"Is a low-input strategy a sound business defence in a drying climate?"

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Is a low-input strategy a sound business defence in a drying climate?"

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Abstract

Attaining farm business success is a major challenge in agricultural regions in Australia where the climate is projected to become drier and more variable represent. Developing effective risk management strategies becomes an important part of farm business management. In these environments the conventional view is often that business success requires the higher yields and higher profits in good years, often supported by additional farm inputs, to offset losses in poorer years.

Some farmers, however, are questioning the merits of this high-risk; high-reward approach. In this paper we draw on a case study of a famer who has adopted a strategy aimed at greatly reducing operating costs in order to self-finance the farm's operating capital. This way of structuring the management of his farm operation is very different from the traditional small business approach of using bank finance for operating capital. In drying, more volatile environments on-going reliance on bank finance for operating capital will become increasingly problematic and demand new approaches to funding the balance sheet of the business.

We used farm financial modelling that draws on validated crop growth simulation modelling (APSIM) to assess the merits of this farmer's low-input approach. When various performance metrics are applied, such as farm profit and peak debt, over a range of seasons the low input business strategy appears to be robust.

Keywords

Climate change; Farm finance; Farm modelling; Farm management; Farm business strategy.

Introduction

Farmers in the Western Australian wheatbelt have experienced noticeable shifts in seasonal patterns over the last 15 years (Kingwell, 2006), with an increased frequency and severity of adverse seasons. These have placed businesses at greater financial risk with working capital becoming increasingly constrained and the banking finance model becoming more difficult. In responding to the perceived greater business risks associated with dryland farming in Western Australia banks have adjusted their lending policies and are more likely to apply risk premiums tailored to farm business performance. Future climate change is expected to exacerbate these trends.

The overall response of most farm managers has been to reduce debt and rely on higher equity ratios to buffer borrowing margins and provide reserves of working capital. The limits to this approach are obvious in that debt reduction can be difficult to achieve in low profit years, however much financial belts can be tightened, and a succession of bad seasons can deplete even the strongest of financial positions. Furthermore the introduction of higher productivity innovations such as self-steering tractors, variable rate seeding , controlled traffic and camera-targeted weed control all place demands on available capital so that growth and innovation can be severely constrained by strategies aimed at conserving capital.

The example of a farm business which has achieved a large scale of operation over a short period, relying on highly geared bank lending and limited off-farm reserves is therefore an exception to this conventional approach (Kingwell et al., 2013) that needs to be tested over a range of climate scenarios.

Business strategy

The notion of a low-input strategy is not unique in that farmers and their advisers generally adopt a rationing approach to all agronomic inputs when prices or responses require it. What is different in this case is that the business approach places more emphasis on the business's balance sheet rather than the profit and loss, i.e. the capital structure and its application is just as important as the gross margins and the input-driven decision making behind it.

Nitrogen fertiliser is typically the largest single variable cost and comprises about 25% of the value of variable input cost. Consequently it is the main target for the tailoring of operating costs to crop income and to the variability of crop income. The two relevant benchmarks in this case (Plunkett, 2013) are the level of costs needed to generate a 25% crop gross margin and a breakeven yield of 0.7 tonnes per hectare, the lowest yield in all but the lowest decile of rainfall years.

Instead of treating the farm's land as a passive resource, upon which productive activities can be based, its asset value is seen as providing for higher than average financial gearing to supplement working capital from cash from crop proceeds. Generating income is about driving the balance sheet so that all farm assets are productively employed.

The asset side of the balance sheet also supports machinery debt and farm infrastructure such as a large on-farm grain storage capacity (Plunkett, 2013). The focus of decision making in this case is more about generating the best return on total assets, rather than the more common approach by farmers and consultants to generate the best operating surplus per unit of rainfall or per hectare. The latter approach may indirectly maximise overall returns as well, but it can also lead to slack capital management or higher risk on operating costs.

The financial risk normally associated with the high debt-servicing arrangements is managed by the low input strategy, which keeps input costs to a minimum so that positive cashflow is generated in all but the lowest quartile of seasons. This approach is reverse to the thinking of how farmers generally approach their management decisions whereby inputs are applied to allow some expression of yield potential.

In this case the low input strategy is not about the lowest level of inputs to achieve an expected yield, but the highest level of costs allowable to breakeven in all but the worst years, thus ensuring that working capital is best protected and debts can be serviced. Most importantly it keeps management of working capital within the farm and the bank manager's oversight to longer term facilities. This degree of financial independence is also fundamental to allowing management to pursue strategies which are outside the conventions for the district.

