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The role of livestock portfolios and group-based approaches for building resilience in the face of accelerating climate change: An asset-based panel data analysis from rural Kenya

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Abstract

This study examines the impact of multiple shocks on assets by employing two waves of a panel data set of 360 rural households in three agro-ecological zones in Kenya. To control for unobserved heterogeneity, a 'within' household fixed effects model was employed. One major finding is that climatic shocks negatively affect households' livestock holdings -apart from small ruminant and non-ruminant livestock due to their higher adaptive capacity. Consequently, households rely on two major coping strategies to smooth their consumption level: (1) adjusting their livestock portfolios, and (2) borrowing from group-based approaches. The latter strategy is particularly important for poor households in safeguarding their already low asset base. The findings suggest that livestock protection policies, such as diversification of livestock portfolios, promotion of fodder banks and index-based livestock insurance, are substantial. Scaling-up of group-based approaches would augment poor households' recovery and resilience against multiple shocks in the face of accelerating climate change.

Keywords: multiple shocks, livestock, group-based approaches, rural Kenya

JEL codes: C33, D13, I18, O12, O13, Q54

1. Introduction

Frequent and concurrent shocks are a key challenge to agrarian settings in developing economies. According to the World Bank (2001) exposure and vulnerability to multiple shocks push households to poverty. Lack of adequate, suitable and affordable insurance arrangements put households at a greater risk in the occurrence of shocks (Dercon et al. 2005). On account of various climatic and economic shocks affecting livelihood and economy in Africa, the African Union (2014) draw attention for strengthening resilience against these shocks. The World Development Report 2014 further accentuates the need to manage risks as a vital pathways for reducing vulnerability, strengthening resilience and for economic growth and development (World Bank 2014). Climate and weather shocks are projected to escalate in frequency and impact in the coming years due to climate change where worse-off households are highly susceptible (Baez et al. 2010). Evidence indicates that climate change exacerbates shocks affecting rural households including production, health, price and crime shocks (Kabubo-Mariara & Karanja 2007; Brown 2014; Blakeslee & Fishman 2014).

There is increasing policy interest in the impacts of shocks on welfare outcomes and assets in developing countries (Dercon et al. 2005; Béné et al. 2012; Demont 2013; Bui et al. 2014). Studies focusing on the effects of multi-shocks on a wide range of welfare outcomes and household asset portfolios are, however, rare. While previous studies focus on the impact of shocks on large livestock (Mogues 2011), this study highlights how multiple shocks affect different livestock portfolios differently, an important approach for climate adaptation policies and farmers' entrepreneurial decisions.

Against this background, the study, which was conducted in Kenya, addresses the following objectives:

a) To examine what types of shocks prevail in rural settings

b) To analyze which strategies are adopted by households with different socio-economic characteristics in order to cope with predominant shocks

c) To investigate how multiple shocks affect households' asset portfolios

The study employed a micro-econometric approach using two-waves of a panel data set stemming from six districts in three agro-ecological regions of rural Kenya. Special attention extends to the interaction of a wider range of shocks to bridge the identified gap by presenting empirical evidence on the impacts of multiple shocks on livestock portfolios. Livestock portfolios are a substantial poverty-reducing strategy for households and economic growth because agricultural activities prevail in rural economic livelihoods and present multiple employment opportunities in Kenya (IGAD 2013; KIPPRA 2013; Onyeiwu & Liu 2013). Besides, livestock provides draft power, which increases agricultural productivity in rural areas through ease of transport. Furthermore, small livestock, such as poultry rearing, guarantees far-reaching gender and social equality implications primarily for

women's role in food and nutrition security,[1] livelihood diversification and economic empowerment in the midst of fast-tracking climate change.

The study findings indicate that livestock is the major coping strategy against shocks, particularly for the asset-rich households. Conversely, asset-poor households depend on intangible assets, such as social capital and group-based approaches, to insure and build their resilience against shocks. The study argues that group-based approaches are vital coping strategies for building resilience, although their effectiveness diminishes in incidents of extreme events. Therefore, group-based approaches may require reinforcement during adverse events, such as drought, flooding and civil conflicts. In the absence of formal insurance, imperfect financial markets and credit constraints, group-based approaches facilitate informal risk-sharing mechanisms that are essential short-term consumption smoothing and asset protection strategies. For instance, group-based welfare associations in rural areas partially manage health shocks by insuring medical or funeral expenses of their members or their family members. Through this approach, households insure their asset portfolios, hence, building resilience against multiple shocks in the face of escalating climate change. Resilience implies an approach that strengthens capacity to cope (reactive resilience), adapt (proactive resilience) and endure adverse events arising from climate-related stress (see Jordan 2015). The study concludes that underplaying idiosyncratic shocks, such as health, crime, socio-political and market shocks may result in substantial loss of livestock portfolios, livestock productivity and income. Besides, the findings have far-reaching labor and gender implications.

[1] In African setting, particular Kenyan setting, it's women role to produce food and ensure household has food and nutrition. Poultry rearing is mostly women business and they have autonomy over the proceeds or decision on consumption especially on eggs and meat.

2. Shocks, coping strategies and assets: evidence from the literature

The sustainable livelihood framework (SLF) represents an approach of relating shocks and coping capability and connecting assets and income. It elaborates the interaction of vulnerability to shocks and its impact on assets and welfare outcomes. DFID (2001: 45) defines shocks as "sudden events that have a significant impact on livelihoods." There are different types of shocks including natural disasters (covariant), market shocks, economic shocks and idiosyncratic shocks (Dercon et al. 2005; Baulch 2011; Oviedo & Moroz 2014). Most of these shocks hit the household in a concurrent and successive manner causing a great loss to the household (Oviedo & Moroz 2014).

The bases for empirical analysis of shocks in development economics include consumption smoothing theory, asset and poverty dynamics. The consumption-smoothing principal indicates that worse-off households are less capable to cope with different categories of shocks such as natural disasters, illness and economic shocks (Dercon 2004; Dercon et al. 2005; Kazianga & Udry 2006). Poor households have fewer assets and often encounter problems of imperfect markets, particularly in access to insurance and financial markets (Dercon 2002; Brown 2014). Evidence in developing countries suggests that the richer households dispose of assets to smooth their level of consumption (Dercon 2002; Carter et al. 2007; Heltberg & Lund 2009; Béné et al. 2012), while the poorest households sacrifice their consumption to protect their assets (Kazianga & Udry 2006). Shocks are expected to have a negative impact on individual and household well-being. Shocks impact negatively the consumption of poor households, i.e. for food consumption (Webb et al. 1992; Dercon et al. 2005) or non-food expenditures (Asfaw & Braun 2004; Wagstaff 2007). Several studies have shown that drought and health shocks (illness and death) reduce consumption and its growth (see Dercon et al. 2005; Beegle et al. 2008), expose kids to nutritional deprivation and stunting growth (Yamano et al. 2005; Alderman 2011) leading to a long-term low human development trap (UNDP 2014). Friedman et al. (2011) show that market shocks especially increased during the food crisis of 2008 resulted to a reduction in caloric intake of Pakistani households by 8 percent whereas urban households were worse-off than the rural households. In addition, socio-political conflict reduces household's income, current food consumption and affects human capital negatively (Justino 2011; Dupas & Robinson 2012). Dupas & Robinson (2012) show that 2007/08 socio-political shocks in Kenya forced women to engage in risky sexual behavior in order to generate income that could result into long-term health implications such as HIV-AIDS or other sexually transmitted diseases.

