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75- Shocks, livestock assets and climate change adaptation in Kenya

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Abstract

The study assesses the impact of shocks on livestock and the role of adaptation to climate change in protecting assets from weather shocks. Data collection relied on a mixed-method approach, including household surveys and participatory rural appraisals (PRAs) in each site. The study uses panel data collected in 2009 and 2012 and a total of 362 balanced panels are used in the study. The study uses fixed effect models in analysis. The findings show that shocks have a negative effect on livestock. Small and large animals are affected differently by different shocks. Large livestock are mostly affected by droughts while market shocks affect small animals. The study also finds that land ownership and income positively affect livestock assets. With regard to adaptation to climate change, farmers who are adapting to changing climate are resilient to weather shocks. Membership in community-based organizations help households in accumulating livestock assets, and this suggests the importance of local institutions in risk management. The study also discusses policy implications.

Key words: Shocks, Livestock, Adaptation, Climate change, Kenya

1. Introduction

Climate change is expected to increase weather variability and incidences of extreme events, which will have an impact on livelihoods and wellbeing as it emasculates development efforts (IPCC 2012). Its negative impacts are mostly felt by poor people in developing countries (IPCC 2001a). Kenya in the recent past has experienced catastrophic floods and severe droughts and other extreme events, which have had a negative impact on sectors vulnerable to climate change such as crop and livestock production, food security and water resources (SEI 2009). In Kenya¹, poor rural farmers are likely to experience adverse impact of climate change taking into account that 70 percent of the labor force depend on agriculture for its livelihood (FAO 2010). Therefore, efforts to facilitate adaptation are needed to enhance the resilience of the agricultural sector, ensure food security, and reduce rural poverty.

Climate and other economic shocks deplete household assets, or predispose households to future asset depletion. In some cases, shocks could be haphazard to thrust households into poverty traps. Climate shocks include drought, erratic rainfall, floods, hailstorm and landslide among others. On the other hand, economic shocks such as death of an economically active household member, illness of family member, shocks caused by criminal activity, social unrest or detrimental price changes affect household well-being. In most cases, the poor resort to depriving their scanty assets to stabilize their current consumption. It is evident that climate change exacerbates production and market shocks in crop and livestock production (Kabubo-Mariara and Karanja 2007; Bird and Shinyekwa 2004).

In the context of climate change, assets are predominantly imperative because they help individuals, households or communities to adapt to increasing variability of production caused by climate change. However, climate-related shocks, such as droughts and floods, could as well deplete these assets that people have accumulated, either by destroying them directly (e.g., loss of livestock during droughts), or because households are forced to sell their assets to cope with these shocks. Poor rural communities are predominantly vulnerable to climate change with respect to individual assets such as human and social capital, as well as household and community assets for instance financial and productive assets. The capacity of individuals, households and communities to deal with such impacts in turn determines their resilience to weather stress (Moser 2007).

The link between climate and economic shocks and welfare of the poor household has also been approached in recent branches of the literature on social capital and development (Mogues, 2011), microcredit (Islam and Maitra 2012), and social protection programs (Andersson et al. 2011). In most rural economies, social networks play an imperative role in mitigating the risks that face agricultural households. Social capital and microcredit are important insurance instruments used by rural communities in dealing with shocks and they protect assets from becoming eroded by shocks (Thorp et al. 2005). However, social capital may as well break down due to severe food shortages as a result of weather shocks as individuals are forced to look for other livelihood strategies (Mogues 2011). Apart from coping with climate shocks as shown in previous studies, both short and long-term

investment in climate change adaptation options is essential (Mogues 2011). For instance, simple adaptation strategies and innovations such as crop diversification and food storage could help in smoothing consumption instead of disposing the household assets. Livestock adaptation innovations such as planting animal feeds and feed storage could reduce animal loss as a result of drought. This paper will contribute to the literature on impacts of shocks on assets by examining the role of climate change adaptation in protecting livestock assets in Kenya. Livestock are an important asset with regard to food security and income generating activity in the rural areas. In Kenya, most farmers engage in mixed-farming. Large livestock include cattle and small livestock include poultry, goat, sheep, pigs and rabbits. Understanding the different types of shocks which affect household's assets may help in designing social protection programs. In the following section, the inter-link between shocks, assets and adaptation is elaborated. Section 3 explains the data used in this study. Section 4 discusses the analytical framework and models. Section 5 presents the results and discussion while section 6 concludes with policy implications.

