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Cornell University

Index-Based Livestock Insurance in Northern Kenya: An Analysis of the Patterns and Determinants of Purchase

(very provisional, initial results!)

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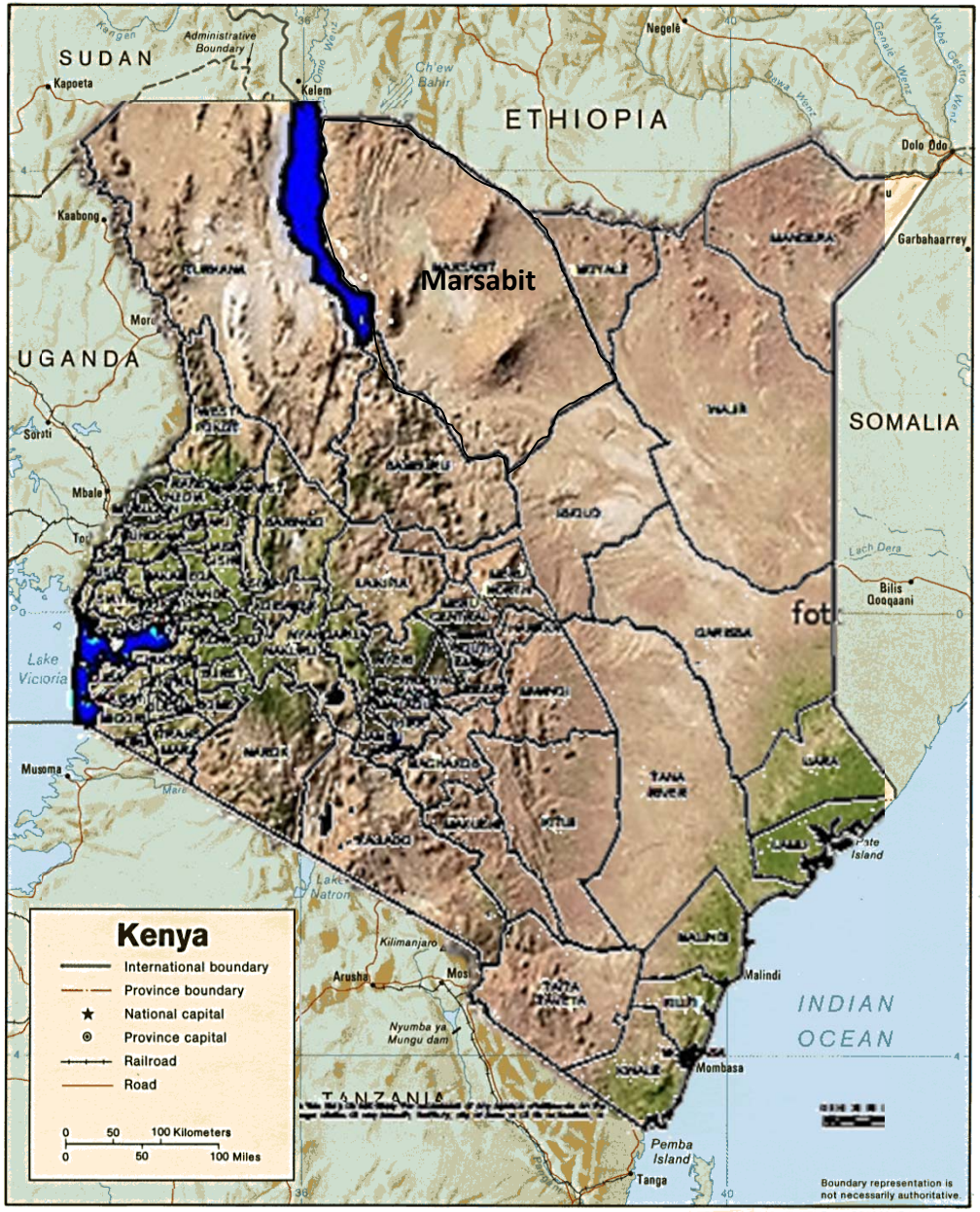
I4 Meetings, Rome

