Examining the Feasibility of Livestock Insurance in Mongolia

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Abstract

Herders in Mongolia have suffered tremendous losses in recent *dzud* (winter disasters) with mortality rates of over 50 percent of the livestock in some locales. This study examines the feasibility of offering insurance to compensate for animal deaths. Such an undertaking is challenging in any country. Mongolia offers even more challenges given the vast territory in which herders tend over 30 million animals. Traditional insurance approaches that insure individual animals are simply not workable. The opportunities for fraud and abuse are significant. Monitoring costs required to mitigate this behavior would be very high.

This study focuses on the potential for using the livestock mortality rate at a local level (e.g. the *sum* or rural district) as the basis for indemnifying herders. Applications of index insurance are growing around the world, although no country has so far implemented such insurance for livestock deaths. But few countries have such frequent and high rates of localized animal death as does Mongolia, and Mongolia is one of the few countries to perform an animal census every year. This concept may therefore be precisely what is needed to start a social livestock insurance program.

Just as importantly, the insurance that is used in Mongolia should not interfere with the exceptional efforts that experienced herders take to save animals during severe weather. Using an individual insurance may, in fact, diminish these efforts. Herders may ask, Why should I work so hard to save my animals if I will simply be compensated for those that are lost? Since the index insurance would pay all herders in the same region at the same rate, the incentives for management to mitigate livestock losses remain strong. No-one would reduce their effort to collect on insurance. Those who increase their efforts during a major event (*dzud*) would likely be compensated for this effort even though they do not lose livestock. In some cases, they could reasonably expect to receive payments that would compensate for the added effort or the added cost of trying to save their livestock.

Executive Summary

Herders in Mongolia have suffered tremendous losses in recent dzud with mortality values of over half of the animals in a number of sum. This study examines three alternatives to insure livestock deaths in Mongolia: 1) traditional livestock insurance that pays individual herders based on their specific losses; 2) weather insurance that would pay when weather events that are likely to create serious losses occur; and 3) index insurance that would pay when livestock mortality rates exceed certain thresholds by sum.

No approach will be easy and none offers the perfect answer. However, after careful analysis, mortality index insurance appears to offer the best choice. This recommendation is made with several key performance criteria in mind: 1) the insurance should not reward poor managers; 2) the insurance must be affordable by a large number of herders and others at risk when major livestock losses occur; 3) the insurance must be sustainable and profitable for emerging private insurance companies; 4) the first products should focus on the most significant covariant risk; 5) a proper role for government should be to foster development of risk sharing markets without imposing large social cost; and 6) the insurance should work in harmony with other initiatives, including the vast array of emergency assistance that is provided.

The mortality index insurance concept meets most of the performance criteria. In particular, since this insurance would pay all herders in the same sum or bag at the same rate, the incentives for management to mitigate livestock losses remain strong. Noone would reduce their effort to collect on insurance. Those who increase their efforts during a major event (dzud) would likely be compensated for this effort even though they do not lose livestock. In some cases, they could reasonably expect to receive payments that would compensate for the added effort or the added cost of trying to save their livestock.

The mortality index insurance would pay anytime the mortality rate (adult livestock deaths divided by the total census number of livestock in the area at the beginning of the year) exceeds a well specified threshold. The payment would be a function of the mortality rate times the amount of protection (or liability) purchased by the herder. This insurance is 1) simple; 2) largely free of the common problems of adverse selection and moral hazard; 3) easy to administer with low administrative cost; and 4) largely effective for getting ready cash to herders in a region during a major event.

Data for a limited number of sum in nearly every aimag were available from 1969-2000. These data afforded the opportunity to perform an assessment of the risk associated with offering a mortality index insurance program across Mongolia. While anyone who knows the recent history of losses understands that a very high level of covariate risk is present, these data show that serious losses occur in livestock in about 1 in 5 years. This is the frequency of loss ratios (indemnity divided by pure premium) in excess of 200% in the simulated mortality index insurance program that would be spread

across Mongolia. And while 2000 is the worst year in the 30 years of data, 1969 is nearly as bad. Historical records also suggest that 1944 was more serious with mortality rates in excess of 30%. These losses would make a mortality index insurance program costly and require some risk sharing in the international capital markets. The report provides ideas about how this might occur with both traditional reinsurance and the emerging weather markets.

The analysis also demonstrates that there are great differences in the relative risk of livestock losses across Mongolia. On a standardized basis, the risk index that was created for all species suggest that 6 of 27 aimags have risk that are 3 times or more higher than the risk in the lowest set of aimags. This magnitude of differences speaks to the need to set different premium rates across Mongolia for any insurance program. Such information also raises serious concerns about the current proposals regarding mandatory insurance that would charge everyone the same premium rates. This idea is flawed and would create the wrong incentives with transfers from those herders in low risk areas to those in high-risk areas. Such transfers not only raise equity concerns, but also would create significant inefficiencies. The report also discusses why mandatory individual insurance would run counter to the goal of improving risk mitigation strategies among herders.

At this stage, there are a number of additional items that would need attention as first steps in designing a pilot project to test the feasibility and acceptability of mortality index insurance. Some basic considerations and next steps follow:

1. **Collect data on mortality and adult livestock numbers for more sum;** make certain that these data are complete for all species of livestock for at least 30 years; create a data set for as many sum as possible but, at a minimum, obtain a geographic spread of sum within a aimag and complete at least five sum for each aimag.
2. **Investigate in some detail the statistical system that is being used to develop the census of animals and the reporting of mortality of animals**. This investigation should be conducted with a clear picture of how these data might be used to make insurance payments. A number of issues should be investigated: 1) what is the quality of these data? 2) Could the data be developed at the bag level? 3) Has the process for developing the data changed in any significant fashion in the last 30 years? 4) Have the data been used in the past to make emergency disaster payments and, if so, is there any evidence that this created any misrepresentation in the data? 5) Given that a census is taken every year, are there adequate safeguards and accounting systems in place to mitigate the opportunity for manipulating the data? 6) What auditing systems might be added to assure that the data process does not change when a insurance payments are being made on the basis of the data? 7) How do herders and others view the quality of the data?
3. **Select a sample of sum to offer the mortality index insurance.** Initially, the government could collaborate with the private insurers and make insurance offers in a select sample of sum. The sample should be selected with some geographical spread in mind. Ideally, the offers would be made in about 30 sum. Given that

the mortality data are widely available, it may be possible to make select a representative sum in every aimag to begin the pilot. This would give as much geographic spread as possible and provide the needed publicity across Mongolia for the concept. Great care should be taken in making certain that the price that is charged reflects the relative risk. The premium rates charged herders and the design of the contracts should be consistent with market principles. Initially, the government could provide some level of reinsurance to private provides to get their involvement. Simultaneously, the concept and pilot design should be presented to the international capital markets obtaining their input and attempting to get their involvement in offering reinsurance.

4. **Develop an extended education and marketing program.** Any successful pilot must educate herders about the potential value and use of this insurance. Some considerable attention should be paid to an educational effort.
5. **Establish appropriate feedback and monitoring of the pilot.** A pilot program should be designed to allow for learning about the concept. This learning must involve a number of dimensions: a) how have the private insurers respond to the opportunity? b) how have the herders responded? c) are herders thinking of and using informal and formal mechanisms to share the index payments within the community? d) has the introduction of the index insurance changed the data development process in any significant fashion?

Much of the effort for a pilot test of mortality insurance could be supported in the pastoral risk management project. However, it would also be an opportunity to gain support from some traditional NGOs. They should be keen to see progress made in this direction. If the pilot were offered in areas that comprised about 5% of the livestock in Mongolia, the total possible market would be 5% of Tg 1 Trillion or about Tg 50 billion. Initial sales would likely not exceed 10% bringing the number to Tg 5 billion. With premiums set at a 3% rate, it would require only about $US 60,000 to set premiums at a break even rate for herders. This level of support may be wise in a pilot program. Additional financing would be needed for resources to examine the issues outlined above and for education and marketing.

Examining the Feasibility of Livestock Insurance in Mongolia

Livestock herds are a vital component of the Mongolian economy making up about one third of the GDP. Further, livestock herders and their families make up a large percentage of the poor in Mongolia. Eighty percent of the herders have less than 200 animals. Herd sizes need to be greater than 200 to sustain a family at a reasonable level of income. Added to the low levels of income for a vast number of the Mongolian herder families, are the persistent risks that plague livestock. Devastating livestock losses are common in Mongolia. Natural disasters and disease not only create serious hardships in the short term but these type of risk also likely retard the development process. Given that there are few coping mechanisms other than the informal family arrangements, the high level of risk adds to the risk adverse behavior of poor herder families. The development literature clearly shows that these type of risks both slow the adoption of new technology and hamper the financial markets. Bankers in Mongolia list risk as the number one reason they don't loan money to herders.

Thus, it is clear livestock insurance could be an important innovation in Mongolia for any number of reasons. However, there are few success stories in the world of wide spread livestock insurance. Many good reasons underlie the problems with livestock insurance. The opportunities for abuse are significant. Livestock management is key to mitigating losses. This creates opportunities for adverse selection by those who consider the insurance a 'good deal' given their management practices. Those who are better managers will opt out. Further, once the insurance is available, moral hazard may occur as managers change their practices and become more risky. Controlling adverse selection and moral hazard requires investments in data and monitoring. In a country like Mongolia, it is nearly impossible to envision effective monitoring systems. Vast distances separate the nomadic herders across the country. Vast differences in management styles and risk among herders are common. It is also nearly impossible to imagine risk classification systems that would identify these differences before the insurance is sold. Finally, the large covariate risks that are present in Mongolian livestock herding operations make livestock insurance extremely challenging for an emerging private insurance market that is unaccustomed to using international capital markets to share risk.

Despite these fundamental problems, the need for livestock insurance in Mongolia is very real. This paper takes on the challenges of making livestock insurance work in Mongolia. It is organized into three primary sections: 1) a brief discussion of impressions and the setting that raise concerns about the existing insurance system and even the opportunities to introduce weather based insurance[2]; 2) introducing the recommendations and the reasons for the recommendations; and 3) a detailed analysis of the recommendations. While any number of alternatives may be tried, the limitation of many of the choices leads to a relatively focused recommendation. The logic for this recommendation should emerge as the sections are developed. The recommendation is made with several key performance criteria in mind: 1) the insurance should not reward

[2] This section benefits from readings and reports prepared by others and interviews conducted by the authors from July 30-August 7, 2001.

poor managers; 2) the insurance must be affordable by a large number of herders and others at risk when major livestock losses occur; 3) the insurance must be sustainable and profitable for emerging private insurance companies; 4) the first products should focus on the most significant covariant risk; 5) a proper role for government should be carefully identified; and 6) the insurance should work in harmony with other initiatives, including the vast array of emergency assistance that is provided.

Three classes of alternatives should be considered: 1) revamping the existing insurance that provide individual coverage to herders; 2) the introduction of weather insurance to protect against the most serious weather events that cause serious economic losses; and 3) the introduction of index insurance that would pay based on sum or bag mortality losses. Each has advantages and disadvantages. Yet, as will become clear, the first two options present significant challenges and run counter to some important performance criteria. The third alternative also has limitations; nonetheless, it appears to hold some promise as it meets many of the performance criteria. In addition, with modest funding this idea could be introduced relatively quickly on a pilot basis.

Impressions and Background

Consecutive dzud, harsh winter conditions, in Mongolia have been devastating. High rates of livestock death marked both the winter of 1999-2000 and 2000-2001. Across Mongolia these rates averaged about 10% in 1999-2000 and about 7.3% as of April 25, 2001 for 2000-2001. Obviously, when the data are disaggregated to the aimags (provinces), sum (counties), or bag (communities within the sum) level some areas had significantly higher losses (in excess of 50 percent in certain sum).