2. Shocks, assets and adaptation

Shocks could affect the household in various ways. For instance, a climate shock affects the amount, value and productivity of assets. This could be the direct consequence from the shock or a difficulty of its impact due to non-existence or scanty application of coping options. Climate change has a direct and indirect impact on livestock assets and other assets. Direct effects occur with regard to reproduction, animal growth and its products while indirect effects occur with regard to availability and quality of animal feeds such as pasture and forage and on distribution and severity of livestock diseases and parasites (Miura 2011; Seo and Mendelsohn, 2006a). In the context of climate change, assets are particularly important because they are essential in helping individuals, households and communities to adapt² to increasingly variability of production caused by climate change. The capacity of individuals, households and communities to deal with such impacts in turn determines their resilience to weather stress (Moser 2007). Climate change hastens risks in agricultural production such as production and market risks (Bird and Shinyekwa 2004).

Rural communities have always tried to come up with mechanisms such as social capital to share risks in attempt to mitigate the consequences of shocks. Households also embrace livelihood strategies such as saving or selling assets to reduce the probability of suffering adverse shocks. These strategies, however, typically mitigate only a small portion of shock and often fail to prevent people falling into destitution, in case of extreme climate and economic shock, may led to households be trapped into a poverty trap (Kurosaki 2013; Carter and Barrett, 2006). Most of the development literature on assets focuses on consumption smoothing on low household's ability to cope with shocks (Dercon 2005; Fafchamps 2003). Another literature is based on assets poverty trap hypothesis³ (Carter and Barrett 2006). With the current trend of climate change, poor rural households may be trapped into poverty as they

² Studies have shown that socio-economics factors affect adaptation (Bryan et al. 2009; Gbetibouo 2009; Bryan et al. 2012; Silvestria et al. 2012).

³ For more detailed discussion on this subject, please see, Carter and Lybbert (2012) Miura et al. (2012), Carter et al. (2007), and Mogues (2011)

try to cope with exogenous shocks; adaptation is essential to try and build resilience and build the assets. This study will contribute to the literature by looking the role of adaption to climate change as a way of coping with weather shocks and protecting household assets.

3. Data

The study uses panel data collected in 2009 and 2012 through a collaborative research project of the International Food Policy Research Institute (IFPRI), the Kenya Agricultural Research Institute (KARI), the Center for Development Research (ZEF), and the University of Hohenheim, Germany. Data collection relied on a mixed-method approach, including household surveys and participatory rural appraisals (PRAs) in each study site. The data come from six districts: Mbeere South, Njoro, Mukurue-ini, Nyeri, Gem and Siaya. The sampling procedure in 2009 was a purposive targeting a wide range of climatic, agro-ecological, and socioeconomic conditions, and a total of 557 randomly selected households were interviewed. The 2009 survey was done following the 2008 to 2009 droughts which hit the country and resulted in high livestock mortality (Zwaagstra et al. 2010:21). The same households were re-visited in 2012, but due to resource constraints, only 360 households were targeted which were a random sample of the total sample of 2009. The dataset contains information on livestock holdings per household, weather and economic shocks, demographics, climate change adaptation options undertaken, social groups, asset endowments, production data and access to information, credit and market. Trained enumerators were used to collect the data, and pre-testing of questionnaire was done in areas with similar ecological condition and the questionnaire adjusted accordingly.

Table 1 presents descriptive statistics on shocks, socio-economics, adaptation and social networks characteristics of the households. The average size of the household varies from 5.42 in 2009 to 5.12 in 2012. Livestock are aggregated in Tropical Livestock Units (TLU)⁴. Thus, the heterogeneity of livestock ownership across agro-ecological zones is taken into account. The findings shows that the average livestock holding has increased by 1.15 from 3.30 TLU in 2009 to 4.35 in 2012, which could indicate an ability of households to recover after the 2008 and 2009 drought.

The results also show that climate shocks were wide-spread in 2009 as 87% of the households experienced drought, and 6% experienced floods, as compared with 51% and 4% in 2012, respectively. These findings of self-reported occurrence of weather shocks (drought and floods) are supported by previous studies that indicate that the drought in Kenya in 2009 had a negative impact on livestock mortality (Zwaagstra et al. 2010:21). Raise in food and input prices (market shocks) also affected household but prevalent in 2009 with 25%, however there is a notable decline to 14% in 2012. The 2009 survey was done during the year with

⁴ The study defined the TLU as follows bulls = 1.2, oxen = 1.42, cattle = 1.0, goats/sheep = 0.2, poultry = 0.04, rabbits = 0.04, pig = 0.3 and Ducks/Turkey/Geese = 0.03 (adopted from FAO 2003; Chilonda & Otte 2006; Njuki et al. 2011).

crisis in global food prices. There is evidence that climate change was one of the key causes of high food prices during 2009 and the poor were mostly hit (Sasson 2012).