June 14, 2012

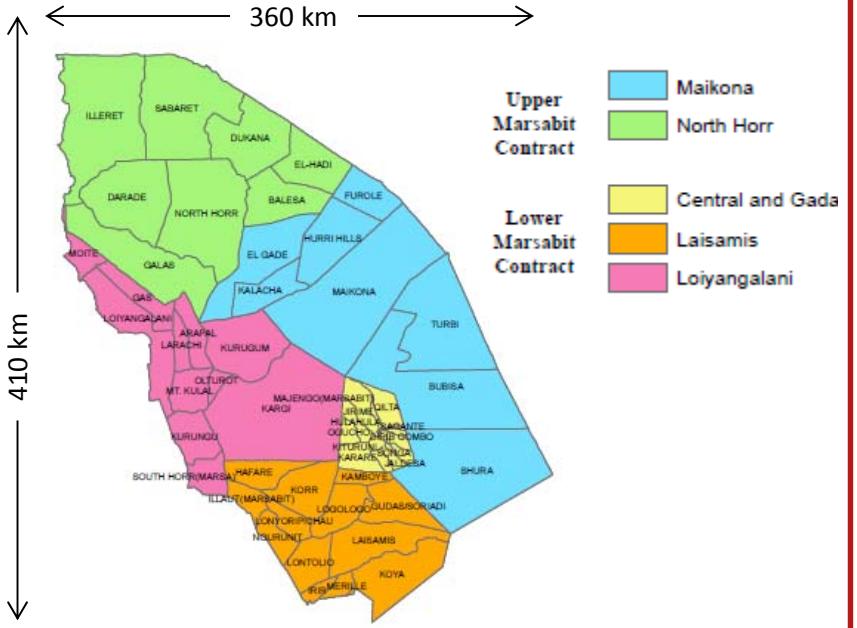
ASAL, Pastoralists and Vulnerability

- Arid and semi-arid lands (ASAL) cover ~ 2/3 of Africa, home to ~20mn pastoralists, who rely on extensive livestock grazing
- ASAL residents confront harsh and volatile environments
- Livelihoods are primarily transhumant pastoralism
- Pastoralist systems are adapted to variable climate, but very vulnerable to severe drought events. Big herd losses cause humanitarian crises, such as the 2011 headline event in East Africa (esp. famine in parts of Somalia).

Study Area in Northern Kenya



➢ Marsabit District

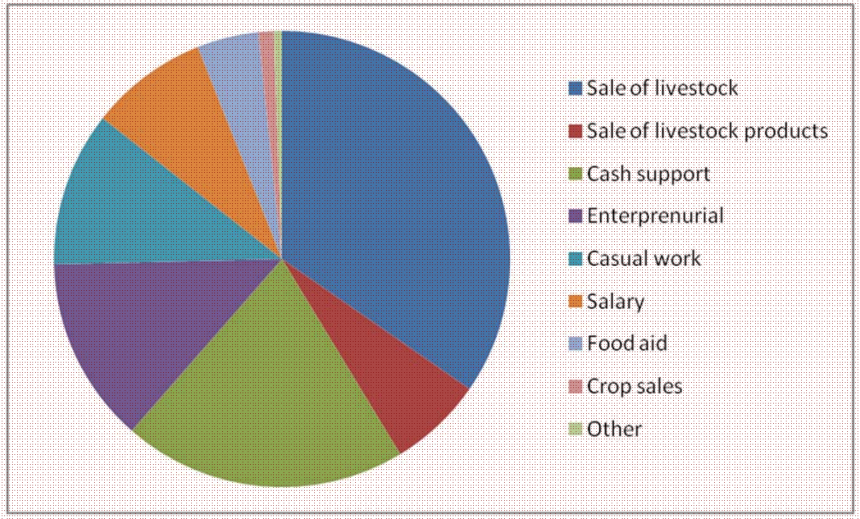


- Pop. 291,166, 0.75% of country, (2009 census)
- **Four main ethnic groups**
- **Two ecological/livelihood zones:**

  Upper: arid/pastoral
  Lower: semi-arid/agro-pastoral

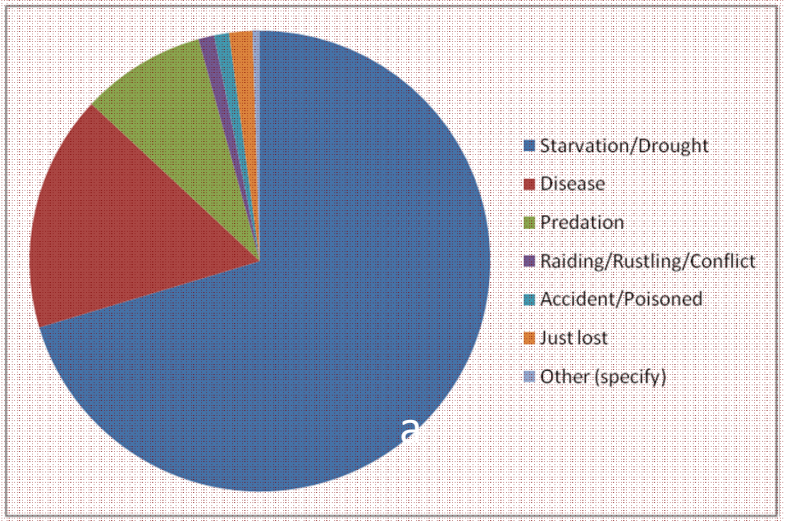
Northern Kenya: Context for IBLI

Component Shares of Income



- Sale of livestock and livestock products constitute 40% of household income
- External support (food and cash) make up nearly 25% of household income

Cause of Livestock Mortality



- Drought is by far the leading cause of livestock mortality
- Disease and Predation likely to be directly related to drought