Numerous theories have emerged as to why the losses were so high. No doubt a combination of explanations gives insights into the problem. Two general categories of explanations dominate: 1) the weather; and 2) the macro environment. Weather events include: 1) drought prior to winter; 2) heavy snow; 3) cold temperatures; 4) freezing and thawing of snow causing ice; and 5) the combination of these events. Macro environment explanations include: 1) the inexperienced herders that have returned to herding after reform; 2) the breakdown in the infrastructure of wells for water along the traditional routes of otor; 3) the lack of forage reserves that were supplied by the former regime; and 4) a general lack of capital to purchase needed feed during the dzud.

While it is common to express concern that the macro environmental events have created a structural shift and added to the risk in Mongolia, caution should be taken. As devastating as recent years have been, at least four or five years during the period of 1944-1993 had equal or greater mortality rates for livestock: 1944, 1967, 1969, 1983, and 1993. The 1944 dzud was the most severe by some measure with around one third of the livestock in Mongolia lost. Interviews with herders suggest that they work hard to mitigate risk. The incentives to do so are stronger today than in the past given private ownership of livestock. In short, it is simply too early to draw any strong conclusions regarding whether there has been a structural shift that makes Mongolia more risky on

average for livestock producers. Nonetheless, the prudent policy makers at various levels are now focused on a host of solutions.

The World Bank Sustainable Livelihoods project is one such effort to find solutions. Three core activities are being coordinated: 1) management of pastoral risk; 2) development of community investment funds; and 3) improving the role of rural micro-finance services. This report is part of the pastoral risk management component, however, important linkages will be made to the other two components. A major thrust of the pastoral risk management component is to provide integrated strategies to assist herders in managing the covariant risk in Mongolian pastoral livestock production. A host of strategies are being considered. Insurance is one. An extremely important aspect of providing integrated strategies is that they not work at cross-purposes. This guiding principle plays a major role in the focus of this paper.

Significant efforts are underway to provide herders the information and training necessary so that they can effectively mitigate risk. Investments in forage equipment, improved weather forecasting, skill development, etc. are all targeted at helping herders mitigate the effects of devastating weather and dzud. Key to these efforts is that herders become better managers and that they have incentives to work hard to reduce livestock losses. Losing large numbers of livestock creates a long-term problem as it takes time to recover from such losses. Thus, it is also in the interest of the broader society that herders be given the proper incentives to reduce livestock losses. Poorly designed insurance products could negate the incentives that are being structured so carefully. Under certain conditions, some herders may choose to reduce their intensive management when they have insurance. Any insurance product that fits into the overall objective of improving the risk mitigation of herders must be designed with these concerns in mind. Successful insurance cannot pay for bad management. If the insurance compensates poor managers who are not working hard to mitigate risk during major weather events, two serious problems will emerge: 1) the insurance will fail and 2) the insurance will work against the other efforts underway to improve management.

Financial Markets in Mongolia

The financial sector is emerging slowly. There are excellent professionals in both the banking and insurance sectors. While there may be strong interest in developing livestock insurance, the task will not be easy. Further, the private insurance companies understand fully how difficult such a task will be, given the high transaction costs of monitoring for both properly classifying risk and for sound underwriting. They also understand that the covariate nature of this risk in Mongolia makes it nearly impossible given their limited capital reserves. The private companies will simply not offer livestock insurance on any significant scale. There may be as many as 10 private insurance companies in Mongolia. One of those companies is offering some 20 insurance products and makes extensive use of the international reinsurance markets. Still, that company has no interest in offering livestock insurance to individual herders.

The existing livestock insurance is offered by Mongol Daatgal Company and one other state owned company. This parastatal insurance is a carryover from the previous regime. The participation is quite low, even in the case of an area where it was required as a condition after getting special loans for restocking. Few herders really understand the current program and the overall uptake appears to be as low as a few percentage points. For those herders who have considered this insurance, premium charges are considered too high. A 6 percent premium rate is charged to all herders, regardless of where they operate. The relative risk of livestock losses varies greatly by region. The payments for this general herd insurance are 100% of insured value less any proceed from sale of skin and bones when the animal dies from weather related causes. Evidence of poor weather must be provided by the sum Meteorological office.

Even if the existing insurance company had a large uptake, it is highly questionable that the program would be successful. There is no reinsurance for the program and management of the program freely admitted serious concerns about the viability of the program even to the point of indicating that there was little desire to get more participation for fear of major loss. These fears are well founded given the covariate risks that are present in livestock losses. This principle will be further described and analyzed below. However, the estimate of the losses for 2000 demonstrates the point. The premium value was roughly Tg 40 million. Indemnities were about 4 times the premium value at roughly Tg 160 million. Given that the livestock herd in Mongolia is worth in excess of Tg 1 trillion, a Tg 40 million premium is an extremely small fraction of the value (far less than even one tenth of 1%).

Given recent livestock losses, it is not surprising to learn that interest among herders about livestock insurance is growing. The Gobi Initiative did interview 146 master herders from Umngovi, Dundgovi, Uvurkhangal and Govi-Altai aimags about their interest in livestock insurance. Only 5% of these herders had any previous experience with buying livestock insurance. When ask about their interest in such insurance: 49% said they were interested; 32% would probably buy; and 17% said they were not interested. However, the willingness to pay was relatively low with premium rates at around 3% of value insured. For the question about what should be a reasonable cost of insurance for those who said they were interested the responses were: 11% checked less than 1%; 51% checked 1% to 3%; 25% checked 4% to 7%; and 12% checked 10%.

While these results are interesting, it is important not to make too much of them. First, this is not a random sample. These are the master herders who were seeking information by attending a conference. If there is a bias it is likely that the interest and willingness to pay are biased upward above the general population of herders. Second, it is not surprising to see large uptakes in agricultural insurance immediately following a disaster. Several references are made in a number of reports about herders being complacent about natural disaster after experiencing several years with no problems. This is also quite common with agricultural insurance. This also speaks to the need to design an insurance alternative that will make relatively frequent payments if possible. Having some level of payments frequently will help assure that herders continue to

purchase the insurance. Third, it is really difficult to gauge the true willingness to pay for insurance until someone is provided the specific details about how the insurance will work. That being said, a target premium rate in the 3% to 5% range is a reasonable target for herders who are short on cash. The current insurance is not aggressively marketed even though there are 27 branches of the Mongol Daatgal Company, with at least one branch in every aimag. We were told that these agents currently concentrate on other lines of insurance. Their presence in each aimag is important nonetheless for any new initiatives in livestock insurance.

The parliament recently rejected an expanded livestock insurance program that would make it mandatory for livestock herders to insure their breeding stock. Two reasons were given for this decision by parliament: 1) livestock are now privately owned and the government can't force owners to insure; and 2) the government can't force private companies to offer insurance that is too risky and will bankrupt them. One herder summed the concerns up best when he said, "maybe it is better for me to spend my money on forage than insurance". Forage is a form of insurance and this herder's instincts are likely correct.

The livestock insurance legislation is currently being redrafted within the Ministry of Food and Agriculture (see Appendix A for an unofficial translation of the current draft legislation). As will be more fully developed below, mandatory insurance is highly questionable given the likely problems with actually classifying herder risk. Some herders have a higher likelihood of loss than others, even higher than their neighbors who are herding in the same region. These higher risk herders are difficult to identify. The current system makes no attempt to differentiate these risks and price accordingly. Thus, if all herders did purchase the current insurance policy, the herders who are better managers would be paying for the losses of those who are poorer managers. The current draft of legislation would charge a flat 2% rate[3]. Given the data on mortality, this rate is highly questionable. The rate appears to be woefully inadequate for the risks that are being insured. No private insurance company is likely to want to engage in selling this insurance. Furthermore, it is highly unlikely than any reinsurer would be interested in coming to Mongolia with these rates and this system.

While the argument is that with full participation there would be some economies of scale and an improved pooling of risk, neither of these benefits is likely to be realized with mandatory livestock insurance. The incremental costs of delivering and monitoring an individual insurance program are likely to be similar regardless of the number of herders insured. Further, while there are some gains to be made in pooling the risks of livestock losses across Mongolia, there is still a very large covariant risk that would create serious reinsurance problems for the current system.

[3] There was some indication that the 2% value had been increased to 4%. However, this is not confirmed. Even 4% is unlikely adequate to support a totally private market policy with the coverage outlined in Appendix A. Someone inside the Ministry has done some analysis on this issue. However, we were not able to locate them and learn about this analysis.

The banking community is very hesitant to loan money to herders. The Ag Bank of Mongolia is involved in the new micro-finance initiative to make a few select loans to herders. Managers of private banks in Mongolia appear to make very few loans to herders and cite the risk as the major reason. Bankers who were presented with the idea of insuring based on mortality losses within the sum expressed a keen interest in this alternative insurance. They understood the potential value and indicated that if such insurance were available they would consider loaning to herders. Given the strong reactions from managers of private banks, the possibility of linking such insurance to loans with the micro-finance initiatives underway is worth further consideration.

Potential Opportunities for Weather Based Insurance

There is a growing interest in weather based insurance around the world. These new markets and insurance products may offer some potential in Mongolia. The World Bank has been involved with investigating the opportunity for such insurance in Morocco, Mexico, Tunisia, Ethiopia, and Nicaragua. Morocco is very close to offering sunflower and cereal grain farmers insurance that would pay when rainfall is below certain thresholds during critical growing periods. Mexico is considering using similar rainfall policies to finance natural disaster relief efforts by provinces.

The Mongolia Meteorology Agency is a professionally managed agency with a long history of collecting detailed weather data. The current director is also the president of the World Meteorology Organization of Asia. Mongolia follows the WMO standards and has done so for several decades. Quality data should be available for most weather statistics. Further, the Meteorology Agency has conducted numerous studies and developed detailed maps of a great number of weather data. The data have been processed into useful information and it is clear that the agency plays a major role in both early warning systems as well as helping explain causes after major events in Mongolia.

Drought is a significant problem in Mongolia. Thus, there is some potential to investigate offering insurance against rainfall shortfalls during the critical months of June and July. As John Morton points out in his report, such insurance could provide timely payments that would be used to purchase fodder and other feeds prior to going into the winter. Further, the combination of drought during the summer months followed by extreme cold during the following winter may be an option worth consideration. However, it is also true that a multitude of weather events create a dzud. The description from "Lessons Learnt from the Dzud 1999-2000" by the UNDP provides an excellent summary of the multitude of causes:

> "The main cause of Dzud disaster in affected areas had resulted from a combination of the following factors. Firstly the livestock had become exhausted due to both **black dzud** (lack of precipitation which leaves livestock without any water supply) and **white dzud** (the snowfall is too deep for the livestock to reach the grass below), in the wither of 1998-1999, a severe summer **drought** in 1999 led to further weakness of livestock. This situation was further aggravated by poor pasture and lack of hay. Heavy snowfall in November and

> December was followed by its melting and icing, leading to the so-called **iron dzud** (an impenetrable ice-cover forms over the pasture that makes grazing impossible). In late December the snow cover became much thicker making it impossible for the livestock to graze on pasture **(white dzud)**. Due to the extreme coldness in January and February and insufficient bodyweight many thousands of livestock died from starvation and freezing."

Hoof dzud is also mentioned as a problem. A hoof dzuf occurs when there are too many hoofs in one area as herders from a problem area have moved their animals in an attempt to find forage. The result is over grazing. Obviously this problem is not created by local weather events. In short, there are an overwhelming number of weather conditions and other factors that create dzud in Mongolia. In his 1997 master's thesis, Enkh-Amgalan created statistical models to explain growth rate of livestock between 1969 and 1990 for 36 sum spread across Mongolia. He attempted to explain variation in the growth rate (basically the birth rate minus the mortality rate) using weather variables. This work is discouraging regarding the potential of any weather-based insurance for protecting against livestock losses. Enkh-Amgalan had to create a myriad of weather variables and then use stepwise regression to obtain explanatory power with his models. Each sum had unique weather events that helped explain the growth rates.

