An Economic Analysis of a Climatic Prediction Rule to Trigger Drought Management Strategies

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Abstract: Early warning of drought would generate major economic gains to the wool and other agricultural industries by permitting better decision-making before and during adverse seasons. An individual wool producer's success in managing drought lies in taking early action to avoid price discounts on culled stock and price premiums on fodder, while keeping remaining stock in a productive condition. The GrassGro decision support tool was used to investigate the value of a climatic prediction rule to trigger management changes in a wool enterprise. The rule is that '*Poor spring conditions tend to follow winters with low available soil moisture and a negative or falling Southern Oscillation Index phase*'. Simulations of typical wool production systems were conducted for Rutherglen and Colbinabbin in Victoria, for each year climatic data was available (99 and 90 years respectively). Estimates of returns from using the rule to trigger the following three management actions were made: i. Fodder purchase, ii. Destocking, and iii. A combined strategy. Analysis was conducted under different stock and grain price scenarios and comparisons were made to a 'perfect knowledge' scenario. For Rutherglen an average net gain was estimated from using the rule for various scenarios for each strategy. Results were less favorable for Colbinabbin. However negative cashflow was estimated for many years at both sites. While this reduces the attractiveness of using the rule rigidly, more flexible use is expected to be more beneficial. For example farmers should be on heightened alert when the rule is triggered, but not necessarily commit to significant changes. The rule may also contribute to reduced stress on farm families and enhance environmental benefits.

Keywords: *climate prediction; farm management; drought; modelling*

1. INTRODUCTION

Early warning of drought would generate major economic gains to the wool and other agricultural industries by permitting better decision-making before and during adverse seasons. An individual wool producer's success in managing drought lies in taking early action to avoid price discounts on culled stock and price premiums on fodder, while keeping remaining stock in a productive condition.

Common drought management strategies used by graziers include combinations of:

- Purchasing fodder and/or using existing fodder reserves.
- Selling stock, starting with cull and non-breeding, to reduce supplementary fodder requirements (e.g. older wethers, cull ewes) or humane destruction if some classes of stock are unsaleable.
- Agisting stock out to other properties or droving to fodder sources.
- Other management decisions such as delaying joining, early weaning, and changing the time of shearing (Hanrahan 1997).

This paper investigates the value of using a predictive rule to trigger management changes in a wool enterprise. The rule proposed is:

'*Poor spring pasture-growing conditions tend to follow winters with low available soil moisture and a negative or falling Southern Oscillation Index (SOI) phase*'.

If such a rule was reliable it would aid in the successful implementation of farmers' drought management strategies, generating economic gains for individual farm businesses. Early warning of drought would also generate benefits for the entire economy by facilitating more efficient use of resources; for example minimising the number of sheep wastefully destroyed. Other benefits such as reduced stress on farm families and reduced environmental impact (e.g. soil erosion) would also result.

2. METHODOLOGY.

2.1 The GrassGro Decision Support Tool

GrassGro simulates pasture growth based on soil information and historical daily climatic data (Moore et al. 1997). Output from a GrassGro simulation of a merino wether enterprise was used as a basis for the analysis. The model was used to estimate production and supplementary feed requirements for each September to May period for stocking rates of 20 wethers/hectare and 12 wethers/hectare for Rutherglen (northeast Victoria) and Colbinabbin (central Victoria) respectively. Farm sizes of 500ha for Rutherglen and 830ha for Colbinabbin were assumed so that stock numbers were similar in each location. Modelling was based on 99 years of weather data for Rutherglen and 90 year's weather data for Colbinabbin.

2.2 Strategies examined

Output from GrassGro was used to assess the potential economic benefit of using the rule to trigger the implementation of the following three drought management strategies:

A. Increase fodder reserves on 1 September (optimum amount determined through analysis at each site) versus purchasing grain as required during the drought.
B. Destock older age group wethers on 1 September (20% of stock) versus destocking as required during the drought.
C. Increase fodder reserve by half the amount of strategy A while destocking by half the amount of Strategy B versus purchasing grain and destocking as required during the drought.

The severity of price changes during a drought will depend on the severity of the drought, the geographic spread of the drought, and world commodity markets. The variation in these factors over time means there are no 'typical' drought prices, which creates difficulty in assessing the economic value of a new prediction tool. Given this, the analysis of using the rule was conducted under different price premium and discount scenarios.

2.3 Assumptions – Strategy A

In assessing strategy A, the following assumptions were made:

- No additional stock were sold during September to May, but sheep were supplemented with wheat to maintain them in condition score 2.
- At September 1 the enterprise has a fodder reserve equal to twice the simulated long-term average supplement fed for September to May.
- When the decision rule is triggered the fodder reserve is increased (a range of different levels of increase were assessed).
- All wheat is purchased at $161 per tonne (10-year real average standard price plus $15 per tonne for cartage (Beattie and Hamilton 2001).
- For all extra grain purchases not required between September and May:
  - ➔ Grain is sold later in the year, assuming 5% is deteriorated prior to sale (rain damage, spilling etc).
  - ➔ Interest of 10% is incurred on funds invested in the grain to recognise their alternative use.
  - ➔ Storage costs of $15 per tonne are incurred (temporary farm bunker storage).