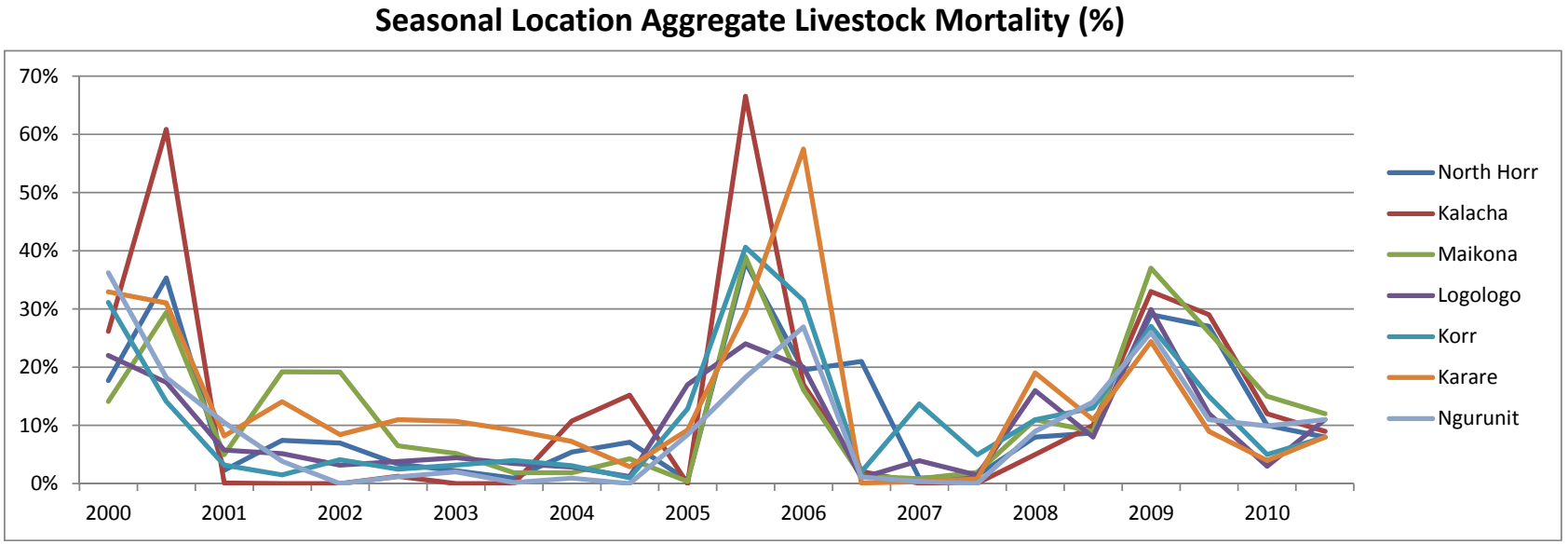
Livestock Share of Productive Assets (Median 100%, Mean 49%)

Data source: Project baseline 2009 (924 Marsabit Households)

Northern Kenya: Context for IBLI

➢ Risk of livestock losses based on ALRMP (2000-2010)

- Droughts are main cause of catastrophic livestock losses (≥20%)
- Livestock losses from droughts are highly covariate, in contrast to other, smaller, idiosyncratic shocks (predation, accident, disease, etc.) in other years



- Key drought years in sample: 2000, 2005-06, 2009
- Drought-related catastrophic herd losses are largely uninsured!

Designing the IBLI index

Need to find a reliable, objectively verifiable, covariate signal, θ_{ls}, that explains variation in household's seasonal livestock mortality

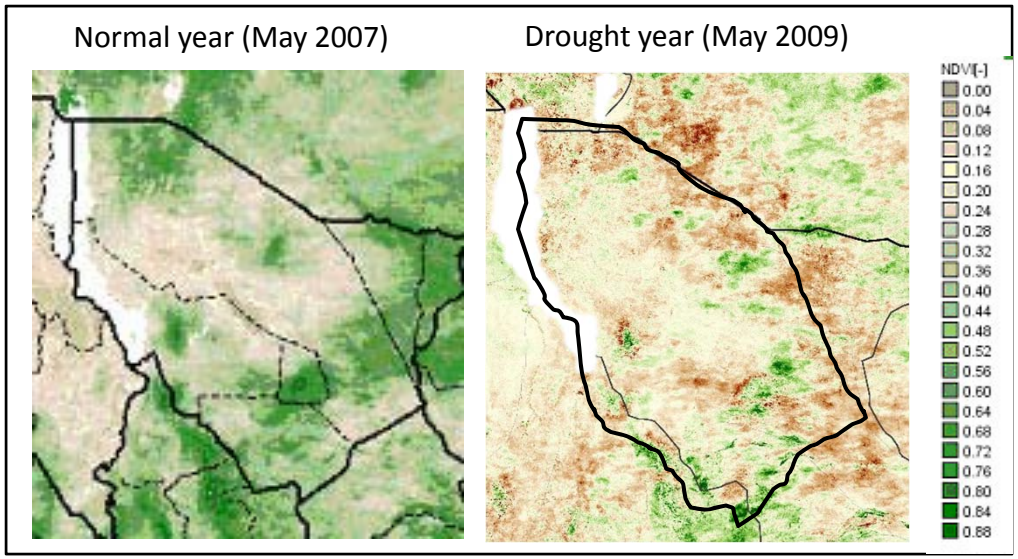
$$M_{ils} = M(\theta_{ls}) + \varphi_{ils}$$