For the data set analyzed here, total income was computed by summation of income from the different sources including farm income, non-farm income, sale of assets, gifts, remittances, pension, savings and income from entrepreneurship activities. There is a notable increase in income from Ksh 102,830 in 2009 to Ksh 153,340 in 2012. Social capital is important during the time of shocks as a risk sharing strategy among affected communities or households. During 2009, 12% of households had at least one member belonging to a community-based organization (CBO) in comparison to 25% in 2012. 61% belonged to other social groups in 2009, and this figure increased to 67% in 2012. Results also show that there is a rise in adaptation to climate change in livestock production with a rise to 51% in 2012 from 24% in 2009.

Table 1: Summary statistics (362 Households)

Variables	2009		2012	
	Mean	Std Dev	Mean	Std Dev
Total TLU	3.30	3.49	4.57	4.35
Large livestock TLU	2.41	2.98	3.51	3.79
Small livestock TLU	0.89	1.15	1.06	1.21
Drought (dummy)	0.87	0.34	0.51	0.51
Flood (dummy)	0.06	0.23	0.04	0.19
Personal shock (Illness and Death) (dummy)	0.34	0.47	0.30	0.47
Production shock (Livestock diseases) (dummy)	0.16	0.36	0.13	0.34
Market shocks (dummy)	0.25	0.43	0.14	0.34
Access to Livestock production information	0.63	0.48	0.79	0.41
Access to credit (dummy)	0.43	0.49	0.55	0.49
Food aid (dummy)	0.18	0.38	0.20	0.40
Total land holding (acres)	16.12	26.46	4.03	6.49
Household size	5.42	2.70	5.12	2.56
Age in years	56.93	12.85	58.17	13.32
Log income in Ksh ('000) per year	102.83	199.88	153.34	176.03
Livestock adaptation to climate change (dummy)	0.24	0.43	0.51	0.50
Any member in HH belong to CBO (dummy)	0.12	0.45	0.25	0.45
Any member in HH Social Capital ⁵ (dummy)	0.61	0.49	0.67	0.49

Source: Authors' computations.

* Ksh = Kenya Shillings.

⁵ Social Capital in this paper refers to membership to any group apart from CBO. These groups include women group, men group, youth group, farmer group, welfare group, saving and credit group and religious group.

4. Analytical methods

This section outlines the analytical methods applied to assess the effect of weather and other shocks on livestock asset and whether adapting to climate change could help build the livestock holdings. There is probable existence of unobserved factors that could affect shocks, adaptations and outcomes thus the use of naive OLS could result to biased estimates.

To address the problem of unobserved heterogeneity and exogeneity, a fixed effects⁶ model is used in this study. The fixed effects model controls for all time-invariant differences between households and the estimated coefficients are not biased. To assess the effects of shocks and adaptation on livestock asset, the following equation was estimated.

$$L_{it} = X_{it}\beta + \odot_{it}\beta + \beta AL_{it} + \alpha_i T + \lambda_t + \mu_{it} \quad (1)$$

Where L_{it} stands for TLU in household i at time t , $X_{it}\beta$ is vector for control variables which include social-economic and institution variables, $\odot_{it}\beta$ is vector parameter for self-reported shock variables that has occurred in the household including weather and other shocks, βAL_{it} represents a dummy for adapting to climate change on livestock production and we hypothesis that household that adapt to the change climate may be able to protect their asset in occurrence of weather shock, $\alpha_i T$ is time dummy variables and λ_i fixed effects variables such as village location and μ_{it} captures both time variant and time invariant unobservable errors.

In order to estimate the possible effect of adaptation to climate change on lessening the impacts of shocks of livestock assets, we estimate reduce form of equation 1 and add an interaction term, representing interaction of adaptation and shocks ($AL_{it} * \odot_{it}$). The following model was estimated.

$$L_{it} = X_{it}\beta + \odot_{it}\beta + \beta AL_{it} + \beta(AL_{it} * \odot_{it}) + \alpha_i T + \lambda_t + \mu_{it} \quad (2)$$

If adapting to climate change reduces the impact of weather shocks on livestock asset the coefficient of the interaction of adaptation and shocks ($AL_{it} * \odot_{it}$) is expected to be positive while coefficient of shocks is expected to be negative. The model applied robust to control for possible heteroskedasticity.

⁶Hausman test proposed by Hausman (1978) was done between fixed and random effects to test for the exogeneity of the unobserved household effects. $P > \chi^2 = 0.000$ thus fixed effect model yields consistent estimators.