Results were then compared to the situation where early grain purchases are not made, but rather additional supplements in excess of the reserve are purchased at the drought premium price. This was conducted under three different fodder premium scenarios: 20%, 40% and 60% based on anecdotal evidence of previous droughts.

2.4 Assumptions – Strategy B

In assessing strategy B, the following assumptions were made:

- Same fodder reserve as for Strategy A.
- The price of 5-year-old wethers on September 1 is $15 per head.
- Stock are supplemented with wheat to keep them in condition score 2 using the fodder reserve.
- No supplement is fed beyond the reserve, rather stock are sold as required to prevent the reserve from being exhausted.
- When the decision rule is triggered the oldest age category of wethers (5 year) is sold, representing a 20% reduction in the flock.
- This was then compared to the situation where early destocking did not take place. This was either a case of:
  - i). Destocking was advantageous because stock would have needed to be sold

anyway (at drought prices) to prevent the fodder reserve from being exhausted. This was tested under drought stock price discount scenarios of $5, $10 and $15 per head. The $15 discount essentially represents a scenario of humane stock destruction.

ii) Selling the stock early was unnecessary and incurred a loss of wool production and required replacement stock to be purchased back on May 1 at a 10% premium to the September 1 price. Lost wool production was estimated by GrassGro and was valued at 5-year average prices (AWEX).

Note: In reality selling stock has taxation impacts as well as impacts on future production if suitable replacement stock cannot be found. These issues have not been included in this analysis.

2.4 Assumptions – Strategy C

In assessing strategy C, the following assumptions were made:

- Fodder reserve as in Strategy A and B.
- When the decision rule is triggered the fodder reserve is increased by half the optimum amount determined in strategy A, and destocking is made at half the level as in strategy B.

This was then compared to the situation where early destocking and grain purchasing did not take place but rather destocking and buying grain takes place as required during the drought. The economic benefit/loss in each year the rule was triggered was determined by a combination of whether:

1. The increase in fodder reserve was used, as for Strategy A.
2. Destocking on top of the fodder increase was beneficial, as for Strategy B.

2.5 Perfect knowledge

For Strategies A and B, comparisons were also made with the scenario of 'perfect knowledge' of a drought year. In this scenario drought preparation was only undertaken in years in which it proved worthwhile, and then to the extent that optimised returns.

3. RESULTS & DISCUSSION.

Table 1: Modelling results for strategy A at Rutherglen over the 10 years the rule was triggered.

Premium on grain (% of average price)	20%	40%	60%
Average net gain (loss)*	-$ 1,259	$ 2,073	$ 5,405
Maximum net gain	$ 21,275	$ 14,183	$7,092
Maximum net loss	-$9,128	-$9,128)	-$9,128
% years net gain	50%	50%	50%
Net gain under perfect knowledge of drought.	$ 4,043	$ 8,087	$ 12,130

**Rule triggered 285% increase in fodder reserve.*

Table 2: Modelling results for strategy B at Rutherglen over the 10 years the rule was triggered.

Drought stock discount ($/head)	$5	$10	$15
Net gain (loss)	-$ 10,267	-$ 4,322	$ 1,623
Maximum net gain	$ 9,908	$ 19,817	$ 29,725
Maximum net loss	-$ 43,335	-$ 43,335	-$ 43,335
% years net gain	60%	60%	60%
Net gain under perfect knowledge of drought.	$ 20,136	$ 40,271	$ 60,407

**Rule triggered 20% reduction in stock numbers.*

Table 3: Modelled results for strategy C at Rutherglen over the 10 years the rule was triggered.

Drought stock discount ($/head) Drought grain premium (% av price)	$5	$10	$15
20%	-$ 7,991	-$ 5,514	-$ 3,037
40%	-$ 6,133	-$ 3,656	-$ 1,179
60%	-$ 4,275	-$ 1,798	$ 679

**Rule triggered 10% reduction in stock numbers and 143% increase in fodder reserve.*

For the assumptions used at Rutherglen, following the rule delivered an average net gain under all three strategies at the highest grain premium and/or stock discount scenarios (Tables 1 to 3). Under Strategy A modest average net gain was estimated under the two higher grain premiums, while a net loss was estimated under a 20% premium. The rule only delivered an average net gain under Strategy B for the $15 stock discount scenario. Average losses were recorded under all scenarios of Strategy C except the 60%-$15 scenario which gave a negligible positive result.

A significant number of years of negative cashflow were experienced under every scenario in each strategy.

The difference in profitability of the rule under Strategies A and B reflects the difference in foregone production, or opportunity cost, of a 'false prediction' under each scenario. In this case a false prediction refers to where additional drought preparation was not profitable in years the rule was triggered. Under Strategy A, the only opportunity cost of a false prediction consists of interest, storage and deterioration costs on grain purchases. Under Strategy B the opportunity cost of a false prediction is far greater as unnecessary destocking results in 8 months lost wool production per head under the assumptions used. This suggests that if the rule were to be used, strategy A would be more appropriate. However it does not suggest that drought feeding is a more profitable strategy for managing drought than destocking *per se*. This is because the results only represent the benefit or loss from implementing each strategy at September 1 compared to using the same strategy as required later in the year.