DATA
- Livestock Mortality (ALRMP)
- NDVI (MODIS)

→ **Response Function** →

Index
- Predicted Livestock Mortality

Normalized difference vegetation index (NDVI) from MODIS sensor

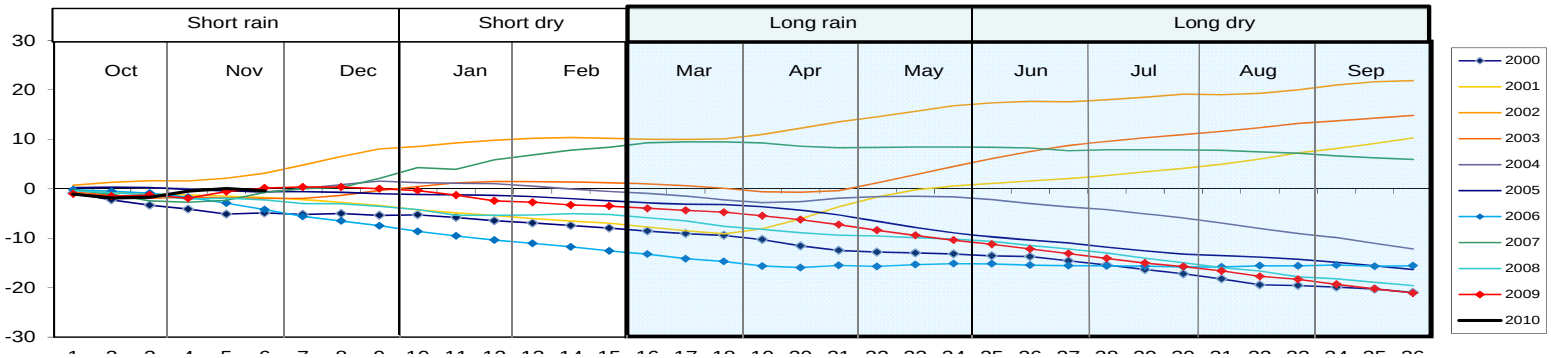


- **Indication of availability of vegetation over rangelands** (reflecting joint state of weather realizations and stocking rates)
- **Spatiotemporally rich** (1x1 km² resolution, available in near-real time every 16 days from 2001- present)

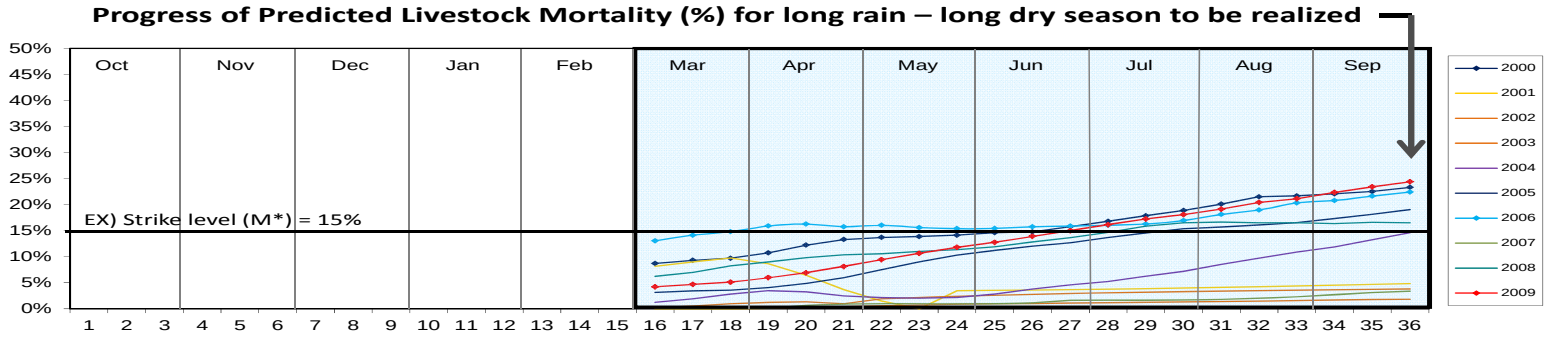
Designing the IBLI index

- Transform cumulative standardized NDVI (czndvi) into predicted livestock loss index that triggers indemnity (Chantarat et al. forthcoming, *J.Risk & Insurance*)
- **Regime switching model** for zone-specific, seasonal mortality prediction:

$$M_{ls} = \begin{cases} M_1\big(X(ndvi_{ls})\big) + \varepsilon_{1ls} & if\ Czndvi\_pos_{ls} \geq \gamma \quad (good\ climate\ regime) \\ M_2\big(X(ndvi_{ls})\big) + \varepsilon_{2ls} & if\ Czndvi\_pos_{ls} < \gamma \quad (bad\ climate\ regime) \end{cases}$$



