Can graziers improve their management of climate risk?

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Abstract

The variable climate has always been a profit driver of grazing industries. The extent of the variability is evident in our unique ecology and the historical climate record. The erratic and uncertain climate makes stocking rate decisions difficult. Many successful graziers have developed herd structures and grazing systems that are flexible and tactical so that they can ride the variable climate.

Graziers have been encouraged to respond to the state of their pasture, the condition of their stock and market signals. Some are also responding to seasonal climate forecasts. For these forecasts to be useful scientists must be clear about the uncertainty, and graziers must incorporate them into sound risk management strategies.

Introduction

Instead of being derivative, we must take up the challenge to be decisively Australian - in the sense of being absorbed by the spirit and nature of this still mysterious land - and in the sense of being truly independent, adventurous and discriminating in our choice of sources of external wisdom. Drinan (1992).

It is stating the obvious that climate is a driver of profit. Through a complex interaction with markets, climate has driven profit up and down throughout the history of grazing in Australia. Any grazier still solvent in the year 2000 has managed to ride this variability. Some graziers have more than coped with this variability, they have recognised both risks and opportunities which they have used to their advantage. In the preface to his best selling book " Thriving on Chaos" the author Tom Peters deliberated on calling his book Coping with Chaos, or Thriving amidst Chaos, but decided to call it Thriving on Chaos. He argued that a revolution is occurring whereby successful businesses are not those that minimise uncertainty and risk but rather those that use variability as a resource.

By using the term "improve" in the title we acknowledge that all farmers are managing climate risk. However, as pressure increases for grazing enterprises to leave a softer environmental footprint while developing harder business management, we have to seek new ways to understand and manage our climate risk.

Learning from ecology

The history of Australian agriculture has been one of adapting farming systems from the Northern Hemisphere. In the late 1950s the agricultural economist K.O. Campbell remarked *"one cannot but be impressed by the extremely limited progress which we, as a people have made in coming to terms with the most insidious and pervasive characteristic of our climate- its variability."* Last year the ABC TV science program Quantum dedicated a program to El Nino. This program concluded that European settlement in Australia has a "Johnnie come lately" mentality of settlers from wetter climates, and in doing so has failed to acknowledge the long unpredictable dry periods and occasional wet periods. This misjudging of the variable climate has an impact on farm business, farm families, the livestock and resources they manage. The damage does not all occur in a drought, it is indeed a paradox that the driest continent faces degradation issues relating to excess water such as dryland salinity, erosion and nutrient runoff.

Tim Flannery from the Australian Museum drew attention to the role of climate in his paper to the NSW Grasslands conference in 1996 and in his book "Future Eaters". He particularly emphasised the impact that the El Nino- Southern Oscillation (ENSO) has had on our ecology *"the trials of ENSO have forced some unusual adaptions on [Australian] plants and animals. These adaptions are varied and sometimes wondrous, but all share a few themes..low rates of reproduction and strict obedience in following and exploiting brief windows of opportunity as they open erratically over the land."* (Flannery 1995). Some of the examples that he and other ecologists have pointed to are as follows:

Our plants are opportunistic rather than seasonal. Note the lack of deciduous trees in Australia, our gum trees flower intermittently throughout the season. Our deserts do not have cacti which, although efficient at using water, require a constant supply. Rather, we have ephemeral plants that bloom following the rain.

Northern hemisphere animals tend to have a reproductive cycle so that young are born in spring whereas Australian animals have smaller litters more erratically. There is even some evidence that the clutch size of exotic birds is decreasing as they adapt to Australian conditions. Stockmen used to think that the red kangaroo could predict the end of a drought because there seemed to be young joeys around as soon as it rained - but it was because the red kangaroo carried their joey as a dormant embryo which grew as soon as the rain came.

Australia does not have large carnivores like lions and tigers. Large warm blooded carnivores sit at the apex of the food chain which is probably the best place to be - until there is a drought- then it is much better to be a lizard, of which we have an abundance. Reptiles can survive by slowing down their metabolism during harsh conditions. Humans, being omnivore and able to exploit marine sources can survive periods when land-based protein is short. Likewise introduced carnivore like foxes have a wide diet and can survive on berries and insects. They have also benefited from the introduction of rabbits as a major food source.

