An Empirical Evaluation of the Nature and Extent of Livestock Shocks in Sedentary Pastoral Households in Northern Kenya

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INTRODUCTION

Background

- Livestock greatly supports pastoral household livelihoods in the Arid and Semi-arid Lands (ASALs) of northern Kenya.
- Camel, cattle, sheep, and goats are the main livestock which provide both tangible and intangible returns (Guliye et al. 2007; McPeak et al. 2010; Jensen et al. 2015).
- These households are highly dependent on livestock for survival, income, wealth, risk management and financial security.
- Livestock accounts for more than two-thirds of average income of pastoral households (Chantarat et al. 2013; Elhadi et al.2015).
- Livestock are highly vulnerable to shocks which expose the households to food and income insecurity.
- Because of great dependency on livestock, more than 70 percent of pastoral households in northern Kenya are vulnerable to various shocks, including droughts (Opiyo et al., 2014).
- Traditionally, livestock has been raised under nomadic pastoralism in the arid and semi-arid rangelands.

INTRODUCTION CONT.

- Socioeconomic factors and markets are motivating pastoralists to modify from predominantly nomadic systems to sedentary systems (Thornton et al. 2007; Seré et al. 2009, Shibia et al.2013.)
- The sedentary systems include partially and fully settled households.
- Fully settled households is characterized by restricted mobility of households and grazing regimes anchored around market centres.
- Both the nomadic and sedentary pastoralist systems are highly vulnerable to droughts and other shocks.
- Such shifts could have implications on policy targeting the changes in the way different categories of pastoral households cope with and manage various shocks.
- The arid and semi-arid northern Kenya experience frequent catastrophic droughts (Adow 2008; Mude et al. 2011).
- The occurrence was 5 times in the last 17 years (2000, 2004-05, 2010-11, 2014, and 2017).

INTRODUCTION CONT.

- Persistent drought leads to livestock deaths inflicting catastrophic production risks and food insecurity on pastoral households (McPeak et al. 2010; Chantarat et al., 2013; Jensen et al., 2015).
- Despite the existing social and institutional adaptation mechanisms, pastoral households are still vulnerable to shocks.
- Even in normal periods there are some random shocks that cause livestock deaths.
- The losses of livestock as a result of drought starvation and the other random shocks could represent a substantial production risk.
- Such losses could have implications on different categories of pastoral household food security and incomes.
- However, earlier studies did not estimate the extent of livestock losses resulting from various shocks for the emerging sedentary pastoral households.
- The loss of livestock due to shocks impose threats to food and income security and the survival of sedentary households.
- This highlights the importance of securing livestock through managing shocks and building resilience of pastoral households.

RESEARCH QUESTIONS

This study seeks to answer;

- What is the extent of livestock losses for partially settled and fully settled households?
- To what extent does the livestock losses due to random and non-random shocks affect partially settled and fully settled households?
- What are the implications of livestock losses on pastoral households’ food security?

OBJECTIVES

- **Overarching goal;**
  - Evaluate the impact of livestock shocks for sedentary pastoral households in Marsabit County, northern Kenya.

Objectives

1. Compare the losses of livestock associated with random and non-random shocks between fully settled and partially settled households.
2. Evaluate the extent of livestock losses associated with random and non-random shocks and their implications on food security.

CONCEPTUAL FRAMEWORK

- The main objective of a pastoralist in a sedentary production system is to maximize the expected utility of profits.
- The individual decision maker is assumed to be risk averse.
- The profit function is defined as;
- $\pi(q) = Pq - Cq$
- Where q is the output and p is the price of output restricted to be nonnegative and given.
- The output q for pastoralists is produced under uncertainty subject to random and non-random shocks denoted by $\emptyset$
- Thus the profit function is stated as;
- $\pi(q) = Pq(\emptyset) - \mathrm{C}\mathrm{q}(\emptyset)$
- The output is a function of both random and non-random shocks which serves as both production and economic risks.
- The expected utility of profit = *E [U (Pq* ($\emptyset$) - *C q* ($\emptyset$)]

CONCEPTUAL FRAMEWORK CONT.

- A pastoral household maximizes expected utility of profits subject to q produced under shocks (∅) related to non-random (q_t) and some random factors (ε_t).

$$q_{t+1} = \emptyset(q_t - \varepsilon_t)$$

$$\text{Max} \quad EU\left[P(q_{t+1}) - C(q_{t+1})\right]$$

- Maximization of survival of livestock and the expected utility of profits is dependent on uncertainty related to drought and non-random shocks(∅)
- The (∅) depends on;
- Household characteristics x_{ho}
- Herd characteristics x_{he}
- Interventions x_i
- Management practices x_m
- Subject to resource constraints (feed, labor, veterinary, and cost of insurance).