- **Predicted seasonal mortality index** that determines IBLI payout



Key Contract Features

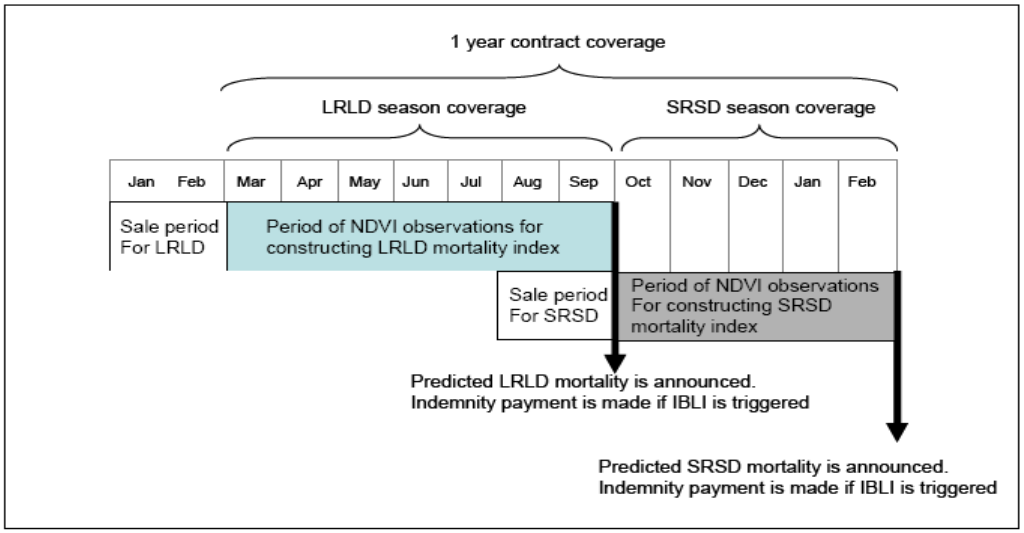
SPATIAL COVERAGE

How wide a geographic area can/should a single index-cover?

- **Two Separate NDVI-Livestock Mortality Response Functions**
- **Five Separate Index Coverage Regions**

TEMPORAL COVERAGE

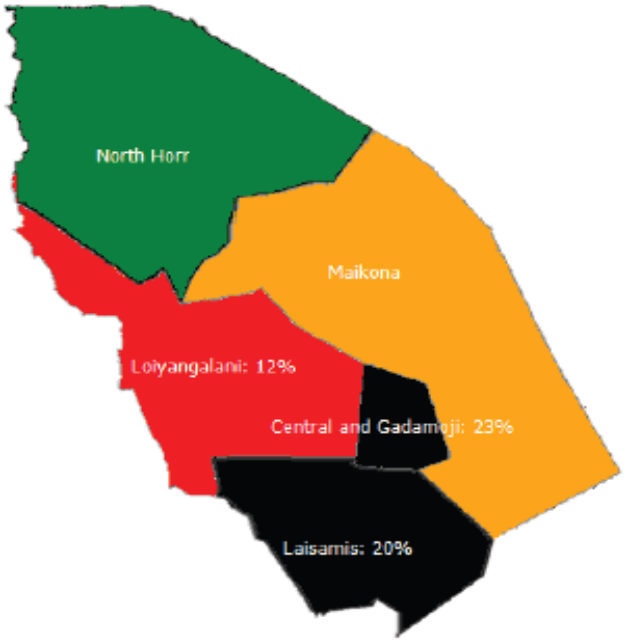
- Over what time span should an index cover?



