of holding small livestock species are evident. The mitigating role of livestock diversification is beyond conceptualisation as in previous studies. This is now empirically validated in the context of farmer-herder conflict and seasonal agricultural practices through rigorous hypotheses testing on a different measure of ASF consumption.

5.2 Recommendations for policy considerations

For conflict-exposed households, engaging in livestock diversification strategy raises some important issues. First is the possibility that households will stop investing in large livestock or sell them to purchase small livestock less vulnerable to conflict stress. The second is that households may receive livestock as relief materials from humanitarian assistance. In either of these strategies for diversifying livestock portfolios, there is the need for such to be informed

by evidence-based conflict analysis to guide against unintended negative consequences (Cordaid, 2015). For example, livestock sale needs to be strategically planned to maximise return and reduce distress sales. Intelligence gathering and early warning systems were instrumental in helping households sell their cattle in South Sudan conflict situations to reinvest in less risky activities (Catley, Bishop, & Leyland, 2005). This present research shows that cattle, sheep and goats may not be ideal for relief material in conflict situations as they are more valuable and can increase the risk of depression due to the concerns that they may be stolen. Ultimately, "to mitigate or reduce conflict, food security interventions need to be based on a thorough conflict analysis, assessing the linkages between the conflict, the agricultural situation, the value chain, and the effects that the proposed intervention may have (Cordaid, 2015, p. 6)".

Furthermore, the government's approaches to conflict in Nigeria have been mainly through kinetic military action, whereas adopting a non-kinetic approach that takes cognisance of the roles of traditional and religious institutions may be more effective in conflict management, resolution, and peacebuilding. This call is especially relevant in resolving the conflict between farmers and herders, driven mainly by climate change events. The protracted nature of the conflict would also require conflict-sensitive livestock policies, for example, promoting a sedentary cattle ranching system, irrigation systems, climate-smart agricultural production system, and land tenure policies. Promoting small livestock production, as they are less vulnerable to destruction in conflict, is also conflict sensitive. Open grazing bans should be done in phases and with diplomatic attention to the diverse interests of conflicting parties.

In partnership with humanitarian organisations, the government should prioritise food and non-food interventions for livestock-holding households most vulnerable to conflict shocks. Specifically, nutrition-specific intervention should target critical seasons of nutritional

vulnerability for these vulnerable households. In addition, nutrition-sensitive approaches such as livestock diversification, as highlighted in this research, should be promoted and coupled with fruits and vegetable gardening, which are also good sources of micronutrients and can be grown within the homestead. Lastly, the stressors for farmers have increased in recent years with significant consequences for food security and nutrition. Additional psychosocial support for conflict victims is needed.

5.3 Research contributions to knowledge

The key contributions to the body of knowledge are in the areas of the study location, the conceptual framework developed, and the metrics and methodologies adopted in examining the research phenomena, which produce evidence-based outcomes that have significant relevance for policies on critical aspects of sustainable development. Conducting this research in Nigeria is a significant contribution to the body of research, given the peculiarity of the country and the limited empirical evidence in the country on this research area. Nigeria is the most populous African country, where ongoing conflicts have persisted for over a decade and ranked in the top position among the countries with the worse indexes for measuring sustainable development. Given very few studies ahead of this present study in Nigeria, the findings from this research have significant implications for humanitarian interventions and policies on food security, nutrition, and mental health for conflict-exposed households in Nigeria and Africa at large.

From an extensive literature review on the thesis's topic, this thesis links the different concepts and constructs in the research questions to draw up a conceptual framework that lends understanding to the relationships between conflicts, livestock assets, and well-being outcomes, thus significantly improving the understanding of the relationships. In addition, measuring conflict using different parameters and actors provides a broader perspective of

conflict impacts on the outcomes measured. At the same time, evidence on the context of livestock assets' vulnerability to conflict risk is provided to improve the understanding of the resilience capacity of livestock-holding households. Unlike previous studies, nutrition was measured using ASF consumption and introducing new indicators for measuring ASF consumption.

Furthermore, limited in the extant literature and where this research makes another significant contribution is quantifying the mental health impact of conflict among the farming communities. Additional contribution on this front is the evidence of the moderating effect of livestock assets, which further strengthens the link between agriculture and health in developing countries and is relevant in extending livestock relief materials to conflict victims.

5.4 Strengths, limitations, and suggestions for future research

This research has used datasets solely from secondary sources. The advantage is that the researcher can analyse nationally representative observations and carry out a cohort study using a quasi-experimental design. In addition, it saves time and resources for the data collection on the researcher's part. More importantly, it allows the aggregations of household-level data with georeferenced conflict data, which is a breakthrough for studying the impact of conflict at the micro level. Even though the assemblage of large datasets from different datasets is also time-consuming and a rigorous exercise, but a worthy skill to acquire by a quantitative researcher.

However, using secondary data can pose some limitations to the scope of the research. One is being unable to measure some indicators and relying on proxy variables. For example, some specific aspects of resilience capacities could have been used for computing a resilient index while understanding the contributions of each component. However, land and livestock assets are also key components of household resilience capacities. As provided in this research, evidence of their roles in building resilience to conflict is equally valid. An opportunity to

collect primary data would have captured some other relevant indicators. These may include data on insurance, community conflict management mechanism, social network, and individual risk attitude to improve and triangulate the evidence from the secondary data, an area to be considered for further research.

Furthermore, investigating the effects of conflict on the mental health of Nigerian farmers is limited to using cross-sectional observations as made available in one round of the longitudinal survey. This limitation precludes investigating the temporal relationship between depression and the risk factors. However, there are significant insights from the research outcomes being the first to quantify the prevalence of depression symptoms among farmers in Nigeria and their risk factors using nationally representative data. This evidence is significant and should motivate future investments in a cohort study on the mental health of farmers in Nigeria.

This research has also measured nutrition and health, respectively, using animal-source foods consumption and mental health, indicators that have limited application in related research yet, are innovative in addressing the research objectives. However, it was worth noting that the questions on food consumption coping strategies were not explicitly asked about animal-source food consumption but were suggestive. Suggestive because of the high negative correlation with animal-source food consumption and not on other nutritious food. Hence, even though the correlation validates their being used as a short-term measure of ASF consumption in conflict situations, the results should be interpreted bearing this point in mind. Moving forward, one of the questions on food consumption coping strategies, that is, “the number of days in the past 7 days any member of the household had to rely on less preferred foods,” could be modified by defining “less preferred food” to including component of nutrition or healthy diets without losing the value of what the indicator intends to measure.

References

Acharya, Y., Luke, N., Naz, S., & Sharma, D. (2020). Exposure to conflict-related violence and nutritional status of children in Iraq. *SSM-Population Health*, *11*, 100585.

ACLED (2019). Armed Conflict Location & Event Data Project (ACLED). Regional Overview – Africa 19 March 2019. Available at: https://acleddata.com/2019/03/19/regional-overview-africa-19-march-2019/.

Adelaja, A., & George, J. (2019a). Effects of conflict on agriculture: Evidence from the Boko Haram insurgency. *World Development*, *117*, 184-195.

Adelaja, A., & George, J. (2019b). Terrorism and land use in agriculture: the case of Boko Haram in Nigeria. *Land Use Policy*, *88*, 104116.

Adigun, O. W. (2019). A critical analysis of the relationship between climate change, land disputes, and the patterns of farmers/herdsmen's conflicts in Nigeria. *Canadian Social Science*, *15*(3), 76-89.

Ajala, O. (2020). New drivers of conflict in Nigeria: an analysis of the clashes between farmers and pastoralists. *Third World Quarterly*, *41*(12), 2048-2066. doi:10.1080/01436597.2020.1811662.

Akresh, R., Lucchetti, L., & Thirumurthy, H. (2012). Wars and child health: Evidence from the Eritrean–Ethiopian conflict. *Journal of development economics*, *99*(2), 330-340.

Akresh, R., Verwimp, P., & Bundervoet, T. (2011). Civil war, crop failure, and child stunting in Rwanda. *Economic Development and cultural change*, *59*(4), 777-810.

Alderman, H., Hoddinott, J., & Kinsey, B. (2006). Long term consequences of early childhood malnutrition. *Oxford economic papers*, *58*(3), 450-474.

Alders, R. G., Campbell, A., Costa, R., Guèye, E. F., Ahasanul Hoque, M., Perezgrovas-Garza, R., ... & Wingett, K. (2021). Livestock across the world: diverse animal species with complex roles in human societies and ecosystem services. *Animal Frontiers*, *11*(5), 20-29.

Allison, S. (2020). Conflict is still Africa's biggest challenge in 2020. *Relief Web, January*, *6*.

Alloush, M., & Bloem, J. R. (2022). Neighborhood violence, poverty, and psychological well-being. *Journal of Development Economics*, *154*, 102756.

Andersen, I., Rossi, R., & Hubloue, I. (2022). Community-Level Mental Health and Psychosocial Support During Armed Conflict: A Cohort Study from the Democratic

Republic of the Congo, Mali, and Nigeria. *Frontiers in public health*, 10:815222. doi:10.3389/fpubh.2022.815222.

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for depression in well older adults: Evaluation of a short form of the CES-D. *American journal of preventive medicine*, *10*(2), 77-84.

Anne-Judith N., & Kinsumba, N. (2019). FAO Northeast Nigeria Rapid Gender Analysis in Livestock, Fisheries and Apiculture of Affected Population in Borno, Adamawa and Yobe States November 2018– December 2018.

Apeh, A. A., Opata, C. C., Amaechi, C. M., & Njoku, O. N. (2021). Cattle rights versus human rights: herdsmen–farmer clashes in Nigeria. *Rural History*, *32*(2), 197-216. doi:10.1017/S0956793321000029.

Arias, M. A., Ibáñez, A. M., & Zambrano, A. (2019). Agricultural production amidst conflict: Separating the effects of conflict into shocks and uncertainty. *World Development*, *119*, 165-184.

Arslan, A., Asfaw, S., Cavatassi, R., Lipper, L., McCarthy, N., Kokwe, M., & Phiri, G. (2018). Diversification as part of a CSA strategy: the cases of Zambia and Malawi. In Climate Smart Agriculture (pp. 527-562). Springer, Cham.

Ayenew, H. Y., Biadgilign, S., Schickramm, L., Abate-Kassa, G., & Sauer, J. (2018). Production diversification, dietary diversity and consumption seasonality: panel data evidence from Nigeria. *BMC public health*, *18*(1), 1-9.

Azad, M., Crawford, E. E., & Kaila, H. K. (2018). *Conflict and Violence in Nigeria: Results from the North East, North Central, and South South Zones* (No. 130198, pp. 1-44). The World Bank.

Azzarri, C., Zezza, A., Haile, B., & Cross, E. (2015). Does livestock ownership affect animal source foods consumption and child nutritional status? Evidence from rural Uganda. *The Journal of Development Studies*, *51*(8), 1034-1059.

Babu, S. C., Looden, J., Ajmal, M., Rana, A. W., Omar, J., & Srivastava, N. (2021). *Nutrition sensitive food systems in conflict affected regions: A case study of Afghanistan* (No. 2007). International Food Policy Research Institute (IFPRI).

Bageant, E., Liu, Y., & Diao, X. (2016). *Agriculture-nutrition linkages and child health in the presence of conflict in Nepal* (No. 1515). International Food Policy Research Institute (IFPRI).

Baliki, G., Brück, T., & Stojetz, W. (2018). Drivers of resilience and food security in North-east Nigeria: Learning from microdata in an emergency setting. *Final Report to the*

Food and Agriculture Organization. ISDC – International Security and Development Center, Berlin, Germany.

Banda, L. J., & Tanganyika, J. (2021). Livestock provide more than food in smallholder production systems of developing countries. *Animal Frontiers*, *11*(2), 7-14.

Baron, E. C., Davies, T., & Lund, C. (2017). Validation of the 10-item centre for epidemiological studies depression scale (CES-D-10) in Zulu, Xhosa and Afrikaans populations in South Africa. *BMC psychiatry*, *17*(1), 1-14.