Production risks are severe and frequent in rural households that depend on rain-fed food production systems. Weather shocks escalated by changing climate have direct effects on livestock reproduction, animal growth and productivity (FAO 2009). Besides, weather shocks have indirect effects on livestock portfolios through reduced availability of livestock feeds, low quality of livestock feeds, multiplication of parasites, and epidemic diseases, such as Rift

Valley Fever. Livestock diseases result in losses in production (reduced productivity), disruptions to local and international markets (quarantine and travel bans) and threats to the poorer households who depend on them for livelihood (FAO 2009). In addition, livestock diseases are a threat to human health and development through zoonotic diseases[2] or food-borne illnesses (*ibid*). Other shocks such as health shocks affect livestock portfolios because household uses livestock as a reactive resilience (coping strategy) through distress sales to cater for the sudden medical bill.

The reviewed literature pays limited attention to other shocks, apart from drought and health, which could affect household welfare. There is also inadequate attention to a wider range of asset categories including livestock portfolios, which may be affected differently by shocks and may have different implications for household well-being.

[2] These diseases are transmitted from animals to human beings.

3. Data and sampling procedure

This study uses two-waves of a panel data set of households in three agro-ecological zones (AEZ) of rural Kenya —the semi-arid, medium potential and high potential zones. The sampled districts included Mbeere South and Nakuru (semi-arid zones), Gem and Siaya (medium potential zones) and Mukurweini and Othaya (high potential zones'highlands'). The International Food Policy Research Institute (IFPRI) and the Kenya Agricultural Research Institute (KARI) collected the first round of data in 2009/2010, whereas a random sample of the same households were re-visited and re-interviewed in 2012 by the survey team. The first wave of data collection involved a stratified sampling strategy aiming at a wider range of climatic, agro-ecological, socio-economic and cultural conditions, policy and institutional arrangements, and susceptibility to climate change (see Bryan et al. 2013 for details). The second wave of data collection targeted a sample size of 360 households out of 557 households attributable to financial and logistical restraints. Sampling involved a random and probability proportion to size sampling procedure of the total sample. Ultimately, the analyses were based on a balanced random panel sample of 360 households to address the study's objectives.

Table 1 Definitions and summary statistics of the key variables for the period 2009-2012

		2009 (N=360)		2012 (N=360)	
Variables	Definitions	Mean	Std. Dev.	Mean	Std. Dev.
Household size	Number of household members	5.37	0.14	5.15	0.14
Dependency ratio	Ratio of dependents, <15years and >64years	0.79	0.04	0.84	0.05
Age in years	Age of the household head	56.14	13.00	57.94	13.03
Total TLU	Tropical livestock units owned by the household	3.99	4.33	5.36	5.50
Total annual income in Ksh '000	Total household income in Ksh '000, in 2009 prices	95.05	126.88	151.97	165.96
Access to credit†	Access to credit from informal or financial institutions	0.44	0.50	0.57	0.50
Consumer durable asset	Indices of consumer durable assets	0.30	0.17	0.34	0.14
Farm assets	Indices of farm tools and machinery assets	0.57	0.13	0.58	0.09
Social amenities	Indices of access to social amenities	0.47	0.14	0.54	0.14
Land in acres	Land size in acre	16.09	26.54	4.00	6.46
Crop extension service†	Access to crop extension service	0.53	0.50	0.83	0.38
Livestock extension service†	Access to livestock extension service	0.44	0.50	0.67	0.47
Social capital (group-based approaches)†	If any of the household members belongs to social groups	0.76	0.43	0.93	0.26
Safety nets†	Received food aid or participated in food or cash for work programs	0.18	0.38	0.20	0.40
Remittances†	Money sent home by working relatives	0.27	0.023	0.59	0.025
N	Number of observations	360		360	

Notes: Superscript † presents variables in binary format. Ksh represents Kenya shillings.
Source: Authors' computations centered on the survey data.

The survey instruments for 2009 and 2012 included modules capturing information on household assets, livestock holdings and income sources, demographics (age, gender, education level, household size) and institutional factors such as group-based approaches. They also included modules on adaptation measures undertaken, production data, access to information, credit and market access. The questionnaire was designed to capture the shocks affecting the household, coping strategies and the monetary loss from incidence of multiple shocks. Table 1 presents the definition of key variables and descriptive analysis for the periods 2009 and 2012. The monetary values for 2012 were deflated using Kenyan consumer price index (CPI)3 by taking CPI for 2009 as the base category year.

The Tropical Livestock Units (TLU) quantified an extensive range of different livestock portfolios in a consistent manner.[4] The study disaggregated livestock portfolio into poultry (chicken, fowl, duck, turkey), small ruminant and non-ruminant livestock (rabbits, pig, goats/sheep), cattle (cows, bulls, heifers, calves), and draft livestock (oxen and donkeys). This analytical approach straightens the effects of shocks on diverse livestock portfolios. Table 2 presents a summary and asset dynamics for the periods 2009 and 2012.

Table 2 Asset dynamics for 2009-2012 periods

Assets	2009 (Mean)	2012 (Mean)	% change in growth	Average asset growth/year
Poultry	0.30	0.43	0.43	0.14
Small livestock	0.93	1.56	67.74	22.58
Cattle	2.43	3.18	30.86	10.29
Draft livestock	0.63	0.79	25.40	8.47
Total TLU	3.99	5.54	38.85	12.95
Land size	16.09	4.00	-75.14	-25.05
Social capital†	0.76	0.93	22.35	7.46
N	360	360		

Notes: †Variables are in binary format. Ksh represents Kenyan shillings.
Source: Authors' computations centered on the survey data.

There is a progressive growth, particularly for small livestock and social capital, which could imply the likelihood of households' ability to recover after the 2008 to 2009 drought. Besides, there is a notable increase in preferences for small livestock because of its liquidity and its substantial adaptive capacity to a changing climate. The Kenyan new constitution (2010) advocates equal rights for both boys and girls on inheritance of their parents' properties. This policy could have led to sub-division of land.

[3] The CPI for 2012, by the time of survey was 133.06, and the CPI for 2009 was 100, applied as the base year.

[4] The TLU conversion factors used are as follows: bulls = 1.2, oxen = 1.42, cattle = 1.0, goats/sheep = 0.2, poultry = 0.04, rabbits = 0.04, pigs = 0.3, donkeys =0.8, ducks/turkey/geese = 0.03

4. Descriptive analysis

4.1 Types of shocks prevailing in rural settings

Table 3 presents the different categories of shocks, their definitions, their occurrences in percentage and loss of income from their occurrence.

Table 3 Shocks experienced by Kenyan rural households (percentage)

Shock	Definitions	Prevalence (%)*	Loss of income (Ksh)
Overall shock	If the household is affected at least by one shock	99.5	
Number of shocks	The total number of shocks reported	2.51	
Climatic shocks			
Drought	Inadequate rain and prolonged dry spell	69.2	43,834
Erratic rain	Uneven and erratic rain	41.5	47,911
Hailstorm	Heavy rainfall with hail	14.4	19,845
Frost	Solid deposition of water vapor from humid air	4.9	61,232
Flooding	Too much rain that covers land with water, overflow of water bodies as rivers, streams.	4.7	16,754
Non-climatic shocks			
Animal health	Livestock diseases	14.4	31,748
Crop pests	Loss of crop before harvest due to pest infestation	23.9	33,965
Loss of crop harvest	Loss of crop during storage	4.6	27,996
Illness	Illness of a family member	19.8	45,951
Death shock	Death of a family member	12.6	44,500
Market shock	Increase in input prices, the decline in output prices, no market for the output, poor seed quality	18.9	17,716
Crime shock	Theft of cash, crops, livestock or other assets	11.5	20,840
Socio-political shock	Violence, ethnic conflicts, taxation, social discrimination	7.4	33,967
Personal shocks	Loss of employment, separation/ divorce, dispute in the family, imprisonment	2.4	31,325
Positive shock			
Remittances	Money sent home by working relatives	42.8	

Notes: *Prevalence presents the percentage of responses of the households affected by shocks and is self-reported.[5] Multiple shocks were reported. Ksh represents Kenya shillings. The monetary values are in 2009 prices.
Source: Authors' computations centered on the survey data.