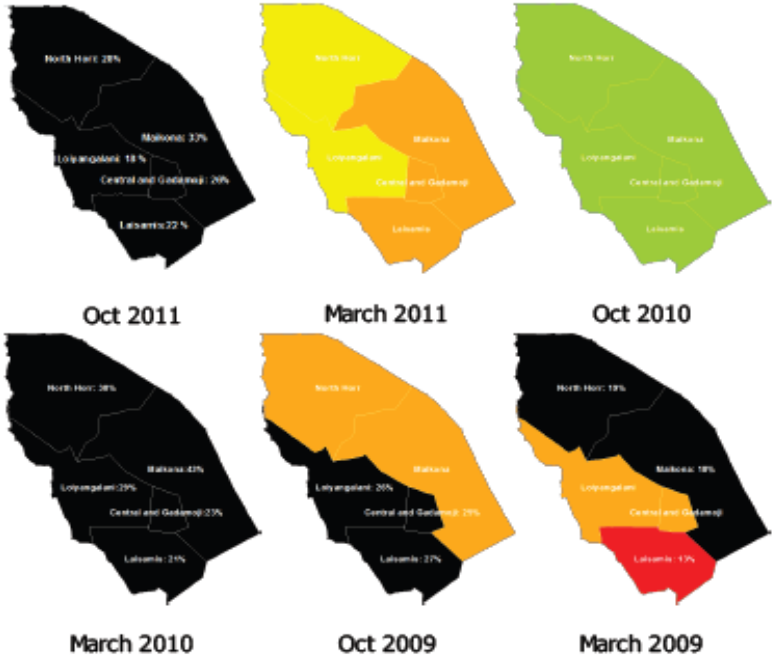
Predicted Mortality Index Readings

Green	**Good Regime Stable:** Here, the division in question is within a good regime and is characterized as stable. This means that the forage conditions are above normal and are either improving or at least have not worsened over two consecutive months. Index readings do not relate to livestock mortality due to forage scarcity.
Yellow	**Good Regime Worsening:** While the division in question is characterized by better than average forage cover over the past year, the situation has been consistently worsening within the past two months (that is to say that the past two months the forage situation has been lower than the long run average). Index readings do not relate to livestock mortality due to forage scarcity.
Orange	**Bad Regime Moderate:** The sum of forage available over the past year has dropped below the long-run average. However, while the division in question is under considerable stress, the model **predicts less than 10% average livestock mortality**. At these levels the model is not as accurate in predicting losses as they are not yet widespread.
Red	**Bad Regime Accute:** Average livestock deaths predicted to be **between 10 and 15%**. At this level, model predictions become more precise. The situation is quite serious but not yet classified as severe. Indemnity payout will not be triggered and individuals are expected to cater to this level of losses.
Black	**Bad Regime Severe:** The drought is now severe. Forage scarcity has been pronounced over a long period and greater than 15% of livestock in the area are predicted to have died. Indemnity payout will be triggered if conditions persist throughout the season up to the potential payout period.

Index reading for Marsabit: 18 Feb 2012 - 4 Mar 2012



Previous Index readings for Marsabit



Impact Evaluation: Two-Way Stratification

- **Site selection: 16 locations**

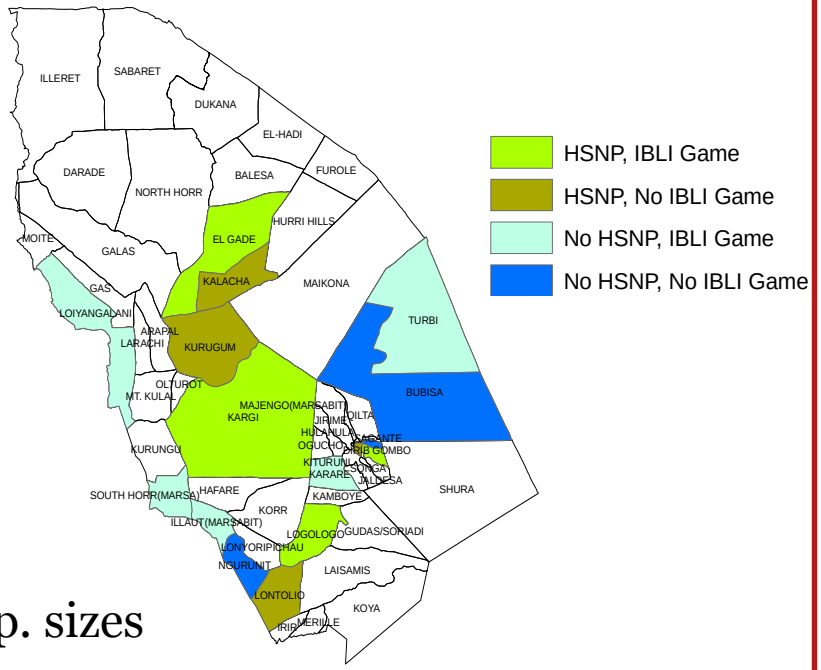
  Confounding factor: ongoing implementation of cash transfer (HSNP)

  - Randomly select 50% from locations with and without HSNP

  Encouragement design

  - Insurance education game: played among 50% sample in game site
  - Discount coupon for 1st 15 TLU insured: (no subsidy for 40% of sample, 10%-60% subsidies for the rest)

	IBLI Game	No IBLI Game
HSNP	4 sites	4 sites
No HSNP	4 sites	4 control sites



- **Sample selection: 924 households**
  - Sample/site proportional to relative pop. sizes
  - For each site, random sampling stratified by livestock wealth class (L, M, H)

Determinants of IBLI Demand

➢ Research Question

- What are the determinants of household demand for IBLI? (price sensitivity, wealth, herd size, education, product understanding, risk aversion, credit access, livelihood diversification, trust…)

➢ Existing Literature

Authors	Product	Results
Bryan 2010	Insured loan Malawi	Uptake ↓ ambiguity aversion
Cole et al. 2010	Rainfall Insurance India	Uptake ↑ literacy and trust, ↓ price, credit constraints
Cole et al. 2007	Rainfall Insurance India	Uptake ↑ wealth, edu, risk aversion, ↓ price
Gine et al. 2008	Rainfall Insurance India	Uptake ↑ wealth, trust, ↓ risk aversion, credit constraints
Gine and Yang 2007	Insured loan Malawi	Lower uptake of insured loan than loan
Hill et al. 2011	Rainfall Insurance Ethiopia	Uptake ↑ edu, wealth, ↓ risk aversion