Our ecology is indeed unique, a careful reading of "My Country" by Dorothea MacKeller shows it is a patriotic poem, making it clear that Australia is more than a God-forsaken version of England. She is saying if you *"love green and shaded lanes, ordered woods and gardens, brown streams and soft, dim skies.- I know but cannot share it, my love is otherwise. - I love a sunburnt country a land of sweeping plains, of ragged mountain ranges, of droughts and flooding rains"*. Understanding and working with this variability is important for economic and ecological viability.

Using our rich heritage of climate data

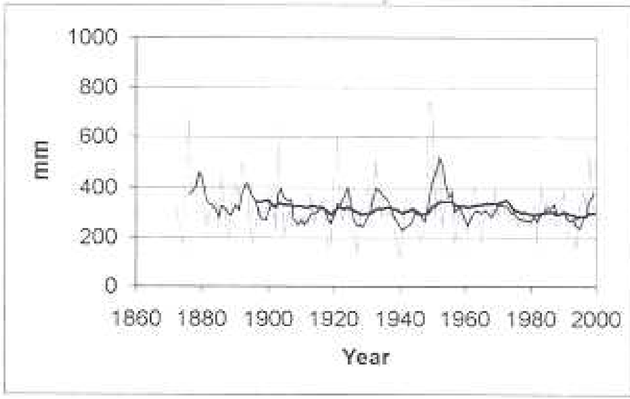

Figure 1. Time series of rainfall for May to October at Armidale averaged over one season (....), 5 years (—) and 30 years (▬**).**

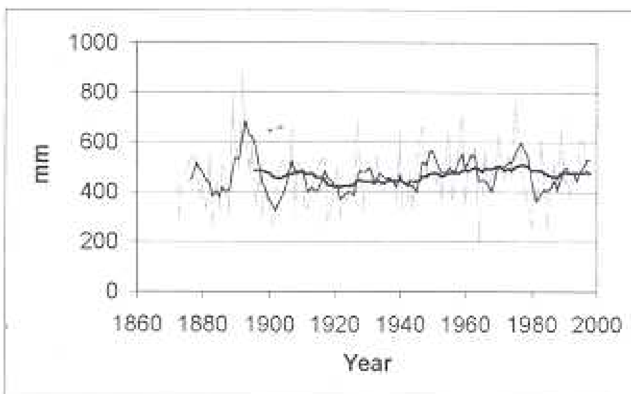

Figure 2. Time series of rainfall for November to April at Armidale averaged over one season (....), 5 years (—) and 30 years (▬**).**

Figures 1 and 2 are the time series of rainfall for Armidale. A number of observations can be made about this time series of rainfall.

1. The record goes back a long way. Despite a short history of European settlement, Australia has one of the best historical records of rainfall in the world. Many of these records have been kept by farming families and represent an enormous amount of fastidious unpaid work. We are selling ourselves short if we just take this data and average it and say that Armidale has an average rainfall of 783mm. This luxury of just using the average may be possible in the Northern Hemisphere where the rainfall is much more consistent.
2. The only constant in the graph is the variability. This variability represents both downside risks and opportunities.
3. There are trends in the rainfall in the 5 year moving mean and the 30 year moving

mean. This implies that we need to be careful about human memories and for that matter detailed experiments that have been run in drier or wetter runs of years.

4. Every decade has had droughts and floods. One of the warnings of this graph is that the decade 2000 to 2010 will be an extraordinary decade if we do not have a drought. However, as stated earlier, the graziers who survived the 1990s must, by definition be doing something right.

Stocking rates and a variable climate

The matching of animal demand to pasture supply is complex enough in a reliable climate. It is made very difficult in our erratic climate. Not only have graziers had to deal with the roller coaster ride shown in figures 1 and 2 they have had to deal with changing demands on what society expects and demands from them. On the one hand graziers are being encouraged to increase their stocking rates to improve production and stay viable, on the other hand overgrazing is high on the list of concerns society is raising with agriculture.

The need to increase stocking rates in average to good seasons

Commenting on graziers and climate risk Donnelly (1997) remarked *"It seems likely that memories of losses during drought, in particular, inflate farmers' estimates of the riskiness of the farming environment. The profits that are consequently foregone during the majority of seasons place the longer term sustainability of many farmers at risk."* Donnelly acknowledged the potential of seasonal forecasts to improve the efficiency of management. However he concluded *"the harsh reality is that the majority of farmers could immediately increase their productivity and efficiency simply by adopting less conservative management practices"*.