The results show that almost all households (99.5%) have been affected by at least one major shock during the survey periods in 2009 and 2012. Further, households are affected by multiple concurrent shocks, with the average count across all rural households being 2.51

[5] Self-reported shocks may suffer from representation 'attributions of causality' by responding households instead of the actual occurrence of the events or from 'selection attrition'. However, this is mostly a problem for cross-sectional data (Hoddinott & Quisumbing 2003).

shocks, while some households experience more than six incidences of shock. Drought and erratic rain are the most prevalent climatic shocks experienced by households in rural Kenya resulting in low agricultural productivity, decline in income and food insecurity. Health shocks (illness and death) are the major idiosyncratic shocks (32.4%) affecting rural households. Market shocks were reported by 18.9 percent of households. The survey of 2009 was carried out during the global food crisis, while the follow-up survey was carried out after the 2011 drought and high food prices in Kenya. The respondents were asked to estimate systematically the amount of loss from the shock experienced by the household. Occurrences of shocks led to tremendous loss of income with frost, drought, erratic rains, health, market and socio-political shocks reporting highest loss of income.

4.1.1 Shock prevalence across wealth Quintiles

To examine the effect of shocks on poor and rich households, we disaggregated household welfare levels into assets and income Quintiles (deprived Quintile, 2nd Quintile, 3rd Quintile and well-off Quintile). Cross-tabulation and X^2 results show that the poorest households in the community are more likely to experience a higher impact of drought considering both asset and income Quintiles ($P<0.001$). The asset-Quintiles demonstrate a higher likelihood of hail storms and frost affecting the better-off households ($P<0.05$). Likewise, income-Quintiles show that the occurrence of frost is likely to affect better-off households ($P<0.001$). Farmers owning a larger piece of land under coffee or tea production are more likely to experience higher impacts of frost. Those households endowed with more assets are likely to experience theft of their properties, i.e. crime shocks ($p<0.05$). Households with lower income-Quintiles are prone to social shocks, i.e. discrimination from social settings or political shocks, such as violence or civil disputes ($p<0.05$).

4.1.2 Shock prevalence across gender of the household head

The 'feminization of poverty' theory dictates that female-headed households 'women' are more susceptible to shocks because of their limited coping capacity, further making them susceptible to poverty. The findings indicate both male- and female-headed households are vulnerable to drought, with a reporting of 69 percent and 71 percent, respectively. Male-headed households reported a higher prevalence of crop pest shock. In contrast, female-headed households (both *de facto* and *de jure*)[6] reported a higher incidence of flooding than male-headed households ($p<0.10$). The *de jure* female-headed households reported highest incidence of death since most of them had lost their spouses (widows). Female-headed households experienced on average a higher number of shocks (2.7) as compared to male-

[6] *De jure* female-headed households comprise women who are widowed, divorced or were never married, while *de facto* female-headed households include women who are married but whose spouses currently migrated.

headed households (2.5) ($p<0.10$).[7] Notably, *de jure* female-headed households reported a higher number of shocks (2.7) than *de facto* female-headed household (2.6).

4.1.3 Shock prevalence across agro-ecological zones

Identifying local-specific shocks is paramount in designing location-explicit risk management tools. The results of cross-tabulation and X^2 statistical tests show that while drought shock is comparatively common in all agro-ecological zones, it is more prevalent in semi-arid regions, reported by 78 percent of the households ($p<0.001$). Further, erratic rains and frost are prevalent in the high potential zones ($p<0.05$). Flood is prevalent in medium potential zones (6%) and semi-arid zones (7%) regions, while hailstorms shocks are purely prevalent in the medium potential zones (38%). Market shocks are more prevalent in the medium potential zone, while crop pest and crop loss after harvest are more dominant in semi-arid regions ($p<0.05$). Criminal shocks are mostly prevalent in medium potential areas. Further, illness and death incidences are highly prevalent in medium potential zone ($p<0.001$) because of a higher disease burden, particularly HIV-AIDS and malaria. Social and political shocks are prevalent in the semi-arid areas (Njoro district) attributed to different ethnic groupings, and the region was worse hit by 2007/08 post-election violence.[8]

4.2 The role of assets in ex-post household coping strategies

As shown in Figure 1, 19 percent of the affected households did not embrace any strategy to cope with shocks. Sale of livestock portfolios (cattle, goat, sheep and poultry) was the principal consumption smoothing strategy reported by 40 percent of the households.

[7] Azad et al. (2014) argue that female-headed households are often victims of flooding and experience a higher incidence of shocks because of the existing social inequalities. Likewise, the death of a husband result to their spouses losing the assets, particularly if they do not have property rights or due to existing norms and traditions.

[8] Multivariate probit models on the drivers of shock exposure show that geographical locations, household headship and wealth indicators influence vulnerability to shocks. Elderly-headed households and those having kids <15 years of age face increase likelihood of death and illness of family member, respectively.

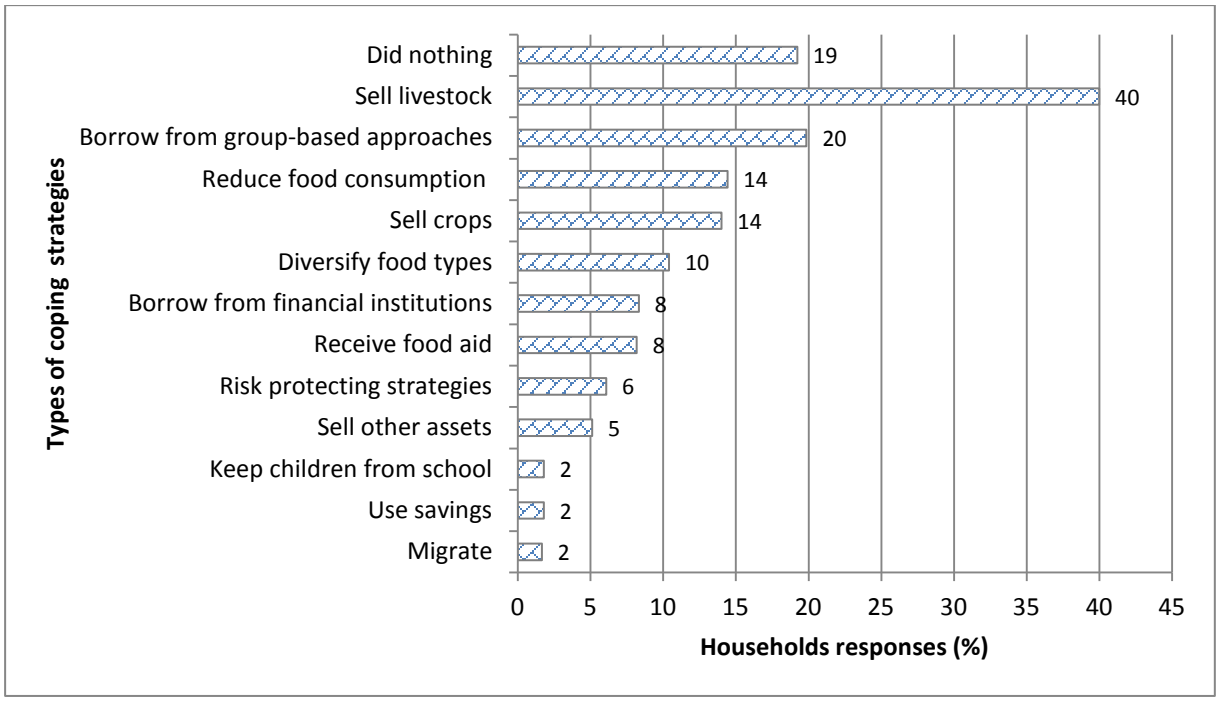

Figure 1 Households' ex-post coping strategies for 2009 and 2012 (percentage)

Source: Authors' computations based on the survey data.

