SHORT, NON-REFEREED PAPER

ANALYSIS OF LONG-TERM RAINFALL IN THE FELIXTON MILL SUPPLY AREA AND INVESTIGATION OF DERIVATIVES AS A HEDGING MECHANISM AGAINST DROUGHT

HOWES RE[1], DUCASSE G[2] AND FUNKE T[3]

South African Cane Growers' Association, PO Box 888, Mount Edgecombe 4300, South Africa

[1]richard.howes@canegrowers.co.za [2]guy.ducasse@canegrowers.co.za
[3]thomas.funke@canegrowers.co.za

Abstract

Rainfall since 1948 was assessed in order to highlight the plight that growers in the Zululand region of the industry have faced. Analysis of the trend included an attempt to take a forward-looking view on future sustainability practices given the weather trends, and the potential use of weather derivatives to mitigate risk.

SASRI rainfall records for the Felixton catchment area were used to make the long-term rainfall assessment to determine whether the region is facing a long-term drying off of the climate. An initial weather derivate model was built to assess suitability for mitigation of adverse rainfall risk.

The conclusion reached was that the Felixton region has been experiencing decreasing rainfall over an extended period. Mean annual rainfall from 1948 to 2004 was 1038.1 mm. A total of 15 of the 16 years from 2001 to 2016 had annual rainfall below this level.

It should be noted that the preliminary analysis in this paper indicates that weather derivatives have the potential to mitigate risk however further analysis is required to determine a mechanistic hedging strategy that would leave growers better off over the long term through hedging.

Introduction

Seasonal rainfall has traditionally been measured against long term mean (LTM) rainfall to estimate the crop potential for the current season. Anecdotal evidence from the grower community suggested that the climate in the Felixton region had changed over time with annual rainfall decreasing over the recorded period. The long-term climate trend is a critical piece of information for growers when determining long-term strategy for their farming operations. If the climate records confirmed a drying climate, this information would be crucial for decision making on irrigation investment, diversification, and growth strategies. Declining rainfall, and the resulting declining yields, would necessitate increases in farm scale among other interventions to remain viable.

Rainfall records for the Felixton mill supply area are available from 1948 (source: South African Sugarcane Research Institute (SASRI) Weather Web: http://portal.sasa.org.za/weatherweb). An analysis of the rainfall records was undertaken to see if this anecdotal evidence could be confirmed.

It will be shown in this short paper that rainfall has a declining trend. As a result, the second objective was to carry out an initial investigation into weather derivatives as a mitigation strategy.

Strategies are required to mitigate against the declining rainfall and resultant decline in farm yields. These could include investment in irrigation infrastructure, diversification into higher value crops, and consolidation of farms into larger scale operations to benefit from economies of scale (through mergers, acquisitions, and through creation of cutting fronts).

Weather derivatives offer an additional mitigation option. Weather derivatives are a mechanism that allows a grower to pay a premium to an insurer who pays out a return if the rainfall received in the period for which the derivative is taken is either more (a put) or less (a call) than the LTM for the period.

Rainfall data is gathered using satellite-based weather monitoring operated by NASA, and growers can buy derivatives that hedge against the risk of rainfall anomalies (too little rainfall during growing months and too much during harvesting).

In this paper, the 2016 drought stricken season was used to demonstrate the mechanics of weather derivatives as a hedging mechanism. A sample calculation for the Felixton region was conducted as a preliminary step to assess the viability of derivatives as a hedging strategy, and to gauge the need for further work to build a mechanistic model for purchasing derivatives to mitigate risk.

This paper is the preliminary first step towards a more rigorous analysis of climate change in the Felixton area and the suitability of weather derivatives to mitigate against any change.

Annual Rainfall

The annual rainfall from 1947 to 2016 is shown by decade in Figure 1.