The combination of the general descriptions of a variety of sources about the cause of a dzud and the detailed work of Enkh-Amgalan create serious concerns about the use of weather based insurance for managing herder losses. Further, while the Meteorology data appear to be of high quality, the basic stations may be too far apart in many regions to satisfy the requirement of weather insurance at a local level. Weather insurance should be considered as a means of reinsuring the alternative that is recommended in this paper. It is likely that an index of weather events could be created to explain the most serious insurance losses across Mongolia. Given that weather can now be traded in a global market, this option may offer a workable and affordable reinsurance complement (see Skees 1999 for further details).

The Focused Recommendation

Given the problems with the existing insurance program and the likely limitations of using weather insurance directly with herders, it becomes important to recap the overall problem.

- ✓ It is logical that the current livestock insurance program has problems. Given the importance of understanding the core reasons for these problems, the references at the end were expanded to add other material that highlights the difficulty of providing agricultural insurance anywhere in the world. In particularly Skees and Barnett go into many of these practical and conceptual problems. Skees and Barnett provide much more detail about the conceptual problems and the literature to support the concerns about

supplying individual insurance. Mongolia has unique characteristics that make these core problems even more challenging.

- ✓ Multiple and complex weather conditions create the dzud. Actually documenting and understanding these events is important for risk mitigation and early warning efforts. However, after the fact the events are not as important as the outcome – extremely high livestock losses.

An attempt to construct a performance checklist will help the discussion. Table 1 makes this attempt and provides a subjective assessment for each of our three alternatives. These assessments are solely based on professional judgment and should not be taken as the final word. The table is provided as a quick guide to the reader so that they can more fully understand why this paper recommends the use of mortality index insurance.

Table 1: Subjective Performance Assessments for Alternative Approaches

Performance Goals	*Traditional Insurance*	*Weather Insurance*	*Mortality Index Insurance*
Insurance should not reward poor manages	Fails	Pass	Pass
Affordability for poor herders	No	Could be	Could be
Effective risk protection for individual herders	For the most risky yes	In some cases	Most likely
Focused on the most significant covariant risk	No	Could be	Likely
Sustainable & profitable for private companies	Highly unlikely	Possible	Possible
Fits with other forms of emergency aid	No	Possible	Possible
Low transaction costs	No	Should be	Should be
Acceptance from intentional risk sharing markets	Not likely	Should be	Can be
Opportunities for well defined rolls for government and markets	With great care	Possible	Possible

It is clear that traditional approaches are scored the most poorly. A careful reading of Skees and Barnett will give more insights into the basis for that judgment. Traditional insurance scores best for providing specific protection to individual headers. However, in the current system the most risky herders who are in the most risky areas will receive this benefit since everyone is charged the same flat rate. These are precisely the wrong incentives given the desire to motivate herders to adopt risk mitigation methods. Further, if there were a large uptake in this insurance

due to a major campaign to educate herders, it is likely that the major participants would be those who are most risky. This could create serious losses for the pool, especially given the covariate risk problem. While some believe that compulsory insurance will fix this problem, they are very likely mistaken. Further, it is ill advised to require the best herd managers to use their precious cash for insurance that likely will not work for their operation. This only reduces their opportunity to invest in more effective risk mitigation strategies.

Both the weather index and mortality index insurance score better on several criteria. Weather insurance is unlikely to protect against the great number of unique weather conditions that can create a problem with livestock mortality. This led to the recommendation to pursue insurance mortality rates directly. This idea is also limited on at least three important fronts: 1) an individual herder who is a good manager can have a loss and not get paid; 2) the quality of the mortality data might change once insurance is being sold based on these numbers; and 3) it will still be difficult to manage the covariant risk that are present in Mongolia. Each of these points will be discussed further below. Additionally, some very careful attention must be paid to numerous details to have successful mortality index insurance.

Description of the mortality measure

The work by Enkh-Amgalan used data from 36 sum for the period 1969-1999 on mortality rates and birth rates[4]. These data are fairly reliable and afford the opportunity to perform a rather complete analysis of the risk and the possibilities for insuring based on mortality rates within each sum. The data were updated for the years 1991-2000.

While statistics are developed for adult animals and offspring within the year, we chose to use the adult mortality statistics to develop the insurance index. The census of animals is performed every year. The mortality rate is the ratio of total losses of adult animals divided by the number of animals reported in the end of the previous year census.

$$Mortality = \frac{adult\,losses}{total\,animals} \ .$$

Offspring losses are excluded on the following grounds:

1. Compared to other age groups offspring are highly vulnerable and loss rates are usually high. The offspring loss rate is calculated as a ratio of offspring lost to the total number of born. When losses associated with immature delivery are included, the losses increase further. Therefore, inclusion of offspring losses would significantly increase the premium rates making it less likely that herders could afford the insurance.

[4] 1975 and 1979 are missing from the data.

2. Recording and monitoring of offspring losses are more difficult compared to that of adult animals. In Mongolia, statistics on animal numbers are based on the livestock census data carried out in December each year. However, data on offspring, which are delivered from February to June, are based on reporting during the year, which are less reliable than the final livestock census data.
3. Inclusion of offspring loss rates makes the calculation of the loss rate more complicated. Calculation of the loss rate as a ratio of total losses incorporating losses of both adult animals and offspring to the number of animals at the beginning of year might be criticized mathematically. The number of offspring does not have direct relationships with the number of animals at the beginning of year. A separate index relating the ratio of offspring losses to the total number of offspring births might be possible but is well beyond the scope of any recommendation at the present time.

All the data on animal numbers at the beginning of year and animal losses are collected from the Central Statistics Board of Mongolia. The process of collecting data is quite involved and has been in place for well over thirty years. Each sum has records of the herder household and animal numbers by species for each household. Sum and bag governors are responsible for administering the census and for maintaining these records in good order.

Individual herders are responsible for reporting losses to the bag officials. Losses include all animals that have died due to dzud or other natural disasters (flash flooding was mentioned as being a problem as well). Losses also include death of animals due to disease, theft of animals, and animals who have wondered off during storms never to return. While there may be some initial concern about including all of these numbers in the insurance index, since this is an index and not individual insurance, there should be no real problem. The theft and lost animals values are a relatively small percentage of the total number of animals lost during a year. Professionals in the sum of Undurshireet estimate the value at about 10% of the total number of losses.

Theft is rightly considered an uninsurable risk in the current system. No one wants to encourage herders to be careless in protecting their animals from thefts or in making certain that animals do not wonder off. Offering insurance based on the average losses for the sum or bag will not encourage this behavior. The watchful herder has the same incentives to be diligent since they will be paid only based on the sum average loss rate. By the same token, the negligent herder who allows large numbers of animals to wonder off or be stolen will not be compensated beyond the sum average loss rate. Thus, the incentives for good management remain soundly in place. Furthermore, the theft rates are likely relatively constant from year to year. Thus, their inclusion in the insurance index neither creates an incentive problem nor a rate making issue. One would not want theft variation to cause rates to increase since the index is being constructed primarily to compensate herders for losses due to natural disasters and disease.

It is extremely important that the data integrity be maintained. It is also highly significant that Mongolia does a complete census of all animals each year. This affords the important opportunity to audit reported losses from one year to the next. Bag

governors give monthly reports on livestock, including information on movement from one sum to another. Records are kept of where the animals have been moved. Thus, by all counts, it should be quite difficult to create grossly false numbers to trigger an indemnity payment. Nonetheless, it is reasonable to implement an outside auditing process should this index insurance be adopted. Local and aimag politics may still provide enough incentives to government officials that they may be tempted to 'create losses'. The systems for developing the census and the reporting of losses are standard across Mongolia. These systems should not be changed. The historic records are the basis for rating any index on mortality rates.

The only recommended modification is that some thought be given to using auditors from nearby aimags. It would be better to have these professionals involved for a variety of reasons: 1) local officials are more likely to trust and cooperate with these professionals than someone form an insurance company or the national government; 2) these professionals know the systems; and 3) they also have a stake in any potential fraud that may be emerging within a particular region. If anyone is 'creating losses' it is likely that the whole system will have to pay for such fraud at some point. Importantly, the loss experience within region should be used for rate adjustment. Thus, any cheating will first result in higher rates in the region where the cheating occurs. This, of course, will be a slow process and should not be relied on to provide the only due diligence incentives.

How might mortality insurance work?

The sum of Saintsagaan in the aimag of Dundgobi is used to illustrate how such mortality insurance may work. There were 2,800 cattle, 63,200 sheep, 43,300 goat, and 11,100 horses in this sum in 2000. This sum had extremely serious losses in 2000 with the mortality rate on cattle at 72%; sheep at 41%; goats at 44%; and horses at 33%. The simple fact that each of these species had serious losses in the same year illustrates the covariant risks that are present within a sum. More importantly the fact that many other sums across Mongolia experienced serious losses in the same year further makes the point about covariant risk. The correlation of losses was strong among species with an aimag and across aimags.

Figure 1 and 2 show the statistics for the 30 years of data for mortality rates for sheep in this sum. Sorting the 30 years of data from the minimum to the maximum creates the cumulative distributions. Since there are thirty years, each year represents a 1 in 30 frequency. Thus, the minimum value is a 1/30 event, the percentile on the second value is the previous value + 1/30, and so on until the maximum event is achieved and set as the 100^{th} percentile. This array can now be used to establish a number of possible triggers that represent frequency of the event. Using frequency to define a disaster is an important criterion. Public policy makers should be able to relate to frequency. In simple terms; How often does an event have to occur before it is a disaster? If one thinks of living in the desert, the rainfall is always very low. Noone should decide that every year is a disaster because it never rains in the desert. A 1 in 5 year event may be a reasonable trigger. Such events are generally serious in Mongolia and getting paid 1 of 5 years should be frequent

enough to keep herders engaged in purchasing the insurance. A 1 in 5 year corresponds to the 80th percentile.

Clearly two extreme years stand out in the sheep mortality data for Saintsagaan sum: 1971 at 34% and 2000 at 41%. The 80th percentile begins at a more modest mortality rate of 6.5%, which occurred in 1981. The data appear below for the 80th percentile and above. This contract would pay only for values above the 80th percentile, thus only values above 6.5% mortality would trigger a payment. Any number of contract designs can be considered. Some of these will be pursued in another section.

Percentile	Mortality	Year
80%	6.5	1981
83%	6.8	1994
87%	7.9	1980
90%	10.8	1977
93%	12.4	1993
97%	33.8	1971
100%	40.6	2000

A contract that would simply pay the mortality rate times the value of liability purchased would have an average payout over the 30 years of about 3.7% (the sum of the positive numbers above 6.5% divided by the total number of years 30). This is a very straightforward way to calculate premium rates. More complex methods would need to be implemented should a program be constructed. These methods would rely on putting more structure into the assumptions about the shape of the parent distribution. Several tests were performed on various sum data sets. The smoothed distribution that is presented below is an example of the type of work that is needed. This distribution is fitted with special non-parametric kernel estimators. More importantly, one should consider fitting these type of distributions by sum and then using spatial procedure to smooth the fitted distributions across space.

Given that this is an index contract that pays based only on the data for the sum[5], the question of insurable risk becomes the only significant underwriting concern for the individual herder. Even here it would not create significant problems if herders were allowed to purchase liability values that are greater than the value of their herd. Use of an example will make the issues clear. Let's assume that a herder has 500 sheep. The value of an average sheep at the end of 2000 was about Tg 22,000. Thus, this herder might purchase an insurance policy with a value of Tg 11 million. If the policy were rated at 4%, the herder would pay Tg 440,000.

[5] One local sum leader from Undurshireet liked the concept very much. However, he insisted that their data was good enough to offer such insurance at the bag level and rightly understood that offering the policy at that level would offer superior risk protection to the individual herder. The discussion quickly turned to difference in mortality rates among the four bag in Undurshireet for the 2000 dzud.