There is good support for Donnelly's assertion that profit is foregone by conservative stocking rates. One of the comments made from economists and more recently highlighted by benchmark studies is that farmers (and agronomists) concentrate on variable costs (fertilisers, seed, shearing, drenching) whereas it is the fixed costs that are the major cost in running a farm. Holmes Sackett and Associates (1998) point out that over 70% of farm costs are fixed costs. They argue that in areas above 500 mm rainfall and with one labour unit the minimum scale for wool or lamb production is 8,000 DSE and for beef production is 10,000 DSE. Generally, carrying more stock spreads the fixed costs over more units and leads to higher profit.

The need to decrease grazing pressure in poorer seasons

Not only is there pressure for graziers to be more efficient in their business enterprise, there is increasing pressure to be more careful in their land management. Scott (1996) commented *"We have been mining our land since European settlement – not only our rangelands but also our higher rainfall zones. There has been a severe overgrazing during a century of exploitive pastoralism"*.

A recurring theme in past grassland conferences has been the decline in perennial pastures (Archer et al 1993, Hutchinson and King 1996, Simpson 1996). One of the main suspects appears to be the poor recovery after drought. In some cases as much or even more damage may occur during a dry spell than a drought. Boschma and Scott (2000) conducted an experiment at Chiswick near Armidale where they controlled the water supply to a pasture and compared a mild drought (equivalent water to 40 percentile of the spring summer rainfall) and a severe drought (equivalent water to 10 percentile of spring summer rainfall). They found that cocksfoot and ryegrass were more damaged by regular cutting under a mild drought than a severe drought. In a severe drought the pasture stops growing, in a mild drought the pasture keeps regrowing from stem and root reserves which when regularly removed before the plant can rebuild reserves will kill the plant.

As an experienced Queensland grazier observed *"we have to learn to live on the top half of our pasture."* This makes good sense for both ecological and economic reasons. Scott (1996) showed that an improved pasture that cost $200.00/ha to establish will provide feed at $60.00 per tonne if it only lasts 2 years, $30.00 per tonne if it lasts 3 years and about $10.00 per tonne if it lasts more than 10 years. At the last NSW Grasslands conference, David Mitchell from Delegate gave details of his drought feedlot describing it as *"his biggest win in agriculture"* because it had *"protected and primed his pastures for when the drought broke"* (Mitchell 1999).

Riding the variable climate with flexible stocking rates

The dilemma of stocking rate is solved by a flexible approach to stocking rates. In other words being tactical. Selling and buying stock is easier said than done. The old saying about sell and regret but sell anyhow, highlights the difficulty of decision making under uncertainty. In hindsight a lucky decision can look smarter than a wise decision. Buying stock is also made more difficult by concerns over disease (footrot and OJD) and the risk of weed contamination. Nevertheless a flexible stocking rate is the only way to ride the variable climate. One of the clearest findings of the RISKFARM studies conducted at Armidale was to build herd structures and grazing systems that were flexible and tactical (Thompson 1996).

In livestock enterprises the tactical response is to the state of the pasture, the condition of the stock and the state of the market. All of these factors are influenced by the seasonal conditions. However, I am suggesting that graziers should also respond to seasonal climate forecasts. This idea is not new. Almost 100 years ago in the Agricultural Gazette, John Barling of Manilla in northern NSW wrote *"when more records are available, an accurate forecast can probably be made for a considerable period in advance. Needless to say, when that time arrives, it will be possible to greatly reduce, or even entirely prevent, the now constantly recurring losses in stock and crops; for if it be known that a succession of dry seasons are due, understocking the country must be resorted to, and its reverse when damp seasons are to follow"*. Barling (1902) based his work on cycles in the climate record, this was quite a challenge for Manilla where records only started in 1885. Undeterred he found a relationship between a number of country areas and Sydney and then used the Sydney records from 1840 for analysis.

Seasonal climate forecasts from the Bureau of Meteorology, CSIRO or the Queensland Centre for Climate Application are based on the relationship between the Australian climate and the oceans. When a farmer is using a seasonal climate forecast, they are tactically responding to the state of the surrounding ocean. Oceans are like the fly wheel of the atmosphere and have a longer 'memory'. For a given change in temperature there is as much energy held in the top 2.5 m of the ocean as there is in the whole atmosphere. The Pacific Ocean is a huge mass of water stretching along much of the equator and controlling much of the climate of the region.