5. Results and Discussion

Table 2: Fixed effects regression results on livestock assets (panel 362 households)

	Small livestock TLU	Cattle TLU	Total TLU	Restricted model-Total TLU
⁷Shock variable				
Drought (dummy)	-0.141 (0.094)	-0.755 (0.288)*	-0.896 (0.326)**	-0.858 (0.039)*
Flood (dummy)	-0.390 (0.088)*	-1.026 (0.602)	-1.417 (0.073)*	-1.417 (0.722)*
Personal (Illness and Death) (dummy)	0.088 (0.077)	0.224 (0.272)	0.314 (0.029)	0.393 (0.299)
Production (Livestock diseases)	-0.129 (0.105)	0.021 (0.259)	-0.108 (0.273)	-0.168 (0.248)
Market shocks (dummy)	-0.180 (0.105)*	-0.372 (0.276)	-0.553 (0.031)*	-0.575 (0.320)*
Access to information on livestock production	0.051 (0.105)	0.836 (0.405)*	0.780 (0.438)**	0.855 (0.476)**
Access to credit (dummy)	0.162 (0.124)	-0.212 (0.230)	-0.050 (0.298)	-
Food aid (dummy)	-0.164 (0.130)*	-0.823 (0.275)**	-0.785 (0.326)**	-0.96 (0.344)**
Socio-economic variables				
Land size (Log acres)	0.112 (0.050)*	0.110 (0.113)	0.222 (0.131)*	0.299 (0.123)*
Household size	0.027 (0.035)	0.175 (0.097)*	0.203 (0.126)	-
Age in years	0.061 (0.270)*	0.191 (0.112)*	0.252 (0.127)*	-
Age in years squared	-0.001 (0.000)*	0.001 (0.000)	-0.002 (0.001)*	-
Log income in Ksh	0.065 (0.021)**	0.139 (0.070)*	0.205 (0.079)*	0.223 (0.123)**
Climate adaptation				
Livestock adaptation to climate change (dummy)	0.126 (0.076)*	0.497 (0.280)*	0.623 (0.030)*	0.605 (0.037)*
Adaptation*drought	-	-	-	0.037 (0.418)
Adaptation*floods	-	-	-	0.048 (0.467)
Social networks				
Any member in HH belong to CBO (dummy)	0.321 (0.142)*	0.582 (0.287)*	0.904 (0.340)**	0.861 (0.333)*
Any member in HH social Network ⁸ (dummy)	0.119 (0.141)	0.152 (0.343)	0.034 (0.419)	-
Joint Test F-statistics	2.61***	2.72***	3.71***	3.35***

Source: Authors' computations

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Regression include village and time fixed effects. The variables included in the model but not presented include distance to market and age squared.

⁷ Shocks were self-reported by the respondents, further analyses are underway using climatic data from the study sites.

Households have varied outcomes because of occurrence of shocks which may include loss of assets and income, decline in crop yields and incase of severe drought loss of entire crop, death of livestock and food shortage. To reduce the effect of shocks, households opt for short-term consumption smoothing strategies such as sale of assets and borrowing from neighbors, credit institutions or from social groups. The findings show that households mentioned to have received food aid through food for assets and food for work programs, or emergency food relief. The findings also show that 22% to have sold livestock to cope with given shock, indicating the important of livestock in coping with shocks.

Table 2 presents the results for the fixed effects estimation of the model. The first column refers to small animals TLU the second column to large livestock TLU (cattle) and third column to total livestock TLU as dependent variable. The fourth column presents a restricted model for total TLU and the interaction terms between adaption and shocks. The findings show that market risks negatively and significant affect small animals, and not large livestock, however it affect total livestock holding. Occurrence of market shocks resulted to a decline of 0.18 units of small animals. Our findings are comparable to previous studies that small animals are more liquid and easily disposable thus customarily used for consumption smoothing in occurrence of shocks (Ifejika Speranza 2011).

Droughts and floods shocks affect livestock holding negatively and significantly. The household who experienced drought reduced livestock by 0.89 units of TLU across time. With regards to floods, the affected household reduced livestock by 1.42 units across time. These results corroborate with previous finding on impacts of climatic shock on livestock assets (Mogues 2011). Though small animals are affected by drought, the coefficient is statistically insignificant. Previous study have shown that small animals are important adaptation strategy given the decline in average landholding size and the increase in the frequency of dry spells resulting in low fodder/pasture availability. Small animals consume less feed and water in comparison with large animals such as cows. They also require less space, are less labor intensive, and act as alternative sources of food and income. Small animals are also the first to be disposed of during climatic shocks, consistent with previous findings (Ngigi et al. 2012; Ifejika Speranza 2011).