Baumann, M., & Kuemmerle, T. (2016). The impacts of warfare and Armed conflicts on land systems. *Journal of Land Use Science*, *11*(6), 672-688.

Baumann, M., Radeloff, V. C., Avedian, V., & Kuemmerle, T. (2015). Land-use change in the Caucasus during and after the Nagorno-Karabakh conflict. *Regional environmental change*, *15*(8), 1703-1716.

Bello, B., & Abdullahi, M. M. (2021). Farmers-Herdsmen Conflict, Cattle Rustling, and Banditry: The Dialectics of Insecurity in Anka and Maradun Local Government Area of Zamfara State, Nigeria. *SAGE Open*, *11*(4), doi.org/10.1177/21582440211040117.

Bellon, M. R., Kotu, B. H., Azzarri, C., & Caracciolo, F. (2020). To diversify or not to diversify, that is the question. Pursuing agricultural development for smallholder farmers in marginal areas of Ghana. *World Development*, *125*, 104682.

Benjaminsen, T. A., & Ba, B. (2021). Fulani-dogon killings in mali: Farmer-herder conflicts as insurgency and counterinsurgency. *African Security*, *14*(1), 4-26.

Black, M. M. (2003). Micronutrient deficiencies and cognitive functioning. *The journal of nutrition*, *133*(11), 3927S-3931S.

Block, S., & Webb, P. (2001). The dynamics of livelihood diversification in post-famine Ethiopia. *Food policy*, *26*(4), 333-350.

Brinkman, H. J., & Hendrix, C. S. (2011). Food Insecurity and Violent Conflict: Causes. *Consequences, and Addressing the Challenges*, *World Food Programme*, (No. 24). Occasional Paper.

Brottem, L. V. (2016). Environmental change and farmer-herder conflict in agropastoral West Africa. *Human ecology*, *44*(5), 547-563. DOI https://doi.org/10.1007/s10745-016-9846-5.

Brottem, L. V. (2021). The Growing Complexity of Farmer- Herder Conflict in West and Central Africa. Africa Security Brief No. 39 July 2021. A publication of Africa Center for Strategic Studies

Brück, T., & d'Errico, M. (2019). Reprint of: Food security and violent conflict: Introduction to the special issue. *World Development*, *119*, 145-149.

Brück, T., & Schindler, K. (2009). Smallholder land access in post-war northern Mozambique. *World Development*, *37*(8), 1379-1389.

Brück, T., d'Errico, M., & Pietrelli, R. (2019). The effects of violent conflict on household resilience and food security: Evidence from the 2014 Gaza conflict. *World Development*, *119*, 203-223.

Brück, T., Dunker, K., Ferguson, N., Meysonnat, A., & Nillesen, E. E. (2018). Determinants and dynamics of forced migration to Europe: Evidence from a 3-D model of flows and stocks. *Available at SSRN 3261693*.

Brück, T., Habibi, N., Martin-Shields, C., Sneyers, A., Stojetz, W., & van Weezel, S. (2016). The Relationship between Food Security and Violent Conflict: Report to FAO. *ISDC (International Security and Development Center), 22*.

Cacciatore, J., Gorman, R., & Thieleman, K. (2020). Evaluating care farming as a means to care for those in trauma and grief. *Health & place*, *62*, 102281.

Carletto, G., Covarrubias, K., Davis, B., Krausova, M., Stamoulis, K. G., Winters, P. C., & Zezza, A. (2007). Rural income generating activities in developing countries: re-assessing the evidence. *eJADE: electronic Journal of Agricultural and Development Economics*, *4*(853-2016-56112), 146-193.

Cassimon, D., Fadare, O., & Mavrotas, G. (2021). Development finance, governance quality and their impact on food and nutrition security in Sub-Saharan Africa. *Review of Development Finance*, *11*(2), 1-17.

Catley, A., Bishop, S., & Leyland, T. (2005). *Policies, Practice and Participation in Complex Emergencies: The Case of Livestock Interventions in South Sudan; a Case Study for the Agriculture and Development Division of the Food and Agriculture Organization*. Feinstein Internat. Famine Centre.

Charlson, F., van Ommeren, M., Flaxman, A., Cornett, J., Whiteford, H., & Saxena, S. (2019). New WHO prevalence estimates of mental disorders in conflict settings: a systematic review and meta-analysis. *The Lancet*, *394*(10194), 240-248.

Chauveau, J. P., & Richards, P. (2008). West African insurgencies in agrarian perspective: Côte d'Ivoire and Sierra Leone compared. *Journal of Agrarian Change*, *8*(4), 515-552.

Chinwokwu, E. C., & Michael, C. E. (2019). Militancy and Violence as a Catalyst to Kidnapping in Nigeria. *International Journal of Police Science & Management, 21*(1), 17-35.

Christian, C., Hensel, L., & Roth, C. (2019). Income shocks and suicides: Causal evidence from Indonesia. *Review of Economics and Statistics, 101*(5), 905-920.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological bulletin*, *98*(2), 310.

Collier, P., Elliott, V. L., Hegre, H., Hoeffler, A., Reynal-Querol, M., & Sambanis, N. (2003). Breaking the Conflict Trap: Civil War and Development Policy. *World Bank Publications*.

Cordaid (2015). Smallholders and Food Security in Fragile Contexts. Cordaid's Approach and Track Record. https://www.cordaid.org/en/wp-content/uploads/sites/3/2015/06/Cordaid-Position_paper_FoodSecurity-LR.pdf.

Cox, T. P. (2012). Farming the battlefield: the meanings of war, cattle and soil in South Kivu, Democratic Republic of the Congo. *Disasters*, *36*(2), 233-248.

Croicu, M., & Kreutz, J. (2017). Communication technology and reports on political violence: Cross-national evidence using African events data. *Political research quarterly*, *70*(1), 19-31.

Dabalen, A. L., & Paul, S. (2014). Effect of conflict on dietary diversity: Evidence from Côte d'Ivoire. *World Development*, *58*, 143-158.

Daghagh Yazd, S., Wheeler, S. A., & Zuo, A. (2019). Key risk factors affecting farmers' mental health: A systematic review. *International journal of environmental research and public health*, *16*(23), 4849.

Day, A., & Caus, J. (2020). *Conflict Prevention in the Era of Climate Change: Adapting the UN to Climate-Security Risks*. United Nations University.

Delgado, C., Murugani, V., & Tschunkert, K. (2021). Food Systems in Conflict and Peacebuilding Settings: Pathways and Interconnections.

Desiere, S., Hung, Y., Verbeke, W., & D'Haese, M. (2018). Assessing current and future meat and fish consumption in Sub-Sahara Africa: Learnings from FAO Food Balance Sheets and LSMS household survey data. *Global food security*, *16*, 116-126.

Ducrotoy, M. J., Revie, C. W., Shaw, A. P., Musa, U. B., Bertu, W. J., Gusi, A. M., ... & Welburn, S. C. (2017). Wealth, household heterogeneity and livelihood diversification

of Fulani pastoralists in the Kachia Grazing Reserve, northern Nigeria, during a period of social transition. *PloS One*, *12*(3), e0172866.

Eberle, U. J., Rohner, D., & Thoenig, M. (2020). *Heat and Hate: Climate Security and Farmer-Herder Conflicts in Africa* (No. 15542). CEPR Discussion Papers.

Eck, K. (2012). In data we trust? A comparison of UCDP GED and ACLED conflict events datasets. *Cooperation and Conflict*, *47*(1), 124-141.

Eklund, L., Degerald, M., Brandt, M., Prishchepov, A. V., & Pilesjö, P. (2017). How conflict affects land use: agricultural activity in areas seized by the Islamic State. *Environmental Research Letters*, *12*(5), 054004.

Enders, W., & Sandler, T. (2011). *The political economy of terrorism*. Cambridge University Press.

Fadare, O., Akerele, D., Mavrotas, G., & Ogunniyi, A. (2019a). Effect of Conflict and Food Price Shocks on Calorie Intake and Acute Malnutrition in Nigeria: A Micro-Panel Data Analysis. In *93rd Annual Conference, April 15-17, 2019, Warwick University, Coventry, UK* (No. 289676). Agricultural Economics Society-AES.

Fadare, O., Mavrotas, G., Akerele, D., & Oyeyemi, M. (2019b). Micronutrient-rich food consumption, intra-household food allocation and child stunting in rural Nigeria. *Public health nutrition*, *22*(3), 444-454.

Fadare, O., Zanello, G., & Srinivasan, C. (2022). The joint effects of terrorism and land access on livestock production decisions: Evidence from northern Nigeria. *World Development Perspectives*, *27*, 100447.

FAO & Tufts University. (2019). Twin peaks: the seasonality of acute malnutrition, conflict and environmental factors – Chad, South Sudan and the Sudan. September 2019. Rome.

FAO, IFAD, UNICEF, WFP & WHO. (2017). The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome, FAO.

FAO, IFAD, UNICEF, WFP & WHO. (2019). The State of Food Security and Nutrition in the World 2019. Safeguarding against economic slowdowns and downturns. Rome, FAO.

FAO. (2018). Livestock production systems spotlight Nigeria. FAO, Rome, Italy. https://www.fao.org/3/CA2149EN/ca2149en.pdf

FAOSTAT (2018). FAOSTAT, www.fao.org/faostat/en/ Rome: FAO.

Fatas, E., Jiménez, N., Restrepo-Plaza, L., & Rincón, G. (2021). The behavioral consequences of conflict exposure on risk preferences. In *Oxford Research*

Encyclopedia of Economics and Finance. https://doi.org/10.1093/acrefore/9780190625979.013.637

FATF-GIABA-GABAC (2016), Terrorist Financing in West and Central Africa, FATF, Paris www.fatf-gafi.org/publications/methodsandtrends/documents/terrorist-financing-west-central-africa.html.

FEWS NET (2013). Famine Early Warning Systems Network. Seasonal Calendar for a Typical Year. Available at: https://fews.net/west-africa/nigeria/seasonal-calendar/december-2013. Accessed 7 April 2021.

Food and Agricultural Organization of the United Nations (FAO). (2019). *The future of livestock in Nigeria. Opportunities and challenges in the face of uncertainty*. Rome. https://www.fao.org/documents/card/en/c/ca5464en

Forest, J. J. (2012). Global trends in kidnapping by terrorist groups. *Global Change, Peace & Security*, *24*(3), 311-330.

Friedman, J., & Thomas, D. (2009). Psychological health before, during, and after an economic crisis: Results from Indonesia, 1993–2000. *The World Bank Economic Review*, *23*(1), 57-76.

Garmyn, A. J. (2021). More than meat: contributions of livestock systems beyond meat production. *Animal Frontiers*, *11*(2), 3-5.

Gaye, S. B. (2018). *Conflicts between farmers and herders against a backdrop of asymmetric threats in Mali and Burkina Faso*. Friedrich-Ebert-Stiftung Peace and Security, Centre of Competence Sub-Sharan Africa.

Gebreyes, Y., Lemma, G. B., Deng, L. B., & Abdullahi, S. (2016). The Impact of Conflict on the Livestock Sector in South Sudan. *Juba: Food and Agriculture Organization South Sudan*.

George, J., Adelaja, A., & Awokuse, T. O. (2021). The agricultural impacts of armed conflicts: the case of Fulani militia. *European Review of Agricultural Economics*, *48*(3), 538-572.

George, J., Adelaja, A., & Weatherspoon, D. (2020). Armed conflicts and food insecurity: evidence from Boko Haram's attacks. *American Journal of Agricultural Economics*, *102*(1), 114-131.

Glass, N., Perrin, N. A., Kohli, A., & Remy, M. M. (2014). Livestock/animal assets buffer the impact of conflict-related traumatic events on mental health symptoms for rural women. *PLoS One*, *9*(11), e111708.

Glass, N., Perrin, N. A., Kohli, A., Campbell, J., & Remy, M. M. (2017). Randomised controlled trial of a livestock productive asset transfer programme to improve economic and health outcomes and reduce intimate partner violence in a post-conflict setting. *BMJ Global Health*, *2*(1), e000165.