KEY FINDINGS

The business strategy of reducing input costs reduces losses in poor seasons but it also foregoes potential upside from higher yield in good seasons. Depending on the level of nitrogen fertiliser selected, there is opportunity to avoid much larger downside losses with relatively small reductions in profit potential in good seasons.

In this case the low input approach is not simply an expression of the manager's risk aversion, or the preference for lower but more stable income over a higher but more volatile annual income. Low nitrogen (N) use in this context has been analysed by Monjardino et al (2012) for broadacre farms in the South Australian and Victorian mallee in response to concern by the peak industry R&D corporation that N use in broadacre systems was declining. Their main conclusion was risk averse behaviour was evident in that most farmers were under-fertilising with N and that a more targeted approach to N on different soil types was the best approach to raising levels.

Our analysis for the case study farm in the WA wheatbelt supports this view to some extent, in that whole farm profit responds unequivocally to rates of N above zero application where the farmer relies solely on soil available nitrogen. However the advantage of higher rates of N, at 50 kg Ns/ha is not evident in this M3 region of WA, even for historical climates.

Secondly, the changing climate increases the risk associated with higher levels of crop input costs.

As the climate becomes hotter and drier the frequency of unpredictable adverse events such as frosts and extremely hot days at flowering have increased, adding to the financial risk of broadacre cropping. The use of lower rates of N can reduce losses in the poor seasons by saving outlays, but also avoiding the costs of high-yielding crops haying-off when unexpected terminal drought conditions occur. In years when water availability limits crop growth higher rates of N have little benefit and simply add to costs with little if any carry–over benefit. It is only in the most favourable seasons, which become less frequent in future climates, that the payoff to the highest rates of N can be achieved.

In the future climate scenarios that were modelled, the reward for higher rates of N at 50 kg N/ha., become increasingly risky and are likely to be preferred only by those expecting to beat the odds from a run of better seasons.

Thirdly, the use of benchmarking to guide input decisions or develop business strategies needs to be treated carefully.

The most common benchmark of farm performance used in WA is the rate of return to capital. Farms are ranked by this measure and, when combined with other input and output measures, the best and worst performers are identified. From these comparisons are drawn well known adages such as the need for attention to detail, a focus on the big issues, and many small changes adding up to large differences (McConnell, 2014).

The distribution of profit outcomes derived from a range of seasons in which different N application rates will be employed highlights one of the main problems with the benchmarking approach, i.e. in comparing N use by upper and lower quartiles there is no reference to the counterfactual case. The relative gain from high and medium rates of N over zero indicates the likelihood that each approach will be more profitable, but the ranking produced by benchmarking obscures this relationship.

By comparing farmers who all use about the same levels of N, (+/-25%) would suggest that the highest users are always ranked as the best, but that obscures the fact that some high N users who had less profit would have been ranked outside the top quartile.. The probability distribution for the different levels of N indicates the likelihood of each level of profit outcome. The top ranked farmer in each season will almost certainly come from the cohort using the highest N rate, but that finding obscures results from farmers who adopted the same high input strategy but whose profits were less due to an inadequate yield response.

Fourthly, was the question of whether rotational sources of extra nitrogen from leguminous crops, could be a profitable substitute for bag nitrogen.

The findings of Abadi (2013, pers comm) are replicated in the results which show reduced profit from all levels of additional areas of peas in the rotation. Legume crops provide variable levels of residual soil N, depending on plant biomass, seed yield and other losses. Peas also return higher prices than cereals, but this is more than offset by lower average yields (50%) which can be much lower in dry seasons. Peas are also restricted to the heavier soils and are more susceptible to disease, pests and harvest losses. Factoring in these effects results in lower profit from any expansion in pea area as an alternative to applying bag nitrogen. However, tactical or opportunistic increases in pea areas are precluded by this analysis which is limited to YIYO comparisons.

Finally, whether further reductions in operating cost by increasing the area of fallow in the rotations will be profitable

Chemical fallows were used on about 7% of the case study farm, (Plunkett, 2013) as a means of storing soil moisture, and allowing for cheaper and more effective weed control using a camera-targeted boomspray, which cut herbicide use to 10% on these areas.

Fallowing is therefore a very effective management practice in bringing newly acquired or leased land into the program where herbicide-resistant weeds or heavy weed burdens are encountered. The paddocks coming out of fallow can subsequently be dry-sown ahead of the main program, which extends the sowing window for other crops and greatly eases pressure at seeding when spraying and soil moisture problems can interfere with optimal timing for crop establishment.

