INDEX-BASED LIVESTOCK INSURANCE: PROTECTING PASTORALISTS FROM DROUGHT-RELATED LIVESTOCK LOSSES

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Andrew Mude received a Ph.D. in economics (with concentrations in development economics and applied econometrics) from Cornell University (in the United States) and is currently lead scientist and project leader for the Index-Based Livestock Insurance program at the International Livestock Research Institute, based in Nairobi, Kenya. Dr. Mude's current portfolio focuses on issues of resilience and vulnerability amongst poor livestock-dependent households, particularly in pastoral areas.

ABSTRACT

This paper describes the design, logic and implementation of an award-winning innovation in the provision of formal insurance to help drought-vulnerable livestock keepers manage the risk of widespread livestock mortality. Much of the Horn of Africa is Arid and Semi-Arid lands (ASALs) populated by pastoralists. These are among the most vulnerable populations in the region as their livestock-dominated livelihoods are constantly threatened by increasingly severe droughts that has made the boom-and-bust dynamic a constant feature of their production systems.

To help these populations better manage the risk of drought-related livestock losses, a pilot index-based livestock insurance (IBLI) product was launched in January 2010 in Marsabit District of Northern Kenya. Index-based insurance products represent a promising and exciting innovation for managing the climate related risks that vulnerable households face (www.ilri.org/ibli). This IBLI product has many innovative features. It appears to be the first to develop the index insurance product from longitudinal household data so as to minimize basis risk in product design. It is one of the first developed to protect the productive asset holdings of the poor and vulnerable rather than just their income streams. It is one of the first to be based on more spatially distributed remotely-sensed vegetation data, rather than rainfall series from a sparse set of fixed point meteorological stations, as the IBLI index is derived from satellite-based normalized differenced vegetation index (NDVI) series that summarize the state of rangeland forage availability at high spatiotemporal resolution. Finally, IBLI Marsabit was designed to complement a new (unconditional) cash transfer program (the Hunger Safety Nets Program, HSNP) the government launched in the area and the IBLI impact evaluation design explicitly enables identification of the independent and synergistic effects of HSNP and IBLI as alternative means of addressing the risk and financing constraints faced by the poor.

This paper will discuss the process of identifying, developing and implementing the IBLI project. We shall highlight the design methodology of the insurance index, describe its key features and how it relates to the risk profile and production system it seeks to manage. The paper will also touch on the determinants of uptake and initial impact assessment results that are being generated. The paper will make use of the comprehensive project panel data based on annual household surveys launched in October 2009. Aimed at allowing for rigorous analysis of demand and impact assessment, the data employs an encouragement sampling design made up of differential access to insurance educational extension (in the form of an experimental insurance game, which allows players to learn the mechanics and value of IBLI) and discount coupons that, in varying the effective price of insurance, allows the estimation of a demand curve and the relevant price elasticities.

The paper will tease out the implications of the analysis and the insights gained from implementation and draw out recommendations to guide efforts at scaling up the IBLI project as well as improving client targeting and the design of the product. Understanding the impact of various determinants will help identify effective approaches to catalyzing demand; including the appropriate pricing strategy. This quantitative assessment will be supplemented by the results of various qualitative interactions with clients, their representatives and various stakeholders in the area to help develop context and draw insights to explain some of the analytical findings.

KEYWORDS

Drought risk management, index insurance, pastoralists, livestock mortality, vegetation index

Index-Based Livestock Insurance

Protecting Pastoralists Against Drought-Related Livestock Mortality

ILRI

International Livestock Research Institute

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JIRCAS: November 28 2012

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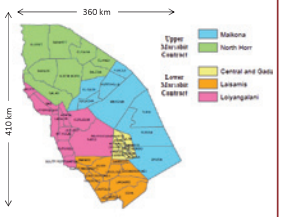
Initial Study/Pilot Area: Marsabit District in Northern

- Focus on Marsabit District



- Pop. 291,166, 0.75% of country, 83% are pastoralists (census 09)
- **Four main ethnic majorities**
- **Two ecological/livelihood zones**:
  Upper: arid/pastoral
  Lower: semi-arid/agro-pastoral