The southern oscillation index and El Nino

The strength of the Southern Oscillation is measured by the difference in air pressure between the two regions; the commonly-used 'Troup' index reflects the air pressure difference between Darwin and Tahiti, records for which started in 1869 and 1876 respectively. This Southern Oscillation Index (SOI) usually ranges from -30 to +30. Troup's index is a refinement of the basic differences in air pressure in that it measures the differences in anomalies in the air pressures—the monthly means minus the long-term means. A Troup SOI of -10 means the Tahiti-Darwin pressure difference is 1 standard deviation on the negative side of the long-term mean for that month.

El Nino originally referred specifically to a warming of the sea off the coast of Peru, now more generally used for the unusual warming of a large area of the eastern equatorial Pacific Ocean. This is strongly linked to changes in the Walker Circulation and to negative phases of the Southern Oscillation. The opposite of these conditions has been called La Nina or Anti-Enso. Some climate scientists refer to warm and cool episodes.

Is it worth paying attention to the SOI in Armidale ?

Although these terms are familiar to most tableland graziers they sound rather tropical and equatorial. They certainly sound distant from Armidale in the winter. Table 1 shows the May to October rainfall for a number of locations and the changes to the rainfall when the average SOI for the period May to October is above + 5 or below – 5. In the last 100 years there have been about 25 years when the SOI has been below –5 and about 25 when it has been above + 5. There is a significant reduction in the average rainfall. In the case of Arimdale, the average of the years that the SOI is below – 5 is 75% of the long term average and about 120% of the long term average when it is positive.

The median is the point that half the years are higher than and half are lower than. It is usually less than the average because the average is pulled up by a few very wet years. Table 1 shows that in Armidale there is only a 17% chance of being in the top half of the distribution when the SOI is negative and 71% chance of being in the top half of the distribution when the SOI is positive.

The data in table 1 are all a simultaneous relationship and hence of little use for planning. The purpose of the information is to answer the question whether the SOI is worth paying any attention to in Armidale. The answer is that for the May to October period the SOI works about as well (or as badly) in Armidale as in Queensland.

A major contribution to using the SOI has come from Roger Stone, CSIRO, who recognised that the movement of the SOI from month to month is often more important than the actual value. Table 2 shows the chance of getting different amounts of rainfall in the period June to November for different phases of the SOI in April and May. A positive phase is when the SOI was positive in April and May, a falling phase is when it was positive in April and negative in May. The probability tests indicate the chance of the distribution being different from that of all years. When the SOI is neutral in

April and May there is no significant difference, but for the rest of the phases there is a 90% or higher chance that the different pattern is not due to chance alone.

Beyond the SOI

The SOI is a blunt instrument and blunt instruments sometimes miss. However in the hands of a skilled operator they can be quite useful. There are farmers who are currently using the SOI as part of their decision making. They are using it as part of their management strategy. There are rapid advances in climate science, some of these include the use of sea surface temperatures from the Indian ocean and the Great Southern Ocean, or a better prediction of the latitude of sub tropical ridge. It is tempting to read the press releases of the latest approach and toss out tried and tested blunt tools like the SOI. I prefer to see these new tools as building on the SOI. Remember it is the Pacific Ocean which spans so much of the equator and is the engine room of world climate.

In addition to the effort in finding statistical relationships between indices such as the SOI and climate, there is a large international effort in developing models of the oceans and atmosphere. These attempt to incorporate to a greater or lesser extent the underlying physical processes. The impetus for the model development is largely climate change and greenhouse issues, but there are likely to be many valuable spin-offs for agriculturalists. The Bureau of Meteorology has a new site where they list 8 such models that have been peer reviewed. The models are used to predict the ocean temperature in the eastern equatorial Pacific Ocean. Cool conditions are associated with positive and warm conditions with negative SOI. This information is available on the Bureau of Meteorology site http://www.bom.gov.au/climate/ahead/ENSO-summary.shtml The other excellent site that many people are using is Long Paddock http://www.dnr.qld.gov.au/longpdk. The Bureau of Meteorology is now issuing seasonal temperature forecasts as well as rainfall forecasts.