The benefits of 'perfect' knowledge compared to the implementation of a standard rule under the assumptions used were huge for Strategies A and B. This was due to a combination of ability to take more extensive action in bad drought years, and savings from not following false predictions. Benefits under 'perfect knowledge' were greater for Strategy B because the greater opportunity cost of a false prediction is avoided. However estimates for 'perfect knowledge' under Strategy B should be interpreted with caution, as destocking of up to 83% would be required. The loss of flock genetics may prevent this from being a practical option.

Table 4: Simulated results for strategy A at Colbinabbin over the 9 years the rule was triggered.

Drought grain premium (% of average price)	20%	40%	60%
Average net gain (loss)*	-$ 1,031	$ 662	$ 2,354
Maximum net gain	$ 11,424	$ 7,616	$ 3,808
Maximum net loss	-$ 4,902	-$ 4,902	$ 4,902
% years net gain	44%	44%	44%
Net gain under perfect knowledge of drought.	$ 2,699	$ 5,398	$ 8,097

**Rule triggered 178% increase in fodder reserve.*

Table 5: Simulated results for strategy B at Colbinabbin over the 9 years the rule was triggered.

Drought stock discount ($/head)	$5	$10	$15
Average net gain (loss)*	-$ 15,333	-$ 10,947	-$ 6,561
Maximum net gain	$ 9,869	$ 19,737	$ 29,606
Maximum net loss	-$ 38,982	-$ 38,982	-$ 38,982
% years net gain	44%	44%	44%
Net gain under perfect knowledge of drought.	$ 13,914	$ 31,780	$ 47,671

**Rule triggered 20% reduction in stock numbers.*

Table 6: Simulated results for strategy C at Colbinabbin over the 9 years the rule was triggered.

Drought stock discount ($/head) Drought grain premium (% of av price)	$5	$10	$15
20%	-$ 13,269	-$ 12,173	-$ 11,076
40%	-$ 11,962	-$ 10,866	-$ 9,769
60%	-$ 9,580	-$ 8,484	-$ 7,387

**Rule triggered 10% reduction in stock numbers and 89% increase in fodder reserve.*

Under a stocking rate of 12 wethers per hectare an average net gain was only estimated for Colbinabbin under the two higher premium scenarios of Strategy A. An average net loss was estimated for all scenarios under Strategy B and Strategy C for the assumptions and stocking rate used. As for Rutherglen the rule delivers far lower benefits than the perfect knowledge scenario. The number of years of negative cashflow was higher at Colbinabbin than Rutherglen for each strategy.

In interpreting the figures in tables 1 to 6 it is logical to ask the question 'What can be expected to happen to prices in the severe droughts successfully predicted by the rule', as this will determine the profitability of following the rule. This is a difficult question to answer as outlined in the introduction. Even assuming major price changes do occur in bad drought years, the cost of making unnecessary management changes in some years makes using the rule to trigger management changes unattractive in cash flow terms for both sites. This is because the risk created by negative cashflows could offset any long-term benefits.

However it is important to note that no account has been given in this analysis to production beyond May in the season following the drought. For example earlier preparation for drought may enable damage to pastures during a drought to be minimised, enabling more rapid recovery from drought.

The profitability of using the rule as a trigger for management will also vary between business due to differences in enterprise type, stocking rate and a farmer's attitude to risk. Stocking rate can be linked to a farmer's attitude to drought risk. For example farmers who are adverse to drought risk may run low stocking rates to avoid the impact of drought. Under lower stocking rates a reduction in available feed will be less critical and hence the risk of financial downturn can be lower. The results shown for each site are only valid for the enterprise type and stocking rate selected. Benefits to other enterprises could include:

- Cropping: Improved warning of crop yields. This could then be used to decide whether to cut some cereal crop for hay/silage or graze it in order to maximise returns for the year.
- Livestock: Deciding on whether to plant a summer crop.

As well as the purely economic benefits of having improved warning of drought, others benefits could include:

- Stress: Having a trigger to undertake planning can reduce stress levels for farm families. This is because they provide some extra reassurance on what will happen in the future and can provide a trigger to plan for financing for the upcoming period.
- Environmental benefits: By changing management earlier degradation to pastures, soil erosion, and nutrient runoff can be minimised. This has not been valued in the above analysis.

4. CONCLUSIONS

Modelling suggests that using the rule as a trigger for the early implementation of a drought management strategy is not an attractive option at Rutherglen or Colbinabbin from an economic perspective, despite the rule providing reasonable accuracy in physical terms at each site. However analysis was only based on results up to the end of May each year with no consideration given to production beyond this time.

Despite this, the rule can provide benefits to grazing and other industries at each site if used in a less rigid fashion. For example the farm manager should be on heightened alert of the potential for a poor spring in years the rule is triggered, but not necessarily commit to significant management changes. Clearly the benefits from this will be lower and more poorly defined than if the rule provided a more effective drought prediction. Benefits could include reduced stress on farm families and environmental benefits.

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