The option to further reduce operating costs by increasing areas that can be chemically fallowed is therefore an attractive option for the farm manager in most seasons. The downside is that whole farm profit is reduced by the gross margin forgone, less the cost of spraying. Also there is some from value from stored soil moisture to subsequent crops, ranging from quite high to very low depending on the amount of summer rain and amount of growing season rainfall in the next season.

Our analysis shows that reducing cropping intensity by fallowing more paddocks is generally less profitable unless there are clear indications about prospective price or yield penalties which can be avoided such as by excluding marginal paddocks from the program after a late starting rain.

Modelling approach

We developed a whole farm model which calculated profit, return on capital, and cashflow, to test various input levels under historical and future climate scenarios.

In more detail, the following aspects of the modelling were as follows;

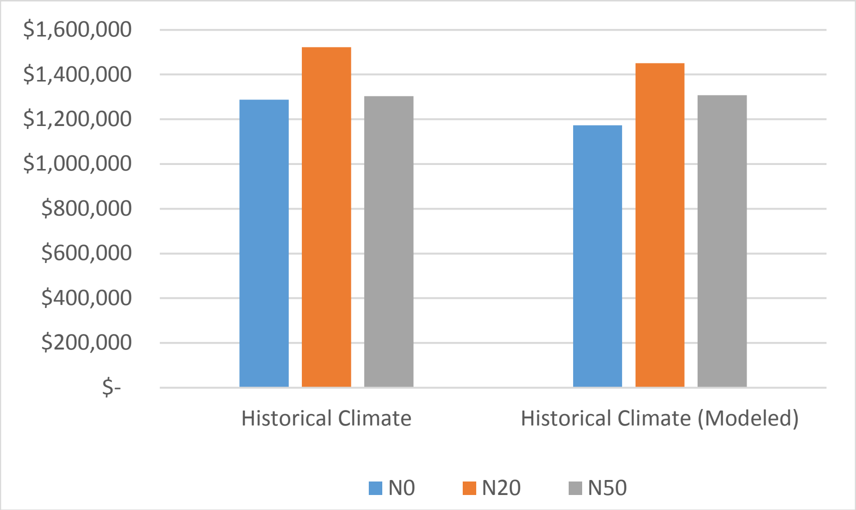
- We used 40 years of simulated climate from the Everfarm project (Muhuddin, 2015) to derive wheat yield for future seasons The Everfarm project used the **APSIM** crop growth model, which measured wheat growth from daily temperature and water availability data.
- Whole farm profit for future seasons was estimated using the **Imagine** model developed to include several different crop rotations on 2 soil types, 3 N levels, for the main crops which were wheat, barley, peas, and canola.
- The distribution of 40 years of steady state (YIYO) wholefarm profit outcomes were examined for different N levels on cereals (zero, 20 kg N/ha.; 50 kg N/ha).
- Nitrogen fertiliser was selected to represent the low input strategy because it is the main component of variable cost. The three levels approximate respectively, the current use on the case study farm, the average rate used by most farmers in the M3 zone across a range of seasons, and the average rate used by the top 25% of performers in the Planfarm Bankwest survey (Planfarm Bankwest, 2013).
- Some adjustment (minus 20%) was made to APSIM predicted cereal yields to account for disease, timeliness of sowing, rotational and other effects, according to advice form experienced agronomists. The rotations selected were typical of those used on the farm, but were fixed over time and balanced so that variations in the crop area would not influence annual profit.
- Farm profit was determined by crop yields at prevailing real prices, less operating costs and overheads, consistent with the case study farm and regional benchmarks. Profit was not varied by carryover effects from previous seasons as each year was treated as independent.
- The effects of tactical changes to rotations, crops selected and input levels, and the timing of N applications were not possible with this approach and while these are obviously major considerations in farmers' decision making, they were not considered essential to estimating the long term effect of changes in climate, which was the focus of this study.

Results

We firstly conducted a backwards validation of the modelling process to ensure that the modelling results based on simulated historical climate matched the modelling results based on actual historical climate data. The average farm profit over 40 years based on the climate simulation model and APSIM generated yields was compared against the farm profit from actual climate records for the zone (see Graph 1 below). The comparison revealed a close match-up of results for each of the three nitrogen levels.

The profits from modelled climate data were slightly lower than the profits based on historical climate records which may indicate we made some over-compensation in the APSIM assumptions, but these were not large enough to warrant further refinement. The modelling approach was therefore considered to be adequately suitable for estimating the effects of a similar 40 year period of future seasonal outcomes on whole farm profit and financial performance.