Besides, households sold other assets, including crop stock (14%), land (1%), trees and consumer durable assets (5%), and they used up their savings (2%). Overall, 62% of the affected households adopted risky strategies of disposing of assets to smooth consumption level. The second prime strategy followed by households to enhance resilience was borrowing money through group-based approaches, including friends, relatives and social groups (20%), suggesting the importance of informal risk-sharing mechanisms. Only 8% of the households borrowed money from formal financial institutions.

In sum, descriptive analyses show that group-based approaches are particularly crucial in coping with idiosyncratic shocks such as death (37%) and illness (35%), market shocks (24%), as well as covariant shocks such as drought (19%) and erratic rainfall (12%). With the absence of formal insurance and financial insurance or lack of collateral to borrow, informal insurance mechanisms and group-based approaches are substantial. Furthermore, the affected households sacrifice their food consumption, which suggests welfare loss, besides diversifying food intake and reliance on food relief.9 A very low percentage of affected households engross risk-protection strategies, such as acquiring new skills (2%), engaging in income generating activities (2%), acquiring new livestock assets (1%) and planting trees (1%).

[9] Food relief is a short-term consumption smoothing mechanism provided by relief agencies, such as governments, non-governmental organizations (NGOs) or religious organizations during exogenous shocks (e.g., droughts, floods and conflicts).

5. Empirical Strategy

5.1 Estimating probabilities of undertaking coping strategies

Examining the probability of choice to cope or not to cope relies on the random utility model. The household decides to cope with a shock when the utility of coping is higher than the utility of not coping with shock incidence. Firstly, an affected household decides to take a coping strategy or not. Secondly, a household makes a decision on available and appropriate strategies to cope with a shock. Employing a Probit model, we estimated the probabilities on observed binary coping strategy as follows

$$C_{it} = \begin{cases} 1 & \text{if } C^*_{it} > 0, \\ 0 & \text{otherwise} \end{cases} \qquad (1)$$

where C_i takes the value of 1 if the affected households made the decision to cope and 0 otherwise. As households could embrace several coping or reactive resilience strategies that could be correlated with shocks, an estimation approach that addresses correlation across J-binary observations (coping strategies) and across unobservable variables over time is required. A univariate standard approach such as Logit or Probit estimating a single binary coping strategy could result into inefficient parameters especially with large correlation. The multivariate Probit model addresses this problem by allowing for correlation structure over time (Cappellari & Jenkins 2003, 2006). We estimated a multivariate binary panel model (J^{th} number of Probit equations, concurrently) by employing the maximum simulated likelihood that yields a consistent estimator (Cappellari & Jenkins 2006). The multivariate binary panel model for the coping strategy i and Probit equation J at time t, is given as follows

$$CS^*_{jt} = X^*_{jt}\beta_j + S_{jt}\beta_j + \varepsilon_{jt} \quad t = 1,..,T \text{ and } j = 1,..,J \qquad (2)$$

$$CS_{jt} = 1 \text{ if } cs^*_{jt} > 0, \qquad 0 \text{ otherwise}$$

where CS_{jt} presents the outcome for J-different coping strategies at time t. The multivariate probit analysis considered $J = 8$ reported by at least 6 percent of the households. These strategies include selling livestock, selling crops, borrowing from informal sources (group-based approaches), borrowing from formal financial institutions, relying on food relief, reducing food consumption, diversifying food intake and risk protecting behaviors. X_{jt} is the vector of observed predictor variables that determine the probabilities of undertaking a given coping strategy. These observed predictors include geographical location, wealth indicators, gender of the household head and access to extension services. While S_{jt} is the vector of self-reported shocks affecting households, β_j presents the vector of coefficients to be estimated for the J^{th} coping strategy, while ε_{jt} is the error term

assumed to be multivariate normally distributed and having unobserved fixed effects α_j (Cappellari & Jenkins 2003, 2006).[10]

5.2 Estimating the impact of shocks on livestock portfolios

The natural starting point for examining the impact of shocks on livestock portfolios involves estimating the naïve ordinary least squares (OLS) as follows

$$A_{it} = \boldsymbol{X}_{it}\beta + \boldsymbol{S}_{it}\beta + \alpha_i T + \varepsilon_{it} \qquad (3)$$

where A_{it} presents livestock portfolios for household i at time t and $\boldsymbol{X}_{it}\beta$ is a vector of the predictor variables, including household characteristics, socioeconomic and institutional factors. $\boldsymbol{S}_{it}\beta$ is a vector parameter for self-reported covariant shocks, idiosyncratic shocks and positive shock that influence households' asset portfolios. $\alpha_i T$ is a time dummy variable and ε_{it} presents both time variant and invariant unobservable errors. However, in panel data analysis, there is probable existence of unobserved factors that could affect the dependent variable (welfare outcomes) and independent variables (multiple shocks). As the naïve OLS estimation procedure ignores heterogeneity across households and village characteristics, it would result in inconsistent and biased estimates.

Alternatively, a random or fixed effects model could be applied. To select between these two models, the Hausman test for exogeneity of the unobserved household fixed effects (within) and random effects (between) model was carried out. The Hausman test favored the 'within' fixed effect model, which accounts for all time-invariant differences between households and the estimated coefficients are consistent.

A structural model of the fixed effects is specified as follows

$$A_{it} = \boldsymbol{X}_{it}\beta + \boldsymbol{S}_{it}\beta + \alpha_i T + \lambda_t + \varepsilon_{it} \qquad (4)$$

Whereas the variables are as explained above, this model captures household fixed effects. The λ_i captures fixed effects variables such as village location and household fixed effects. Household fixed effects control for unobserved heterogeneity across households, while village fixed effects control for the average situation of covariant shocks affecting the household in a particular village. The study compared the econometric results for both pooled OLS and household fixed effects models. The Wald test for the joint impact of multi-shocks on livestock portfolios examined whether covariant and idiosyncratic shocks jointly affect livestock portfolios.

[10] The error term has zero mean and variance-covariance matrix σ, where σ on the leading diagonal has a value of 1 and correlation of off-diagonal elements such that $p_{ij} = p_{ji}$, which imply that $p_{ii} = 1$ for entire $i = 1, .., j$.