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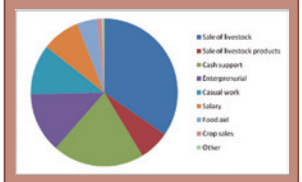
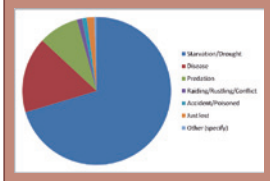
Motivating IBLI: Centrality of Livestock Economy and Risk Profile

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)

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Index-Based Livestock Insurance

- An innovative insurance scheme designed to protect pastoralists against the risk of drought related livestock deaths
- Based on satellite data on forage availability- NDVI , this insurance pays out when forage scarcity is predicted to cause livestock deaths in an area.

DATA
- Livestock Mortality
- Remotely-Sensed NDVI

→ **Response Function** →

Index
- Predicted Livestock Mortality

IBLI PILOT

- First launched in Northern Kenya in Jan 2010.
- Ethiopia pilot launched in Southern Ethiopia in Aug 2012.

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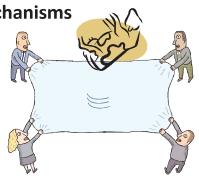
Why IBLI? Social and Economic Welfare Potential

➢ An effective IBLI program can:

- **Prevent downward slide of vulnerable populations**
- **Stabilize expectations & crowd-in investment by the poor**
- **Induce financial deepening by crowding-in credit S & D**
- **Reinforce existing social insurance mechanisms**



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Contract Design: From Theory to Practice

➢ **Prerequisites for a Suitable Index-Insurance Product**:

1. DEFINING THE RISK
   - Area-based product → the risk must be covariate in nature
   - Risk must be quantifiable and predictable
   - Risk must be 'indexable'
2. IDENTIFYING THE INDEX
   - Index is a single-valued, specific measure associated with insured-risk upon which payment decisions are made
   - Must be: i) Easy to Measure, ii) Precise Indicator of Insurable Risk, iii) Cannot be Easily Manipulated iv) Consistently Available

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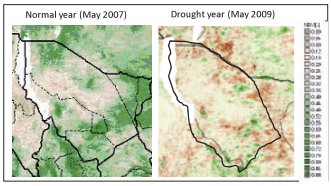
Contract Design

3. DESIGNING THE INDEX

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

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

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 km^2 resolution, available in near-real time every 16 days from 2001- present)

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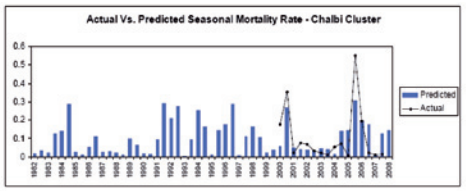
Contract Design

4. TESTING INDEX PERFORMACE

- Minimizing "BASIS Risk":
- How well does the index correspond to the outcome it is measuring?
- How well does the index correspond to individual outcomes?



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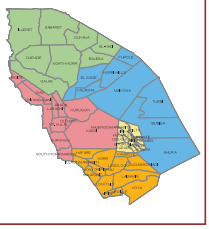
Contract Design

5. CONTRACT FEATURES: SPATIAL COVERAGE

- How wide a geographic area can a single index-cover?
  - What is the spatial precision range of the response function?
  - At what level of resolution is the necessary data available?
  - Administrational considerations

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



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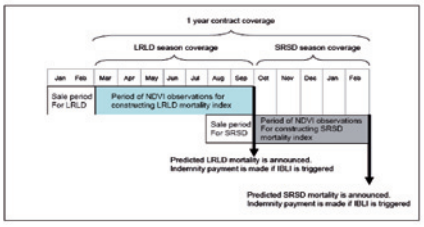
Contract Design

6. CONTRACT FEATURES: TEMPORAL COVERAGE

- Over what time span should an index cover?
  - Function of the production system/risk profile being modelled
  - Administrational considerations



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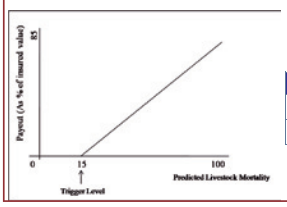
Contract Design

7. CONTRACT FEATURES: RISK COVERAGE AND PRICING

- Need to select an index strike point to trigger indemnity?
  - Trade off: Higher Strike → Lower Risk Coverage → Lower Cost
  - Conditional or Unconditional?
  - Payoff structure: Linear, Segmented, All or nothing, No claims bonus?