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, *225*(2), 254-277.

Gorsevski, V., Kasischke, E., Dempewolf, J., Loboda, T., & Grossmann, F. (2012). Analysis of the impacts of Armed conflicts on the Eastern Afromontane forest region on the South Sudan–Uganda border using multitemporal Landsat imagery. *Remote Sensing of Environment*, *118*, 10-20.

Habtemariam, L. T., Gornott, C., Hoffmann, H., & Sieber, S. (2021). Farm production diversity and household dietary diversity: Panel data evidence from rural households in Tanzania. *Frontiers in Sustainable Food Systems*, 151.

Haddad, L., Achadi, E., Bendech, M. A., Ahuja, A., Bhatia, K., Bhutta, Z., ... & Reddy, K. S. (2015). The Global Nutrition Report 2014: Actions and accountability to accelerate the world's progress on nutrition. *The Journal of nutrition*, 145 (4), 663-671. https://doi.org/10.3945/jn.114.206078 PMID: 25740908

Hendrix, C. S., & Salehyan, I. (2012). Climate change, rainfall, and social conflict in Africa. *Journal of peace research*, *49*(1), 35-50.

Hendrix, C., & Brinkman, H. J. (2013). Food insecurity and conflict dynamics: Causal linkages and complex feedbacks. *Stability: International Journal of Security and Development*, *2*(2).

Hertog, K. (2017). The intrinsic interlinkage between peacebuilding and mental health and psychosocial support: The international association for human values model of integrated psychosocial peacebuilding. *Intervention*, *15*(3), 278-292.

Hetherington, J. B., Wiethoelter, A. K., Negin, J., & Mor, S. M. (2017). Livestock ownership, animal source foods and child nutritional outcomes in seven rural village clusters in Sub-Saharan Africa. *Agriculture & Food Security*, *6*(1), 1-11.

Hidoto, Y. (2015). Cattle Counting Ceremony among the Wolaita (Ethiopia): Exploring Socio-Economic and Environmental Roles. *Open Journal of Ecology*, *5*(05), 159.

Hitzhusen, F. J., & Jeanty, P. W. (2006). Analyzing the effects of conflicts on food security in developing countries: An instrumental variable panel data approach. 2006 Annual meeting, July 23–26, Long Beach, CA 21483, American Agricultural Economics Association.

Hsiang, S. M., Burke, M., & Miguel, E. (2013). Quantifying the influence of climate on human conflict. *Science*, *341*(6151), 1235367.

ICG. (2017) International Crises Group, 2017. Herders against farmers: Nigeria's expanding deadly conflict. Crisis Group Africa Report N∘252.

Ickowicz, A., Ancey, V., Corniaux, C., Duteurtre, G., Poccard-Chappuis, R., Touré, I., ... & Wane, A. (2012). Crop–livestock production systems in the Sahel–increasing resilience for adaptation to climate change and preserving food security. *Building resilience for adaptation to climate change in the agriculture sector*, *23*, 261.

ICON and & PSJ. (2020). "Nigeria's Silent Slaughter: Genocide in Nigeria and the Implications for the International Community,". 2020. International Committee on Nigeria (ICON) and International Organization for Peacebuilding and Social Justice (PSJ). Available at https://clientwebproof.com/Nigeria-Silent-Slaughter.

Institute for Economics & Peace. (2020) Global Terrorism Index 2020: Measuring the Impact of Terrorism, Sydney, November 2020. Retrieved from http://visionofhumanity.org/reports. Accessed March 23, 2021.

International Crisis Group. (2018). Stopping Nigeria's Spiralling Farmer-Herder Violence. *Africa Report*, (262).

International Food Policy Research Institute (IFPRI). (2021). 2021 *Global Food Policy Report*: Transforming Food Systems after COVID-19. Washington, DC: International Food Policy Research Institute. https://doi.org/10.2499/9780896293991.

International Monetary Fund (IMF). (2022). IMF Strategy For Fragile And Conflict-Affected States. IMF Policy Pape. International Monetary Fund Washington, D.C.

International Organization for Migration (IOM), (2021). Environmental Migration, Disaster Displacement and Planned Relocation in West Africa. IOM. Geneva.

Islam, A., & Maitra, P. (2012). Health shocks and consumption smoothing in rural households: Does microcredit have a role to play?. *Journal of Development Economics*, *97*(2), 232-243.

Jahnke, H. E., & Jahnke, H. E. (1982). *Livestock production systems and livestock development in tropical Africa* (Vol. 35). Kiel: Kieler Wissenschaftsverlag Vauk.

Jamison, J. C., McGee, K., Oseni, G., Perng, J. T. T., Sato, R., Tanaka, T., & Vakis, R. (2018). The Relationship between Conflicts, Economic Shocks, and Death with Depression, Economic Activities, and Human Capital Investment in Nigeria. *World Bank Policy Research Working Paper*, (8685).

Jayne, T. S., Fox, L.O., Fuglie, K.E., & Adelaja, A.D. (2021). Agricultural productivity growth, resilience, and economic transformation in sub-Saharan Africa. *Association of Public and Land-grant Universities (APLU)*.

Kah, H. K. (2017). 'Boko Haram is losing, but so is food production: conflict and food insecurity in Nigeria and Cameroon. *Africa Development*, *42*(3), 177-196.

Kahn-Lang, A., & Lang, K. (2020). The promise and pitfalls of differences-in-differences: Reflections on 16 and pregnant and other applications. *Journal of Business & Economic Statistics*, *38*(3), 613-620.

Kaila, H. K., & Azad, M. A. K. (2019). Conflict, Household Victimization, and Welfare: Does the Perpetrator Matter? *World Bank Policy Research Working Paper*, (9019).

Kasimbu, J. (2010). Pastoralism at the Edge. "Effects of drought, climate change and migration on livelihood systems of pastoralist and mobile communities in Kenya. *International Organization for Migration. Nairobi, Kenya*.

Kazemi, S., Keshteli, A. H., Saneei, P., Afshar, H., Esmaillzadeh, A., & Adibi, P. (2021). Red and White Meat Intake in Relation to Mental Disorders in Iranian Adults. *Frontiers in nutrition*, 450.

Kazianga, H., & Udry, C. (2006). Consumption smoothing? Livestock, insurance and drought in rural Burkina Faso. *Journal of Development economics*, *79*(2), 413-446.

Kemmerling, B., Schetter, C., & Wirkus, L. (2022). The logics of war and food (in) security. Global Food Security, 33, 100634.

Kessler, R. C., & Bromet, E. J. (2013). The epidemiology of depression across cultures. *Annual review of public health*, *34*, 119-138.

Khonje, M. G., Ricker-Gilbert, J., Muyanga, M., & Qaim, M. (2022). Farm-level production diversity and child and adolescent nutrition in rural sub-Saharan Africa: a multicountry, longitudinal study. *The Lancet Planetary Health*, *6*(5), e391-e399.

Kim, H. (2019). In the wake of conflict: the long-term effect on child nutrition in Uganda. *Oxford Development Studies*, *47*(3), 336-355.

Koren, O. (2018). Food abundance and violent conflict in Africa. *American Journal of Agricultural Economics*, *100*(4), 981-1006.

Kray, H. A., Heumesser, C., Mikulcak, F., Giertz, Å., Bucik, M. (2018). Productive Diversification in African Agriculture and its Effects on Resilience and Nutrition. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/942331530525570280/Productive-Diversification-in-African-Agriculture-and-its-Effects-on-Resilience-and-Nutrition

Kuemmerle, T., & Baumann, M. (2021). Shocks to food systems in times of conflict. *Nature Food*, *2*(12), 922-923.

Kumar, N., Harris, J., & Rawat, R. (2015). If they grow it, will they eat and grow? Evidence from Zambia on agricultural diversity and child undernutrition. *The journal of development studies*, *51*(8), 1060-1077.

Landis, S. T. (2014). Temperature seasonality and violent conflict: The inconsistencies of a warming planet. *Journal of Peace Research*, *51*(5), 603-618.

Lange, S., & Reimers, M. (2014). *Livestock as an Imperfect Buffer Stock in Poorly Integrated Markets* (No. 162). Discussion Papers. Courant Research Centre PEG.

Latino, L. R., Pica-Ciamarra, U., & Wisser, D. (2020). Africa: The livestock revolution urbanizes. *Global food security*, *26*, 100399.

Le, K. (2021). Armed conflict and child weight in DR Congo. *Advances in Public Health*, *2021*.

Le, K., & Nguyen, M. (2020). The impacts of armed conflict on child health: Evidence from 56 developing countries. *Journal of Peace Research*, 00223433211066417.

Lewinsohn, P. M., Seeley, J. R., Roberts, R. E., & Allen, N. B. (1997). Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and aging*, *12*(2), 277.

Liverpool-Tasie, L. S. O., Sanou, A., Reardon, T., & Belton, B. (2021). Demand for imported versus domestic fish in Nigeria. *Journal of Agricultural Economics*, *72*(3), 782-804.

Maass, B. L., Katunga Musale, D., Chiuri, W. L., Gassner, A., & Peters, M. (2012). Challenges and opportunities for smallholder livestock production in post-conflict South Kivu, eastern DR Congo. *Tropical animal health and production*, *44*(6), 1221-1232.

Maiangwa, B., Uzodike, U. O., Whetho, A., & Onapajo, H. (2012). "Baptism by Fire": Boko Haram and the reign of terror in Nigeria. *Africa Today*, *59*(2), 41-57.

Martin-Shields, C. P., & Stojetz, W. (2019). Food security and conflict: Empirical challenges and future opportunities for research and policy making on food security and conflict. *World Development*, *119*, 150-164.

Maxwell, D., Watkins, B., Wheeler, R., & Collins, G. (2003). The coping strategies index: A tool for rapidly measuring food security and the impact of food aid programmes in emergencies. *Nairobi: CARE Eastern and Central Africa Regional Management Unit and the World Food Programme Vulnerability Assessment and Mapping Unit*.

McKay, A., & Thorbecke, E. (2019). The anatomy of fragile states in Sub-Saharan Africa: Understanding the interrelationship between fragility and indicators of well-being. *Review of Development Economics*, *23*(3), 1073-1100.

Megersa, B., Markemann, A., Angassa, A., & Valle Zárate, A. (2014a). The role of livestock diversification in ensuring household food security under a changing climate in Borana, Ethiopia. *Food Security*, *6*(1), 15-28.

Megersa, B., Markemann, A., Angassa, A., Ogutu, J. O., Piepho, H. P., & Zárate, A. V. (2014b). Livestock diversification: an adaptive strategy to climate and rangeland ecosystem changes in southern Ethiopia. Human Ecology, 42(4), 509-520.

Mekuria, W., & Mekonnen, K. (2018). Determinants of crop–livestock diversification in the mixed farming systems: evidence from central highlands of Ethiopia. *Agriculture & Food Security*, *7*(1), 1-15.

Micha, R., Mannar, V., Afshin, A., Allemandi, L., Baker, P., Battersby, J., ... & Grummer-Strawn, L. (2020). 2020 global nutrition report: action on equity to end malnutrition.

Miller, S., Johnson, N., & Wherry, L. R. (2021). Medicaid and mortality: new evidence from linked survey and administrative data. *The Quarterly Journal of Economics*, *136*(3), 1783-1829.

Minoiu, C., & Shemyakina, O. N. (2014). Armed conflict, household victimization, and child health in Côte d'Ivoire. *Journal of Development Economics*, *108*, 237-255.

Monteleone, C. (2016). Do terrorism, organized crime (drug production), and state weakness affect contemporary Armed conflictss? An empirical analysis. *Global Change, Peace & Security*, *28*(1), 35-53.

Moritz, M., Garcia, V., Buffington, A., & Ahmadou, M. (2019). Pastoralist refugee crisis tests the resilience of open property regime in the Logone Floodplain, Cameroon. *Land Use Policy*, *86*, 31-42.