6. Econometric results

6.1 Drivers for undertaking coping strategies

Table 4 Multivariate Probit results on probabilities of undertaking coping strategies

	Coping action	Sell livestock	Sell crops	Borrow from informal sources	Borrow from financial institutions	Depend on food aid	Reduce food consumption	Diversify food	Risk protection strategies
Drought	0.101	0.113	-0.001	0.042	-0.082	0.224	0.451**	0.325*	-0.258
	(0.147)	(0.130)	(0.162)	(0.151)	(0.198)	(0.220)	(0.174)	(0.184)	(0.200)
Erratic rains	0.349*	0.233*	0.194	0.066	-0.152	0.123	0.335*	0.233	0.149
	(0.136)	(0.119)	(0.150)	(0.140)	(0.183)	(0.191)	(0.147)	(0.162)	(0.191)
Hailstorms	0.908***	0.076	0.132	0.095	0.075	-0.117	0.160	0.277	0.287
	(0.196)	(0.165)	(0.200)	(0.186)	(0.297)	(0.294)	(0.195)	(0.199)	(0.236)
Market shocks	-0.147	0.025	0.398*	0.447**	0.608***	-0.093	0.355	0.137	0.002
	(0.159)	(0.130)	(0.154)	(0.149)	(0.177)	(0.223)	(0.151)	(0.168)	(0.199)
Illness	-0.176	0.436**	0.375*	0.766***	0.533**	0.031	-0.132	-0.291	-0.053
	(0.157)	(0.126)	(0.150)	(0.141)	(0.186)	(0.211)	(0.166)	(0.182)	(0.212)
Death	0.427*	0.207	0.332*	0.682***	0.513*	0.308	-0.103	-0.222	0.046
	(0.165)	(0.148)	(0.179)	(0.161)	(0.222)	(0.216)	(0.194)	(0.220)	(0.241)
Production	-0.187	0.262*	0.143	0.302*	0.544***	-0.094	0.293*	0.170	0.180
	(0.123)	(0.104)	(0.128)	(0.123)	(0.163)	(0.159)	(0.130)	(0.145)	(0.165)
Crime	0.032	0.153	0.254	-0.044	0.346	-0.163	-0.016	-0.057	0.544*
	(0.186)	(0.158)	(0.194)	(0.188)	(0.227)	(0.302)	(0.191)	(0.206)	(0.211)
Remittance	-0.015	0.101	0.144	0.308*	-0.180	0.146	0.207	-0.271*	-0.002
	(0.127)	(0.106)	(0.134)	(0.126)	(0.169)	(0.167)	(0.136)	(0.151)	(0.175)
Age	-0.003	-0.002	0.008	0.005	-0.001	0.017**	0.006	0.004	-0.013*
	(0.005)	(0.004)	(0.005)	(0.005)	(0.007)	(0.006)	(0.005)	(0.006)	(0.007)
Household size	-0.055	-0.027	0.021	-0.078*	-0.067	0.048	0.065	0.036	0.018
	(0.043)	(0.036)	(0.046)	(0.042)	(0.058)	(0.060)	(0.045)	(0.048)	(0.058)
Dependency ratio	0.124*	-0.010	0.069	-0.030	-0.232*	0.096	0.073	-0.011	0.101
	(0.068)	(0.059)	(0.073)	(0.070)	(0.110)	(0.086)	(0.071)	(0.081)	(0.090)
Land in size	0.157**	-0.137**	-0.106*	-0.202**	-0.014	-0.112	0.158*	0.062	-0.040
	(0.059)	(0.050)	(0.064)	(0.060)	(0.074)	(0.079)	(0.062)	(0.069)	(0.082)
Livestock TLU	0.006	0.012	-0.047**	0.008	0.016	-0.040*	-0.007	0.005	0.015
	(0.013)	(0.011)	(0.017)	(0.012)	(0.018)	(0.021)	(0.013)	(0.014)	(0.016)
2nd quintile	0.029	0.146	0.042	0.366*	-0.096	0.179	-0.233	-0.275	-0.170
	(0.179)	(0.157)	(0.222)	(0.188)	(0.281)	(0.246)	(0.185)	(0.225)	(0.274)
3rd quintile	-0.306*	0.174	0.487*	0.261	0.066	0.261	-0.042	0.214	-0.054
	(0.191)	(0.157)	(0.207)	(0.191)	(0.252)	(0.247)	(0.182)	(0.206)	(0.263)
4th quintile	-0.114	0.023	0.620**	0.144	0.202	0.477*	-0.500*	-0.137	-0.099
	(0.188)	(0.162)	(0.209)	(0.198)	(0.247)	(0.247)	(0.204)	(0.223)	(0.259)
Richest quintile	0.094	-0.057	0.551*	0.008	0.069	0.075	-0.581**	-0.093	0.034
	(0.185)	(0.164)	(0.213)	(0.205)	(0.253)	(0.268)	(0.214)	(0.228)	(0.262)
Safety nets	0.269	-0.240	-0.154	0.506	0.011	0.127	0.039	-3.846	0.510
	(0.416)	(0.360)	(0.506)	(0.386)	(0.617)	(0.469)	(0.442)	(0290)	(0.466)
Extension service	0.173	0.086	-0.231	0.181	0.085	0.074	0.008	-0.278*	0.241
	(0.140)	(0.117)	(0.145)	(0.143)	(0.191)	(0.180)	(0.144)	(0.159)	(0.204)
Medium potential	-0.415*	-0.137	0.264	0.220	-1.040***	0.208	0.307	0.341*	-0.118
	(0.196)	(0.159)	(0.201)	(0.187)	(0.265)	(0.281)	(0.200)	(0.216)	(0.248)
Semi-arid	0.013	0.273*	0.328*	0.343*	-0.603**	1.247**	-0.125	-0.581*	-0.426*
	(0.159)	(0.139)	(0.179)	(0.170)	(0.204)	*(0.224)	(0.189)	(0.230)	(0.246)
Household size (bar)	-0.087*	0.087*	-0.003	0.083*	0.053	-0.028	-0.043	0.017	-0.034
	(0.050)	(0.043)	(0.056)	(0.049)	(0.068)	(0.070)	(0.054)	(0.057)	(0.069)
Constant	-0.620	-0.928**	-2.210	-2.092	-1.261*	-3.413***	-2.442**	-1.982***	-0.963
	(0.405)	(0.347)	(0.442)	(0.418)	(0.540)	(0.568)	(0.453)	(0.493)	(0.552)

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). The Likelihood ratio X^2 (28) = 38.69, P >X^2 = 0.086. The Wald test, X^2 (184) = 448.33, P >X^2 = 0.0000, for multivariate Probit model. The poorest quintile is used as a base variable in income Quintiles. High potential zones were used as a base variable for agro-ecological zones. Mundlak-Chamberlain approach estimated the random model by including the time-average of household size to control for unobserved effects and correlation of the underlying predictors.

Source: Authors' computations centered on the survey data

As shown in the first column of Table 4, households that experience incidences of erratic rains, hailstorms or death of a family member are more likely to respond to shocks. Household characteristics, especially dependency ratio and land size, influence the likelihood

of undertaking a coping strategy in the face of multiple shocks. Further, the geographical location influences the likelihood of taking up a coping strategy, where residents in medium potential zones are less likely to cope with shocks as compared to households in high potential zones.

Results from the multivariate probit analysis show that shock types influence strategies and the probability of a household selecting numerous strategies to cope with similar shocks. Households that experience drought, erratic rainfall, illness or death of a family member and production shocks have a higher probability of disposing of livestock and crop stock to counter shocks. The death of a family member and loss of income due to illness of a household member and reduced purchasing power resulting from market shocks trigger borrowing of credit from both informal and formal financial institutions. Receiving remittances, (positive shock) significantly increases the likelihood of borrowing from group-based approaches because of the enhanced capacity to repay back credit. Drought and erratic rains rather than idiosyncratic shocks increase the probability of reducing household food consumption level and diversifying food types to smooth consumption levels.

