Weather-Indexed Crop Insurance

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1. Introduction

There has been a growing demand for crop insurance in third world countries to combat poverty among farmers. Farmers in these countries could greatly improve crop yields if they had access to higher quality inputs, such as seeds and fertilizers. However, in order to buy these higher quality inputs the farmers need to obtain loans from microfinance institutions. These institutions are reluctant to extend loans to farmers due to the risk of loan default resulting from crop failure. With increasing abnormal weather patterns due to climate change, the concern for crop failure is on the rise and the need for such insurance is becoming more significant.

Weather indexed insurance contracts were first developed in 2007 for farmers in Malawi, Tanzania and Kenya by the International Research Institute for Climate and Society at Columbia University.

Motivated by a non-governmental organization's unsuccessful attempt to buy a crop insurance product for the farmers they serve, we designed rainfall indexed crop insurance for maize farmers in Kakamega, a western region of Kenya. The payouts of the insurance are determined by the amount of rainfall measured at a certain weather station over a covered period of time. The typical insurance need per farmer is about $50 US and our aim is to have the expected payout be no more than 5% of the insured amount. Based on 38 years of rainfall data from 1970 to 2007 of the Kakamega region, and applying a similar method to that of Daniel Osgood et al. [3], we calculated payout amounts over the years. Our goal is to develop a crop insurance product priced attractively for the farmers with benefits satisfactory to microfinance institutions.

Based on the 38 years of data, the payout distribution is very sparse, and we are working to generate more data, through a simulation, that will lead us to a more robust payout distribution. This is a work in progress

2. Rainfall-Indexed Crop Insurance

Insurance covered period starts from the sowing of the maize and ends after 20 weeks. The covered period is divided into five phases during which payout can occur. Maize requires different amounts of rainfall to grow properly during its various stages of development, not needing much rainfall towards the end of a growing season.

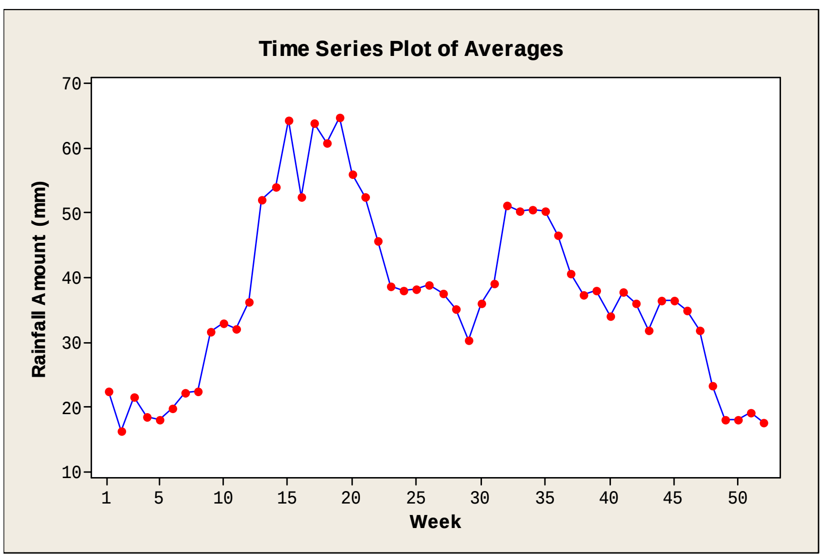
In any given phase we define two levels of rainfall amounts; Stress level and Failure level.

Table 1. The Stress and Failure levels of the five phases.

Phases	Days	Rain Needed (mm)	Stress Level (mm)	Failure Level (mm)
1) Germination	0-29	68.6	27.4	0.0
2) Vegetation	30-55	137.2	54.9	0.0
3) Silking	56-88	268.2	134.1	53.6
4) Milk/Dough	89-125	204.2	81.7	0.0
5) Maturity	126-140	38.1	15.2	0.0

Certain growing periods require more rainfall than others, and as such, it's important for those periods to occur during times of the year with the most potential rainfall. This allows the crops to have the greatest opportunity to avoid complete failure. As can be seen in the time series plot of average weekly rainfall for a 38-year period, Figure 1 below, weeks 10 through 45 typically have the highest rainfall amounts. Taking this into consideration, we designed our contract assuming no corn would be planted earlier than March 1st, so that crucial stages such as silking should occur during the weeks of the year that historically have the most rainfall. We note that there are two growing seasons in the region. Our study is focused on the main growing season that starts in the spring.

Figure 1.



Definitions

Covered Period: Starts from the sowing of the maize and ends after 20 weeks. The covered period is divided into five phases as defined in Table 1 above during which payout can occur.