Contract Cluster	Consumer Price
Upper Marsabit	5.5%
Lower Marsabit	3.25%

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Determinants of IBLI Success

1) DEMONSTRATE WELFARE IMPACTS

(Based on anticipated behavioral changes after receipt of Oct 2011 payments. 24% of 924 households insured)

	Insured		Uninsured		Impact
	Qtr 3	*Qtr 4*	*Qtr 3*	*Qtr 4*	DD'
Reduce the number of meals eaten each day	60	35	75	71	-22***
Rely more on food aid	88	50	91	92	-38***
Rely on assistance from others	39	22	40	41	-18***
Pull children otherwise in school, out of school	9.7	8.0	10	8.9	-0.4
Sell livestock	39	18	28	32	-25***
Increase non-livestock activities like petty trade	26	25	23	28	-6.2
Send family members to look for work elsewhere	3.5	4.9	5.7	8.3	-1.2
Did not do anything different	24	8.8	20	16	-13***

- **33% drop in households employing hunger strategies (with severe long-term consequences for the young)**
- **50% drop in distress sales of assets**
- **33% drop in food aid reliance (aid traps)**

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Determinants of IBLI Success

2) Demonstrate long-term sustainability

Jan/Feb 2010: 1974 Contracts Sold	Average	Total	Max	Min
Total Livestock Units (Sales)	3	5965	60	0.2
Premiums Paid ($)	23.6	46602	550	1.3
Jan/Feb 2011: 595 Contracts Sold	Average	Total	Max	Min
Total Livestock Units (Sales)	2.1	1229	20	0.1
Premiums Paid ($)	15.2	9033	165	1.1
Aug/Sept 2011: 509 Contracs Sold	Average	Total	Max	Min
Total Livestock Units (Sales)	1.6	836	100	0.1
Premiums Paid ($)	12.1	6122	650	0.7
Aug/Sept 2012: 219 Contracts Sold	Average	Total	Max	Min
Total Livestock Units (Sales)	1.9	413	10.75	0.1
Premiums Paid ($)	14.4	3150	154	0.7

- Team has identified several remediable explanations for the drop in sales including premature push for commercial sustainability
- Public support motivated by development objectives can catalyze commercial market.

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The IBLI Research and Development Agenda

Going forward, IBLI seeks to build on the success, and lessons, of the initial pilot phase with a comprehensive 4-pronged strategy.

Overarching Goal:

- To enhance livelihoods and reduce the vulnerability of pastoral populations.

Specific Project Purpose:

- Generate a critical mass of informed pastoralists purchasing IBLI products that are mediated by a capacitated insurance industry within a supportive policy and institutional environment.

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The IBLI Research and Development Agenda

1) Assessments of the behavioral change and welfare impacts of IBLI.

2) Development of institutions and capacities necessary to provide sustainable IBLI services across the industry

3) Improving precision and accuracy of IBLI contracts and designing contracts for all of Northern Kenya.

4) Developing Meso and Macro Level Index-Based Risk Transfer Products.

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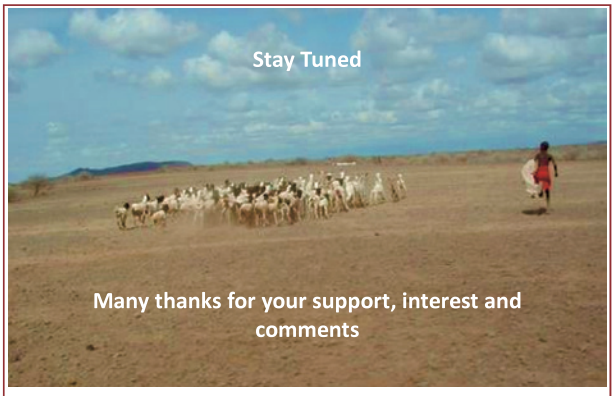