➢ New (?) Contributions to Existing Literature

- Considering asset risk while prior products concern income risk
- Basis risk controls; hypotheses of spatial and intertemporal adverse selection
- Setting is characterized by non-convex asset accumulation dynamics (which could determine household's valuation of IBLI, Chantarat et al. working paper)

Data and Key Variables

- **Baseline Data (Collected Oct/Nov 2009 prior to first IBLI sales in Jan 2010)**

Unless otherwise specified the baseline is the source of all explanatory variables

Bought IBLI	Dependent Variable Probit Model Sourced from Round 2 (Oct/Nov 2010) survey, verified by administrative data. (Dummy =1 if household indicates that they purchased IBLI in Jan/Feb 2010)
Ln(tluIBLI)	Dependent Variable Linear Model Sourced from Round 2 self-reported number and type of livestock insured verified by administrative data
Effective Price	Price net of premium discount for those who received discount coupons. Administrative data used to match households with the receipt and value of discount coupon . Unit: percent insured value paid as premium.
TLU drought mortality (LRLD SRSD)	Seasonal drought-related TLU mortality rate (LRLD – Mar09-Sept09), (SRSD – Oct08-Feb09). Focused on mortality resulting from drought/starvation. Denominator is max of beginning season or end season mortality.
TLU drought mortality z score sq (LRLD SRSD)	(individual mortality – location mean mortality)/(location SD mortality) (squared)
Relative TLU drought mortality (LRLD SRSD)	= 1 if individual mortality is greater than location-level mean mortality
Know IBLI	Index of IBLI knowledge adding correct answers from 4 related questions in Round 2 survey. 1 point was given to correct answers for each of the following multiple-choice questions: Based on your understanding of IBLI, 1) How often do you have to pay a premium to remain reinsured? 2) when do you expect compensation? 3) what does compensation depend on,?4) do you expect your premium to be returned if you do not get compensated?
Played Game	=1 if household was selected to play the insurance game. Administrative data on game households used to identified treated households.
Expected Loss	Respondent's subjective expected herd mortality (%) rate for the 2009-2010 SRSD and LRLD coupled seasons

Result 1: Determinants of IBLI Purchase

Probit Estimates	
hhsize	0.014*
headage	0.003
headagesq	0
headsex	-0.049
respondantsex	0.055
gradeattain	-0.01
daycons_percap	0
index	-0.001
effectprice	-4.729***
receivediscoupon	0.212***
lstockincshare	-0.069
lslivelihood	-0.065*
tlu	-0.002*
tlu2	0
LRLDtludrghtmortality	0.036
SRSDtludrghtmortality	-0.586***
LRLDtludrghtmortzscoresq	-0.001
LRLDtludrghtmortrelational	-0.133***
SRSDtludrghtmortzscoresq	0.01**
SRSDtludrghtmortrelational	0.022
risktaking	0.139***
riskmoderate	0.148***
expectloss	0.242***
cashTLU10	0.021
hardloanlstock	0.131***
imploanlstock	0.06
receiveHSNP	0.024
playedgame	0.002
knowibli	0.026**
numinfosource	0.038***
numnetgroups	0.029
CENTRALDIV	-0.137**
LAISAMISDIV	0.02
LOIYANGALANIDIV	-0.181***

- **Price has expected strong effect. Discount coupon has a positive behavioral effect on purchase independent of its price discount.**
- **Basis risk impact: As expected households with higher than mean (LRLD) mortality less likely to purchase.**
- **Risk preferences: Increased appetite for risk increases probability of purchase. Innovators' characteristic or indications of a lottery?**
- **Intertemporal Adverse Selection: More likely to purchase as expectation of future mortality loss increases.**
- **Knowledge: Better understanding of product associated with uptake. But, other than impact on knowledge, playing extension game has no effect.**
- **Spatial Adverse Selection: Three divisions of Lower Marsabit face same market price of 3.25% but have different historical burn rates (Central 1.4%, Laisamis 2.9%, Loiyangalani 1.7%). Patterns of uptake consistent with spatial adverse selection, not with marketing-based or other differences (lower uptake in Central and Loiyangalani relative to Laisamis).**

Pseudo R^2	0.469

Result 2: IBLI Demand Elasticity Estimates

Dep var : ln (total TLU insured)	
lneffectprice	-0.7064***
lnmonthpcincome	0.0823
tlu	0.0146**
tlu2	-0.0002*
receivediscoupon	0.2734**
knowibli	0.0104
receiveHSNP	0.0981
cashTLU10	0.3608**
CENTRALDIV	0.4574**
LAISAMISDIV	-0.0522
LOIYANGALANIDIV	-0.5316***
_cons	-2.7105***
r^2	0.404
N	221