Long term climate data can be used to assess the risks and returns of different strategies available to a grazing enterprise, seasonal forecasting is one factor to be included in tactical decision making and short term (1-7 day) weather forecasts can improve the operational decisions involved in running a farm. There is a lot of weather information on the Bureau site, some of it well tailored for agriculture in SILO. There are Northern American weather sites that cover Australia that some farmers are finding useful: http://grads.iges.org/pix/prec7.html, http://grads.iges.org/pix/aus.fcst.html or http://personal.accuweather.com. The weather information is also available through fax, free to air media and Pay TV.

Finally, a word from 1903

As can be seen in figures 1 and 2, managing the variable climate is not a recent problem. Late in the 18th century was a time of optimism. In 1881 the official yearbook attributed the run of good seasons to the settlement of the interior stating with confidence that " *droughts are no longer the terror they used to be*". Following the drought of 1902, the Agricultural Gazette put together a series of articles titled "Lessons of the Drought". Mr R.H. Gennys from Glen Innes Experimental Farm gave the report for New England. He concluded with the following lessons.

Keep a large reserve of pure water

Grow plenty of fodder when you can and put it away for bad times; it will pay for the trouble with large interest when the dry times come, as they surely will in a few years.

It is cheaper to grow fodder in good seasons than buy in bad

Get stock of hardy constitutions and do not keep too many old ones; when they begin to decline in value fatten when possible and sell to the butcher.

Stock should not be allowed to get too low in condition before starting to feed them. This is an important matter.

These words from 1903 remain pertinent as does the advice written in 1902 from John Barling to destock when the forecast is for a dry season and increase the stocking rate when a damp season is forecast. Computer models, seasonal climate forecasts and the internet are valuable tools. Considering the depth of experience from Gennys, Barling along with agricultural scientists and graziers past and present, advances in climate science must be used to build on this wisdom rather than replace it.

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Table 1. Simultaneous relationship between May to October rainfall and May to October average SOI for a number of towns in NSW and Queensland.

	Average May to October rainfall			Chance of exceeding the median		
	All yrs	SOI < -5	SOI > +5	All yrs	SOI < -5	SOI > +5
Armidale	316	238	375	50%	17%	71%
Glen Innes	346	273	419	50%	27%	79%
Inverell	312	233	382	50%	23%	72%
Barraba	284	213	344	50%	23%	70%
Tamworth	292	226	351	50%	29%	72%
Scone	271	222	310	50%	29%	71%
Singleton	293	240	349	50%	41%	60%
Dubbo	279	218	358	50%	23%	76%
Orange	481	378	587	50%	19%	82%
Cowra	317	261	386	50%	29%	73%
Yass	351	305	423	50%	34%	73%
West Wyalong	236	195	284	50%	31%	73%
Parkes	292	237	369	50%	37%	77%
Wagga	313	262	371	50%	27%	79%
Tumut	483	398	572	50%	26%	80%
Moree	240	180	296	50%	30%	68%
Walgett	204	141	264	50%	18%	81%
Condobolin	218	176	266	50%	30%	75%
Hay	204	169	251	50%	37%	70%
Bourke	150	97	208	50%	15%	85%
Goondiwindi	247	185	312	50%	30%	69%
Toowoomba	328	258	383	50%	28%	76%
Roma	218	148	291	50%	17%	80%
Dalby	242	182	292	50%	29%	68%
Emerald	181	127	251	50%	32%	80%

Table 2. Lag relationship between April and May SOI and June to November rainfall at Armidale: – Output from Australian Rainman.

Chance of rainfall at ARMIDALE RADIO STATION 2AD
using SOI phases: Apr to May

Rainfall period: Jun to Nov Rainfall period: Jun to Nov	SOI Falling	SOI Negative	SOI Neutral	SOI rising	SOI Positive	All years
% yrs with at least 569 mm	4	0	4	0	15	5
450 mm	4	5	13	17	23	13
400 mm	9	10	25	37	38	25
350 mm	17	20	46	55	50	39
300 mm	57	45	69	83	81	69
250 mm	87	55	88	93	96	85
182 mm	100	85	88	100	100	95
% chance > median: 337 mm	28	20	52	73	62	50
Probability tests	0.924	0.986	0.023	0.988	0.919	
Significance level	#	*	NS	*	#	
Years in historical record	23	20	24	30	26	123
Highest recorded (mm)	837	451	574	549	871	871
Lowest recorded (mm)	196	148	112	212	208	112
Median rainfall (mm)	314	280	340	357	356	337
Average rainfall (mm)	331	280	339	373	412	352