For related information, visit www.ilri.org/ibli

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Chairman Dr. Tomoyuki Kawashima: Let me introduce the third presenter, Dr. Andrew Mude. Dr. Andrew Mude has a Ph.D. in economics from Cornell University and he is Lead Scientist and Project Leader for the index-based livestock insurance program at the International Livestock Research Institute (ILRI), based in Nairobi. He is going to show his activities in ILRI.

Dr. Andrew Mude: Thank you very much, Chair. Good afternoon ladies and gentlemen. I would first like to thank JIRCAS very much for giving me the honor of an invitation to give this presentation.

We have been talking today about the importance of resilience and particularly also trying to bring together new technologies, so using technology to help improve resilience. The project that I'm working on, index-based livestock insurance, is actually an attempt to design a new technology, and also to implement it and assess its impacts, to help protect pastoralists against drought-based livestock mortality. So I should also thank Junichi the previous speaker, who has helped me quite a bit by setting up the context, because he also works with pastoralists and one of his project sites is in Marsabit, which is the initial site where we began studying the conditions in 2008 that resulted in our design of this product and its launch in January 2010. You know a bit about Marsabit. It is in northern Kenya; it is a very arid area, and it is an area in which the Pastoral production system dominates.

Why do we have index-based livestock insurance? What are the conditions that it is trying to cover? What you need to have first is an understanding of the importance of the livestock economy in the area, and also a bit of its risk profile. First of all, the shares of income. This is based on a household survey that we conducted in Marsabit in 2009, which was the baseline. We have been following these 924 households every year since then, so we have a four-year panel.

This pie chart shows the component shares of income. Here in blue is the sale of livestock and in red is sale of livestock products like milk and hides and so on. You can see that for this population, livestock and livestock products contribute 40% of household income. So that is a really big proportion of the income coming from those two aspects. Just to also put it in context, you find that external support in these communities in the form of food aid and cash also constitute nearly 25% of household income. So these are relatively poor communities which require a lot of external support, largely in the form of food and cash aid.

Livestock is very important to income, but livestock is also the key productive asset in the area. By productive asset we are talking about those assets that will help to build the wealth of the households, so of course livestock. We are not really talking about their homes or their huts, but if they have shops or if they have vehicles that are useful productive endeavor, if they have any farming equipment and so on. You can find that for the mean household, the livestock share of productive assets is 49%, but for the median household. It is 100%. So livestock is very critical in this economy.

What are the threats to livestock? Livestock mortality is a key source of vulnerability in the area. You find that here in blue, drought contributes almost 70% of livestock mortality. In red is the incidence of mortality caused by disease and predation. Disease is likely to increase during times of drought, because the livestock are weak and their immune systems are negatively affected.

So this is the context in which we designed this product known as index-based livestock insurance. I imagine that you are all familiar with traditional insurance that is used for assets such as your house, your car, or even your health. The idea is basically to take this concept, but to redesign it in a form that is suitable for an area such as Marsabit. The insurance product covers drought-related livestock mortality, as I have explained. Basically, how and index-based product works, which is an innovation in insurance is that the indemnity is not paid to an individual. The indemnity is based on an index that proxies or is related to the underlying risk that you are trying to cover, but is based on the geographical average of the area of interest. I will explain more.

In designing this index, we used satellite-based readings of forage availability on the ground and we matched those up with livestock mortality data that has been collected in the region by the government from 2000. Every month a select number of households in the area were surveyed. So we used to that livestock mortality data with a remotely sensed Normalized Difference Vegetation Index (NDVI). You calibrate an empirical relationship, which we are calling the response function, and from that you are able to predict area average livestock mortality. When you get that area average livestock mortality, that is the index upon which insurance is written.