Premium paid = liability x premium rate
Tg 440,000 = Tg 11,000,000 x .04

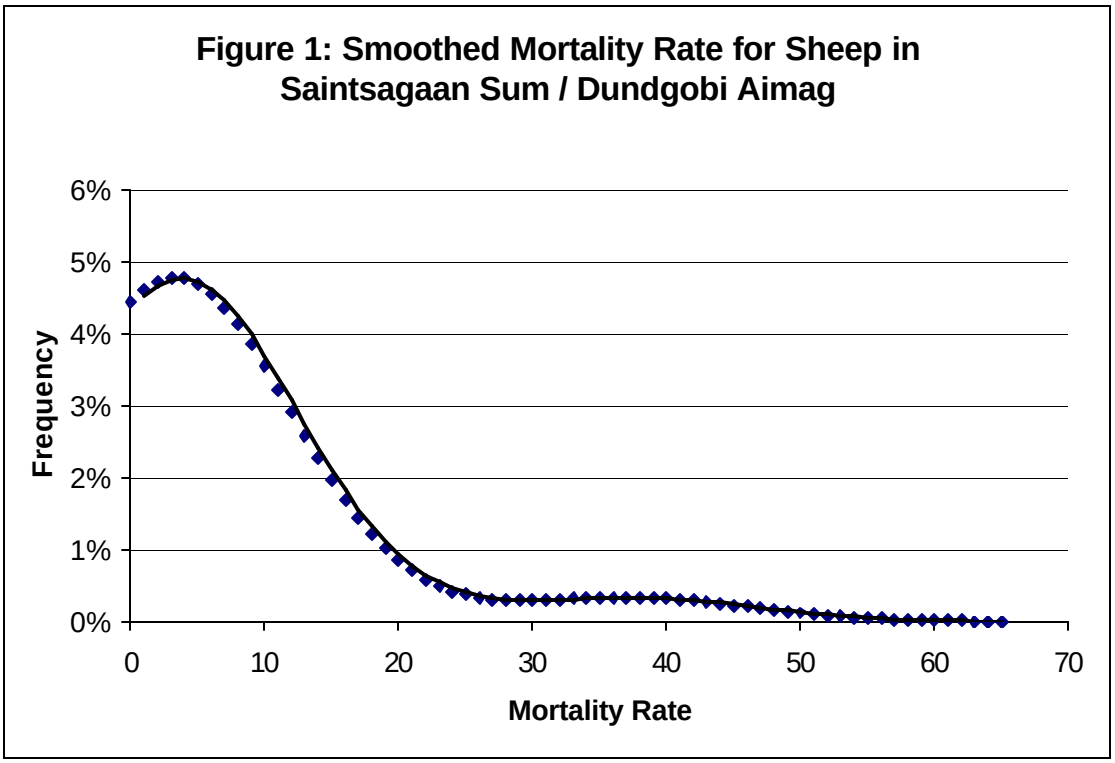
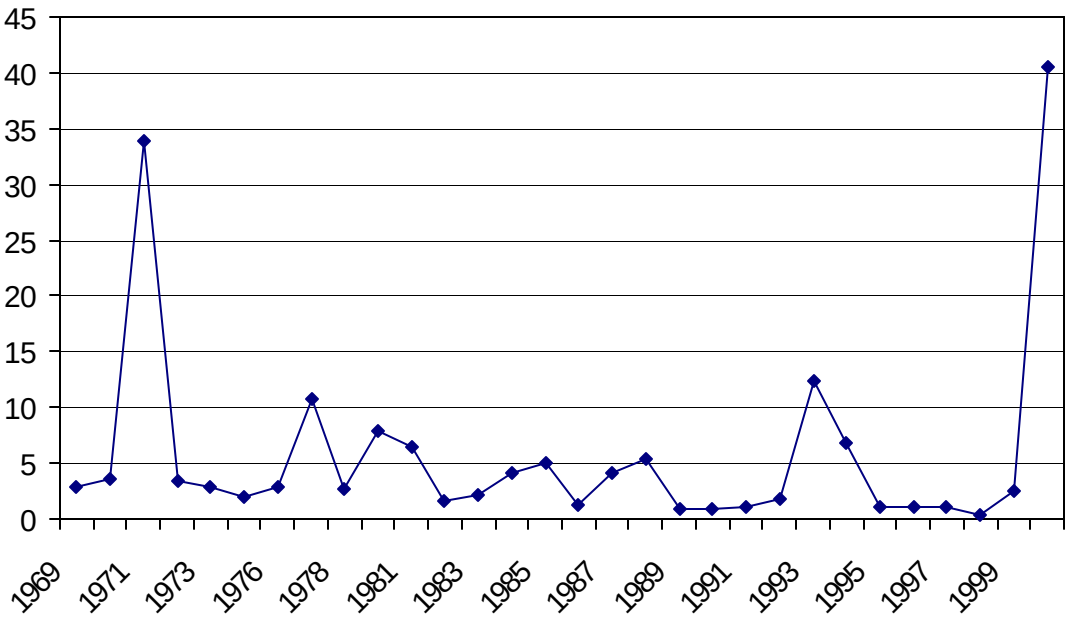


Figure 1: Mortality Rates of Adult Sheep: Saintsagaan Sum / Dundgobi Aimag



Again, the herder should be allowed to select any liability value within some reasonable limits. Any lower value should be allowed and an upper bound of 150 to 200 percent the value of the sheep herd may make sense. Allowing any value will give the herder significant choice and increase the likelihood that some who have little cash can purchase some level of insurance. Obviously, the sales agent needs to make certain that such decisions are made with full knowledge of how the payment will be made.

The fact that the contract integrity is not a function of the liability for the individual herder is very important. It also means that the value of an individual species is not nearly as important as it is when insuring the individual animal. This means that any reasonable number can be used to value livestock, especially if herders are allowed to 'scale up' on the contract and select values at 150 or 200 percent of the average value of their herd. Keep in mind that both rates and payouts are driven by the value insured (liability). The value insured has no impact on the outcome of the statistic (the sum or bag mortality rate).

The payout structure for this policy in the years with sum mortality rates at 6.5% and above would be the product of the mortality rate and the liability. Thus, in 2000 this herder would have the following payment calculation:

if mortality rate is > the strike level of 6.5% then
Payment = liability x mortality rate
Tg 4,466,000 = Tg 11,000,000 x .406

By now it should be clear that this payment would be made to the individual holding this policy regardless of the mortality rate for the individual with the policy. While such insurance may seem strange there are distinct advantages of this type of policy and there is ample precedent for such policies. Skees, Black, and Barnett explain the motivation and design for the U.S. crop insurance program that is an index contract paying only when county yields drop below certain thresholds.

Besides the low administrative costs and the lower likelihood of abuse associated with the contract, a major advantage of using the mortality rate is that it rewards good behavior. Those herders who have been successful in having lower mortality rates than their neighbors through hard work and investments during the year to mitigate risk receive the payment based on the average losses of the sum. Those who have greater losses still receive a payment in the years that are bad. However, that payment gives them no incentives to relax in trying to save their animals since any rate of mortality beyond the average will not be paid. Once an index contract system is in place, the private insurance market would have better opportunities to offer individual insurance that pays for losses to individuals that are beyond those paid by the sum or bag mortality policy. Such individual insurance will now be more independent in nature since the index contract will remove much of the covariant risk. But more importantly, the private sector would have the proper incentives to charge for and perform individual underwriting.

With the mortality index insurance there is little opportunity for adverse selection and moral hazard. The administrative costs should be considerably less than traditional insurance. Thus the major loads that will be added to the premium rates will be almost totally a function of the commission paid sales agents and the premiums that are needed to build reserves and pay reinsures for the covariate risk. More will be said about these important issues in the next section. Another major advantage of this recommendation is that quality historical data exist and good systems are in place to develop these data all across Mongolia. There is no need to start a new system.

How might a contract appear to the herder?

While neither author is a lawyer, it may be helpful to show how simple the language might be for an index insurance contract with a herder in Saintsagaan.

DRAFT LANGUAGE FOR ILLUSTATION ONLY

This insurance is solely based on the official sum statistics on adult livestock losses for cattle and yak in sum Saintsagaan in aimag Dundgobi. The insurance will pay you when the mortality rate (the ratio of adult losses during the year 2002 divided by the total herd population at the beginning of the year) exceeds a rate of 6.5%. To be eligible, you must register for this insurance by May 1 of 2001. Registration involves a statement of intent to purchase and a reporting of your animal numbers at that time.

Value of Insurance
While we believe the average value of cattle and yak to be about Tg 100,000, you may purchase any value of insurance between Tg 20,000 and Tg 200,000 per animal reported.

Paying Premium
You will pay a premium rate of 4% times the value of insurance you chose. The premium payment is due on January 1 of 2002. Should no payment be received by that time, we will cancel this insurance policy.

Paying for losses:
If the mortality rate for the sum of Saintsagaan in aimag Dundgobi exceeds 6.5%, we will pay you the product of the mortality rate times the value of insurance you have chosen. Please understand that you may have livestock losses when the sum mortality rate does not trigger a payment.

Analysis of the Risk Profile Across Mongolia

Data were obtained for 36 sums with at least one sum in nearly every aimag in Mongolia. These data were mostly complete for cattle, sheep, and goats from 1969-2000 (year 1975 and 1979 are missing). Camel and horse mortality rates were obtained for 1991 to 2000. Special procedures were used to fill in the data series for camels and horses. Regressions of the following form were fit using the available data:

$$\text{Camel Mortality}_t = C + b_1 \text{ x Cattle Mortality}_t + b_2 \text{ x Sheep Mortality}_t + b_3 \text{ x Goat Mortality}_t$$
$$\text{Horse Mortality}_t = C + b_1 \text{ x Cattle Mortality}_t + b_2 \text{ x Sheep Mortality}_t + b_3 \text{ x Goat Mortality}_t$$

where t = years 1991-2000.

These regressions had reasonably high R squared values and for those few that did not, a simple procedure was used to scale the cattle mortality in the same fashion as existed in the 10 years that were available (the ratio of camel mortality over cattle mortality). Missing years were replaced with estimated data. While this may introduce some problems, the likely bias is in the direction of adding slightly too much covariate risk. The intent is to get a complete cost accounting of offering this insurance for all species in every sum and aimag in Mongolia.

Once the data adjustments were complete, there was a complete matrix for all five species for each of the 30 years and in each aimag. The aimag estimates basically assume that all sums within the aimag will have similar relative risk as the ones that were available. There may be some spreading of risk within an aimag that are not reflected using this approach. However, again the intent it to give some indication of how a mortality index might perform across Mongolia. The bias that is introduced with the methods employed here is in the right direction for this type of work. The covariant risk will be slightly overstated due to this bias.

Given the matrix of mortality rates, any number of index policies can be designed. The 1999 value of number of head by aimag are used to represent value at risk throughout the time period. This is a common practice to use today's value at risk with a time series of events in order to model the losses. Since the risks are spatial in nature it is important that they be calculated using the current values at risk. This effectively weights the risk spatially by the location of the livestock in Mongolia. The underlying assumption is that the 30 years represent the likely future distribution of events. Also, using the actual events for the 30 years maintains the spatial correlation among aimags. This is very important as it allows for a more complete picture of the covariate risk across Mongolia. Again, the assumption, as with most statistical data work, is that the past is a good predictor of the future. There are no apparent trends in the mortality rate data. And while 2000 and 2001 are unusual events, there are similar events in longer series of data for Mongolia. It is too early to tell if there are any structural changes that make Mongolia more risky for livestock herders.

The matrix of mortality rates is 30 by 22 by 5 (30 years, by 22 aimags, and 5 animal species). The matrix for animal values is simply a 1 x 22 x 5 (1 = 1999 values that are imposed over the 30 years, by 22 aimags, by 5 animal species). Value at risk is calculated as follows:

$$\text{Value at risk}_{as} = \text{Number of animals in 1999}_{as} * \text{Average value of animal in 2000}$$

where a = aimag and
s = animal species

Animal Values Used in the Analysis

Species	Value (Tg)
Cattle and yak	100,000
Sheep	22,000
Goat	14,000
Camel	100,000
Horse	70,000

Given these calculations, the estimated value for all livestock in Mongolia is about Tg 1.1 trillion (see table 3). If the policy were made available at an average premium rate of 3%, the total premium would equal about Tg 32.8 billion. This also makes the strong assumption that all livestock would be insured at the full value. The analysis will make this assumption to give the full scope of this insurance. However, it is quite simple to factor all numbers down with any assumption one wishes to make about the rate of participation. For example, at 10% participation the premium would equal Tg 3.3 billion.