CONCEPTUAL FRAMEWORK CONT.

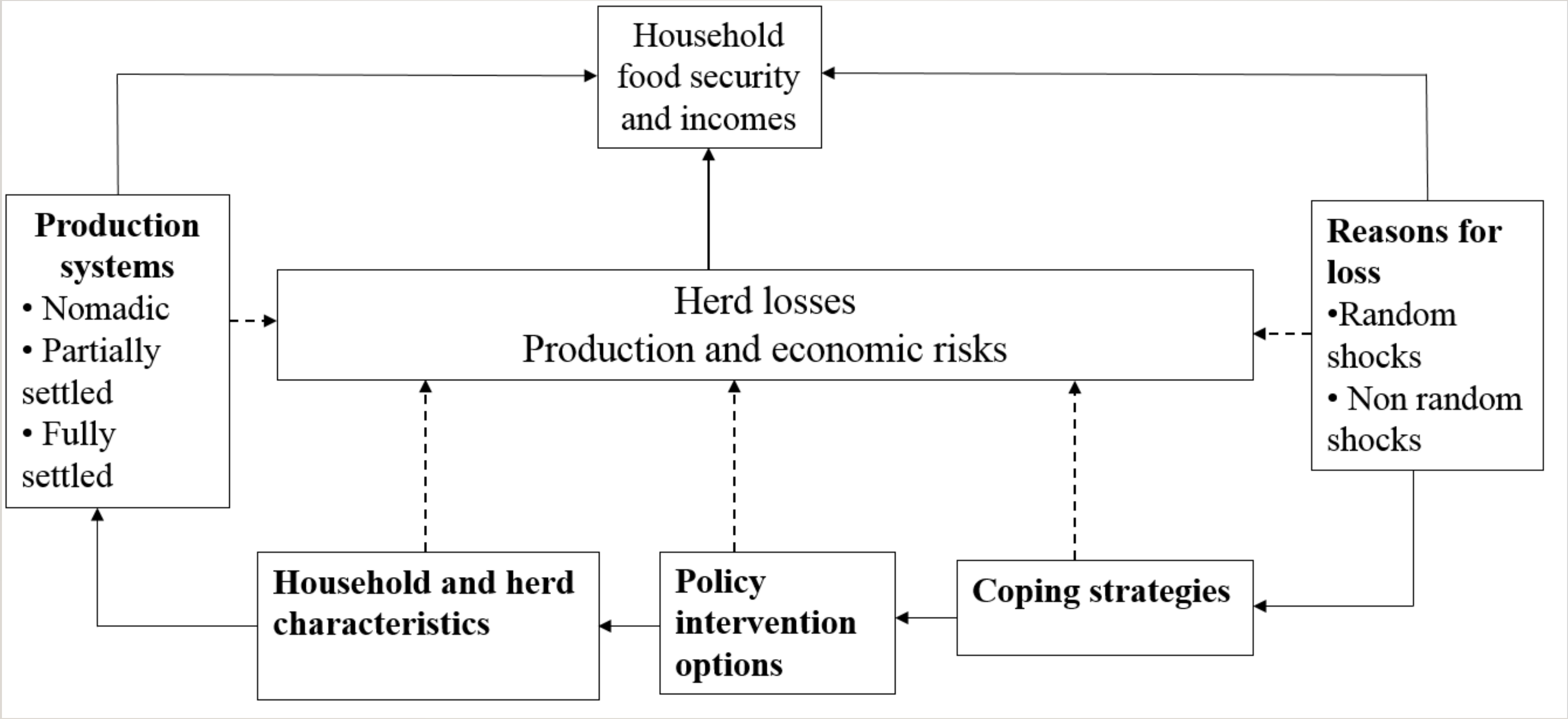

Figure 1: analysis of conceptual framework for herd losses

EMPIRICAL EVALUATION AND MODEL

- The objective of the study is to analyze the dependent variable y (number of livestock losses due to $\emptyset$) given a set of independent variables $x_{ho}, x_{he}, x_i,$ and x_m .
- Since the response variable is discrete, its distribution places probability mass at nonnegative integer values (Cameron and Trivedi 2005).
- Fully parametric formulations of count models accommodate this property of the distribution.
- Therefore the dependent variable follows a Poisson distribution and a Poisson model.
- Count regressions are also nonlinear which could accommodate $\emptyset$.
- However, unobserved heterogeneity and small mean property has to be addressed.

EMPIRICAL EVALUATION AND MODEL CONT.