As I mentioned earlier, we first launched a commercial product that was mediated through the market by local insurance companies in Kenya and also reinsured by Swiss Re which is one of the world's largest reinsurance companies. It was first launched in January 2010 in northern Kenya, and we have also been working in southern Ethiopia and launched a product this August 2012.

Why do we have this program? Why do we hypothesize that in such a system, an insurance program could be beneficial? First, it can prevent the downward slide of vulnerable populations into poverty. By this I mean that there is a lots of research that has been done in the area, some of it by some of my own colleagues that shows the presence of what we call "asset-based poverty traps" and what this means is that, given that the Pastoral production system and the way that they migrate from place to place, if you fall below a certain threshold, estimated to be an average of 10 livestock units, you begin to then enter a decumulation trajectory, because you are forced to sedentarize and you do not have access to forage and water and you fall into a low-level equilibrium. The idea is that perhaps insurance can compensate people to ensure that they keep above the threshold and keep a viable size of herds. There is also the idea of stabilizing expectations and encouraging the investments of the poor. What this means is that when you have one of your key assets that is very volatile, the incentives to invest might be a lot less than if you reduce the risks associated with this. Further, it can be hypothesized that it can induce financial deepening by crowding in-credit supply and demand, and basically this is by insurance reducing the risk of an asset as insurance will do, which increases the collateral value of that asset, and so it is possible that banks and other financial institutions in that area can offer credit on the basis of that collateralized insurance.

So how do we design this product? Well, first of all, you have got to define the risk. I already talked about that; the risk is drought-related livestock mortality. But the risk has to be a particular type of risk, and it has to be a risk that is covariant in nature. And what this means is when the risk heads a particular area, most of the people in the area are affected in a similar way. This is because the index indicates the average condition. So if the average condition is covariant then it is unlikely to be experienced by most people. Then of course it needs to be a risk that can be predicted, so that it can be modeled and we can predict livestock mortality in an area. And the index itself has to have a certain qualities. It needs to be a specific measure that can be highly associated with the risk. The reason why in the pastoral production system, we can use these satellite-based measures of forage is a good predictor of livestock mortality is because in that system you do not have much supplementation. The livestock gets almost 100% of its nutrition from the forage, of which satellites are capturing their condition. Also, the index must be easy to measure; it should not be manipulated by either the individual getting insurance or the insurance company, and satellites are certainly not manipulable by either of those two parties. Satellite data is consistently available and freely available on the Internet at high levels of resolution.

So, how do we design the index? I think I've already talked about this, but this graphic at the bottom shows you the data that we are using. It is the NDVI from a sensor which is a satellite of the US National Oceanic and Atmospheric Agency. You can see that in normal years, such as in May 2007, it looks quite green, while in drought years. It looks very brown. That is the data that we are using and it is the signal that we use to predict livestock mortality based on how liberated empirical relationship.

The index or the insurance is only as good as its performance. So one of the issues with index-based insurance is what is called basis risk, which defines the difference between the index and the actual experience. If the index has predicted average mortality in an area, it is not necessarily the case, and in fact it is not likely to be the case

that everybody is experiencing the same average. So the wider the dispersion, the weaker the product. That is why I said earlier, it is important for index insurance products that the risk you are trying to insure is highly covariant.

This graph shows our data from 2000 to 2010. There are no black you see what the actual livestock mortality experienced in this particular area is, and the blue is the predicted. We can predict all the way from 1982, because we have satellite data available from 1982. You see, quite a high level of correlation between the predicted and the actual data.

Once you have designed the product, in order to sell it on the ground. There are certain key contract features that you need to identify. First is how wide of a geographic area can a single index cover? This is a map of the Marsabit District. Marsabit District is one of the largest districts in Kenya and so you can expect that the conditions of pastoralists living in this area will be quite a bit different from those in lower Marsabit. And actually, they are; up in this area in the blue and green that we are calling the upper cluster, you have mostly camels, goats and sheep, and it is a lot drier in this area. Here at the bottom it is mostly cows and a bit less dry or vulnerable to droughts. So we have to have two separate indices. We have got a response function for what we call the upper cluster and another response function for what we are calling this low cluster. And that is just a relationship. But even then, we have still broken it down into five different divisions. So in this area for the upper cluster, we take the average NDVI reading in this area and plug that into the response function to get predicted livestock index in North Horr which is this green area, and for blue we take the average of the index NDVI readings in this area known as Maikona and we use that using the same response function to predict livestock mortality in that area.