- Demand seems relatively price inelastic (surprisingly).
- Considerable and statistically significant behavioral effect of discount coupon receipt, independent of price
- Financial liquidity: measured as a dummy = 1 if household indicates sufficient cash savings to purchase 10 TLU worth of IBLI, matters to quantity demanded. But cash transfer (HSNP) receipts do not.
- Herd size: very modest increase up to ~mean+1 SD. Only weakly consistent w/ poverty trap hyp.
- No effect of knowledge of IBLI, nor of income

Provisional Summary Findings

Demand for IBLI in Marsabit, Kenya pilot appears:

- **Reinforce prior index insurance studies' findings on:**
  - price effects (price inelastic demand)
  - risk preference effects
  - wealth effects
  - financial liquidity effects

- **More novel:**
  - behavioral effects from promotional coupons but not from game exposure
  - associated with superior understanding of product
  - negatively associated with a proxy for basis risk
  - perhaps some intertemporal and spatial adverse selection

Thank you for your time, interest and comments!

Variable Labels

VARIABLE	LABEL	VARIABLE	LABEL
boughtIBLI	=1 if hh purchased IBLI as per R2 survey	**LRLDtludrghtmortality**	LRLD TLU drought mortality
hhsize	Household size	**LRLDtludrghtmortzsq**	LRLD location level tlu drought mortality z score squared
headage	age of household head	**LRLDtludrghtmortrelational**	=1 if LRLD TLU mortality is greater than location level mean
headsex	gender of household head (=1 if female)	**SRSDtludrghtmortality**	sRSD TLU drought mortality
respondantsex	gender of survey respondent (=1 if female)	**SRSDtludrghtmortzsq**	SRSD location level tlu drought mortality z score squared
gradeattain	Highest grade attained by household head	**SRSDtludrghtmortrelational**	=1 if SRSD TLU mortality is greater than location level mean
dayconPC	Daily per capita consumption (in KSH)	**risktaking**	=1 if risk aversion from preference game indicates either slight or neutral aversion to risk
asset index	Asset index from first PC	**riskmoderate**	=1 if risk aversion from preference game indicates either intermediate or moderate aversion to risk
effectprice	Effective price taking into account the value of discount received (if any)	**expectloss**	expectation of future livestock loss.
receivediscoupon	Whether you received a discount coupon for IBLI as per R2 survey	**cashTLU10**	=1 if cashsavings sufficient to purchase 10TLU of insurance
lstockincshare	fraction of annual income representated by sales of livestock and livestock products	**hardloanlstock**	=1 if chances of getting loan for restocking are deemed quite difficult to difficult
lslivelihood	=1 if hh head's primary economic activity is herding of livestock.	**imploanlstock**	=1 if chances of getting loan for restocking are deemed impossible
tlu	TLU standardized livestock owned at R1 survey period in Sept 09	**receiveHSNP**	=1 if household member is HSNP program recipient
CENTRALDIV	=1 if household located in Central Division	**playedgame**	=1 if member of the household played the IBLI game
LAISAMISDIV	=1 if household located in Laisamis Division	**knowibli**	Index of IBLI knowledge adding correct answers from 4 IBLI featured (R2 survey)
LOIYANGALANIDIV	=1 if household located in Loiyangalani Division	**numinfosource**	Number of sources from which they heard about IBLI as per R2 survey
		numnetgroups	Total number of social network groups members of households are involved in (R2 survey)

Summary Statistics

variable	mean	sd	min	max
boughtIBLI	0.272	0.445	0	1
hhsize	5.571	2.353	1	14
headage	47.888	18.329	18	98
headsex	0.371	0.483	0	1
respondantsex	0.746	0.436	0	1
gradeattain	1.121	3.091	0	13
dayconPC	53.969	107.015	6.610	3032.146
asset index	0.000	1.000	-0.945	6.664
effectprice	0.031	0.012	0.013	0.055
receivediscoupon	0.325	0.468	0	1
lstockincshare	0.419	0.395	0	1
lslivelihood	0.447	0.497	0	1
tlu	16.125	24.534	0	361.143
CENTRALDIV	0.239	0.427	0	1
LAISAMISDIV	0.219	0.414	0	1
LOIYANGALANIDIV	0.249	0.433	0	1

variable	mean	sd	min	max
LRLDtludrghtmortality	0.280	0.280	0	1.778
LRLDtludrghtmortzsq	0.985	1.712	0.000	15.023
LRLDtludrghtmortrelational	0.452	0.498	0	1
SRSDtludrghtmortality	0.063	0.221	0	3.560
SRSDtludrghtmortzsq	0.987	4.313	4.99E-06	64.872
SRSDtludrghtmortrelational	0.291	0.455	0.000	1
risktaking	0.290	0.454	0	1
riskmoderate	0.440	0.497	0	1
expectloss	0.352	0.182	0.05	0.95
cashTLU10	0.084	0.278	0	1
hardloanlstock	0.459	0.499	0	1
imploanlstock	0.380	0.486	0	1
receiveHSNP	0.183	0.387	0	1
playedgame	0.297	0.457	0	1
knowibli	1.512	1.344	0	4
numinfosource	2.036	1.699	0	9
numnetgroups	0.550	0.823	0	6