Mortimore, M. J., & Adams, W. M. (2001). Farmer adaptation, change and 'crisis' in the Sahel. *Global environmental change*, *11*(1), 49-57.

Mosha, D., Canavan, C. R., Bellows, A. L., Blakstad, M. M., Noor, R. A., Masanja, H., ... & Fawzi, W. (2018). The impact of integrated nutrition-sensitive interventions on nutrition and health of children and women in rural Tanzania: study protocol for a cluster-randomised controlled trial. *BMC nutrition*, *4*(1), 1-8.

Murendo, C., Gwara, S., Mazvimavi, K., & Arensen, J. S. (2019). Linking crop and livestock diversification to household nutrition: Evidence from Guruve and Mt Darwin districts, Zimbabwe. *World Development Perspectives*, *14*, 100104.

National Bureau of Statistics & World Bank. (2016). *Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA).* Nigeria Post-harvest Survey Data, www.worldbank.org/lsms-isa.

NBS (National Bureau of Statistics, Nigeria). (2020). "2019 Poverty and Inequality in Nigeria: Executive Summary." May, NBS, Abuja, Nigeria.

Ngigi, M. W., Mueller, U., & Birner, R. (2021). Livestock diversification for improved resilience and welfare outcomes under climate risks in Kenya. *The European Journal of Development Research*, *33*(6), 1625-1648.

Nnaji, A., Ma, W., Ratna, N., & Renwick, A. (2022b). Farmer-herder conflicts and food insecurity: Evidence from rural Nigeria. *Agricultural and Resource Economics Review*, 1-31.

Nnaji, A., Ratna, N., Renwick, A., & Ma, W. (2022a). Risk perception, farmer− herder conflicts and production decisions: evidence from Nigeria. *European Review of Agricultural Economics, 2022; jbac012, https://doi.org/10.1093/erae/jbac012*.

Nuvey, F. S., Kreppel, K., Nortey, P. A., Addo-Lartey, A., Sarfo, B., Fokou, G., ... & Bonfoh, B. (2020). Poor mental health of livestock farmers in Africa: a mixed methods case study from Ghana. *BMC public health*, *20*(1), 1-12.

Ogunniyi, A. I., Mavrotas, G., Olagunju, K. O., Fadare, O., & Adedoyin, R. (2020). Governance Quality, Remittances and their Implications for Food and Nutrition Security in Sub-Saharan Africa. *World Development*, 127, 104752.

Okafor, G., & Chikalipah, S. (2021). Estimating the effect of terrorism on agricultural production in Nigeria. *African Development Review*, *33*(4), 703-714.

Okoli, A. C. (2019). Cows, cash and terror: how cattle rustling proceeds fuel Boko Haram insurgency in Nigeria. *Africa Development/Afrique et Developpement*, *44*(2), 53-76.

Olaniyan, R., Faleye, O. A., & Moyo, I. (Eds.). (2021). *Transborder Pastoral Nomadism and Human Security in Africa: Focus on West Africa*. Taylor & Francis.

Olff, M., Koeter, M. W., Van Haaften, E. H., Kersten, P. H., & Gersons, B. P. (2005). Impact of a foot and mouth disease crisis on post-traumatic stress symptoms in farmers. *The British Journal of Psychiatry*, *186*(2), 165-166.

Olowogbon, T. S., Yoder, A. M., Fakayode, S. B., & Falola, A. O. (2019). Agricultural stressors: identification, causes and perceived effects among Nigerian crop farmers. *Journal of agromedicine*, *24*(1), 46-55.

Owens, T., Hoddinott, J., & Kinsey, B. (2003). The impact of agricultural extension on farm production in resettlement areas of Zimbabwe. *Economic Development and Cultural Change*, *51*(2), 337-357.

Oyaniran, T. (2020). Current state of Nigeria agriculture and agribusiness sector. In *Proc. Afr. Continential Free Trade Area (AfCFTA) Workshop* (pp. 1-14).

Pal, S., & Kar, S. (2012). Implications of the methods of agricultural diversification in reference with Malda district: Drawback and rationale. *International Journal of Food, Agriculture and Veterinary Sciences*, *2*(2), 97-105.

Paul, S., Shonchoy, A. S., & Dabalen, A. (2015). *Food crop diversification as a risk mitigating strategy during conflict: evidence from Cote d'Ivoire* (No. 496). Institute of Developing Economies, Japan External Trade Organization (JETRO).

Perry, B. D. (2002). *Investing in animal health research to alleviate poverty*. ILRI (aka ILCA and ILRAD).

Pettersson, T., & Wallensteen, P. (2015). Armed Conflicts, 1946–2014. Journal of Peace Research, 52(4), 536–550.

Pica-Ciamarra, U., Tasciotti, L., Otte, J., & Zezza, A. (2011). *Livestock Assets, Livestock Income and Rural Households: Cross-Country Evidence from Household Surveys* (No. 17890). The World Bank Group. *https://openknowledge.worldbank.org/handle/10986/17890*

Pinstrup-Andersen, P., & Shimokawa, S. (2008). Do poverty and poor health and nutrition increase the risk of armed conflict onset? *Food Policy*, *33*(6), 513-520.

Quandt, A., & McCabe, J. T. (2017). "You Can Steal Livestock but You Can't Steal Trees." The Livelihood Benefits of Agroforestry during and after Violent Conflict. *Human Ecology*, *45*(4), 463-473.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied psychological measurement*, *1*(3), 385-401.

Raleigh, C. (2019). *Global Conflict and Disorder Patterns*. Armed Conflict Location & Event Data Project. http://www.jstor.org/stable/resrep25633.

Raleigh, C., Linke, A., Hegre, H., & Karlsen, J. (2010). Introducing ACLED: an Armed conflicts location and event dataset: special data feature. *Journal of peace research*, *47*(5), 651-660.

Randolph, T. F., Schelling, E., Grace, D., Nicholson, C. F., Leroy, J. L., Cole, D. C., ... and Ruel, M. (2007). Invited review: Role of livestock in human nutrition and health for

poverty reduction in developing countries. *Journal of livestock science*, *85*(11), 2788-2800.

Ritchie, H., & Roser, M. (2017). Meat and dairy production. *Our World in Data*.

Rockmore, M. (2011). The cost of fear: The welfare effects of the risk of violence in Northern Uganda. *Households in Conflict Network Working Paper*, *109*.

Rockmore, M. (2020). Conflict-Risk and agricultural portfolios: Evidence from northern Uganda. *The Journal of Development Studies*, *56*(10), 1856-1876.

Rutstein, S. O., & Johnson, K. (2004). DHS comparative reports 6: the DHS wealth index. *Calverton, MD: ORC Macro*.

Schinina, G., Babcock, E., Nadelman, R., Walsh, J. S., Willhoite, A., & Willman, A. (2016). The integration of livelihood support and mental health and psychosocial well-being for populations who have been subject to severe stressors. *J Ment Heal Psychosoc Support Confl Affect Areas*, *14*(3), 211-22.

Sewando, P. T., Mutabazi, K. D., & Mdoe, N. Y. (2016). Vulnerability of agropastoral farmers to climate risks in northern and central Tanzania. *Development Studies Research*, *3*(1), 11-24.

Simpkin, P., Cramer, L., Ericksen, P. J., & Thornton, P. K. (2020). Current situation and plausible future scenarios for livestock management systems under climate change in Africa. *CCAFS Working Paper*.

Sklar, R. L. (1967). Nigerian politics in perspective. *Government and Opposition*, *2*(4), 524-539.

Slavich, G. M., & Irwin, M. R. (2014). From stress to inflammation and major depressive disorder: a social signal transduction theory of depression. *Psychological bulletin*, *140*(3), 774.

Sparling, T. M., Cheng, B., Deeney, M., Santoso, M. V., Pfeiffer, E., Emerson, J. A., ... & Kadiyala, S. (2021). Global Mental Health and Nutrition: Moving Toward a Convergent Research Agenda. *Frontiers in Public Health*, *9*.

Swanepoel, F. J. C., Stroebel, A., & Moyo, S. (2010). *The role of livestock in developing communities: Enhancing multifunctionality*. University of the Free State/CTA.

Sweetland, A. C., Norcini Pala, A., Mootz, J., Kao, J. C. W., Carlson, C., Oquendo, M. A., ... & Wainberg, M. (2019). Food insecurity, mental distress and suicidal ideation in rural Africa: Evidence from Nigeria, Uganda and Ghana. *International Journal of Social Psychiatry*, *65*(1), 20-27.

Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2853-2867.

Tranchant, J. P., Gelli, A., & Masset, E. (2021). *Impact of conflict-related violence and presence of armed groups on food security: Evidence from longitudinal analysis in Mali* (No. 2095). International Food Policy Research Institute (IFPRI).

Turner, M. D., Ayantunde, A. A., Patterson, K. P., & Patterson III, E. D. (2011). Livelihood transitions and the changing nature of farmer–herder conflict in Sahelian West Africa. *The journal of development studies*, *47*(2), 183-206. https://doi.org/10.1080/00220381003599352

Ugwueze, M. I., Omenma, J. T., & Okwueze, F. O. (2022). Land-Related Conflicts and the Nature of Government Responses in Africa: The Case of Farmer-Herder Crises in Nigeria. *Society*, 1-14.

UNHCR. (2021). https://www.unhcr.org/uk/nigeria-emergency.html. UNHCR - Nigeria emergency. (2021).

United Nations (2021) Human Rights Climate Change and Migration in the Sahel. available at: https://www.ohchr.org/sites/default/files/2021-11/HR-climate-change-migration-Sahel.pdf

United Nations Development Program (UNDP). (2019). Measuring the Economic Impact of Violent Extremism Leading to Terrorism in Africa. UNDP Report 2019.

United Nations Development Program (UNDP). (2022). Integrating Mental Health and Psychosocial Support into Peacebuilding: UNDP Guidance Note 2022. https://www.undp.org/publications/integrating-mental-health-and-psychosocial-support-peacebuilding.

van den Bosch, M., & Meyer-Lindenberg, A. (2019). Environmental exposures and depression: biological mechanisms and epidemiological evidence. *Annual review of public health*, *40*, 239-259.

Verpoorten, M. (2009). Household coping in war-and peacetime: Cattle sales in Rwanda, 1991–2001. *Journal of development Economics*, *88*(1), 67-86.

Verwimp, P., Justino, P., & Brück, T. (2019). The microeconomics of violent conflict. *Journal of Development Economics*, *141*, 102297.

Vigil, S. (2017). Climate change and migration: Insights from the Sahel. *Climate Change and Migration: Insights from the Sahel*, 51-71.

von Grebmer, K., Bernstein, J., Wiemers, M., Schiffer, T., Hanano, A., Towey, O., ... & Fritschel, H. (2021). Global hunger index: hunger and food systems in conflict settings. *Bonn: Welthungerhilfe*.

VOX. (2021). How kidnap-for-ransom became the "most lucrative industry in Nigeria. https://www.vox.com/22596198/students-nigeria-profit-kidnapping. Accessed April 20, 2022.

Walker, A. (2012). *What is boko haram?* (Vol. 17). Washington, DC: US Institute of Peace.

Watson, C., & Catley, A. (2009). Livelihoods, livestock and humanitarian response: the Livestock Emergency Guidelines and Standards. In *Livelihoods, livestock and humanitarian response: the Livestock Emergency Guidelines and Standards*. Humanitarian Practice Network (HPN); Overseas Development Institute (ODI).

Wing, C., Simon, K., & Bello-Gomez, R. A. (2018). Designing Difference in Difference Studies: Best Practices for Public Health Policy Research. *Annual Review of Public Health*, *39*, 453-69.

Woerheide, W., & Persson, D. (1992). An index of portfolio diversification. *Financial services review*, *2*(2), 73-85.

World Bank. (2018). Poverty and shared prosperity 2018: Piecing together the poverty puzzle. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/30418. Accessed April 20, 2022.