Graph1. Average farm profit based on APSIM Yields



Discussion of Results

Reducing input cost reduces losses in poor seasons, but it also foregoes potential upside from higher yield in good seasons

In this case the low input approach is not simply an expression of the manager's risk aversion, or the preference for lower but more stable income over a higher but more volatile annual income. Low N use in this context has been analysed by Monjardino et al (2012) for broadacre farms in the South Australian and Victorian mallee in response to concern by the peak industry R&D corporation with declining N use in broadacre systems. Their main conclusion was risk averse behaviour was evident in that most farmers were under-fertilising with nitrogen and that a more targeted approach to N on different soil types was the best approach to raising levels.

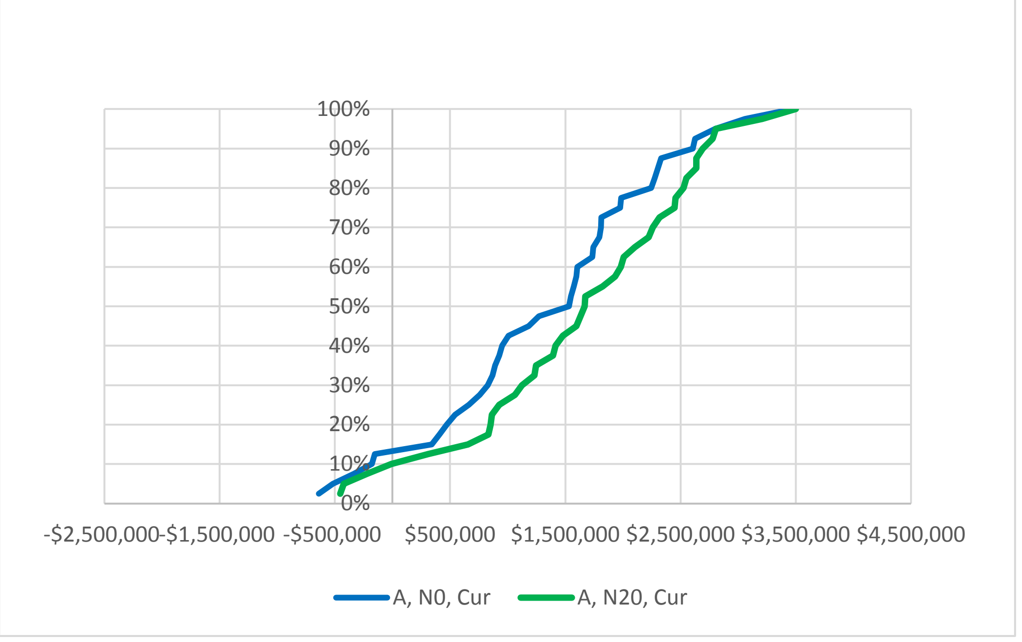
Our analysis for the case study farm in the WA wheatbelt supports this view to some extent, in that whole farm profit responds unequivocally to rates of N above zero application. However the advantage of higher rates of N, at 50 kg N/ha is not evident in this case, even for historical climates.

The average farm profit over the thirty year period in Graph 1 was highest at $1.46m with 20 kg N/ha of applied nitrogen. The case study farm varied its application rate between 8 kg N/ha following a poor year and about 15 to 20 kg N/ha previously. However the typical rates for the M3 region of WA are closer to 25 kg N/ha, with the top 25% of producers using an average of 43 kg N/ha in a good year. (Planfarm Bankwest, 2013).

There was some $500,000 more profit from applying 20 kg N/ha of applied N over the zero rate, but only $100,000 more from the highest rate of 50 kg N/ha, which indicates both diminishing response and a long term penalty from the incidence of poor seasons when N response at high rates can be negative due to crops burning-off.