Households in the fourth and richest Quintiles are more probable to sell crops to smooth their level of consumption and are less likely to reduce food consumption as compared to the poorest households. Indeed, rich households have a higher likelihood to access food aid than the poorer households do, which could imply poor targeting of the food aid program and possible influence of elite capture. On the contrary, households in lower Quintiles have a higher probability of depending on group-based approaches because they typically have limited capacity to borrow credit from financial institutions. The elderly-headed households have a higher likelihood to rely on food aid since they have limited livelihood options. Results show that geographical locations influence coping strategies where households in semi-arid areas have a higher likelihood to dispose of their livestock and depend on food aid, but lower probability to borrow from financial institutions, diversify food and adopt risk-protection strategies as compared to households in high potential zones. Cross-tabulations and X^2 analyses show while asset- and income-rich households dispose of livestock, sell crops, diversify food intake to smooth their level of consumption and migrate looking for a livelihood, asset- and income-poor households smooth their assets by foregoing their consumption and keeping their children from schools.

6.2 Impact of shocks on livestock portfolios

Table 5 presents the household fixed effects estimation results on the impacts of shocks on poultry, small livestock, cattle, draft livestock and total livestock holdings. The findings indicate that drought negatively and statistically significantly affects poultry, cattle, and overall livestock holdings over time, even though the significance levels and units of loss differ across livestock portfolios. Households experiencing drought are more likely to reduce

cattle by 0.96 units, poultry by 0.13 units and 1.42 units of total livestock holdings, across time. Erratic rains have a statistically significant effect on disposal of poultry due to its quick source of protein and fast convertibility into cash in the course of extreme events to smooth consumption levels. Wald tests indicate that drought, erratic rains and hailstorms jointly affect all livestock portfolios, apart from small ruminant and non-ruminant livestock.

Table 5 Fixed effects regression results on the impact of shocks on livestock assets

	Poultry	Small livestock	Cattle	Draft livestock	Total livestock portfolio
Drought	-0.132**	-0.081	-0.957**	-0.246	-1.416**
	(0.042)	(0.111)	(0.349)	(0.235)	(0.534)
Erratic rain	-0.128***	-0.106	-0.087	0.088	-0.233
	(0.034)	(0.178)	(0.261)	(0.219)	(0.465)
Hailstorm	-0.067	-0.229	-0.129	-0.450	-0.876
	(0.048)	(0.172)	(0.488)	(0.359)	(0.836)
Market shock	-0.085*	-0.288*	-0.531*	0.104	-0.800*
	(0.044)	(0.140)	(0.245)	(0.246)	(0.452)
Illness	-0.070*	0.033	0.177	-0.400*	-0.260
	(0.039)	(0.074)	(0.301)	(0.221)	(0.431)
Death	0.001	0.167	0.048	0.183	0.399
	(0.061)	(0.176)	(0.411)	(0.241)	(0.650)
Crop pest	0.033	-0.031	-0.291	-0.147	-0.436
	(0.052)	(0.138)	(0.269)	(0.217)	(0.468)
Livestock diseases	-0.042	0.366	-0.055	0.044	0.313
	(0.050)	(0.489)	(0.293)	(0.254)	(0.637)
Socio-political shock	-0.149	-0.099	0.087	-0.354*	-0.515
	(0.124)	(0.189)	(0.515)	(0.213)	(0.563)
Crime shock	0.213*	0.490	0.219	-0.075	0.848
	(0.118)	(0.629)	(0.323)	(0.305)	(0.807)
Remittance	-0.019	0.160	0.236	0.023	0.402
	(0.047)	(0.130)	(0.231)	(0.138)	(0.391)
Primary education	-0.005	-0.096	0.145	0.304	0.348
	(0.073)	(0.265)	(0.496)	(0.291)	(0.862)
Age	0.005	0.015*	0.030	0.003	0.054
	(0.004)	(0.009)	(0.027)	(0.019)	(0.048)
Land size	0.035	-0.036	0.297*	0.101	0.397*
	(0.025)	(0.077)	(0.143)	(0.077)	(0.193)
Household size	0.018*	0.023	0.102	0.106	0.250
	(0.009)	(0.0329	(0.092)	(0.070)	(0.178)
Dependency ratio	0.038	-0.056	0.099	0.097	0.179
	(0.025)	(0.080)	(0.183)	(0.186)	(0.372)
Extension service	0.087*	-0.040	0.612*	0.240	0.899*
	(0.041)	(0.100)	(0.241)	(0.184)	(0.369)
Safety nets	0.195*	-0.120	-1.228*	0.019	-1.134*
	(0.093)	(0.255)	(0.513)	(0.251)	(0.663)
Constant	0.107	0.163	0.858	-0.560	0.568
	(0.193)	(0.455)	(1.359)	(1.032)	(2.497)
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-squared (within)	0.073	0.026	0.058	0.043	0.0642
F- statistic (19)	2.69***	1.11	2.33**	1.68*	1.86*
Wald test -climatic shocks (3)	6.94***	0.66	3.41*	1.69*	2.67*
Wald test-idiosyncratic (6)	1.28	0.62	0.54*	0.82	0.75
Wald test-total shock (9)	3.57***	0.78	1.84*	2.32*	2.04*
N	720	720	720	720	720

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). Regression includes the village and time fixed effects. Age squared is included in the model. Estimation considered shocks reported by at least 7% of the households.
Source: Authors' computations centered on the survey data.

Market risks significantly reduce poultry, cattle portfolios and total livestock portofolios while socio-political shocks reduce households' draft livestock portfolio. Negative impacts of shocks on draft livestock could have labor implications, subsequent lower agricultural productivity and loss of income in rural areas. Illness of family members significantly decreases poultry and draft animals in the household. Poultry does not face indivisibility problems, and in case of urgent need of cash for medical bills, it is easily convertible. Wald tests indicate that idiosyncratic shocks jointly affect cattle, but do not jointly affect overall livestock portfolios over time. Nevertheless, joint covariant and idiosyncratic shocks jointly affect all livestock portfolios with the exceptions of small ruminant and non-ruminant livestock.

Functioning rural institutions, land size and safety nets significantly increase ownership of poultry over time. Households with access to livestock extension services significantly increases their poultry, cattle and overall livestock holding. A large household size is likely to increase poultry over time. Households with access to safety net programs, such as food aid, 'food for work' and 'food for assets' programs, are also more likely to increase poultry. However, access to safety net programs is unlikely to protect cattle and overall livestock holdings. Pooled OLS regression results present almost similar finding with that of household fixed effects, apart from higher standard errors. The unique difference in the OLS results is that hailstorms significantly reduce small livestock, while crop pest incidences are more likely to reduce cattle portfolios, and remittances are more likely to increase total livestock holdings.

7. Discussion

The study presents an integrated overview of multiple shocks affecting livestock portfolios, and the potential of livestock and group-based approaches for building resilience in the face of accelerating climate change in rural Kenya. Descriptive results indicate that extreme climate events - particularly drought and erratic rainfall - remain major natural threats to agricultural production, food and nutrition security, loss of income and assets and worsened poverty in Kenya and similarly in Sub-Saharan Africa (SSA) (see Dercon et al. 2005; Béné et al. 2012; Debebe et al. 2013; Shiferaw et al. 2014 for similar findings). Health shocks are the major idiosyncratic shocks that contribute to significant loss of person-hours and foregone income. Besides, the study presents further insights on the importance of other less prevalent shocks —market, crime and socio-political shocks— that have implications for household welfare outcomes, decline in income and adversely affect livestock portfolios. These shocks have received limited attention in both Kenya and the SSA region.