World Bank. (2021). Nigeria. https://data.worldbank.org/country/nigeria. Accessed April 20, 2022.

World Bank. (2022). Moving Towards Sustainability: The Livestock Sector and the World Bank. https://www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank.

World Health Organization. (2004). Vitamin and mineral requirements in human nutrition. In *Vitamin and mineral requirements in human nutrition* (pp. 341-341).

Zanello, G., Shankar, B., & Poole, N. (2019). Buy or make? Agricultural production diversity, markets and dietary diversity in Afghanistan. *Food Policy*, *87*, 101731.

Appendix

Appendix A

Table A.1. LSMS-ISA's data collection period and sample used for the research

Waves[a]	Data Collection Date	Total household sample	Agricultural household sample	Agricultural household sample used		
				Chapter I[b]	Chapter II	Chapter III[c]
Wave 1	Round 1: Post-planting Aug.–Oct. 2010	5,000	3,314	2,023	3,314	
	Round 2: Post-harvest Feb.– Apr. 2011	4,939	3,256		3,256	
Wave 2	Round 3: Post-planting Sep.–Nov. 2012	4,880	3,160	1,913	3,160	
	Round 4: Post-harvest Feb.– Apr. 2013	4,854	3,087		3,087	
Wave 3	Round 5: Post-planting Aug.–Oct. 2015	4,696	3,017	1,817	3,015	
	Round 6: Post-harvest Feb.– Apr. 2016	4,592	3,021		3,010	3,021
Total				5,753	18,842	3,021

Source: Authors from LSMS-ISA Nigeria

Note: Only the agricultural household sub-survey of the LSMS-ISA, which is about 60% of the entire sampled households, was employed for the analysis.

[a]Wave 4 (Rounds 7 and 8, 2017/2018) was excluded from the analysis due to sample redesigning, which returned less than 30% of the households in the baseline to the panel.

[b]Chapter I uses only the data from Northern Nigeria, where violent conflicts were largely concentrated during the periods studied and regions with a larger proportion of livestock-holding households. **[c]**Information on the mental health states of household heads was only available in Round 6 of the survey.

Appendix B

Table B.1. LSMS-ISA Data Collection Season, 2010-2016

	Post-harvest season			Post-planting season			
	February	March	April	August	September	October	%
2010					93.25%	6.75%	100
2011	2.12%	94.25%	3.39%				99.76
2012					26.75%	71.81%	98.56
2013	17.56%	82.10%	0.24%				99.9
2015				30.53%	68.50%	0.97%	100
2016	24.84%	74.77%	0.29%				99.9

Source: Author.

Table B.2. Correlation between nutrients-dense foods consumption and food insecurity coping strategies

	ASF consumption	Meat consumption	Milk consumption	Poultry consumption	Fish consumption	Vegetable consumption	Fruits consumption
ASF consumption	1.000						
Meat consumption	0.615*	1.000					
Milk consumption	0.622*	0.228*	1.000				
Poultry consumption	0.427*	0.258*	0.094	1.000			
Fish consumption	0.659*	0.354*	0.197*	0.069*	1.000		
Vegetable consumption	0.012	-0.026*	-0.094*	-0.067*	0.0123	1.000	
Fruits consumption	0.104*	-0.032*	-0.034	-0.139*	0.076*	0.124*	1.000
Days rely on less-preferred foods	-0.097*	-0.124*	0.062*	-0.196*	-0.014	0.067*	0.143*
Days limit the variety of food eaten	-0.094*	-0.133*	-0.020	-0.214*	-0.001	0.063*	0.151*
Days limit portion size at mealtime	-0.075*	-0.113*	-0.034	-0.198*	0.002	0.051*	0.128*
Days reduce meals eaten in a day	-0.072*	-0.114*	-0.067*	-0.180*	0.013	0.043*	0.129*
Days restrict consumption for children to eat	-0.081*	-0.089*	-0.024	-0.109*	-0.041*	0.018*	0.055*
Days borrow food or rely on help from a friend	-0.024*	-0.021*	-0.021	-0.087*	0.003	-0.006	0.028*
Days have no food in your household	-0.021*	-0.037*	-0.001	-0.056*	0.005	-0.014*	0.053*
Days households have to go to sleep hungry	-0.036*	-0.061*	-0.016	-0.042*	0.006	-0.011	0.052*
Days have to go a whole day and night not eaten	-0.027*	-0.018	0.019	0.005	-0.002	-0.036*	-0.003

Source: Author.

Table B.3. OLS regression results of the association farmer-herder conflict and covariate determinants have with ASF consumption

	Animal-source food consumption (100g/day/aeq)			Animal-source food consumption coping strategies					
				Number of days households had to rely on less-preferred foods			Number of days households had to limit the variety of food eaten		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
FH conflict	-0.016	0.037**	-0.002	-0.006	-0.098*	-0.028	-0.104**	-0.195***	-0.117***
	(0.019)	(0.019)	(0.019)	(0.054)	(0.054)	(0.055)	(0.044)	(0.045)	(0.044)
Survey year trend		-0.060***			0.110***			0.110***	
		(0.004)			(0.008)			(0.007)	
Seasonal year trend			-0.024***			0.040***			0.024***
			(0.003)			(0.007)			(0.006)
Own livestock	-0.035*	-0.047***	-0.039**	0.111***	0.131***	0.116***	0.087***	0.107***	0.091***
	(0.018)	(0.018)	(0.018)	(0.036)	(0.036)	(0.036)	(0.033)	(0.033)	(0.033)
Log of value of crop produced	-0.005**	-0.003	-0.004*	-0.023***	-0.027***	-0.024***	-0.016***	-0.020***	-0.017***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Average years of HH education	-0.011***	-0.009***	-0.011***	-0.004	-0.007**	-0.005	-0.003	-0.006*	-0.003
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
HH size	-0.068***	-0.069***	-0.068***	0.003	0.004	0.003	-0.004	-0.003	-0.004
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Wealth index	0.058***	0.059***	0.058***	-0.074***	-0.074***	-0.074***	-0.066***	-0.066***	-0.066***
	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Distance to market	-0.001***	-0.001***	-0.001***	-0.001**	-0.001*	-0.001**	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to population	0.003***	0.003***	0.003***	-0.003***	-0.004***	-0.003***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Annual rainfall	-0.000***	-0.000***	-0.000***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Annual mean temperature	0.005***	0.006***	0.005***	-0.003**	-0.004**	-0.004**	0.002	0.001	0.002
	(0.009)	(0.006)	(0.008)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Constant	0.104	0.152	0.158	1.315***	1.161**	1.218***	-0.303	-0.456	-0.361
	(0.199)	(0.198)	(0.199)	(0.461)	(0.461)	(0.462)	(0.383)	(0.385)	(0.385)
Number of observations	16,970	16,970	16,970	18,842	18,842	18,842	18,838	18,838	18,838
R-squared	0.105	0.122	0.108	0.047	0.058	0.049	0.076	0.089	0.077

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B.4. Impacts of farmer-herder conflict on ASF consumption (ATT)

	Animal-source food consumption (100g/day/aeq)				Animal-source food consumption coping strategies							
					Number of days households had to rely on less-preferred foods				Number of days households had to limit the variety of food eaten			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
FH conflict	-0.077***	0.033	-0.028	-0.010	-0.140**	-0.054	0.115*	0.062	-0.243***	-0.100*	0.071	0.027
	(0.024)	(0.023)	(0.022)	(0.023)	(0.064)	(0.064)	(0.062)	(0.063)	(0.053)	(0.053)	(0.054)	(0.054)
PH season	0.027***	0.032***	0.021**	0.024***	-0.078***	-0.074***	-0.084***	-0.088***	-0.141***	-0.137***	-0.151***	-0.155***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.020)	(0.020)	(0.020)	(0.020)	(0.018)	(0.018)	(0.018)	(0.018)
FH conflict*PH season	-0.091***	-0.095***	-0.092***	-0.100***	0.134*	0.094	0.176**	0.189***	0.041	0.006	0.101*	0.117*
	(0.027)	(0.026)	(0.023)	(0.023)	(0.070)	(0.070)	(0.070)	(0.070)	(0.059)	(0.059)	(0.060)	(0.061)
Own livestock		-0.035*		0.042*		0.109***		0.081*		0.085**		0.038
		(0.018)		(0.023)		(0.036)		(0.044)		(0.033)		(0.043)
Log of value of crop produced		-0.005**		0.001		-0.023***		0.008		-0.016***		0.006
		(0.002)		(0.002)		(0.004)		(0.005)		(0.004)		(0.005)
Average years of HH education		-0.011***		-0.001		-0.004		-0.007		-0.003		0.001
		(0.002)		(0.003)		(0.004)		(0.005)		(0.003)		(0.005)
HH size		-0.068***		-0.021***		0.004		0.040***		-0.003		0.045***
		(0.003)		(0.005)		(0.005)		(0.012)		(0.005)		(0.010)
Wealth index		0.058***		0.043***		-0.074***		-0.076***		-0.066***		-0.075***
		(0.004)		(0.009)		(0.008)		(0.016)		(0.008)		(0.015)
Distance to market		-0.001***		-0.006*		-0.001**		0.007		-0.002***		0.003
		(0.000)		(0.003)		(0.000)		(0.006)		(0.000)		(0.006)
Distance to population		0.003***		0.001**		-0.003***		0.000		-0.005***		0.002
		(0.000)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)
Annual rainfall		-0.000***		0.002***		0.001***		-0.003***		0.001***		-0.002***
		(0.000)		(0.000)		(0.000)		(0.001)		(0.000)		(0.001)
Annual mean temperature		0.005***		0.010		-0.003**		0.002		0.002		0.017
		(0.001)		(0.009)		(0.002)		(0.012)		(0.001)		(0.015)
Household fixed effects	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Constant	0.741***	0.085	0.739***	-4.412*	1.172***	1.355***	1.147***	3.190	1.054***	-0.234	1.024***	-1.027
	(0.011)	(0.199)	(0.005)	(2.426)	(0.022)	(0.461)	(0.011)	(3.343)	(0.020)	(0.383)	(0.010)	(3.997)
Number of observations	16,970	16,970	16,970	16,970	18,842	18,842	18,842	18,842	18,838	18,838	18,838	18,838
R-squared	0.003	0.106	0.002	0.015	0.001	0.047	0.002	0.008	0.004	0.078	0.004	0.011
Number of households			3,671	3,671			3,708	3,708			3,708	3,708

Note: ATT is average treatment effect on the treated. Robust standard errors in parentheses. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table B.5. Impacts of livestock diversification on ASF consumption (ATT)