To begin the analysis it was assumed that the premium rates would need to be loaded at least by about 40%[6]. Further, a target of about 3% average premium rates was used. Therefore, the contracts needed to set the coverage or trigger mortality rates for each aimag and species so that the average pure premium (before loads) would equal roughly 2.15%. There will be variations around this rate and these are reported in summary statistics below to give some idea of the relative risk across aimags.

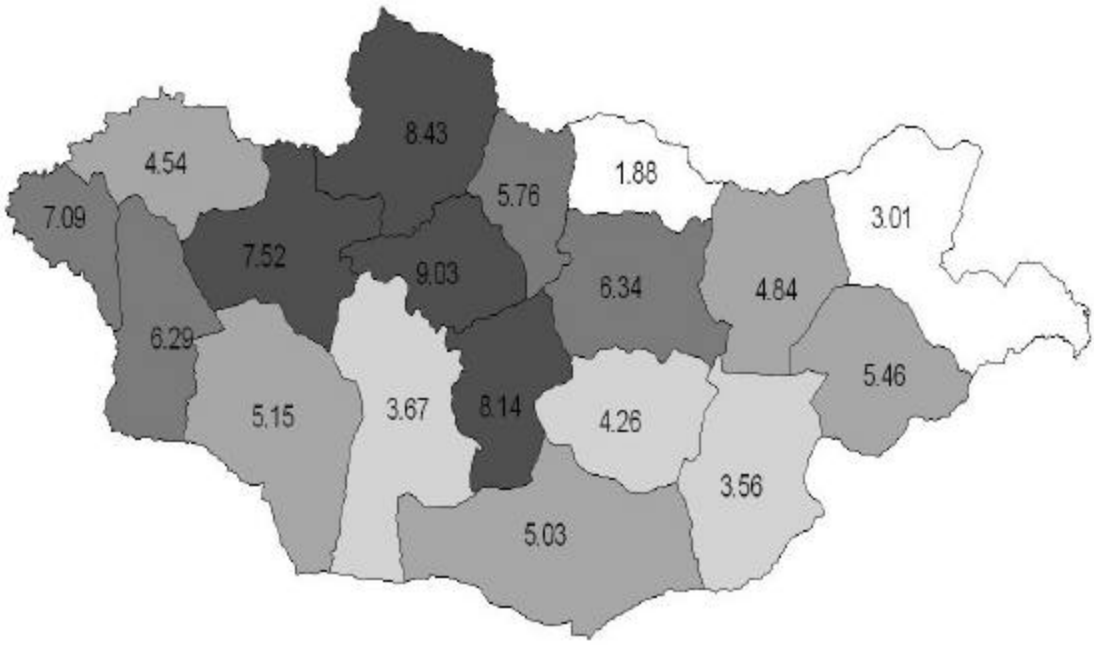
The trigger values were set by each animal species so that the average pure premium rates would equal the target of 2.15%. To accomplish this task the following strike percentiles were used by species; 1) cattle = 86%; 2) sheep and goats = 80%; 3) camel = 76%; and 4) horses = 70%. The contract design used the principle of paying at the mortality rate for values above the strike. The strike mortality values are reported in Table 4. Corresponding values of the insurance or the pure premium rates are reported in Table 5. As is quite evident there are large differences across Mongolia for these risks. The pure premium rates are each multiplied by 1.4 to load for some administrative costs and for reinsurance. Should a mortality index insurance be constructed one would want to put the structure of parent distributions in place and not have as large of differences in the premium rates across Mongolia. Still, the differences are important as they do reflect the risk profile of the country.

[6] This load is likely low. However, a lower number is used with the assumption that the factors that cause this work to over estimate the spatial risk have already loaded the rates to some extent.

Table 3: Values of livestock used by Aimag (all values are in Tg 1 Million)

Aimag	Cattle	Sheep	Goat	Camel	Horse
Arhangi	46,400	12,122	14,294	100	20,860
Bayan-Oligii	11,400	11,352	9,030	800	5,530
Bayanhongor	19,800	26,378	12,292	4,000	11,200
Bulgan	26,400	7,392	11,172	100	14,700
Darhan_Unl	3,300	946	1,260	500	17,640
Dornod	14,600	2,728	6,048	600	7,280
Dornogobi	10,400	8,272	6,678	3,000	8,610
Dundgobi	12,700	16,874	13,538	50	1,050
Gobi-Altai	7,900	22,638	12,138	3,500	7,280
Govisumber	1,400	924	896	10	1,540
Hentii	22,900	7,788	9,492	2,500	7,560
Hovd	15,100	17,512	11,032	400	21,280
Hovsgol	48,200	14,938	14,000	2,300	8,120
Omnogobi	4,000	19,976	6,216	1,900	20,160
Orhon	2,800	990	1,106	10	910
Ovorhangii	29,600	20,460	19,922	1,100	13,440
Selenge	11,000	3,036	4,592	10	910
Suhbaatar	21,100	7,678	9,660	9,900	8,330
Tov	24,100	10,868	16,450	1,300	13,160
Ulaanbaatar	5,300	1,210	1,540	700	13,580
Uvs	16,800	13,420	13,622	100	3,220
Zauhan	27,100	15,268	17,696	2,800	15,190

Figure 1: Map of Share of Livestock by Aimag as a Percent of Total Country Value



To illustrate the relative risk across Mongolia in more detail, a special analysis was performed that fixed the average strike for each aimag at the average value for each species. Thus, all aimag would begin making payments at the same mortality rates. Those rates are: 1) 9.1% for cattle; 2) 6.2% for sheep; 3) 6.5% for goats; 4) 5.6% for camels; and 5) 3.2% for horses. This relative position of these values also shows the relative risk for different species. The pure premium averages about 2.5% for each of these species of livestock.

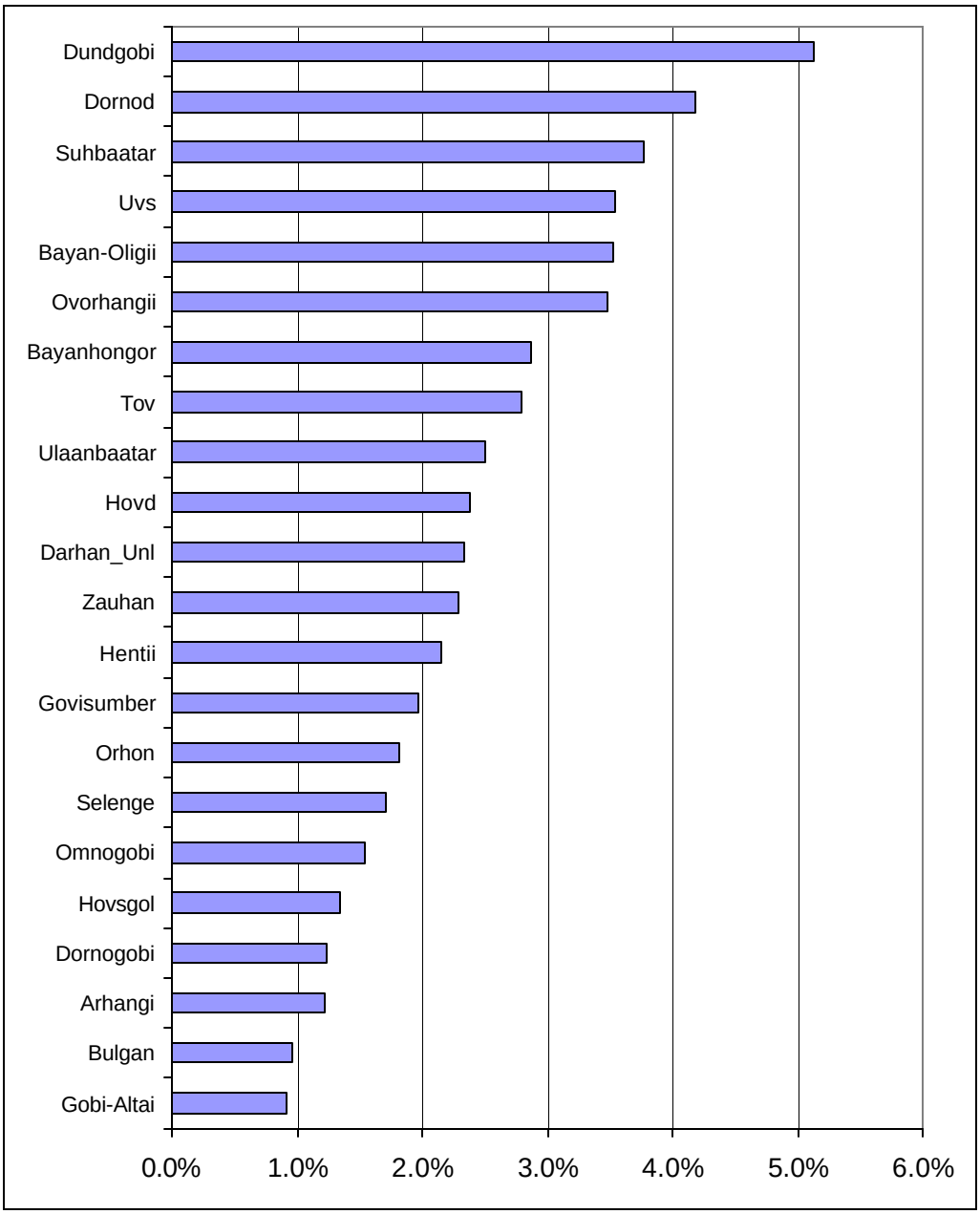
$$Loss\cos t = \frac{\sum payouts}{\sum Liability}$$

the sum of all payouts for all years and all species is simply divided by the sum of all liabilities for all species and years. This normalizes the risk picture and allows for a more appropriate comparison of the relative risk position of the different aimags given today's livestock values.

Figure 3 shows large differences in the relative risk of the various aimags – from about 1% to 5% given these strikes and the insurance design. This table can be used for a variety of purposes as it reflects the current risk profile given the relative risk different livestock in the different aimags with the current values at risk.

Given the principles laid out above it is possible to develop estimates of the 30 year loss experience for a book of business that is equally spread across Mongolia. This analysis has driven the data and procedures described above to

Figure 3: Risk ranking of aimags for all livestock species using the same strike mortality rate and calculating the weighted average loss cost



create Tables 3-5. Loss ratio is the experience within a given year. Such data give a good estimate of the covariate risk that remains after pooling the risk across aimags and species.