The study's findings indicate that livestock is the major coping and building resilience strategy against shocks, particularly for the asset-rich households. Livestock portfolios, particularly poultry and small livestock are easily convertible to cash or quick sources of protein, hence constituting an essential coping strategy. Besides, distress sales of poultry and small livestock have gender implications in the sense that the women's assets are the first to be disposed of in the time of crisis because female spouses in the household mainly own and have autonomy over income and products from these livestock portfolios. Furthermore, small ruminants –goats and sheep– have a higher tolerance to water and feed scarcity due to drought, heat stress and higher offspring survival rate than cattle (Bati 2013). Therefore, they withstand poor quality feeds due to drought, floods or massive hailstorms, and hence, small livestock portfolios are likely to build households' coping capacity (reactive resilience) and adaptive capacity (proactive resilience). Besides, the study provides emerging insights that livestock portfolios are affected by socio-political and market shocks that have received limited attention in previous studies. Empirical evidence indicates covariant shocks are important shocks affecting livestock; nonetheless, underplaying the idiosyncratic shocks may result to substantial loss of livestock portfolios.

Group-based approaches are an important coping tool in the absence of consumption loans, costly formal insurance and credit constraints, through facilitating informal insurance and micro-credit that are essential for short-term consumption smoothing and asset protection strategies (see Fafchamps & Lund 2003; Islam & Maitra 2012; Demont 2013). Furthermore, social capital is a valuable post-shock recovery vehicle that empowers households to rebuild livestock assets (see Mawejje & Holden 2014 for Uganda) and building resilience of rural communities against extreme events (Bernier & Meinzen-Dick 2014). Our findings suggest that group-based approaches are mostly helpful in managing the incidence of idiosyncratic shocks —death, illness and market shocks, as compared to covariant shocks —drought and

erratic rainfall, most importantly for the asset-poor households. Therefore, group-based approaches may require reinforcement during extreme events through social protection programs such as public safety nets. Our findings, however, indicate that safety nets programs protect poultry portfolios and not other livestock holdings. This is because safety nets programs improve food security, well-being and protect distress sale of assets in the short-run (Béné et al. 2012; Berhane et al. 2013), nonetheless, households incline to sell assets to cope with shocks in the long-run (Little et al. 2004; Andersson et al. 2011). Interestingly, households that received remittances are more likely to enhance coping capacity by increasing their ability to borrow through group-based approaches, hence smoothing their consumption level, besides, increasing livestock portfolios (see also Mohapatra et al. 2009; Beuermann et al. 2014 for more examples).

8. Conclusion and policy implications

This study examines the impact of shocks on rural households' assets by employing a unique two-wave panel data set from Kenya. Vulnerability to shocks and coping strategies differ significantly across wealth prominence, agro-ecological zones and household headship, suggesting that policies for tackling susceptibility, risk management and poverty reduction ought to consider the heterogeneity across these groups. Besides, households dispose of livestock, crop stock and other assets in order to heighten their coping and reactive resilience to multiple shocks. These findings indicate the need for emergency social protection programs and short-term interventions, such as cash transfers, food relief and policies that hearten remittances, to heighten asset protection and consumption smoothing.

The findings that climatic shocks are predominant and affect livestock assets through distress sales and death, points towards the need for far-reaching livestock protection policies. Besides, uptake of poultry and small ruminant and non-ruminant livestock, the diversification of livestock portfolios is a major step towards coping and strengthening resilience with weather shocks, climate change and boosting households' food and nutritional security. Poultry and small livestock multiply speedily, are easy to restock and have a higher adaptive capacity. Small livestock rearing has also far-reaching implications for women's livelihood diversification and economic empowerment in the midst of accelerating climate change. Furthermore, in semi-arid regions, there is a vital need to promote and adopt index-based livestock insurance that is functioning and demonstrating a positive impact on asset protection and consumption smoothing to the beneficiaries in Northern Kenya (see Janzen & Carter 2013). Besides, fodder planting and conservation through fodder banks should be encouraged to ensure a steady supply of quality feeds during dry spells.

Group-based approaches could be a vehicle for asset accumulation through acquiring livestock, multiplication, sharing-out livestock on rotational basis for reproduction purposes or hiring out of draft livestock, which requires heavy investment for a single household. This approach will ease labor needs, while increasing agricultural productivity. Group-based welfare associations partially manage risks, particularly health shocks by catering for medical or funeral expenses of its members and their family members hence insuring household income and asset. Scaling-up and reinforcing of group-based approaches through training on basic risk management and financial skills would consequently augment poor households' recovery and resilience against multiple shocks in the face of escalating climate change. However, the growth of social capital and participation in group-based approaches diminishes in the incidents of extreme events such as drought, flooding or civil conflicts. Therefore, there is a need to tackle collective action problems, time, resource constraints and manage risks in order to promote proactive resilience through group-based approaches.

In spite of covariant shocks being the most important shock types affecting household livestock portfolios and welfare, underplaying idiosyncratic shocks, such as health, market, crime and socio-political shocks, could result in substantial loss of livestock portfolios, reduced income, reduced integration of group-based approaches, and increase in poverty levels. Therefore, enhancing security, social and political stability in rural settings could safeguard assets, fortify social cohesiveness and the potential for group-based approaches.

References

African-Union, 2014. Common Africa Position (CAP) on the Post- 2015 Development Agenda. In *22nd Ordinary Session of the Assembly of the Union on 31 January 2014*. Addis Ababa, Ethiopia.

Alderman, H., 2011. *No Small Matter. The Impact of Poverty, Shocks, and Human Capital Investments in Early Childhood Development*, Washington D.C.: The World Bank.

Andersson, C., Mekonnen, A. & Stage, J., 2011. Impacts of the Productive Safety Net Program in Ethiopia on livestock and tree holdings of rural households. *Journal of Development Economics*, 94(1), pp.119–126.

Asfaw, A. & Braun, V., 2004. Is Consumption Insured against Illness? Evidence on Vulnerability of Households to Health Shocks in Rural Ethiopia. *Economic Development and Cultural Change*, 53(1), pp.115–129.

Azad, A.K., Hossain, K.M. & Nasreen, M., 2013. Flood-induced vulnerabilities and problems encountered by women in northern Bangladesh. *International Journal of Disaster Risk Science*, 4(4), pp.190–199.

Baez, J., Fuente, A. De & Santos, I., 2010. Do Natural Disasters Affect Human Capital? An Assessment Based on Existing Empirical Evidence. *IZA Discussion Paper, Bonn*, 5164.

Bati, B.M., 2013. *Climate change, cattle herd vulnerability and food insecurity: Adaptation through livestock diversification in the Borana pastoral system of Ethiopia*. University of Hohenheim.

Baulch, B., 2011. *Why Poverty Persists. Poverty Dynamics in Asia and Africa.*, Edward Elgar Publishing, Cheltenham, UK. Northampton, MA, USA.

Beegle, K., Weerdt, J. & Dercon, S., 2008. Adult Mortality and Consumption Growth in the Age of HIV / AIDS. *Economic Development and Cultural change*, 56(2), pp.299–326.

Béné, C., Devereux, S. & Sabates-wheeler, R., 2012. Shocks and Social Protection in the Horn of Africa : Analysis from the Productive Safety Net Programme in Ethiopia. *IDS Working Paper*, 395.