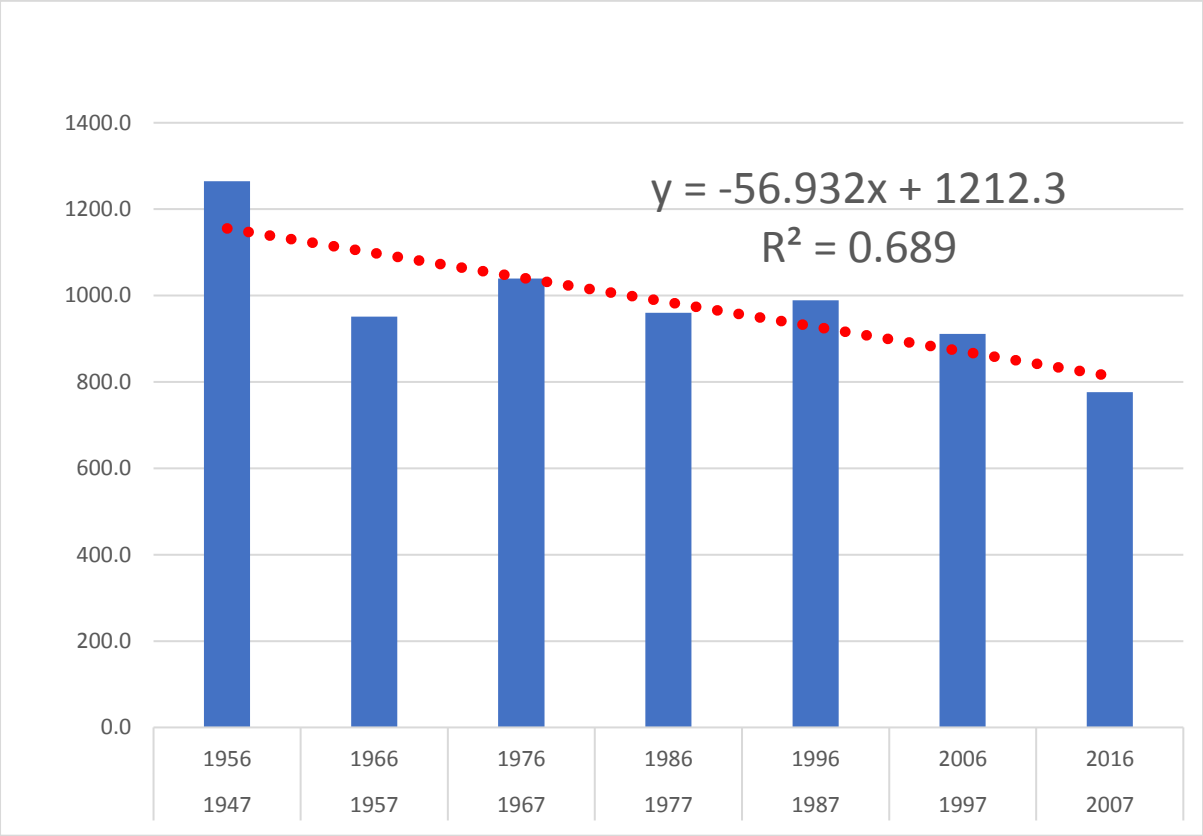

Figure1. Felixton rainfall data, presented as the annual average for each decade for the record period 1947 to 2016.

Drought recovery periods

Based on SA Cane Growers' Association cost surveys and through assisting growers with budgets, it was found that a grower needs approximately three to four years to recover from one year of drought. The data in Figure 2 indicates a variability of rainfall in the Felixton supply area suggesting that there were few periods when growers had a sustained recovery. In the 68 years since 1947 there have been only two periods of four or more consecutive years of rainfall in excess of 1000 mm.

The statistical values for the entire data set are as follows:

Mean annual rainfall:	984.4 mm
Standard Deviation:	268.8
Coefficient of Variation:	0.273

For the first 16 years of this 68 year period, 1948 to 1963, there were 15 years with rainfall over the LTM (94%). In the past 16 years of this period there were four years where rainfall exceeded the LTM (25%).

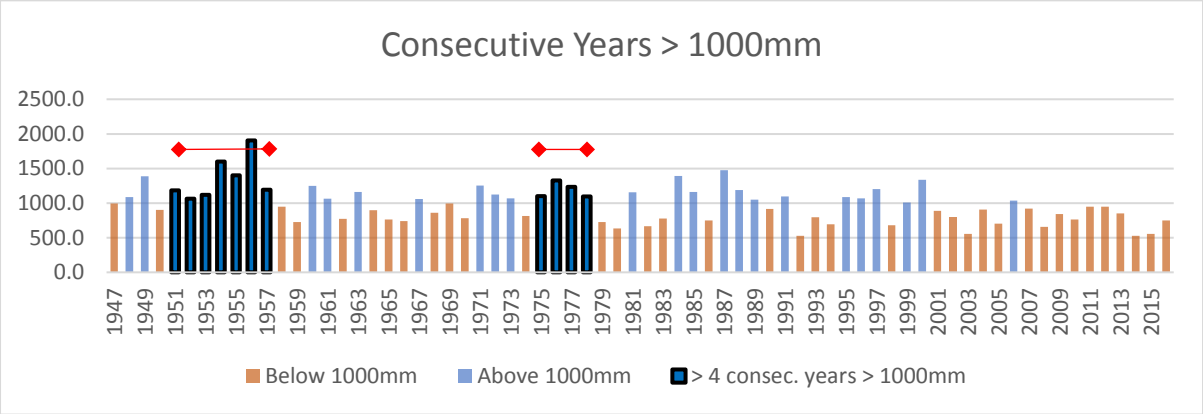

Figure 2. Periods of four or more consecutive years of rainfall above 1000 mm.