$$LR = \frac{\sum Payouts}{\sum \Pr emiums}$$

Figure 2: Map of Livestock Risk Index Across Mongolia

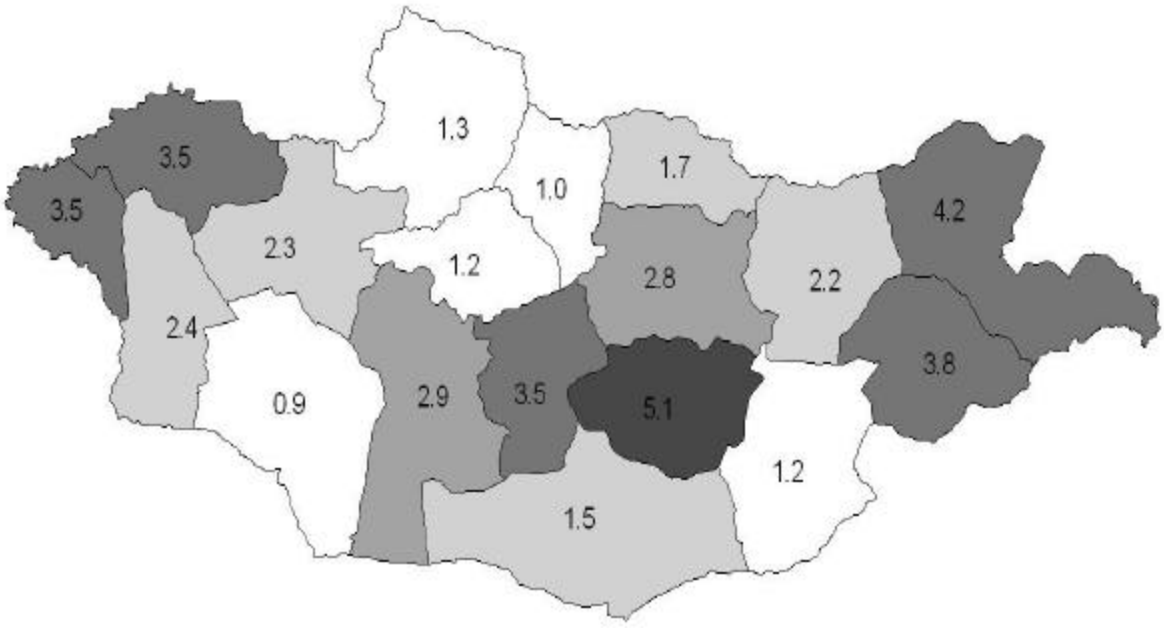


Table 4: Mortality Strike Values Used – By Aimag and Species

Aimag	Cattle	Sheep	Goat	Camel	Horse
Arhangi	6.0%	7.5%	7.2%	3.8%	1.4%
Bayan-Oligii	20.1%	4.8%	6.7%	3.0%	3.4%
Bayanhongor	9.2%	7.2%	7.5%	4.3%	3.8%
Bulgan	5.4%	6.3%	6.4%	6.9%	3.1%
Darhan_Unl	8.2%	6.1%	6.5%	5.4%	4.1%
Dornod	11.8%	9.2%	12.4%	8.9%	4.2%
Dornogobi	8.9%	5.9%	5.8%	7.2%	2.9%
Dundgobi	10.5%	6.5%	7.8%	6.1%	5.2%
Gobi-Altai	7.0%	4.9%	4.8%	3.0%	3.6%
Govisumber	8.2%	6.1%	6.5%	5.4%	4.1%
Hentii	6.3%	7.9%	8.1%	6.0%	3.1%
Hovd	6.4%	7.1%	5.0%	3.7%	4.4%
Hovsgol	4.3%	7.0%	6.3%	2.9%	1.9%
Omnogobi	9.9%	5.4%	6.3%	2.8%	2.2%
Orhon	8.2%	6.1%	6.5%	5.4%	4.1%
Ovorhangii	10.1%	7.9%	7.9%	5.3%	6.3%
Selenge	7.0%	6.7%	6.9%	8.4%	3.5%
Suhbaatar	14.2%	9.7%	11.6%	7.5%	3.2%
Tov	10.5%	6.6%	6.4%	8.1%	3.1%
Ulaanbaatar	10.5%	6.6%	6.4%	8.1%	3.1%
Uvs	10.6%	6.4%	6.9%	7.5%	9.5%
Zauhan	6.5%	5.8%	5.1%	3.8%	3.6%

Table 5: Pure Premium Rates By Aimag and Species

Aimag	Cattle	Sheep	Goat	Camel	Horse
Arhangi	1.1	2.2	2.1	1.2	0.7
Bayan-Oligii	3.8	2.7	3	2.4	2.5
Bayanhongor	2	1.9	2	1.7	2.2
Bulgan	0.8	1.9	1.9	3.2	1.3
Darhan_Unl	1.6	1.6	1.7	1.5	1.8
Dornod	2.2	3	4.3	3.1	2.4
Dornogobi	1.3	1.5	1.5	1.8	1
Dundgobi	5.9	3.7	4.1	3.5	4.3
Gobi-Altai	1.3	1.3	1.1	1.3	1.8
Govisumber	1.6	1.6	1.7	1.5	1.8
Hentii	1.8	2.3	2.2	2.4	1.7
Hovd	1.5	2.1	2.2	1.4	2.6
Hovsgol	1.2	3	2.6	1.4	1.1
Omnogobi	2.2	1.4	1.6	1.4	1.9
Orhon	1.6	1.6	1.7	1.5	1.8
Ovorhangii	2.6	2.5	2.2	2	3.8
Selenge	1.5	1.9	1.5	3	1.5
Suhbaatar	2.1	2.5	3.3	3.1	1.9
Tov	3	2.2	1.8	3.4	1.9
Ulaanbaatar	3	2.2	1.8	3.4	1.9
Uvs	2.8	1.8	2.2	2.1	4.6
Zauhan	2.9	1.9	1.8	1.7	2.3

In essence any value greater than 100 suggests that premiums in that year would not cover the payouts. As one would expect, the aggregate values are generally lower than some of the values by species. While there is some risk spreading and diversification, there remain some serious losses. The year 2000 exceeds 400 % loss ratio. The next worse year is 1969 at 357%. Another way to highlight the bad years is to show excess losses as is done in figure 4.

At this stage all the information that is needed to operate an insurance company to insure all species in every aimag of Mongolia is organized. To simplify things, we return to some basic principles and use some rounded numbers. It is very important to understand that this analysis is being performed to give insights into the overall risk profile in Mongolia and to spur thinking about what the actual cost might be to run a complete insurance program using the mortality index insurance. Above all, the methods for reinsurance and administrative cost *are not recommendations.* They are simple abstractions designed to motivate thinking and give the needed insights.

We assume that the total liability for the insurance company is Tg 1 Trillion (note the value in the work above is Tg 1.09). We use the average pure premium rate that is 2.15%. With a load of 40 percent, the premium at would be very close to 3%. Again, another simplifying assumption is that this insurance company will ask an international reinsurer to pay for all losses beyond those that can not be covered with the unloaded pure premium. Table 7 gives the complete profile of how this might work. The pure premium value is roughly Tg 21.5 billion. Our hypothetical Mongolian insurance company pays this sum first and then any losses beyond that point would be paid in a simple stop loss by an international reinsurer. The column "Reinsure Pays" gives the estimated payments under this system. These average Tg 9.1 billion per year. Since the pure premium is used the net receipts before any expense beyond pure premium for the company also average Tg 9.1 billion per year. These measures are an excellent proxy for the degree of covariant risk that remains in the system.

It is assumed that with this type of primary insurance and with some opportunities for added efficiency in weather markets, the reinsurance can be negotiated at a favorable rate. For simplicity and given this assumption, the pure reinsurance cost of Tg 9.1 billion is loaded by 50%. Thus the annual cost for international reinsurance is set at Tg 13.5 billion (9.1 x 1.5).

Given our structure of reinsurance, it is now possible to determine how the rest of the funds may be spent. First, we return to the pure premium and load that value by 40%: 21.5 x 1.4 = Tg 30 Billion. Next we account for the average value of the indemnities that the insurance company must pay: 21.5 – 9.1 = 12.5. Finally, we assume the residual premium income is available for all remaining cost (profits, administrative costs, etc.). This value is about 14% of the loaded premium and should reasonable. Some may be concerned that this is a low value. However, keep

Table 6: Estimates Annual Loss Ratios for All Species Given Pure Premiums

Year	Aggreate Loss Ratio	Cattle Loss Ratio	Sheep Loss Ratio	Goat Loss Ratio	Camel Loss Ratio	Horse Loss Ratio
1969	357	453	272	254	330	404
1970	82	86	45	77	72	128
1971	288	309	267	327	280	235
1972	48	0	90	102	25	28
1973	69	10	90	126	34	94
1974	24	0	30	79	13	0
1976	46	0	87	107	5	19
1977	282	227	389	327	145	228
1978	0	0	0	0	0	0
1980	107	115	80	101	273	103
1981	52	72	18	35	28	81
1982	44	68	0	15	204	55
1983	252	231	259	253	383	255
1984	45	0	96	65	31	44
1985	85	29	130	167	60	45
1986	47	10	100	70	40	24
1987	60	51	64	67	209	35
1988	68	46	66	122	69	50
1989	0	0	0	0	0	0
1990	79	61	110	109	62	44
1991	69	58	64	61	169	84
1992	44	47	17	13	69	100
1993	241	316	213	121	162	287
1994	74	88	80	25	176	77
1995	13	0	16	0	109	32
1996	5	0	0	0	0	26
1997	57	44	78	34	2	90
1998	12	0	20	23	14	13
1999	6	7	0	0	0	18
2000	434	663	307	308	24	386

in mind that the primary administrative cost is marketing and sales, collecting premiums, and making indemnity payments. All other statistics and loss adjustments should occur within the existing system. Thus, 14% may be well within the range of the cost needed. The total annual average position of the Mongolian insurance company follows:

- ✓ •Load premium by 40% to pay for other cost
- ✓ •2.15 x 1.4 = 3% premium rate
- ✓ •Revenue = Tg 30 Billion premium
- ✓ •Reinsurance = Tg 13.6 B
- ✓ •Loss paid by insurer = Tg 12.4 B
- ✓ •All other costs = Tg 4.0 B

Table 7:Balance sheet activities for hypothetical insurance company

Year	Pure Loss Ratio	Payouts or Indemnities	Overall Pure Premium less Indemnities	Reinsurer Payments	Co. Pure Prem less Indemnities	Company Net Position
1969	357%	76.8	(55.3)	-55.3	0	-9.1
1970	83%	17.8	3.7	0.0	3.7	-5.4
1971	289%	62.0	(40.6)	-40.6	0.0	-9.1
1972	48%	10.3	11.2	0.0	11.2	2.1
1973	70%	15.0	6.5	0.0	6.5	-2.5
1974	24%	5.2	16.3	0.0	16.3	7.3
1976	46%	9.9	11.6	0.0	11.6	2.5
1977	283%	60.7	(39.2)	-39.2	0.0	-9.1
1978	0%	-	21.5	0.0	21.5	12.4
1980	108%	23.2	(1.7)	-1.7	0.0	-9.1
1981	53%	11.3	10.2	0.0	10.2	1.1
1982	44%	9.5	12.0	0.0	12.0	2.9
1983	252%	54.2	(32.7)	-32.7	0.0	-9.1
1984	45%	9.7	11.8	0.0	11.8	2.8
1985	85%	18.3	3.2	0.0	3.2	-5.9
1986	47%	10.1	11.4	0.0	11.4	2.3
1987	60%	12.9	8.5	0.0	8.5	-0.5
1988	68%	14.7	6.8	0.0	6.8	-2.3
1989	0%	-	21.5	0.0	21.5	12.4
1990	79%	17.0	4.4	0.0	4.4	-4.6
1991	69%	14.9	6.6	0.0	6.6	-2.4
1992	45%	9.6	11.9	0.0	11.9	2.8
1993	242%	51.9	(30.4)	-30.4	0.0	-9.1
1994	75%	16.0	5.5	0.0	5.5	-3.6
1995	14%	2.9	18.5	0.0	18.5	9.5
1996	5%	1.1	20.4	0.0	20.4	11.3
1997	57%	12.3	9.2	0.0	9.2	0.2
1998	13%	2.7	18.8	0.0	18.8	9.7
1999	6%	1.3	20.2	0.0	20.2	11.1
2000	434%	93.3	(71.8)	-71.8	0.0	-9.1

Averages can be deceptive however. The net position of the values above is zero. Table 7 provides a clear indication that there is great variation around zero. When the losses exceed the pure premium, the insurance company will pay out Tg 9.1 billion. In the years when there are no payments, the net gain will be Tg 12.4 billion. Clearly our insurance company must have capital reserves to manage the risk that remain. Nonetheless, the system designed here does limit the losses.

An Alternative Payout Structure

One concern with the contract designed above is that once the trigger mortality rate is crossed there would be a payment at that rate. This may encourage moral hazard on the part of the officials who are developing the statistics for mortality rates. If they believe that the numbers are close to trigging a payment, they may 'create losses' by

making certain that the values will trigger a payment. This incentive is stronger given the fact that levels of payment are high once the trigger is crossed. An alternative to reduce these incentives would be to scale the payments in once the trigger is crossed. For example, if the trigger were set at a 10% mortality rate, each 1 percentage point above that level could be considered what is referred to as a 'tick' and a certain level of payment could be tied to each 'tick'.