- **Estimation for count data models**
- **Poisson Model**
- $Prob(Y = y|x_i) = \left(\frac{e^{-\lambda_i}\,\lambda_i^{yi}}{y_i!}\right)$, $y_{i=0,1,2,\ldots}$
- Where
- $\lambda_i = \exp\left(x_i'^{\beta}\right), \quad i = 1, \ldots, N$
- The log likelihood function
- $lnL = \sum_{i=1}^{n} -\left[\lambda_i + y_i x_i'^{\beta} - lny_i!\right]$
- The poison regression model was estimated as $Y_{it} = E(Y_{it}) + \varepsilon_{\,it} = \varepsilon_{\,i} + \varepsilon_{\,it}$

EMPIRICAL EVALUATION AND MODEL CONT.

- Where Y_{it} is an independently distributed Poisson random variable with a mean of $\varepsilon_{\ i}$ for each individual cases;
- $\varepsilon_i = E(Y_{it}) = x_i'^{\beta} + \varepsilon_{it}$
- Usefulness of Poisson may be restricted by the assumption of mean equals to variance of y_i (Green, 2012).
- Test for overdispersion

EMPIRICAL EVALUATION AND MODEL CONT.

- **Negative Binomial 2**
- Individual, unobserved effect is introduced into the conditional mean of poison model allowing for cross sectional heterogeneity .
- The disturbance ε_i reflects specification error or cross-sectional heterogeneity.
- The distribution of y_i conditional on x_i and μ_i remains Poisson with conditional mean and variance.
- $ln_{ui} = x_i'^{\beta} + \varepsilon_i = ln\lambda_i + ln_{\ ui}$
- $Y_{it} = E(Y_{it}) + \varepsilon + \mu_{it} = \mu_{\ i} + \varepsilon + \mu_{\ it}$

EMPIRICAL EVALUATION AND MODEL CONT.

- The two models (poison and negative binomial regression) will be estimated using ;
- $y = \gamma_m \chi_m + \gamma_{ho} \chi_{ho} + \gamma_{he} \chi_{he} + \gamma_i \chi_i$
- where y is the incidences of loss associated with shocks and γ parameters to be estimated.
- χ_m a vector of management practices (fully and partially settled, number of animals herded and form of labor used).
- χ_{ho} a vector of household characteristics (Gender, age, level of education, and household income).
- χ_{he} a vector of herd characteristics (herd size, type of animal, base camp, and the age of the animal)
- χ_i a vector of access to formal and informal interventions (migration, access to credit, lending, and borrowing, cash and income transfers, insurance, veterinary and feeding).

DATA AND ESTIMATION ISSUES

- The study used secondary data obtained from Index Based Livestock Insurance (IBLI) project implemented through ILRI.
- The design of the project is described in Chantarat et al. 2013
- The available data for IBLI is a panel data for five rounds of survey conducted on 924 pastoral households for the period 2009 – 2016.
- Cross-sectional data for the fourth round was used .
- The sample size was 653 (255 for fully settled and 398 for partially settled) cases of livestock loss obtained from herds for these households.
- The data was tested and corrected for endogeneity and heteroscedasticity. Hausman test and bootstrap was used for correction.
- The test for over dispersion for the Poisson model was conducted.
- The results indicated significance (p=0.000) evidence for presence of overdispersion. Based on this conclusion the use of negative binomial model was recommended.
- Descriptive statistics

Variable	Meaning	Mean	Std. Dev.	Min	Max
Settlementherd	1= fully settled, and 0 = partially settled households	0.46	0.50	0	1
nlost	Number of animals lost	3.55	9.69	1	220
Nborn	Number of animals born	4.30	5.90	1	69
Lossreason	Reason for loss	2.73	5.53	1	10
Gender	Gender of the herd owner	0.62	0.48	0	1
Age_HH	Age of the household head	49.56	16.17	21	97
Laborown	Labor used for herding (1= own and 0 hired)	0.35	0.48	0	1
Nq1	Total number of animals currently herded by household	1.54	2.91	0	41
Nq2	Number of herded animals that are owned by household	3.57	3.51	0	41
d_cattle	Dummy for cattle	0.12	0.32	0	1
d_shoats	Dummy for shoats	0.33	0.47	0	1
d_camels	Dummy for camels	0.26	0.44	0	1
Num_Basecamp	The loss event at the (1=base camp and 0= satellite camp)	0.27	0.45	0	1
Animal_age	Number of animals lost greater than 3 years for cattle/camel and greater than 6 months for shoats	0.88	0.33	0	1
Household income (ln)	Household income	10.62	1.24	6	15
Sateliteuse	Frequency of using satellite camp	0.84	0.37	0	1
Lendingmoney	Lending in the last 12 months	0.10	0.30	0	1
Cashsaving	Cash savings in the last 12 months	0.44	0.50	0	1
Transferinincom($)	Cash income in kind and transfer	80.14	2.03	0	2460.50