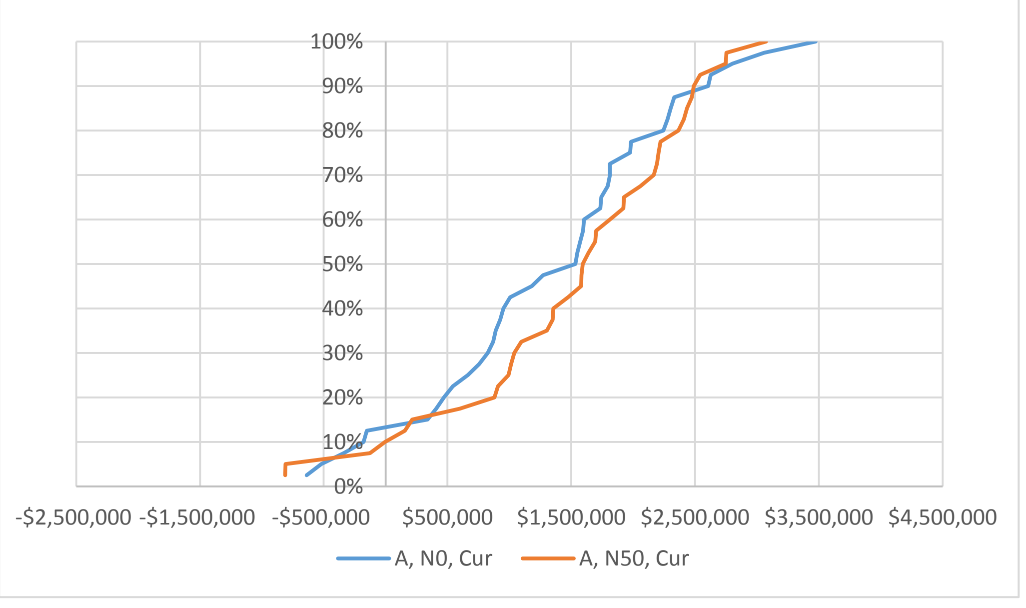
The distribution of profit in Graph 2 below also shows that there is a consistent advantage in the 20 kg N/ha rate of application over zero, using the historical climate data. There is first order stochastic dominance of the 20 kg N/ha application over zero as well as a similar frequency of crop losses from both rates in about 10% of worst seasons.

Graph 2. CDF of annual profit for 20 kg N/ha compared with zero application



In Graph 3 below, the distribution of profits from applying 50 kg N/ha, compared with zero is less consistent than when 20 kg N/ha is applied, with crossovers at both ends of the distributions, so there is second order stochastic dominance but still a large range of seasons where the application rate of 50 kg N/ha is more profitable than zero application of N.

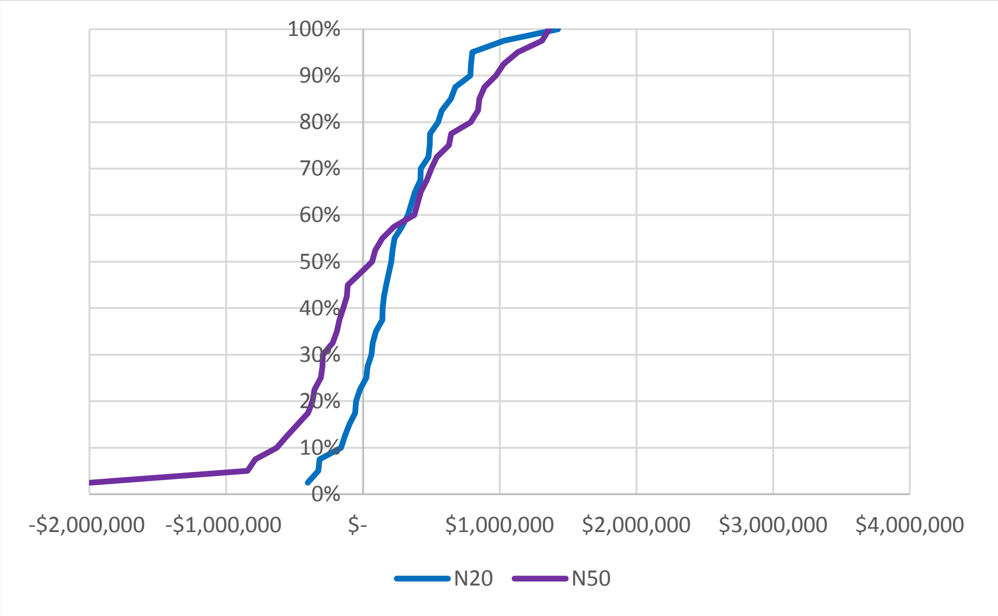
Graph 3. CDF of annual profit for 50 kg N/ha compared with zero application



Depending on the level of nitrogen fertiliser selected, there is opportunity to avoid much larger downside losses with relatively small reductions in profit potential in good seasons.

The two levels of applied nitrogen selected for the modelling don't depict a response curve, but they allow for the relative risk associated with both rates to be directly compared. Graph 4 below, shows the difference curves or profit relative to zero applied N, of the 20 kg N/ha rate and a 50 kg N/ha rate.