	Animal-source food consumption (100g/day/aeq)				Animal-source food consumption coping strategies							
					Number of days households had to rely on less-preferred foods				Number of days households had to limit the variety of food eaten			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
FH conflict	-0.110	-0.062	0.120	0.083	-0.110	-0.062	0.120	0.083	-0.132	-0.049	0.127	0.093
	(0.090)	(0.090)	(0.087)	(0.088)	(0.090)	(0.090)	(0.087)	(0.088)	(0.081)	(0.082)	(0.080)	(0.079)
Livestock diversification	-0.063	0.069	0.154***	0.116**	-0.063	0.069	0.154***	0.116**	-0.031	0.129***	0.248***	0.208***
	(0.049)	(0.047)	(0.051)	(0.051)	(0.049)	(0.047)	(0.051)	(0.051)	(0.046)	(0.044)	(0.046)	(0.047)
FH conflict*Livestock diversification	-0.003	-0.015	-0.145	-0.125	-0.003	-0.015	-0.145	-0.125	-0.121	-0.129	-0.229**	-0.207*
	(0.128)	(0.128)	(0.124)	(0.124)	(0.128)	(0.128)	(0.124)	(0.124)	(0.111)	(0.112)	(0.112)	(0.111)
PH season	-0.165***	-0.161***	-0.172***	-0.178***	-0.165***	-0.161***	-0.172***	-0.178***	-0.187***	-0.185***	-0.205***	-0.211***
	(0.031)	(0.031)	(0.031)	(0.030)	(0.031)	(0.031)	(0.031)	(0.030)	(0.027)	(0.027)	(0.027)	(0.027)
FH conflict*PH season	0.071	0.063	0.134	0.157	0.071	0.063	0.134	0.157	-0.004	0.004	0.109	0.133
	(0.098)	(0.098)	(0.097)	(0.097)	(0.098)	(0.098)	(0.097)	(0.097)	(0.083)	(0.084)	(0.084)	(0.085)
PH season*Livestock diversification	0.239***	0.249***	0.236***	0.239***	0.239***	0.249***	0.236***	0.239***	0.130***	0.142***	0.133***	0.135***
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.049)	(0.048)	(0.048)	(0.048)
FH conflict*PH season	0.077	0.012	0.057	0.045	0.077	0.012	0.057	0.045	0.049	-0.031	-0.002	-0.011
*Livestock diversification	(0.149)	(0.148)	(0.146)	(0.146)	(0.149)	(0.148)	(0.146)	(0.146)	(0.124)	(0.123)	(0.125)	(0.125)
Log of value of crop		-0.023***		0.017**		-0.023***		0.017**		-0.014***		0.016***
produced		(0.006)		(0.008)		(0.006)		(0.008)		(0.004)		(0.006)
Average years of HH		-0.006		-0.009		-0.006		-0.009		-0.004		-0.002
education		(0.004)		(0.007)		(0.004)		(0.007)		(0.004)		(0.006)
HH size		0.002		0.028*		0.002		0.028*		-0.007		0.029**
		(0.007)		(0.015)		(0.007)		(0.015)		(0.005)		(0.013)
Wealth index		-0.054***		-0.077***		-0.054***		-0.077***		-0.048***		-0.078***
		(0.010)		(0.023)		(0.010)		(0.023)		(0.009)		(0.021)
Distance to market		-0.000		0.005		-0.000		0.005		-0.002***		-0.006
		(0.001)		(0.008)		(0.001)		(0.008)		(0.000)		(0.011)
Distance to population		-0.004***		0.003*		-0.004***		0.003*		-0.005***		0.004***
		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)
Annual rainfall		0.001***		-0.002***		0.001***		-0.002***		0.001***		-0.002**
		(0.000)		(0.001)		(0.000)		(0.001)		(0.000)		(0.001)
Annual mean temperature		-0.006***		0.018		-0.006***		0.018		0.002		0.019
		(0.002)		(0.015)		(0.002)		(0.015)		(0.002)		(0.017)
Household fixed effects	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Constant	1.175***	1.994***	1.074***	-1.763	1.175***	1.994***	1.074***	-1.763	1.021***	-0.201	0.894***	-2.066

	(0.031)	(0.531)	(0.023)	(4.264)	(0.031)	(0.531)	(0.023)	(4.264)	(0.028)	(0.435)	(0.020)	(4.812)
Number of observations	12,827	12,827	12,827	12,827	12,827	12,827	12,827	12,827	12,824	12,824	12,824	12,824
R-squared	0.002	0.045	0.010	0.014	0.002	0.045	0.010	0.014	0.004	0.080	0.014	0.020
Number of households			2,960	2,960			2,960	2,960			2,960	2,960

Note: ATT is average treatment effect on the treated. Robust standard errors in parentheses.

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table B.6. Event study results of the effect of farmer-herder conflict on animal source food consumption

	ASF consumption	Meat consumption	Milk consumption	Poultry consumption	Fish consumption	Days relied on less-preferred foods	Days limit the variety of food eaten
	(1)	(4)	(5)	(6)	(7)	(2)	(3)
Year 5	-0.181**	-0.095***	-0.316***	0.048	-0.130***	0.498*	0.722***
	(0.078)	(0.030)	(0.100)	(0.079)	(0.041)	(0.284)	(0.272)
Year 4	-0.088	-0.093***	-0.093	-0.050	-0.047	0.269**	0.433***
	(0.059)	(0.028)	(0.061)	(0.065)	(0.040)	(0.125)	(0.130)
Year 3	-0.150***	-0.063***	-0.020	-0.032	-0.065***	0.466***	0.477***
	(0.039)	(0.020)	(0.064)	(0.051)	(0.020)	(0.109)	(0.096)
year 2	-0.128***	-0.049***	-0.014	-0.086*	-0.046**	0.306***	0.407***
	(0.036)	(0.016)	(0.045)	(0.044)	(0.018)	(0.088)	(0.077)
Year 1	-0.114***	-0.040***	-0.012	-0.022	-0.042***	0.222***	0.182***
	(0.030)	(0.013)	(0.036)	(0.034)	(0.014)	(0.073)	(0.062)
Year 0	-0.003	0.003	0.029	-0.028	0.002	0.147**	0.101*
	(0.028)	(0.015)	(0.042)	(0.035)	(0.016)	(0.068)	(0.056)
Year -1 (base)							
Year -4	0.046	0.010	0.041	-0.015	0.024	-0.091	-0.111
	(0.052)	(0.015)	(0.047)	(0.037)	(0.017)	(0.122)	(0.119)
Year -3	0.156***	0.004	-0.030	0.013	0.038**	-0.120	-0.239***
	(0.051)	(0.019)	(0.032)	(0.048)	(0.018)	(0.105)	(0.089)
Year -2	0.037	0.006	0.052	-0.003	0.005	0.162**	-0.017
	(0.032)	(0.018)	(0.050)	(0.035)	(0.023)	(0.074)	(0.061)
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	16,970	9,794	2,206	2,655	11,769	18,842	18,838
Number of households	3,671	3,105	922	1,511	3,227	3,708	3,708
R-squared	0.022	0.010	0.020	0.025	0.008	0.009	0.011

Source: Author.

Note: Robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Appendix C

Table C.1. Questions and scoring procedures used for assessing the risk of depression following the Centre for Epidemiologic Studies Depression (CES-D) scale

Question Number	Scoring	Less than 1 day (Rarely)	1-2 days (Some)	3-4 days (Occasionally)	5-7 days (Mostly)
	Questions 5 and 8	3	2	1	0
	All other questions	0	1	2	3
	During the last 7 days, how many days [...]				
1	Were you disturbed by things that don't normally bother you?				
2	Did you have trouble keeping your mind on what you were doing?				
3	Did you feel depressed?				
4	Did you feel that everything you did was a burden?				
5	Were you hopeful about the future?				
6	Did you feel afraid?				
7	Was your sleep restless?				
8	Were you happy?				
9	Did you feel lonely?				
10	Did you feel like not getting up in the morning?				

Table C.2. Questions on violent conflict events, and idiosyncratic and covariate shocks experienced by respondents between 2010 and 2016.

	Violent conflict events
1	Any family member killed?
2	Any member captured/kidnapped?
3	Any member forced to work?
4	Any member injured/disabled?
5	Any member made a refugee/IDPs?
6	Any member robbed (money or assets)?
7	Any member suffered physical assaults?
8	Any member suffered sexual violence?
9	Any family assets intentionally destroyed?
10	Family dwelling burned down/destroyed?
11	Family dwelling suffered from damage?
12	Family land occupied/expropriates?
	Idiosyncratic and covariate shocks experienced
1	Death or disability of an adult working member of the household
2	Death of someone who sends remittances to the household
3	Illness of income-earning member of the household
4	Departure of income-earning member of the household due to separation
5	Departure of income-earning member due to marriage
6	Theft of crops, cash, livestock, or other property
7	Pest invasion that caused harvest failure or storage loss
8	Loss of property due to fire or flood

9	Poor rain that caused harvest failure
10	Flooding that caused harvest failure
11	Loss of an important contact
12	Loss of land
13	Death of livestock due to illness
14	Increase in price of inputs
15	Fall in the price of output
16	Job loss
17	Kidnapping /robbery/assault
18	Nonfarm business failure
19	Destruction of harvest by fire
20	Dwelling damaged/demolished

Table C.3. Percentage of households that owned livestock species in Nigeria, 2015-16

	Tropical Livestock Unit coefficient	Percentage of households that owned livestock species	Relative %
Large livestock			
Calf female	0.7	3.36	9.68
Calf male	0.7	3.27	9.42
Heifer	0.7	1.56	4.49
Steer	0.7	0.83	2.39
Cow	0.7	12.34	35.55
Bull	0.7	7.53	21.69
Ox	0.7	4.02	11.58
Donkey	0.5	1.12	3.23
Horse	0.8	0.37	1.07
Camel	1.0	0.31	0.89
Total		35.71	100.00
Small livestock			
Goat	0.1	26.30	38.88
Sheep	0.1	39.39	58.23
Pig	0.2	1.96	2.90
Total		67.65	100.00
Poultry			
Chicken-layer	0.01	1.03	1.85
Chicken-local	0.01	44.91	80.47
Chicken-broiler	0.01	1.29	2.31
Chicken-cockerel	0.01	0.86	1.54
Turkey	0.02	0.6	1.08
Duck	0.01	2.42	4.34
Guinea fowls	0.01	3.01	5.39
Rabbits	0.01	0.26	0.47
Others	0.01	1.43	2.56
Total		55.81	100.00

Note: about 95% of large livestock holders owned cattle; about 98% of small livestock holders owned sheep and goats; and less than 2% of owners of poultry also owned rabbits and other smaller livestock species like guinea pigs and cane rats.
Sources: Author's computation from LSMS-ISA, 2015-2016

Table C.4. Regression results of the relationship between conflict exposure, livestock assets and depression.

	CES-D score ≥8 (Logistic models)						CES-D score (OLS models)					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Conflict exposure	0.409***	0.372***	0.377***	0.337***	0.326***	0.282**	1.153***	0.953**	0.989***	0.786**	0.807***	0.599*
	(0.112)	(0.125)	(0.115)	(0.127)	(0.111)	(0.124)	(0.330)	(0.375)	(0.319)	(0.359)	(0.293)	(0.332)
Poultry	-0.774**	-0.321	-0.709*	-0.215	-0.674*	-0.209	-2.712***	-2.154**	-2.472***	-1.962*	-2.272***	-1.927**
	(0.382)	(0.497)	(0.392)	(0.520)	(0.396)	(0.532)	(0.835)	(1.010)	(0.798)	(0.999)	(0.775)	(0.972)
Conflict exposure*Poultry		-1.375*		-1.450*		-1.318*		-1.682		-1.462		-0.961
		(0.763)		(0.769)		(0.762)		(1.753)		(1.618)		(1.597)
Sheep-Goats	0.096	-0.006	0.099*	-0.009	0.084	-0.024	0.427***	0.177	0.336**	0.093	0.267*	0.050
	(0.059)	(0.078)	(0.057)	(0.077)	(0.059)	(0.081)	(0.152)	(0.172)	(0.143)	(0.163)	(0.146)	(0.163)
Conflict exposure* Sheep-Goats		0.180		0.211*		0.221*		0.438		0.469*		0.433
		(0.125)		(0.122)		(0.125)		(0.313)		(0.283)		(0.290)
Cattle	0.016**	0.013*	0.012**	0.011*	0.014**	0.013**	0.018	0.009	0.009	0.003	0.014	0.009
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.014)	(0.014)	(0.013)	(0.014)	(0.013)	(0.014)
Conflict exposure*Cattle		0.060*		0.051		0.037		0.102		0.072		0.055
		(0.036)		(0.035)		(0.031)		(0.075)		(0.070)		(0.061)
Years of education			-0.023**	-0.023**	-0.022**	-0.022**			-0.028	-0.028	-0.028	-0.028
			(0.009)	(0.009)	(0.009)	(0.009)			(0.020)	(0.020)	(0.020)	(0.020)
Aged below 35 years			0.245	0.253	0.273	0.277			0.339	0.353	0.388	0.392
			(0.170)	(0.171)	(0.176)	(0.177)			(0.432)	(0.431)	(0.441)	(0.440)
Aged between 35-64 years			0.159	0.159	0.184*	0.183*			0.125	0.125	0.181	0.177
			(0.099)	(0.100)	(0.102)	(0.103)			(0.243)	(0.242)	(0.239)	(0.239)
Female			-0.038	-0.043	-0.088	-0.095			0.030	0.022	-0.077	-0.085
			(0.180)	(0.181)	(0.178)	(0.180)			(0.428)	(0.428)	(0.418)	(0.419)
Married			-0.174	-0.169	-0.154	-0.151			-0.517	-0.510	-0.449	-0.445
			(0.147)	(0.147)	(0.147)	(0.148)			(0.323)	(0.322)	(0.323)	(0.322)
Ill health			0.571***	0.576***	0.506***	0.512***			1.713***	1.709***	1.511***	1.510***
			(0.101)	(0.101)	(0.099)	(0.100)			(0.269)	(0.269)	(0.265)	(0.266)
HH experience shocks			0.444***	0.437***	0.437***	0.428***			1.379***	1.347***	1.352***	1.321***
			(0.106)	(0.107)	(0.100)	(0.101)			(0.267)	(0.267)	(0.233)	(0.234)
Christianity			0.099	0.115	-0.118	-0.102			-0.133	-0.115	-0.573	-0.554
			(0.119)	(0.119)	(0.145)	(0.146)			(0.318)	(0.317)	(0.375)	(0.377)