Berhane, G. et al., 2013. *Evaluation of Ethiopia's food security program: Documenting progress in the implementation of the productive safety nets programme and the household asset building programme: ESSP II – EDRI Report*, Washington DC.

Bernier, Q. & Meinzen-Dick, R., 2014. Resilience and Social Capital. *2020 Conference on Building Resilience for Food & Nutrition Security*, 4(May).

Beuermann, D.W., Ruprah, I.J. & Sierra, R.E., 2014. Do Remittances Help Smooth Consumption During Health Shocks? Evidence From Jamaica. *IDB Working Paper*, 522.

Blakeslee, D.S. & Fishman, R., 2014. Weather Shocks, Crime, and Agriculture: Evidence from India. Available at: http://nyuad.nyu.edu/content/dam/nyuad/departments/faculty/david-blakeslee/documents/blakeslee-fishman-weather-shocks-agriculture-crime.pdf.

Brown, M.E., 2014. *Food Security, Food Prices and Climate Variability P*, New York: Routledge.

Bryan, E. et al., 2013. Adapting agriculture to climate change in Kenya: household strategies and determinants. *Journal of Environmental Management*, 114, pp.26–35.

Bui, A.T. et al., 2014. The impact of natural disasters on household income, expenditure, poverty and inequality: evidence from Vietnam. *Applied Economics*, 46(15), pp.1751–1766.

Cappellari, L. & Jenkins, S.P., 2006. Calculation of multivariate normal probabilities by simulation, with applications to maximum simulated likelihood estimation. *The stata Journal*, 6(2), pp.156–189.

Cappellari, L. & Jenkins, S.P., 2003. Multivariate probit regression using simulated maximum likelihood. *The Stata Journal*, 3(3), pp.278–294.

Carter, M.R. et al., 2007. Poverty Traps and Natural Disasters in Ethiopia and Honduras. *World Development*, 35(5), pp.835–856.

Debebe, Z.Y., Mebratie, A. & Sparrow, R., 2013. Coping with shocks in rural Ethiopia. *African Studies Centre Working Paper*, 110.

Demont, T., 2013. Poverty, Access to Credit and Absorption of Weather Shocks: Evidence from Indian Self-Help Groups. *CRED working paper*.

Dercon, S., 2004. Growth and shocks: evidence from rural Ethiopia. *Journal of Development Economics*, 74(2), pp.309–329.

Dercon, S., 2002. Income Risk, Coping Strategies, and Safety Nets. *The World Bank Research Observer*, 17(2), pp.141–166.

Dercon, S., Hoddinott, J. & Woldehanna, T., 2005. Shocks and Consumption in 15 Ethiopian Villages, 1999-2004. *Journal of African Economies*, 14(4), pp.559–585.

DFID, 2001. *Sustainable livelihoods guidance sheets. Department for International Development*, London; UK.

Dupas, P. & Robinson, J., 2012. The (hidden) costs of political instability: Evidence from Kenya's 2007 election crisis. *Journal of Development Economics*, 99(2), pp.314–329.

Fafchamps, M. & Lund, S., 2003. Risk-sharing networks in rural Philippines. *Journal of Development Economics*, 71(2), pp.261–287.

FAO, 2009. *The State of Food and Agriculture: Livestock in the balance*, Food and Agriculture Organization of the United Nations, Rome Italy.

Friedman, J., Hong, S.Y. & Hou, X., 2011. The impact of the food price crisis on consumption and caloric availability in Pakistan: Evidence from repeated cross-sectional and panel data. *HNP Discussion Paper, The World Bank, Washington, DC.*, (November 2011).

Heltberg, R. & Lund, N., 2009. Shocks, Coping, and Outcomes for Pakistan's Poor: Health Risks Predominate. *Journal of Development Studies*, 45(6), pp.889–910.

Hoddinott, J. & Quisumbing, A., 2003. Social Protection Discussion Paper Series Methods for Microeconometric Risk and Vulnerability Assessments. *Social Protection Discussion Paper 0324. World Bank,Washington, D.C.*, (0324).

IGAD, 2013. The contribution of livestock to the economies of Kenya, Ethiopia, Uganda and Sudan. *IGAD Center for Pastoral Areas & Livestock Development (ICPALD) Policy brief*, (8/SCLE/8). Available at: http://www.ncbi.nlm.nih.gov/pubmed/23297435.

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), pp.232–243.

Janzen, S.A. & Carter, M.R., 2013. The Impact of Microinsurance on Consumption Smoothing and Asset Protection: Evidence from a Drought in Kenya. *Selected paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013*.

Jordan, J.C., 2015. Swimming alone? The role of social capital in enhancing local resilience to climate stress: a case study from Bangladesh. *Climate and Development*, 7(2), pp.110–123.

Justino, P., 2011. Violent Conflict and Human Capital Accumulation. *IDS Working Paper*, 379.

Kabubo-Mariara, J. & Karanja, F.K., 2007. The Economic Impact of Climate Change on Kenyan Crop Agriculture : A Ricardian Approach. *Policy Research Working paper, The World Bank*, 4334(August).

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

KIPPRA, 2013. *Kenya Economic Report 2013: Creating an Enabling Environment for Stimulating Investment for Competitive and Sustainable Counties*, Nairobi, Kenya.

Little, P.D. et al., 2004. " Churning " on the margins: How the poor respond to drought in South Wollo , Ethiopia. *BASIS Brief*, 21.

Mawejje, J. & Holden, S.T., 2014. Social capital, shocks and livestock investments: evidence from Masaka District, Uganda. *International Journal of Development Issues*, 13(2), pp.98–112.

Mogues, 2011. Shocks and Asset Dynamics in Ethiopia. *Economic Development and Cultural Change*, 60(1), pp.91–120.

Mohapatra, S., Joseph, G. & Ratha, D., 2009. Remittances and Natural Disasters Ex-post Response and Contribution to Ex-ante Preparedness. *World Bank Policy Research Working Paper*, 4972.

Onyeiwu, S. & Liu, J., 2013. Determinants of income poverty in rural Kenya: an empirical analysis. *Africa Journal Economic and Sustainable Development*, 2(1), pp.53–71.

Oviedo, A.M. & Moroz, H., 2014. A review of the ex post and ex ante impacts of risk A Review of the Ex Post and Ex Ante Impacts of Risk. *Background Paper for World Development Report 2014*, Washington.

Shiferaw, B. et al., 2014. Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather and Climate Extremes*, 3, pp.67–79.

UNDP, 2014. *Human Development Report 2014. Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience* 2014th ed., New York, USA: United Nations Development Programme (UNDP).

Wagstaff, A., 2007. The economic consequences of health shocks: evidence from Vietnam. *Journal of health economics*, 26(1), pp.82–100.

Webb, P., Braun, J. von & Yohannes, Y., 1992. *Famine in Ethiopia: Policy Implications of coping failure at National and Household levels. IFPRI research reports.*, Washington, DC.

World Bank, 2001. Attacking Poverty. *World Development Report 2000/2001. The World Bank, Washington DC.*

World Bank, 2014. *World Development Report 2014: Risk and Opportunity—Managing Risk for Development*, Washington, DC, USA: International Bank for Reconstruction and Development / The World Bank.

Yamano, T., Alderman, H. & Christiaensen, L., 2005. Child Growth, shocks, and food Aid in rural Ethiopia. *American Journal of Agricultural Economics*, 87(2), pp.273–288.