Another issue of the contract design is that you have to specify the temporal coverage. Junichi earlier mentioned that there are two rainy seasons in one the year in Marsabit. So these contracts are year-long contracts, but there are two selling Windows. There is a selling window in January/February, which is a dry season right before the beginning of the long rains. You want to do that because you want to make sure that an individual purchases the insurance before you see any signal of rain or so on or any signal of what the season might look like. If you purchase in January/February then you are covered all the way from March to February of the following year, and there are two potential payout periods: at the end of the long, dry season in September and at the end of the short dry season in February, where the insurance company looks at the index and pays out as a function of that.

Moving forward, what will determine if this product is successful or not? There are two things. One of the things that we think is most important is that it has to demonstrate some positive welfare impacts. This study that is just coming out was based on anticipated behavioral changes due to payments in October 2011. You have heard that there was a big drought in the area in 2011. In 2011 every single contract holder received payments because the contracts triggered. We wanted to know the difference between those who are insured and those who are not insured; what were the different impacts on the household? What you see here is for households who were insured there was a 33% reduction in their employment of hunger strategies, which is reducing the number of meals per day. We heard earlier that this is very important because it has severe long-term consequences. If you have to reduce the intake of important nutrients and so on, the child might have long-term developmental impacts. We also see, for example, a 33% drop in food aid reliance for those who have insurance, which means that the fiscal budget that goes to food aid in the area can be reduced.

The second determinant of the product is long-term sustainability. Ever since January 2010 when we had our first sale period, the number of contracts sold has been decreasing. At first the insurance company sold 1,974 contracts. This has gone down to 595 and just recently to 219 contracts. So why is this? There are many reasons that we have identified that can be remediated. But one of the reasons we feel is that as a project team, from the very beginning we gave the insurance company a lot of support, but we have been systematically reducing our report. The reason is that there is a lot of pressure for commercial sustainability. I think that pressure is premature, so I am in discussions with the donors and supporters in the government of Kenya to give us more time and to allow for more support in the system for us to be able to build sustainability long term. Because actually there are not

many instances of agricultural insurance around the world, whether developing or developed countries, that are 100% commercially sustainable. That is because there must be some other reason that the government considers it to be important for the provision of some kind of report. That is why we do this research, to look and see what the actual benefits are.

Going forward, the main purpose of the project is to generate a critical mass of informed pastoralists. This is very difficult and very important. The areas that we are talking about are areas that have the highest levels of illiteracy and innumeracy. Insurance is a new product so how do you ensure what they are buying before they buy it? But then also we want to make sure that this is mediated through the industry by a capacitated insurance industry. Right now most of the insurance companies in Kenya do not know how to design these products. This is a pilot so we have taken it upon ourselves as the team working on this to try to build capacity within the insurance industry and try to support the government with the development of agricultural insurance policies and under that index insurance policies, to help build the right kind of institutions.

Our research agenda is based on four pillars. One is to continue a rigorous assessment of the behavioral change and the welfare impacts that IBLI index-based livestock insurance has on a pastoral production system. The second is the development of institutions and capacities necessary to build the market and create an institutional support system. The third is improving the design of the contracts and scaling out beyond just Marsabit to other areas of northern Kenya and beyond just Marsabit to other areas in northern Kenya and beyond Borana where we work in southern Ethiopia to other areas there. The fourth is to try and look at a different type of contract. Right now the contracts that we are providing are for individuals at the household level. But it is also possible that such products could be designed for let us say, county governments or even international institutions like the world food program that are tasked to respond to emergencies because there is a lot difficulty even in raising the resources that come about during times of drought and famine, and if they have insurance contracts that are based on a method that can easily predict the instances of famine, then it could be a lots more cost effective for them.

Thank you very much for your attention.

Chairman: Thank you, Andrew for a very nice presentation.