Cooperative society member			-0.075	-0.068	0.189	0.196			-0.566*	-0.561*	0.100	0.103
			(0.148)	(0.148)	(0.164)	(0.164)			(0.341)	(0.339)	(0.360)	(0.359)
Log value of crop produce			-0.031**	-0.033**	-0.027*	-0.029**			-0.075*	-0.076*	-0.056	-0.058
			(0.014)	(0.015)	(0.014)	(0.014)			(0.039)	(0.039)	(0.037)	(0.037)
Log salary income			-0.007	-0.008	-0.008	-0.009			-0.014	-0.016	-0.017	-0.018
			(0.009)	(0.009)	(0.010)	(0.010)			(0.022)	(0.022)	(0.022)	(0.022)
Log other income sources			0.011	0.010	0.012	0.011			0.036	0.033	0.024	0.022
			(0.013)	(0.012)	(0.013)	(0.013)			(0.032)	(0.031)	(0.031)	(0.031)
HH dietary diversity			-0.024	-0.027	-0.063**	-0.065**			-0.122	-0.126*	-0.225***	-0.227***
			(0.030)	(0.030)	(0.032)	(0.032)			(0.075)	(0.075)	(0.076)	(0.075)
Wealth index			-0.067**	-0.063**	-0.081***	-0.078**			-0.170**	-0.164**	-0.173**	-0.168**
			(0.030)	(0.030)	(0.031)	(0.031)			(0.071)	(0.071)	(0.072)	(0.072)
Household size			-0.001	-0.001	-0.008	-0.008			0.020	0.023	-0.004	-0.001
			(0.012)	(0.012)	(0.013)	(0.013)			(0.029)	(0.029)	(0.029)	(0.029)
Rural location			0.021	0.017	-0.129	-0.137			0.251	0.246	-0.116	-0.125
			(0.175)	(0.177)	(0.180)	(0.182)			(0.438)	(0.443)	(0.427)	(0.432)
North-central					0.304	0.345					-0.101	-0.022
					(0.294)	(0.293)					(0.638)	(0.638)
North-east					1.015***	1.028***					2.494***	2.519***
					(0.275)	(0.274)					(0.666)	(0.660)
North-west					0.609**	0.636**					1.012	1.057
					(0.292)	(0.292)					(0.676)	(0.677)
South-east					1.274***	1.281***					2.533***	2.553***
					(0.281)	(0.280)					(0.581)	(0.578)
South-south					1.149***	1.172***					2.386***	2.431***
					(0.284)	(0.283)					(0.625)	(0.623)
Constant	-0.536***	-0.513***	-0.241	-0.185	-0.497	-0.456	6.678***	6.777***	7.770***	7.896***	7.680***	7.765***
	(0.077)	(0.079)	(0.345)	(0.348)	(0.399)	(0.398)	(0.197)	(0.202)	(0.856)	(0.860)	(0.930)	(0.925)
Log pseudolikelihood	-2020	-2012	-1952	-1945	-1909	-1904	0.019	0.024	0.080	0.084	0.118	0.120
Pseudo R-squared	0.011	0.015	0.045	0.048	0.065	0.068	3,021	3,021	3,021	3,021	3,021	3,021
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021						

Numbers in parenthesis are robust standard errors clustered at Local Government Area level.
*** p<0.01, ** p<0.05, * p<0.1.

Table C.5. Regression results of the relationship between conflict experienced, livestock assets and depression (Robustness checks).

	CES-D score ≥8 (Logistic models)						CES-D score (OLS models)					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Conflict experienced	1.280***	0.995***	1.180***	0.902***	1.054***	0.769***	4.326***	4.322***	3.791***	3.751***	3.310***	3.242***
	(0.179)	(0.254)	(0.192)	(0.270)	(0.201)	(0.269)	(0.519)	(0.788)	(0.527)	(0.775)	(0.546)	(0.756)
Poultry	-0.809**	-0.806**	-0.736*	-0.721*	-0.705*	-0.690*	-2.774***	-2.682***	-2.488***	-2.369***	-2.306***	-2.184***
	(0.379)	(0.399)	(0.392)	(0.412)	(0.397)	(0.416)	(0.804)	(0.839)	(0.779)	(0.812)	(0.764)	(0.793)
Conflict experienced *Poultry		-0.269		-0.344		-0.331		-2.183		-2.404		-2.465
		(1.251)		(1.315)		(1.371)		(3.066)		(3.081)		(3.161)
Sheep-Goats	0.061	0.028	0.078	0.043	0.068	0.031	0.294**	0.259*	0.252*	0.209	0.208	0.160
	(0.060)	(0.065)	(0.058)	(0.064)	(0.059)	(0.064)	(0.142)	(0.152)	(0.132)	(0.141)	(0.133)	(0.140)
Conflict experienced* Sheep-Goats		0.431**		0.436**		0.438**		-0.015		0.105		0.143
		(0.192)		(0.176)		(0.173)		(0.424)		(0.429)		(0.437)
Cattle	0.016**	0.016**	0.013**	0.013**	0.013**	0.014**	0.019	0.016	0.010	0.009	0.014	0.012
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.014)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)
Conflict experienced*Cattle		0.001		-0.005		-0.005		0.141**		0.114		0.112
		(0.059)		(0.060)		(0.062)		(0.070)		(0.073)		(0.083)
Years of education			-0.025***	-0.025***	-0.024**	-0.023**			-0.033	-0.032	-0.031	-0.030
			(0.009)	(0.009)	(0.009)	(0.009)			(0.020)	(0.020)	(0.020)	(0.020)
Aged below 35 years			0.208	0.211	0.241	0.242			0.203	0.193	0.279	0.267
			(0.171)	(0.171)	(0.176)	(0.176)			(0.423)	(0.422)	(0.434)	(0.433)
Aged between 35-64 years			0.153	0.153	0.178*	0.177*			0.087	0.075	0.149	0.137
			(0.101)	(0.100)	(0.103)	(0.103)			(0.240)	(0.240)	(0.237)	(0.237)
Female			-0.052	-0.053	-0.107	-0.107			-0.016	-0.009	-0.123	-0.116
			(0.181)	(0.182)	(0.181)	(0.181)			(0.427)	(0.428)	(0.420)	(0.420)
Married			-0.174	-0.169	-0.155	-0.150			-0.515	-0.508	-0.447	-0.440
			(0.148)	(0.148)	(0.148)	(0.148)			(0.325)	(0.326)	(0.324)	(0.324)
Ill health			0.551***	0.553***	0.489***	0.491***			1.626***	1.627***	1.439***	1.442***
			(0.103)	(0.103)	(0.101)	(0.101)			(0.269)	(0.269)	(0.264)	(0.264)
HH experience shocks			0.375***	0.374***	0.371***	0.369***			1.109***	1.105***	1.110***	1.105***
			(0.106)	(0.107)	(0.101)	(0.101)			(0.259)	(0.259)	(0.228)	(0.229)
Christianity			0.178	0.176	-0.062	-0.064			0.072	0.060	-0.432	-0.447
			(0.118)	(0.118)	(0.142)	(0.142)			(0.298)	(0.298)	(0.360)	(0.361)

Cooperative society member			-0.075	-0.083	0.185	0.176			-0.552	-0.567*	0.088	0.071
			(0.150)	(0.150)	(0.166)	(0.167)			(0.337)	(0.337)	(0.358)	(0.358)
Log value of crop produce			-0.030**	-0.030**	-0.026*	-0.027*			-0.068*	-0.068*	-0.052	-0.053
			(0.014)	(0.014)	(0.014)	(0.014)			(0.037)	(0.037)	(0.035)	(0.035)
Log salary income			-0.007	-0.007	-0.009	-0.008			-0.016	-0.016	-0.019	-0.019
			(0.010)	(0.010)	(0.010)	(0.010)			(0.021)	(0.021)	(0.021)	(0.022)
Log other income sources			0.010	0.009	0.012	0.011			0.030	0.029	0.023	0.022
			(0.013)	(0.013)	(0.013)	(0.013)			(0.031)	(0.031)	(0.031)	(0.031)
HH dietary diversity			-0.033	-0.035	-0.069**	-0.071**			-0.147*	-0.149**	-0.242***	-0.243***
			(0.031)	(0.031)	(0.032)	(0.032)			(0.075)	(0.075)	(0.076)	(0.076)
Wealth index			-0.062**	-0.061**	-0.080**	-0.078**			-0.152**	-0.152**	-0.169**	-0.168**
			(0.030)	(0.030)	(0.031)	(0.031)			(0.069)	(0.069)	(0.069)	(0.069)
Household size			-0.002	-0.002	-0.008	-0.008			0.015	0.016	-0.005	-0.004
			(0.013)	(0.013)	(0.013)	(0.013)			(0.029)	(0.029)	(0.029)	(0.029)
Rural location			0.059	0.059	-0.100	-0.101			0.343	0.341	-0.040	-0.043
			(0.176)	(0.176)	(0.182)	(0.182)			(0.432)	(0.433)	(0.426)	(0.427)
North-central					0.387	0.392					0.117	0.130
					(0.281)	(0.281)					(0.610)	(0.610)
North-east					0.986***	0.997***					2.318***	2.338***
					(0.267)	(0.267)					(0.647)	(0.646)
North-west					0.625**	0.628**					1.061	1.058
					(0.287)	(0.288)					(0.665)	(0.666)
South-east					1.308***	1.306***					2.618***	2.618***
					(0.273)	(0.273)					(0.564)	(0.564)
South-south					1.180***	1.185***					2.429***	2.434***
					(0.276)	(0.276)					(0.603)	(0.603)
Constant	-0.450***	-0.434***	-0.125	-0.093	-0.428	-0.394	6.877***	6.891***	8.106***	8.135***	7.866***	7.896***
	(0.064)	(0.064)	(0.349)	(0.352)	(0.399)	(0.400)	(0.171)	(0.171)	(0.851)	(0.852)	(0.914)	(0.914)
Log pseudolikelihood	-1998	-1995	-1935	-1933	-1896	-1893	0.052	0.053	0.104	0.105	0.136	0.137
Pseudo R-squared	0.0220	0.0234	0.0527	0.0540	0.0718	0.0731	3,021	3,021	3,021	3,021	3,021	3,021
Number of observations	3,021	3,021	3,021	3,021	3,021	3,021						

Numbers in parenthesis are robust standard errors clustered at Local Government Area level.
*** p<0.01, ** p<0.05, * p<0.1.