Graph 4. CDF of yearly profits from applying 20 Kg N/ha or 50 kg N/ha versus nil application using current (historical modelled) climate data



There is a 40% chance of a substantially better profit from the higher rate of applied N (see Graph 4) but conversely in 60% of seasons there is more profit form the lower rate of applied N. Moreover, the higher rate of N has more than double the chance of making a loss, nearly 50% versus 25% and the size of these losses can be seen to be very much increased by comparing the area between the two curves and the vertical axis. Not only is N20 (i.e. 20 kg N/ha) more profitable on average than N50, but its risk profile is strongly skewed towards the upside.

So the question arises as to why would the top 25% of farmers in the benchmarking data be associated with the highest N rate, rather than the higher average profit at N20? A possible explanation is that the benchmarks indicate relative performance among a sample of higher N users. It seem likely that in any given year the top quartile who receive the more favourable conditions will achieve the highest profit performance and this will be supported by the payoff to the higher N application.

Conversely the lowest quartile would have been penalised by lower but still higher rates of N than would have been required. In this way the benchmarks can easily bias the information towards the riskier end of the pay-off function by only representing the higher application rates and not referencing any low end results.

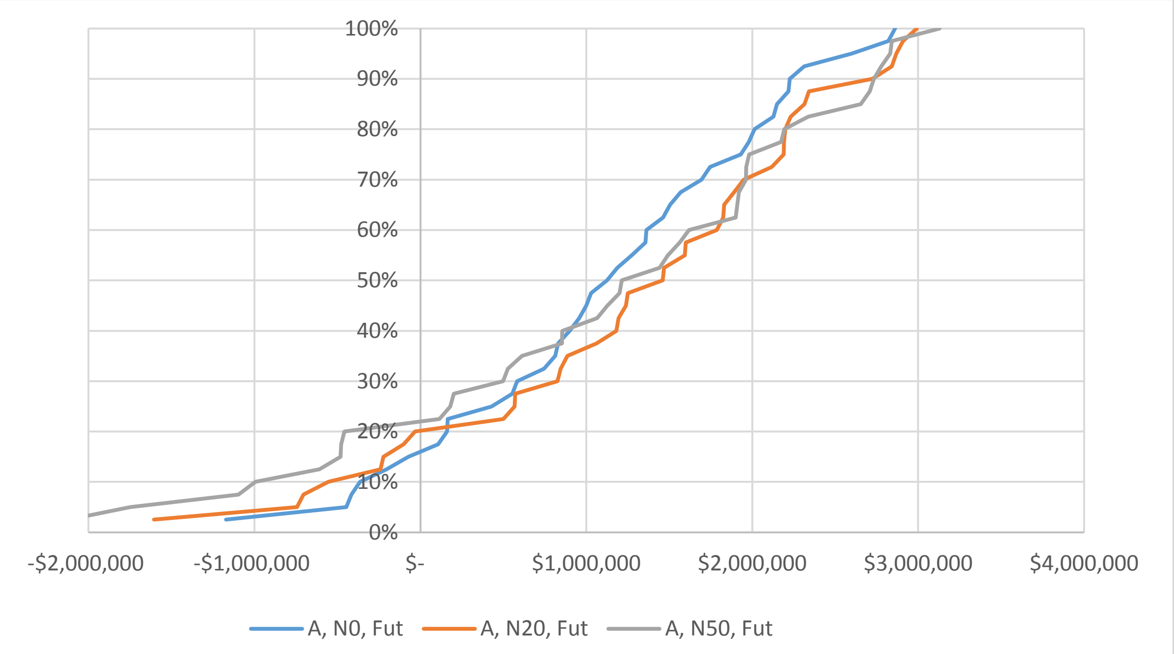
The impact of future climate on farm profit

For future climate scenarios the frequency of losses is about double that over past climate years but the risk is similarly increased at each application rate. Moreover, the size of the loss rises as the application rate of N increases.

Lower rates of N understandably incur slightly higher downside losses than N(0), but offer more upside than a zero rate in about 80% of seasons. Not so clear is whether there is a similar upside from N50 over N 20 in most years.

The crossover of N50 and N zero shows a clear trade-off between higher upside in 60% of seasons, against somewhat larger-sized losses in the other 40% of seasons.