With a tick system, payments would only begin when the mortality rate is equal to 11% and they would be made more gradually. For example, if the corresponding value at risk for cattle is 100,000 Tg and a herder has 100 cattle, they would want insurance values of 10,000,000 Tg. If we consider that the maximum mortality rate in a sum may be 60%, then we have 50 ticks between the trigger value of 10% and 60%. We can divide the 10,000,000 Tg by 50 ticks to get a value per tick of 2,000,000 Tg. Thus, at 11% mortality the herder with 100 cattle would receive 2,000,000 Tg. If the mortality rate is 12%, the payment would be 4,000,000 Tg, and so on.

Payment = (Mortality rate – Trigger) x Tick Value
= (12% - 10%) x 2,000,000.

This system may also be more easily explained to a herder. The explanation is simply – for each point above the trigger you will receive a payment of 2 million Tg. Premium rates and all other considerations could be recalculated using procedures that are similar to those presented above with the new payout rules.

Other Considerations

Concerns Regarding Ability to Predict Bad Years

A number of other considerations should be discussed. The ability of both herders and insurers to know something about the risk of livestock losses in the coming year is a problem. Everyone agrees that in a very dry summer when grass does not grow to adequate height, the likelihood that heavy snow will cover the grass and create a dzud is much greater. Thus, either party can use this information in a fashion that is harmful to the intent. For example, the insurer may decide not to offer insurance given this type of season prior to winter. By the same token the herder may decide that this is the year to purchase the insurance whereas in other years they do not. This is intra-temporal adverse selection. Either form of behavior is undesirable. The rates could be adjusted from year to year. However, this is cumbersome and would likely lower participation in precisely the years when it is needed.

Recommendation: Offering a three-year sequentially updated contract may be the best option to deal with the knowledge that is available about likely losses well in advance of the year beginning. The herder would sign a contract stating that they would be obligated to pay the premium in January for each of the next three years. A renewal of the contract in the following year would also obligate the herder for three more years. The contract would simply roll forward in time with each sign up unless the herder explicitly chose to

cancel. This would prevent either the herder or the insurer from changing their behavior when information going into the winter gives an indication of the likely loss. Premium surcharges could be imposed for herders who chose to take only a one-year contract. Other penalties may be in order for herders who cancel before the contract expires.

A dual Payment System

Recommendation: Given that most dzud create the serious livestock losses in the spring, it may be possible to structure a dual payment system. A preliminary payment could be made in June when conditions clearly show that a serious loss has occurred. The remaining payment would be made at the end of the year.

Linkages to micro-finance

In discussions with herders we asked about the nature of collaboration they engage in with neighbors, farmer associations, cooperatives, etc. While the herders we visited did not belong to associations or cooperatives, they were involved with their extended families and neighbors in a number of joint activities. We described a concept whereby they might collaborate with these same neighbors in buying the mortality index. In this fashion, they could each buy the index based on their own herds and then collectively decide who among them needed the most assistance when the index paid. Such agreement would need to be worked out early and negotiated as the event occurred. The herders we visited felt that this was workable and something they may consider. In effect, such an arrangement would be like a mutual insurance that could even be turned into an effective micro-finance group. If a group of herders in the same region had such arrangements, some of the emerging micro-finance banks may be willing to make loans to the group or to individuals in the group. The index contract should remove the major risk that these herders face.

More formal structures could also be facilitated under the micro-finance component of the World Bank and FAO projects. Farmer associations or cooperatives could be encouraged to follow this model with the promise of loans. The goal would be to get these associations to begin to offer these services of collective and mutual insurance coupled with micro-finance loans. The mortality index contract could be a key component of this activity.

Linkages to Community Investment Funds

When visiting with sum officials about how such index contracts could and should be sold to others who have value at risk when there is a livestock disaster, the immediate question was 'could the sum purchase such a contract?' The answer should be yes. Sum governments undoubtedly suffer fiscally when there is a major loss in livestock. In addition, they are struggling to provide assistance to families in the sum who have suffered the most. Thus, one can envision allowing the sum government to purchase this insurance. It would be a clear indicator of problems and it is scaled in such a fashion that the more serious the problem, the greater the payments. Some share of

community investment funds might be used by sums to purchase these contracts. The important issue for the community is what are the relative costs of purchasing these contracts versus holding some fiscal reserves for these type of livestock disasters?

Given the design of these contracts, there is every reason to allow any entity that has an insurable risk to purchase a mortality index contract. This would not create an underwriting problem and it cannot create extra losses since it is an index. The banks and input supplies may be interested in directly purchasing this contract. Both have a portfolio of risk that is directly tied to the well being of the herders. Many others in the community may also have their income and well-being directly tied to the well-being of the herders.

Alternative Roles for Government

What is presented here are some basic ideas. There are many possible roles for government. Until there is more interaction with policy makers and others about the desired course of action, it is premature to develop this much beyond some basic ideas. Work performed for the government of Argentina could be used as a basic model for government role. The key aspect of whatever role the government plays is that it be limited and that it be structured to spur private insurance markets without giving the insurance markets too much opportunity for rent seeking.

A number of alternative roles for government are possible. At one end of the spectrum, the only involvement may be to continue to support development of the loss data and the census coupled with the appropriate regulatory framework that allows these index contracts to be developed and sold by the private sector. At the other end of the spectrum, a relatively basic (and low value) index contract could be sold and reinsured directly by the government in such a fashion that would facilitate some catastrophe protection for herders and at the same time spur private insurance companies to offer additional insurance coverage. No matter what course is taken the government must remain involved in developing the loss data and the census population. This infrastructure is key to the success of this concept.

If the government could afford to make this index insurance available to all herders at a pure premium rate, the total cost to the government may be about Tg 10 billion. Under such conditions, the herder would pay for a basic policy with premiums that just equal the expected payouts (indemnities). The government would pay for the reinsurance and the administrative cost. If such an approach were tried it would be critical to offer insurance only at the expected value of the animals for the basic government policy. Further, it would be important to create incentives for the private insurers to offer more insurance. For example the private companies could be allowed to sell the government insurance only if they offered some additional value. Otherwise, the basic policy would be available for herders who want no more insurance coverage than what is provided with the government policy. Other delivery channels for the basic policy may be considered.

Once the basic policy was in place, much of the covariant risk would be removed from the market. The private companies could offer individual insurance that would pay for losses not paid for by the basic policy. For example, once the index policy payment is made, herders could file a claim for any remaining losses suffered that are not paid. Another policy could be offered at a lower level or layer of risk. For example, if the basic policy begins paying for mortality rates above 10%, the private policy could pay for mortality rates between 7% and 10%. With this type of layer, the covariant risk would not be nearly as serious as for the upper layer (the basic policy pays the upper layer – losses between 10% and 100%).

Conclusion

The need to carefully consider how livestock insurance may influence the incentives of herders in Mongolia is significant. The overriding goal of maintaining and enhancing the risk mitigation strategies used by Mongolia herders mandates that careful thought be given to how livestock insurance might be structured. This report has provided some thinking to that end. This is at the core of the recommendation that a livestock mortality index be used to provide insurance on a sum or bag level. Such insurance would pay every herder based on the mortality levels within the region, regardless of the individual herder losses. Consequently, the individual herder who works hard to sustain their livestock during a dzud would be rewarded. By the same token, the herder who does not work to sustain their livestock will only be compensated at the losses for the community. This system will not reward the herder who has heavy losses when the community does not. Using the area mortality index to pay nearly eliminates moral hazard and adverse selection. The major concern will be to maintain quality statistics for mortality rates.

Even if a mortality index is used, this study also reveals the high level of co-variate risk that would remain. The models developed here highlight the need for risk sharing in the international community. Just how that risk is shared would depend heavily on the ultimate structure of government involvement in providing some level of reinsurance. In early stages some level of government involvement is needed to spread the risk across Mongolia to the extent possible. However, this role should be as a risk aggregator only so that private providers can combine their risk with others across Mongolia.

Should there be a desire to proceed with a pilot test of the mortality insurance concept, there are a number of additional items that would need attention as first steps. These steps should be taken to test the feasibility and acceptability of mortality index insurance. Some basic considerations and next steps follow:

1. **Collect data on mortality and adult livestock numbers for more sum;** make certain that these data are complete for all species of livestock for at least 30 years; create a data set for as many sum as possible but, at a minimum, obtain a geographic spread of sum within a aimag and complete at least five sum for each aimag.

2. **Investigate in some detail the statistical system that is being used to develop the census of animals and the reporting of mortality of animals**. This investigation should be conducted with a clear picture of how these data might be used to make insurance payments. A number of issues should be investigated: 1) what is the quality of these data? 2) Could the data be developed at the bag level? 3) Has the process for developing the data changed in any significant fashion in the last 30 years? 4) Have the data been used in the past to make emergency disaster payments and, if so, is there any evidence that this created any misrepresentation in the data? 5) Given that a census is taken every year, are there adequate safeguards and accounting systems in place to mitigate the opportunity for manipulating the data? 6) What auditing systems might be added to assure that the data process does not change when a insurance payments are being made on the basis of the data? 7) How do herders and others view the quality of the data?
3. **Select a sample of sum to offer the mortality index insurance.** Initially, the government could collaborate with the private insurers and make insurance offers in a select sample of sum. The sample should be selected with some geographical spread in mind. Ideally, the offers would be made in about 30 sum. Given that the mortality data are widely available, it may be possible to make select a representative sum in every aimag to begin the pilot. This would give as much geographic spread as possible and provide the needed publicity across Mongolia for the concept. Great care should be taken in making certain that the price that is charged reflects the relative risk. The premium rates charged herders and the design of the contracts should be consistent with market principles. Initially, the government could provide some level of reinsurance to private provides to get their involvement. Simultaneously, the concept and pilot design should be presented to the international capital markets obtaining their input and attempting to get their involvement in offering reinsurance.
4. **Develop an extended education and marketing program.** Any successful pilot must educate herders about the potential value and use of this insurance. Some considerable attention should be paid to an educational effort.
5. **Establish appropriate feedback and monitoring of the pilot.** A pilot program should be designed to allow for learning about the concept. This learning must involve a number of dimensions: a) how have the private insurers respond to the opportunity? b) how have the herders responded? c) are herders thinking of and using informal and formal mechanisms to share the index payments within the community? d) has the introduction of the index insurance changed the data development process in any significant fashion?

In a pilot test, one may attempt to offset the cost of the insurance to herders so that herders would just pay the pure premium of the program. This would require some budget obviously. Additional financing would be needed for resources to examine the issues outlined above and for education and marketing. Thus, careful thought must be made as to the scope of a pilot and the total amount of funds available for running such a test.

Main articles of the draft law on livestock insurance

1. Purpose of the law

1.1 Purpose of this law is to regulate the relationships between insurance companies, citizens and legal bodies on compulsory insurance of livestock

4. Scope and forms of livestock insurance

4.1 Livestock insurance can be compulsory and voluntary

4.2 Citizens and legal bodies shall insure breeding animals and young animals to replace aged breeding animals on a compulsory basis

/There were proposals from Mongol Daatgal company and Tushig Daatgal company that livestock insurance should cover all animals not only breeding but this was not accepted in the final draft/

5. Livestock insurance

5.1 Livestock shall be insured on a compulsory basis against the following risks:

5.1.1 Drought and *dzud*

5.1.2 Sudden disasters such as flood, strong storms, cold showers, fires

5.1.3 A class contagious diseases

5.1.4 some serious diseases in B and C classes

6. Insurance agreement and guarantee

6.1 Livestock insurance agreement and guarantees shall be regulated by the articles 9.1 and 9.2 of the Law on Insurance.

6.3 Livestock insurance agreement shall be based on the livestock census data at the end of year and shall be established by 1 April.