Table C.6. AME of the logistic regression results of the relationship between conflict exposure, livestock assets depressive symptoms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Disturbed	Troubles	Depressed	Burdened	Hopeless	Afraid	Restless	Unhappy	Lonely	Struggled
Conflict exposure	0.075***	0.080***	0.016	0.031	0.030	0.080***	0.026	0.034	0.019	0.002
	(0.024)	(0.025)	(0.026)	(0.025)	(0.024)	(0.026)	(0.025)	(0.025)	(0.024)	(0.024)
Poultry	-0.154*	-0.142*	-0.191**	-0.049	-0.100	-0.047	-0.254***	-0.167**	-0.181**	-0.258***
	(0.085)	(0.083)	(0.082)	(0.079)	(0.084)	(0.084)	(0.082)	(0.079)	(0.090)	(0.090)
Sheep-Goats	0.013	0.000	0.004	0.016	0.019	0.022	0.017	0.024*	0.029**	0.009
	(0.014)	(0.012)	(0.014)	(0.013)	(0.015)	(0.013)	(0.012)	(0.013)	(0.012)	(0.013)
Cattle	0.006**	0.004*	0.001	0.000	0.002	-0.000	0.002	0.003	0.003	-0.000
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Years of education	-0.005**	-0.003	-0.002	-0.003	-0.001	-0.005**	-0.003	0.000	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Aged below 35 years	0.061	0.097***	0.051	0.047	-0.045	0.073*	0.048	0.014	0.025	-0.019
	(0.039)	(0.036)	(0.040)	(0.037)	(0.038)	(0.038)	(0.042)	(0.039)	(0.038)	(0.039)
Aged between 35-64 years	0.040*	0.074***	0.047**	0.037*	-0.012	0.031	0.054**	-0.009	0.022	-0.006
	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)	(0.021)	(0.023)	(0.023)	(0.022)	(0.024)
Female	-0.021	0.006	-0.019	-0.032	-0.063	0.058	0.012	-0.023	-0.019	0.010
	(0.040)	(0.041)	(0.041)	(0.039)	(0.043)	(0.040)	(0.043)	(0.040)	(0.040)	(0.040)
Married	-0.033	0.010	-0.032	-0.020	-0.060*	0.047	0.019	-0.039	-0.161***	0.051
	(0.032)	(0.033)	(0.033)	(0.031)	(0.035)	(0.033)	(0.034)	(0.033)	(0.033)	(0.033)
Ill health	0.113***	0.065***	0.014	0.057**	0.086***	0.028	0.073***	0.123***	0.079***	0.025
	(0.022)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)	(0.025)	(0.024)	(0.023)	(0.026)
HH experience shocks	0.094***	0.117***	0.082***	0.095***	-0.054**	0.109***	0.118***	-0.050**	0.064***	0.083***
	(0.022)	(0.018)	(0.021)	(0.020)	(0.023)	(0.022)	(0.022)	(0.021)	(0.022)	(0.025)
Christianity	-0.022	-0.015	-0.020	0.000	0.005	-0.076**	0.007	-0.004	-0.061**	-0.065**
	(0.032)	(0.033)	(0.032)	(0.031)	(0.029)	(0.034)	(0.033)	(0.030)	(0.030)	(0.031)
Cooperative society member	0.043	-0.003	0.057	0.078**	-0.062*	0.006	0.009	-0.015	-0.029	0.013
	(0.036)	(0.034)	(0.036)	(0.036)	(0.037)	(0.033)	(0.038)	(0.036)	(0.037)	(0.036)
Log value of crop produce	-0.006**	-0.005	-0.006**	-0.004	-0.005	0.001	0.001	-0.007**	-0.004	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log salary income	-0.002	-0.005**	-0.002	-0.005**	-0.003	-0.001	0.002	-0.004*	-0.000	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log other income sources	0.002	0.003	0.006**	-0.001	-0.005*	0.006**	-0.001	-0.004	-0.001	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

HH dietary diversity	-0.014**	0.008	-0.001	0.014**	-0.021***	-0.000	0.005	-0.021***	-0.015**	-0.005
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)
Wealth index	-0.017**	-0.012*	-0.020***	-0.020***	0.001	-0.006	-0.019***	-0.002	-0.003	-0.006
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Household size	-0.002	-0.000	0.003	0.003	0.001	-0.002	0.002	0.001	-0.007***	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Rural location	-0.030	0.009	0.002	0.011	0.005	0.017	0.007	0.036	0.054	0.006
	(0.040)	(0.035)	(0.044)	(0.038)	(0.036)	(0.039)	(0.036)	(0.034)	(0.035)	(0.035)
North-central	0.076	-0.055	-0.064	0.085	0.181***	-0.003	-0.016	0.249***	-0.019	-0.092
	(0.065)	(0.054)	(0.056)	(0.064)	(0.050)	(0.054)	(0.051)	(0.060)	(0.054)	(0.057)
North-east	0.227***	0.056	0.066	0.128**	0.321***	0.174***	0.028	0.403***	0.058	-0.025
	(0.059)	(0.052)	(0.058)	(0.062)	(0.045)	(0.051)	(0.054)	(0.059)	(0.051)	(0.053)
North-west	0.140**	-0.058	-0.009	0.172***	0.295***	0.076	0.042	0.324***	0.020	-0.009
	(0.064)	(0.057)	(0.057)	(0.062)	(0.048)	(0.056)	(0.051)	(0.064)	(0.051)	(0.053)
South-east	0.282***	0.213***	0.268***	0.225***	0.156***	0.148***	0.256***	0.282***	0.114**	0.194***
	(0.060)	(0.051)	(0.056)	(0.060)	(0.047)	(0.052)	(0.048)	(0.058)	(0.046)	(0.052)
South-south	0.258***	0.161***	0.275***	0.283***	0.079	0.110**	0.172***	0.195***	0.062	-0.030
	(0.061)	(0.053)	(0.053)	(0.059)	(0.054)	(0.052)	(0.052)	(0.059)	(0.046)	(0.050)
No. of obs.	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

Numbers in parenthesis are robust standard errors clustered at Local Government Area level
*** p<0.01, ** p<0.05, * p<0.1.

Table C.7. AME of the logistic regression results of the relationship between conflict exposure, livestock assets depressive symptoms (Robustness checks).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Disturbed	Troubles	Depressed	Burdened	Hopeless	Afraid	Restless	Unhappy	Lonely	Struggled
Conflict experienced	0.170***	0.133***	0.139***	0.091**	0.115***	0.215***	0.153***	0.109**	0.158***	0.049
	(0.040)	(0.043)	(0.046)	(0.042)	(0.038)	(0.047)	(0.040)	(0.045)	(0.049)	(0.044)
Poultry	-0.113	-0.143*	-0.189**	-0.055	-0.101	-0.067	-0.244***	-0.159*	-0.170*	-0.239***
	(0.084)	(0.087)	(0.083)	(0.080)	(0.086)	(0.085)	(0.082)	(0.081)	(0.090)	(0.089)
Sheep-Goats	0.000	-0.003	0.001	0.011	0.019	0.017	0.018	0.024*	0.029**	0.007
	(0.014)	(0.012)	(0.013)	(0.013)	(0.015)	(0.013)	(0.012)	(0.013)	(0.012)	(0.013)
Cattle	0.003**	0.004**	0.001	0.002	0.000	0.001	0.000	0.000	0.001	-0.000
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Years of education	-0.001	-0.003	-0.002	-0.003	-0.001	-0.005**	-0.003	-0.000	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Aged below 35 years	0.008	0.090**	0.046	0.042	-0.046	0.065*	0.043	0.013	0.022	-0.022
	(0.038)	(0.036)	(0.040)	(0.036)	(0.038)	(0.038)	(0.042)	(0.040)	(0.038)	(0.039)
Aged between 35-64 years	0.029	0.071***	0.044*	0.034	-0.011	0.029	0.052**	-0.007	0.020	-0.008
	(0.022)	(0.023)	(0.023)	(0.022)	(0.022)	(0.021)	(0.023)	(0.023)	(0.022)	(0.025)
Female	0.017	0.005	-0.019	-0.032	-0.065	0.055	0.011	-0.025	-0.019	0.010
	(0.044)	(0.041)	(0.041)	(0.039)	(0.043)	(0.040)	(0.043)	(0.041)	(0.040)	(0.040)
Married	0.052	0.011	-0.029	-0.019	-0.060*	0.047	0.020	-0.041	-0.159***	0.052
	(0.035)	(0.033)	(0.033)	(0.031)	(0.036)	(0.033)	(0.034)	(0.033)	(0.032)	(0.033)
Ill health	0.058***	0.062***	0.011	0.055**	0.084***	0.023	0.071***	0.121***	0.074***	0.023
	(0.022)	(0.023)	(0.024)	(0.023)	(0.024)	(0.023)	(0.024)	(0.024)	(0.023)	(0.026)
HH experience shocks	0.109***	0.110***	0.071***	0.090***	-0.063***	0.096***	0.108***	-0.059***	0.052**	0.078***
	(0.020)	(0.018)	(0.020)	(0.020)	(0.023)	(0.022)	(0.022)	(0.021)	(0.022)	(0.025)
Christianity	-0.013	-0.006	-0.019	0.004	0.010	-0.065*	0.011	0.002	-0.061**	-0.064**
	(0.032)	(0.033)	(0.032)	(0.031)	(0.030)	(0.035)	(0.032)	(0.030)	(0.029)	(0.031)
Cooperative society member	-0.003	-0.007	0.051	0.075**	-0.060	0.002	0.008	-0.012	-0.032	0.011
	(0.036)	(0.034)	(0.036)	(0.036)	(0.037)	(0.033)	(0.038)	(0.036)	(0.038)	(0.036)
Log value of crop produce	-0.002	-0.004	-0.006**	-0.004	-0.004	0.001	0.001	-0.006*	-0.004	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log salary income	-0.002	-0.005**	-0.002	-0.005**	-0.003	-0.001	0.001	-0.004*	-0.000	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Log other income sources	0.001	0.002	0.006**	-0.001	-0.005*	0.006**	-0.001	-0.004	-0.001	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
HH dietary diversity	0.015**	0.007	-0.002	0.013**	-0.021***	-0.001	0.004	-0.021***	-0.016**	-0.005
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)
Wealth index	-0.009	-0.012*	-0.020***	-0.020***	0.001	-0.005	-0.019***	-0.002	-0.004	-0.006
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Household size	-0.004	0.000	0.002	0.003	0.001	-0.002	0.002	0.000	-0.008***	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Rural location	0.029	0.016	0.006	0.014	0.008	0.024	0.010	0.039	0.058*	0.008
	(0.036)	(0.035)	(0.043)	(0.038)	(0.037)	(0.040)	(0.035)	(0.035)	(0.034)	(0.035)
North-central	0.023	-0.037	-0.065	0.093	0.188***	0.017	-0.014	0.256***	-0.021	-0.094*
	(0.054)	(0.053)	(0.055)	(0.062)	(0.049)	(0.052)	(0.050)	(0.060)	(0.052)	(0.057)
North-east	0.081	0.064	0.050	0.127**	0.313***	0.172***	0.015	0.397***	0.041	-0.033
	(0.052)	(0.052)	(0.058)	(0.061)	(0.044)	(0.050)	(0.053)	(0.058)	(0.051)	(0.053)
North-west	0.037	-0.057	-0.014	0.170***	0.296***	0.077	0.044	0.327***	0.016	-0.010
	(0.059)	(0.057)	(0.057)	(0.062)	(0.048)	(0.056)	(0.051)	(0.063)	(0.050)	(0.053)
South-east	0.174***	0.221***	0.264***	0.227***	0.158***	0.155***	0.258***	0.285***	0.113**	0.193***
	(0.049)	(0.050)	(0.055)	(0.059)	(0.047)	(0.052)	(0.047)	(0.057)	(0.046)	(0.052)
South-south	0.204***	0.171***	0.267***	0.285***	0.078	0.116**	0.171***	0.196***	0.056	-0.032
	(0.052)	(0.052)	(0.052)	(0.057)	(0.054)	(0.050)	(0.051)	(0.059)	(0.045)	(0.051)
No. of obs.	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021	3,021

Numbers in parenthesis are robust standard errors clustered at Local Government Area level
*** p<0.01, ** p<0.05, * p<0.1.