The study also shows that access to information on livestock production has a positive effect on livestock holdings. A household who had access to information across time could increase its livestock TLU by 0.78 units. Land holdings and household income have a positive and significant effect on livestock assets. This suggests that wealthier household use their income for consumption smoothing rather than disposing their assets. Earlier studies have shown that poorer households are more vulnerable to adverse shocks than are wealthier households (Glewwe and Hall 1998; McPeak and Barrett 2001). Little et al. (2002) argues that while poor households' tend to sell their assets in response to shocks, their relatively wealthier counterparts maintain a higher asset base by keeping their assets off a devalued market and by purchasing the devalued assets from poorer households. These findings suggest that the initial conditions of the household will determine its coping capacity and the effects of a random shock on future assets and livelihoods.

Membership in a CBO has a positive and significant influence on livestock assets. These findings indicate the usefulness of CBO in risk sharing and mitigation against shocks in the absence of an insurance mechanism. However, membership in other social groups has a positive but insignificant influence on livestock assets. However, group-based approaches may not be able to cope with shocks which are severe and widespread shocks and affect many people in the community, in this case, national or even international assistance is needed (Meinzen-Dick et al. 2010). Previous studies have shown that a social network is important in mitigating shocks in the absence of formal insurance strategies and credit (Islam and Maitra 2012; Mogues 2011).

As adaptation to climate change varies with time, households could increase their livestock by 0.623 units of TLU across study period. The study also finds that simple adapting options such as change in livestock feeds, more production of livestock feed, such as hay, and engage in storage practices such as silage and maize stalk storage could help build resilience to climate change and build livestock assets. Storage of livestock feeds when they are abundantly available enables farmers to use stored feeds during dry spells, thus avoiding possible loss as a result of drought. As expected, interaction of adaptation and weather shocks has a positive coefficient but is statistically insignificant. Adaptation to climate change may not have immediate effects on livestock, in an actual sense, some of the adaptation options involve destocking necessitated by reduction of feeds availability as a result of climate change.

Contrary to our expectation, food aid⁹ and other kinds of aid such as food for work and cash for work programs have a statistically significant negative impact on livestock, which is in line with other studies. For instance, Anderson et al. (2011) found that Productive Safety Net Program (PSNP) in Ethiopia did not safeguards livestock assets and household disinvested in livestock in time of weather shock. Similar studies in Ethiopia show that food aid in the community do not protect households' future assets (Cartel et al. 2006; Little et al. 2006). Food aid program usually target the most disadvantaged who have scanty assets and given persistence of shocks they end up disposing their asset. Conversely, food aid is essential short term inventions to cope with drought.

6. Summary, Conclusion and Policy Implications

Using panel data set from Kenya, this paper examines the ability of households to insure against shocks and the role of climate change adaptation in building livestock assets. The study finds that drought and floods are major climatic threats to livestock production. The study also finds market shocks also affect households through dramatic change of input prices or lack of market for their produce.

⁹ Food aid may reduce short term asset sales however, months later households tend to resort back to elevated sales (Mathys, 1999)

The study used a fixed effect model to assess the effects of shocks on livestock assets and the role of adaptation to climate change and to examine whether social networks could insure households against shocks. The regression results show that drought and floods have had a negative impact on livestock assets, and market risk on small animals, but not on large animals. The findings suggests as an adaptive strategy farmers should adapt small animals such as dairy goats, sheep and poultry, which are not affected by weather shock. Membership in a CBO helps households in building livestock assets, and this suggests the importance of local institutions in dealing with shocks. However it should be noted that local institutions could only deal with shocks with low magnitude, and shocks that affect most people in the community will call for high level of cooperation. Shocks may also affect the social cohesiveness as people are forced to economize as a result of shocks. The study suggests that enhancing resilience to climate-related shocks is a goal of many adaptation strategies employed by smallholder's farmers or pastoralists in Kenya. Therefore, strengthening group-based approaches could present an opportunity to enlarge the social capital of communities and build community adaptive capacity and resilience and/ or mitigation to climate change

The study also finds that adapting to climate change could help in building assets by ensuring no loss as a result of weather shocks. With climate shocks and other kind of shocks being an integral part of rural life in who have limited ways to insure against shocks it is important to understand the role of timely adaptation and group-based approaches in protection of livestock and other assets from becoming eroded by shocks. These results suggest that sensitization is required on both short term and long term adaptation measures in Kenya. Further research is also needed on the importance of climate change as one on the possible way to protect assets against shocks.

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