6.4 An insurance company can partly or wholly reinsure livestock risks by domestic and international companies.

7. Insurance duration

7.1 The duration of livestock insurance agreement shall be for 365 days since the date of signing.

8. Insurance value and premiums

8.1 Value of animals insured shall be established through negotiations between 2 parties

8.2 Premium for compulsory livestock insurance shall be 2% of the value[7].

8.3 Premium shall be paid by 1 April in cash.

9. Insurance indemnities

9.1 Citizens and legal bodies shall report about animal losses within 72 hours in cases of sudden disasters and 2 times per month during droughts and *dzuds*.

[7] There was some indication that the 2% value had been increased to 4%. However, this is not confirmed. Even 4% is unlikely adequate to support a totally private market policy with the coverage outlined in Appendix A. Someone inside the Ministry has done some analysis on this issue. However, we were ner able to locate them and learn about this analysis.

9.2 Working group in charge of identifying and certifying reasons, scope and duration of events that caused animal losses shall be appointed by *sum* Governors. Working group shall be composed of representatives of insurance companies, citizens and legal bodies /clients/, livestock expert, weather expert and other relevant bodies.
9.3 Whether the event can be considered, as drought and *dzud* shall be determined by the Government.
9.4 Insurance companies shall disburse indemnities within 30 days from the date of conclusion by the Working group.
9.5 Indemnities shall by determined on the following rate based on the value under insurance:
9.5.1 100% for sudden disasters, 70% for droughts and *dzuds*
9.5.2 100% for A class diseases, 80% for B and C class diseases.
9.6 Relationships regarding indemnities shall be regulated by articles 13.1-13.6, 13.5.5, 13.9-13.10, 13.12-13.15 of the Law on Insurance.
9.7 Insurance companies shall not pay indemnities in the following cases:
9.7.1 Livestock losses due reasons not indicated in the Agreement
9.7.2 Due to failures by citizens and legal bodies to timely report animal losses and resulting impossibility to determine reasons and scope of losses
9.7.3 Duration of agreement /insurance/ is expired

10. Concessions on insurance premiums
10.1 In cases of citizens and legal bodies are not paid indemnities for 3 consecutive years they shall pay insurance premiums reduced by 20% from the fourth year.

11. Insurance companies
11.1 Compulsory livestock insurance shall be run by insurance companies partly or wholly owned by the state.
11.2 Companies in 11.1 shall have capacity to be reinsured by international companies.

12. Responsibilities to violators of the law
12.1.1 Insurance companies that fail to pay indemnities wholly or partly they shall compensate them and pay penalty in the daily rate of 0.1% from the expired date based on the value of liability.
12.1.2 Citizens and legal bodies that fail to insure livestock shall pay insurance premiums and penalty 10 000-25 000 *tugrug* in the case of citizens and 10 000-40 000 in the case of officials and 50 000-200 000 in the case of legal bodies.
12.2 Costs caused by wrong reporting shall be paid by body who is responsible for wrong reporting.

Selected Readings

Anderson, D.R. "All Risks Rating Within a Catastrophe Insurance System." *J. of Risk and Insurance* 43 (1976): 629-651.

Arrow, K. J. "The Role of Securities in the Optimal Allocation of Risk Bearing." *Rev. of Econ. Studies* 31 (1964): 91-96.

Arrow, K. J. "The Theory of Risk-Bearing: Small and Great Risks." *J. of Risk and Uncertainty* 12 (1996): 103-111.

Barnett, B. J. "U.S. Government Natural Disaster Assistance: Historical Analysis and a Proposal for the Future." *Disasters: The J. of Disaster Studies, Policy & Management.* Forthcoming.

Buzby, J.C., P.L. Kenkel, J.R. Skees, J.W. Pease and F.J. Benson. "A Comparison of Subjective and Historical Yield Distributions with Implications for Multiple Peril Crop Insurance." *Agr. Fin. Rev.* 54 (1994): 15-23.

Cutler, D. M. and R. J. Zeckhauser. "Reinsurance for Catastrophes and Cataclysms." Working Paper 5913. *NBER Working Paper Series*, National Bureau of Economic Research, Cambridge, MA. February, 1997.

Dacy, D.C. and H. Kunreuther. *The Economics of Natural Disasters: Implications for Federal Policy*. New York: The Free Press, 1969.

Doherty, N. A. *Financial Innovation in The Management of Catastrophic Risk.* Presented paper at ASTIN/AFIR Conference, Australia, August 1997.

Epstein, R. A. "Catastrophic Responses to Catastrophic Risks." *J. of Risk and Uncertainty* 12 (1996): 287-308.

Federal Emergency Management Agency. Unpublished data.

Freeman, P. K. and H. Kunreuther. *Managing Environmental Risk Through Insurance*. Boston: Kluwer Academic Press, 1997.

Griffin, P. "Investigating the Conflict in Agricultural Policy Between the Federal Crop Insurance and Disaster Assistance Programs, and Conservation Reserve Program." Unpublished Ph.D. dissertation, Department of Agricultural Economics, University of Kentucky, 1996.

Hazell, P. and J. R. Skees. "Report to the World Bank on Potential for Rainfall Insurance in Nicaragua." January, 1998.

Hoffman, W., C. Campbell and K. Cook. "Sowing Disaster: The Implications of Farm Disaster Programs for Taxpayers and the Environment." Washington, DC: Environmental Working Group, 1994.

Hogarth, R. M. and H. Kunreuther. "Pricing Insurance and Warranties: Ambiguity and Correlated Risks." *The Geneva Papers on Risk and Insurance Theory* 17 (1992): 35-60.

Hogarth, R. M. and H. Kunreuther. "Risk, Ambiguity, and Insurance." *J. of Risk and Uncertainty* 2 (1989): 5-35.

Jaffee, D. M. and T. Russell. "Catastrophe Insurance, Capital Markets, and Uninsurable Risks." *J. of Risk and Insurance* 64 (1997): 205-230.

Kaplow, L. "Incentives and Government Relief for Risk." *J. of Risk and Uncertainty* 4 (1991): 167-175.

Klein, R. "Regulation and Catastrophe Insurance." In H. Kunreuther and R. J. Roth, Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States.* Washington D.C.: Joseph Henry Press, 1998.

Kunreuther, H, J. Meszarous, R. Hogarth, and M. Spranca. "Ambiguity and Underwriter Decision Processes." *J. of Economic Behavior and Organization* 26 (1995): 337-352.

Kunreuther, H. "Combining Insurance with Hazard Mitigation to Reduce Disaster Losses." *Natural Hazards Observer* 17 (1993): 1-3.

Kunreuther, H. "Mitigating Disaster Losses through Insurance." *J. of Risk and Uncertainty* 12 (1996): 171-187.

Kunreuther, H. "Limited Knowledge and Insurance Protection." *Public Policy* 24 (1976): 227-261.

Kunreuther, H. *Recovery From Natural Disasters: Insurance or Federal Aid?* Washington, DC: American Enterprise Institute for Public Policy Research, 1973.

Kunreuther, H. and P. Slovic. "Economics, Psychology, and Protective Behavior." *American Economic Review* 68 (1978): 64-69.

Lamm, R. M. Jr. "The Catastrophe Reinsurance Market: Gyrations and Innovations amid Major Structural Transformation." *Bankers Trust Research.* Bankers Trust Company, New York, NY. February 3, 1997, pp 1-13.

Leikin, H. L. And T. L. Hayes. "National Flood Insurance Program Flood Insurance Rate Review." Federal Insurance Administration, Federal Emergency Management Agency. October 31, 1996.

Lewis, C. M. and K. C. Murdock. "The Role of Government Contracts in Discretionary Reinsurance Markets for Natural Disasters." *J. of Risk and Insurance* 63 (1996): 567-597.

Miranda, M. J. and J. W. Glauber. "Systemic Risk, Reinsurance, and the Failure of Crop Insurance Markets." *Amer. J. Agr. Econ.* 79 (1997): 206-215.

National Oceanic and Atmospheric Administration. http://www.nws.noaa.gov. November 7, 1997.

Natural Disaster Coalition. "America at Risk: The Growing Threat from Natural Disasters." Washington, DC, undated.

Noll, R. G. "The Complex Politics of Catastrophe Economics." *J. of Risk and Uncertainty* 12 (1996): 141-146.

Noonan, B. "A Catastrophe Waiting to Happen?" *Best's Rev.*, February 1994, pp. 30-33.

Priest, G. L. "The Government, the Market, and the Problem of Catastrophic Loss." *J. of Risk and Uncertainty* 12 (1996): 219-237.

Rejda, G. E. *Principles of Risk Management and Insurance.* New York: Harder Collins College Publishers, 1995.

Rettger, M.J. and R.N. Boisvert. "Flood Insurance or Disaster Loans: An Economic Evaluation." *Amer. J. Agr. Econ.* 61 (1979): 496-505.

Rossi, P., J. Wright and E. Weber-Burdin. *Natural Hazards and Public Choice: The State and Local Politics of Hazard Mitigation*. New York: Academic Press, 1982.

Skees, Jerry R. "A Role for Capital Markets in Natural Disasters: A Piece of the Food Security Puzzle." *Food Policy* 25 (2000): 365-378.

Skees, Jerry R. "Opportunities for Improved Efficiency in Risk-Sharing Using Capital Markets." Am*erican Journal of Agricultural Economics.* 81(1999): 1228-1223.

Skees, Jerry R. "Agricultural Risk Management or Income Enhancement?" *Regulation: The CATO Review of Business and Government.* 22 (1999): 35-43.

Skees, Jerry R. and Barry J. Barnett. "Conceptual and Practical Considerations for Sharing Catastrophic/Systemic Risks." *Review of Agricultural Economics.* 21 (1999): 424-441.

Skees, Jerry R. and Barry J. Barnett. "Area Yield and Weather Based Crop Insurance." *Forthcoming Book Chapter, AgriRisk, Australia.*

Skees, Jerry R. and Kimberly Zeuli. "Using Capital Markets to Increase Water Market Efficiency." Presented at the International Symposium on Society and Resource Management. Brisbane, Australia. July 8, 1999.

Skees, Jerry R., "More Crop Insurance Reform: A Good Idea Gone Awry." *Regulation: The CATO Review of Business and Government.* 1st Quarter, 2001, 24: 16-21.

Skees, Jerry R., Barry J. Barnett and J. Roy Black. "Designing and Rating an Area Yield Crop Insurance Contract." *American Journal of Agricultural Economics.* 79 (1997): 430-438.

Skees, Jerry R., Peter Hazell, and Mario Miranda. "New Approaches to Public / Private Crop Insurance." Forthcoming chapter in book to be published by the World Bank, Washington. D.C.

Skees, Jerry, Panos Varangis, Donald Larson, and Paul Siegel. "Can Financial Markets be Tapped to Help Poor People Cope with Weather Risks?" World Bank Working Paper number 2812. March, 2002.

Skees, Jerry, Stephanie Gober, Panos Varangis, Rodney Lester, and Vijay Kalavakonda. "Developing Rainfall-Based Index Insurance in Morocco." World Bank Working Paper number 2577. April, 2001.

Stipp, D. September 8, 1997. "A New Way to Bet on Disasters." *Fortune*.

U.S. General Accounting Office. "Disaster Assistance: Crop Insurance Can Provide Assistance More Effectively than Other Programs." RCED-89-211. Washington, DC: U.S. Government Printing Office, 1989.

U.S. General Accounting Office. "Federal Disaster Assistance: What Should the Policy Be?" PAD-80-39. Washington, DC: U.S. Government Printing Office, 1980.

U.S. General Accounting Office. "Federal Disaster Insurance: Goals are Good, But Insurance Programs Would Expose the Federal Government to Large Potential Losses." T-GGD-94-153. Washington, DC: U.S. Government Printing Office, 1994.

U.S. General Accounting Office. "Natural Disaster Insurance: Federal Government's Interests Insufficiently Protected Given Its Potential Financial Exposure." T-GGD-96-41. Washington, DC: U.S. Government Printing Office, 1995.

Vaughan, E. *Fundamentals of Risk and Insurance.* New York, NY: John Wiley & Sons, 1989.

Walter, A. S. "Risk Management in Agriculture." Testimony before the U.S. Senate Committee on Agriculture, Nutrition, and Forestry.