Derivatives as hedging strategy

The rainfall records since 1948 reflect a declining trend in average annual rainfall across the decades with variability between seasons. This creates an opportunity to hedge against adverse rainfall both during the growing and harvesting seasons.

Hedging is particularly beneficial during planting operations. The cost of replanting is high, introducing a risk, should germination be poor due to inadequate rainfall during the crucial period after planting. A hedge against too little rainfall would provide the necessary funding for replanting in the event of crop failure.

Hedging mechanism

The hedging mechanism uses NASA rainfall data to determine rainfall (current and long term mean) and allows for the purchase of a hedge 20 or more days before the start of the hedging period. The hedging period can be as short as two days and as long as 12 months.

A hedge consists of a 'strike' and an 'exit'. A 'strike' is the value below which the derivative starts to pay out. This is typically a percentage of the LTM for the period, with 60% as a good

starting value (e.g. when LTM rainfall is 100 mm a 60% strike would be 60 mm). An 'exit' is the level of rainfall below which the hedge is paid in full. This is always lower than the strike.

The premium paid as a percentage of the value of the hedge depends on the strike and exit values. The lower the strike and exit values the lower the probability the hedge will pay out and therefore the lower the hedge premium. Optimum values depend on several factors including: reason for the hedge (planting, harvesting), affordability, or required pay-out in the event of extreme weather. The grower is free to determine the value of the hedge as well as the strike and exit values; however, the economics of the premium and probability of pay-out limit the practical values for these parameters.

The example below was determined in conjunction with a weather hedging service provider in South Africa, and is typical of a hedge against low rainfall in the Felixton summer rainfall area for the period in the example. While this is a realistic example hedge for the area and period, further research is required to determine an optimal mechanistic hedging strategy.

Example: Early season hedge, 15 November to 5 December, Felixton area

In this example, an early season hedge from 15 November to 5 December, the hedge would need to be exercised by 25 October (20 days before the hedge period) or earlier.

The 10-year average (2007 to 2016) for rainfall for the period 15 November to 5 December is 77.62 mm. Assuming, a R1,000,000 derivative with a strike of 60% (equates to 47 mm) and an exit of 17 mm (strike less 30 mm), Equation 1 was applied to calculate a pay-out of R33,333.33 per mm:

Pay-out per mm = Derivative value / (strike – exit) Eq 1
= R1,000,000 / (47 – 17)
= R33,333.33

In the 2016/17 season, 11.21 mm of rainfall was recorded by NASA for the period 15 November to 5 December. As this is below the exit of 17 mm, the entire R1,000,000 would have been paid out. The premium for the period would have been 18.5% resulting in a net pay-out of R815,000.

This pay-out should be viewed in comparison to the yield return, should rainfall have been at or above normal for the period. The revenue potential could be simplistically estimated at 10 tons per ha per 100 mm of rainfall:

At LTM:
Yield = 10 tons/ha/100 mm * 77.62 mm
= 7.76 tons /ha
Yield value = 7.76 * 12.5% RV * R4,931.91
= R4,783.95/ha
Value 300 ha = R4,783.95 * 300
= R1,435,155

Actual:
Yield = 10 tons/ha/100 mm * 11.21mm
= 1.12 tons/ha
Yield value = 1.12 * 12.5% RV * R4,931.91
= R690.47/ha
Value 300 ha = R690.47 * 300
= R207,141

Net return LTM:

If rainfall had been at the LTM value, the derivative does not pay and the return on farming operations is revenue from growth for the period less the premium value.

Revenue – Hedge premium
= R1,435,155 – R185,000
= R1,250,155

Net return actual:

Rainfall received for the period was 11.21 mm, which is below the exit of 17 mm, implying the full pay-out of R1,000,000 would be received.

(Revenue + hedge pay-out) – hedge premium
= (R207,141 + R1,000,000) – R185,000
= R1,022,141

Summary

Should the grower have received the LTM rainfall for the period, the farm revenue is decreased by the amount of the premium with no pay-out, a revenue decrease of 12.9%.

In the period 15 November to 5 December 2016, 11.21 mm of rain was recorded. The derivative example used would have resulted in a net revenue of R1,022,141, against a cane revenue without the derivative of R207,141. This represents a net gain of 493%.

Conclusion

Preliminary research indicates that weather derivatives may offer the potential to provide an effective hedging mechanism against the effects of adverse rainfall during the growing season. Hedging has the effect of flattening out the peaks and troughs associated with variable rainfall as experienced in the Felixton mill supply area over the past several decades.

More work needs to be done on determining a mechanistic method of constructing a hedging strategy to ensure maximum effectiveness and eliminate any aspect of ‘gambling’.