Sowing: Starts after observing 25mm of rainfall in the previous 10-day period (sowing condition). The insurance contract begins the first day this condition is met after March 1st.

Payout: Maximum payout is 100, representing 100%, per farmer per growing season. Payout is zero if the rainfall amount in a phase is above its Stress level and is linearly scaled when the rainfall amount is below the Stress level: zero at the Stress level and 100 at the Failure level. (If the total rainfall amount during a phase falls below the failure level, complete crop failure is assumed and the insurance contract pays out the entire 100%.)

Payout in a phase = 100 x (1 – (Total rainfall – Failure level) / (Stress level – Failure level))

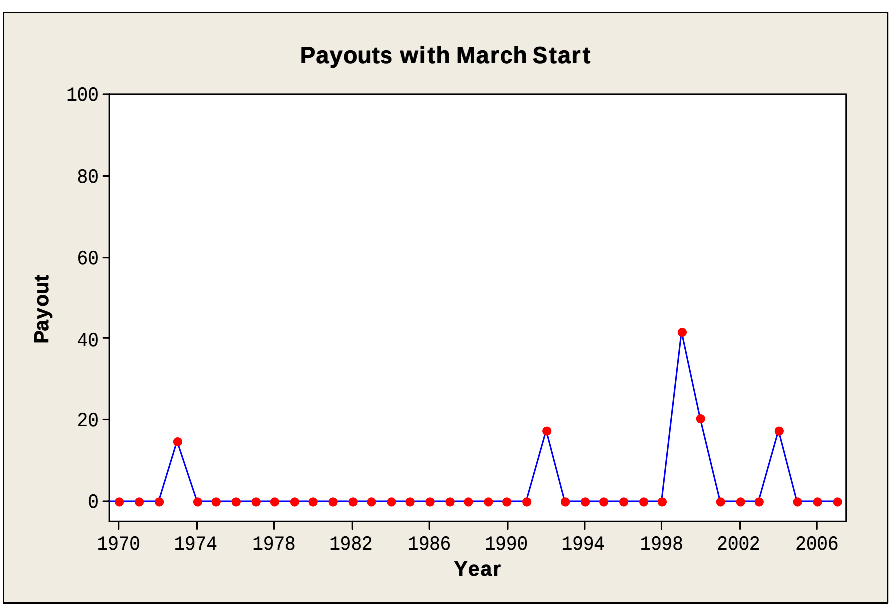
When the total payout reaches the maximum 100, the contract terminates.

Premium Calculation

Our first goal is to have expected payout to be about 5% (severity) so the premium charged will be affordable. The second goal is to have the frequency of the payouts to be about 25% of all years. The number of phases introduced during the covered period affects the frequency and severity of payouts. The 5 phases introduced in Table 1 produced the best results.

Applying the above payout scheme and the rainfall requirements set in Table 1 to 38 years (1970 – 2007) of historical rainfall data produced an expected payout of 2.93% with payout occurring in 13.2% of all years. Payout for any given year can be seen in Figure 2 below.

Figure 2.



Advantages and Disadvantages

The advantages of the use of weather indexed crop insurance are that it decreases moral hazard and adverse selection. Moral hazard is the increased potential for loss resulting from a farmer intentionally allowing a crop to fail in order to collect the insurance payouts. Because actual crop yield is not used in determining payout for the product, any farmer who would try this would not benefit. Adverse selection is the natural tendency for only less skilled farmers to purchase a crop insurance product, as they are more likely to experience crop failure. Because payout is based on rainfall instead of yield for our product, farming skill isn't a factor. Besides these advantages, the ease and lower cost of claim settlements is another very important benefit resulting from the use of this type of insurance product. Because payout is determined by rainfall only, determining payout is extremely simple and doesn't require an inspection of the crops harvested, which makes the product much cheaper to administer. Two of the most important qualities this product needs to have for it to be attractive to farmers in third world countries are simplicity and value. Since there is not a long and complicated settlement process, it is much easier for the farmers to understand.

However, there are several disadvantages associated with the use of weather-indexed crop insurance. Because loss is based on rainfall and not on yield, there is a possibility of discrepancy between actual crop loss and payout. While amount of rainfall and crop yield are highly related, there can be other factors that could lead to a poor crop yield or even complete crop failure. Also, the amount of rainfall used to determine payout has to accurately portray the actual amount of rainfall experienced at each farm. For this to happen, an insured farm must be located within 10 kilometers of a weather station. Since there are currently not enough weather stations in Kenya, this poses a restriction on the availability of the insurance to a wider region.

3. Future Plan

We plan to simulate rainfall amounts based on our historical rainfall data to obtain better estimations of mean and variance of the payout distribution.

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Works Cited

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