RESULTS

Table 2. t test results for losses of livestock for fully settled and partially settled herds

Sources of loss	Fully settled N born= 335		Partially settled N born= 476		P values
	Number	Proportion	Number	Proportion	
Starvation/Drought	105	0.313	91	0.191	0.0150**
Diseases	90	0.269	197	0.414	0.0000**
Predation	21	0.063	39	0.082	0.0802
Raiding/Rustling/Conflict	8	0.024	10	0.021	0.9014
Accident/Poisoned	13	0.039	20	0.042	0.4464
Just lost	3	0.009	5	0.011	0.6330
Rain	9	0.027	26	0.055	0.0146
Premature birth	1	0.003	3	0.006	0.4014
Old age	3	0.009	5	0.011	0.6330
Unknown causes			2	0.004	0.1927
Total loss	255	0.76	398	0.84	

** $p<0.05$

Table 3 count regression estimates of determinants of livestock losses

The dependent variable is the number of livestock lost Explanatory Variables	Poisson Parameter estimates	Marginal effects	Negative Binomial Parameter estimates	Marginal effects
Management practices				
settlementherd	-.47**	-1.14**	-.29*	-.85**
	(.21)	(.48)	(.16)	(.40)
laborown	-0.4**	-1.12**	-.27**	-.95**
	(.19)	(0.56)	(.11)	(.43)
Total animals herded	-.004	-.014	.07	.25
	(.08)	(.23)	(.13)	(.42)
Household characteristics				
Gender	.07	.18	.058	.19
	(.23)	(.67)	(.15)	(.53)
Age of the head of household	.01	-.03	-.003	.01
	(.01)	(.025)	(.003)	(.011)
Log incomeHH	-.24*	-.70**	-.10**	-.34**
	(.13)	(.34)	(.05)	(.16)
Herd characterestics				
Number of animals owned	.024	.07	-.06	-.19
	(.088)	(.24)	(.13)	(.42)
d_cattle (1,0)	-.027	-.08	-.07	-.24
	(.25)	(.70)	(.20)	(.63)
d_shoats (1,0)	1.39***	5.36***	1.08***	4.39***
	(.30)	(1.13)	(.11)	(.58)

The dependent variable is the number of livestock lost	Poisson		Negative Binomial	
Explanatory variables	Parameter estimates	Marginal effects	Parameter estimates	Marginal effects
num_Basecamp (1,0)	-.63 ***	-1.5***	-.50***	-1.35***
	(.21)	(.13)	(.16)	(.38)
Animal_age (1,0)	.29**	.80*	.36**	1.03**
	(.17)	(.44)	(.17)	(.42)
Interventions				
Sateliteuse/migration (scale)	-.94 ***	-3.6***	-.63***	-2.47***
	(.33)	(.4)	(0.12)	(.57)
Lendingmoney (scale)	-.23	1.45	.17	.60
	(.28)	(1.3)	(.20)	(.75)
Cashsaving (1,0)	.088***	-.63***	-.02	.06
	(.018)	(.72)	(.12)	(.39)
Transferincome ($)	-.0034*	-.0098*	-.0268**	-.0087**
	(.0015)	(.0041)	.00115	(.004)
_cons	-.68		0.16	
	(.90)		(0.60)	
Number of observations	653			
Log likelihood	-1097.47		-698.19	
Prob > chi2	0.000***		0.000***	
Pseudo R2	0.3498		0.1125	
/lnalpha			-.708	
			(.11)	
alpha			.70	
			(.05)	
R test of alpha=0			.000*	
Prob >= chibar2				

Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1

DISCUSSION

- The high proportion of livestock lost in the partially settled households (Table 1) implies that out of the total losses;
- 41% were majorly associated with diseases.
- And substantially to drought (19%).
  - Limited access to cost effective veterinary interventions packages
  - Unstable income
  - ability to pay for quality veterinary
- Consistent with the findings of Osofsky et al. (2005)- economic losses resulting from diseases in livestock species (cattle, sheep, and goat) was much higher than economic losses caused by predation, theft or gone missing.
- The overall incidence of losses was significantly lower by one livestock in the fully settled households relative to the partially settled (Table 3).
- However, in table 2, shocks related to deaths due to drought was higher (31%) relative to partially settled%).
  - land degradation and unsustainable feeding management
  - Consequently, herds in base camps approximately lost 1.4 more livestock relative to the animals in the satellite camps.
  - Consistent with Shibia et al. 2013 for peri-urban herds.
  - The losses were significantly attributed to shoats that are more than 6 months of age.