Graph 5. CDF of annual profit for three rates of applied nitrogen in a future climate

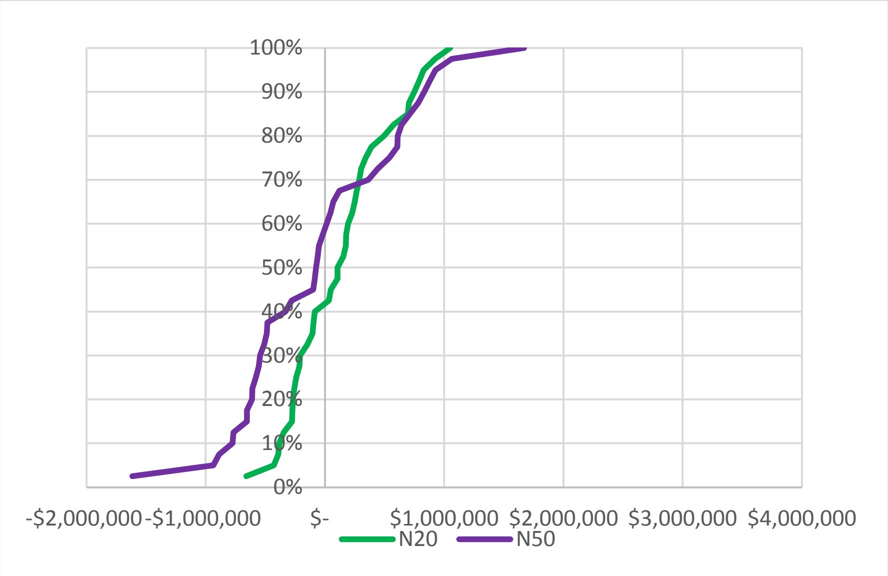


Overall there appears to be a relatively small increase in downside risk from 15% to 22% from zero to the higher rate of N, and not much difference in the upside between the two rates of applied N. However plotting the differences between the N rates against zero provides a much clearer indication of the relative risk between the two application rates.

The difference curves for N50 and N20 relative to zero in future climates, show the relative risk more clearly in Graph 6. The higher nitrogen rate of N50 has very limited upside over N20 in about 30% of seasons; a higher risk of loss in 60% of seasons and much larger size of losses over N 20 when they occur.

Decisions on input levels can be seen to become more difficult in future climate scenarios (Graphs 6 & 7) which include more variability than that experienced in the previous 30 years. If the N50 rate becomes more problematic, how well suited is the N 20 rate as a future strategy?

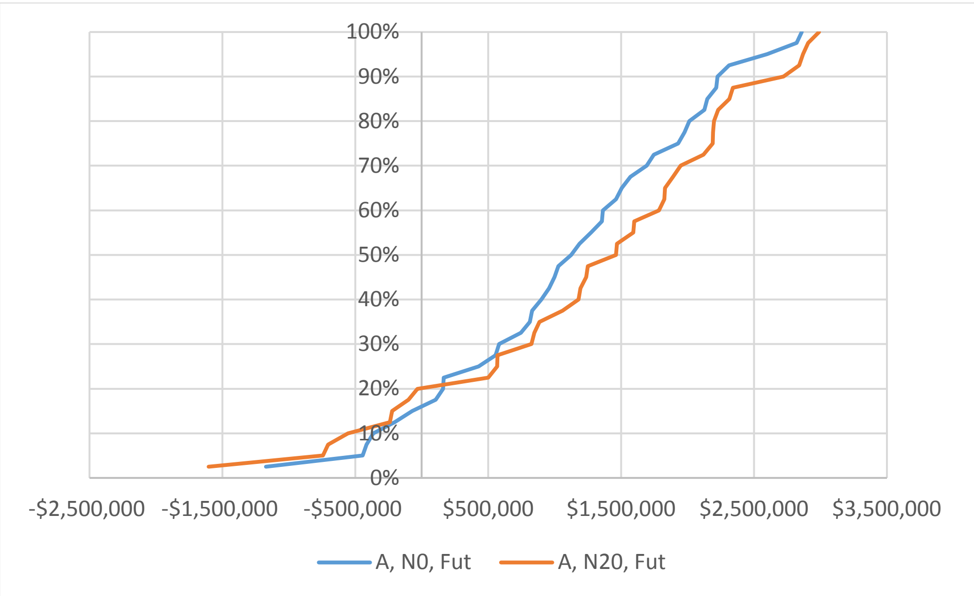
Graph 6. CDF of Annual Profits Relative to N0 using future climate data



In future climates, N20 still appears to have a profit margin over zero applied N in about 80% of seasons and has only 5% more chance of making a loss. These are relatively higher than the annual gains on the upside, so more risk averse managers will find the zero rates a more attractive yet less profitable option.

However the potential upside is large enough to make this low input strategy attractive to all but the most risk averse farmers and it is still sufficiently lower in cost than N50 to be considered a low input strategy.