DISCUSSION

- The marginal effect of labor implies that the use of hired casual labor increases incidence of loss by one more livestock.
- This implies that few herd owners and family members have less direct contact with the routine activities and management of herds.
- Households with stable income significantly experience less number of incidences loss of livestock by 3.4% relative to those who are less stable.
  - Can spend on cost effective veterinary care and feeding management as well as feasible risk management mechanism.
- Cash transfers are not economically sustainable consistent with McPeack et al. 2010.
- Losses of livestock due to shocks mainly disrupts livelihoods through income and food security.
- Milk losses would imply a reduction in dietary intake of milk in daily meals of households leading to malnutrition and loss of income (sale of milk and meat).
- Milk and meat constitute a larger portion of a pastoral household diet.

CONCLUSION AND POLICY IMPLICATIONS

- The survival rate of livestock was 8% more in the fully settled herds relative to the partially settled herds.
- Attributed to shocks in the partially settled herds- diseases was significantly higher by approximately 14.5%.
- In both herds diseases and drought cause a significant shock to the systems.
- Fully settled (27% and 31%) and partially settled (41% and 19%) pastoral households respectively.
- The effects of diseases should not be underestimated.
- Losses due to random and non-random shocks were significantly attributed to herd management practices with special focus on targeting reduction of loss in shoats that are greater than 6 months of age and are in base camps.

CONCLUSION AND POLICY IMPLICATIONS

- The reduction of loss requires targeting use of skilled and experienced labor for herd management, proper coordination between the base and satellite camps, and stable and diversified income.
- This should be combined with ensured access to affordable veterinary care and feeding management coupled with feasible risk management.
- Targeting should be based on building resilience for the different categories of herds and households.
- Interventions should be based on the sedentary herds and households.
- Therefore, ensuring the survival of livestock from both random and non-random shocks could minimize the loss
  - thereby enhancing food, nutrition, and income security of different category of pastoral households.
- The study used count models on cross sectional data.
- However, further examination is being conducted on analysing panel data for the same households using a Tobit and double hurdle approach.

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MATERIALS CITED

- Adow, M. 2008. Pastoralists in Kenya, *Forced Migration Review*, 31:34.
- Chantarat, S. Mude, A .G, Barrett, C.B. and Carter M.R. 2013. Designing index based livestock insurance for managing asset risk in northern Kenya, *Risk and Insurance, 80(1)* 205-237. DOI:10.1111/j.1539-6975.2012.01463.x.
- Elhadi, Yazan Ahmed, Dickson M. Nyariki, and Oliver V. Wasonga. 2015. "Role of Camel Milk in Pastoral Livelihoods in Kenya: Contribution to Household Diet and Income." *Pastoralism* 5(1). ???
- Green, W.H. 2012. *Econometric Analysis*, 7th edition, Boston, Pearson.
- Guliye, A.Y., Noor, I.M., Bebe, B.O., & Kosgey, I.S. 2007. Role of camels (*Camelus dromedarius*) in the traditional lifestyle of Somali pastoralists in northern Kenya. *Outlook on Agriculture*, 36 (1), 29–34.
- McPeak J., Chantarat, S., Mude, A. 2010. "Explaining index based livestock insurance to pastoralists", *Agricultural Finance Review*, Vol. 70, 3, 333-352. Available athttp://dx.doi.org/10.1108/00021461011088477.
- Mude, Andrew G., Chantarat, S., Barrett, C.B., Carter, Michael R., Ikegami, M. and McPeak, J.G. 2011. Insuring against Drought-Related Livestock Mortality: Piloting Index Based Livestock Insurance in Northern Kenya. Available at: http://dx.doi.org/10.2139/ssrn.1844745.
- Opiyo, F. E.O, Wasonga O.V, and Nyagito M. M. (2014). Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. Pastoralism: Research, Policy and Practice 4:10. doi:10.1186/s13570-014-0010-9.
- Osofsky, S.A., Cleavand, S., Karesh, W.B., Kock, M.D., Nyhus, P.J., Starr, L., & Yang, A. (Eds) 2005.*Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health.* IUCN, Gland Switzerland and Cambridge, UK.
- Shibia, M. G., G. Owuor, and B. O. Bebe. 2013. "Evaluation of Losses of Replacement Heifers in Pastoral and Peri-Urban Camel Herds in Semi-Arid Northern Kenya." *Pastoralism:Research,policy and practice* 3(23): 1–8.

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