Graph 7. CDF of annual profit of N0 and N 20 using future climate data

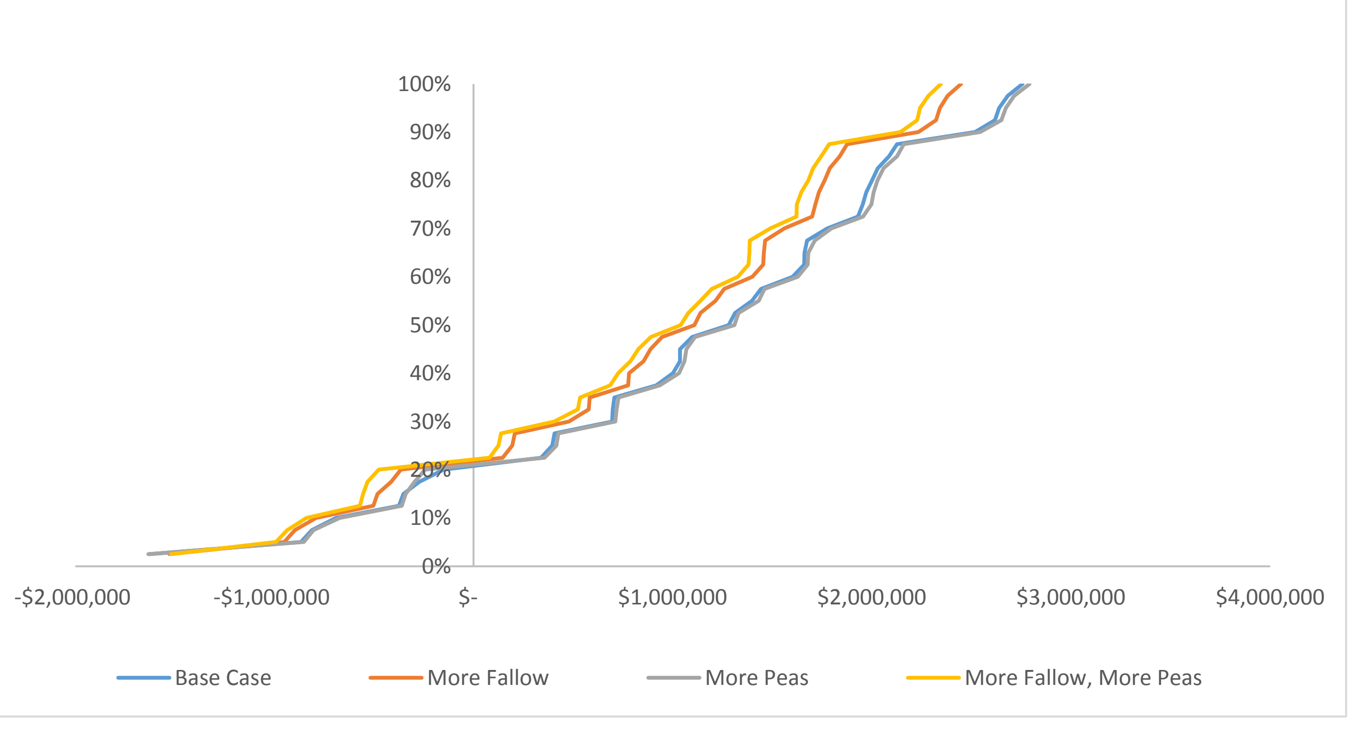


Some other cost reducing strategies

Two further agronomic options as a means to reduce input costs were tested using farm modelling. The first option was to increase the area of fallow from 7% to 20% and the second option was to increase the area of pea legumes in the rotation from 5% to 10%. More fallowed land w\ould reduce operating costs directly as well as improve seeding efficiency and improve soil water storage for subsequent crops.

More pea legumes diversifies grain production and provides some organic soil nitrogen to reduce bag N requirements for following crops, as well as providing some disease break for subsequently grown cereals. We tested each of these options independently and in combination, with the results shown in Graph 9.

Graph 9. CDF of yearly profits comparing effects of less intensive rotations for N20, in future modelled climate



The results show that neither of these management options appear to offer any improvement in profit over the current rotations and systems which is consistent with findings of previous work on these options. In the case of peas the value of fixed nitrogen is less than the cost of artificial substitutes and the other agronomic advantages are offset by disease or insect costs.

In the case of fallow the cost savings are more than offset by foregone gross margin on crop due to the lowered cropping intensity. The advantage of stored soil moisture and better weed control may be of greater tactical value to the program than is depicted here, so that this result should be seen in the context of long term changes, facilitated integrated weed management and the influence of seasonal variability which reduces the impact of stored water in a large proportion of seasons when rainfall is adequate. This makes increased fallowing the least profitable alternative by a large margin.

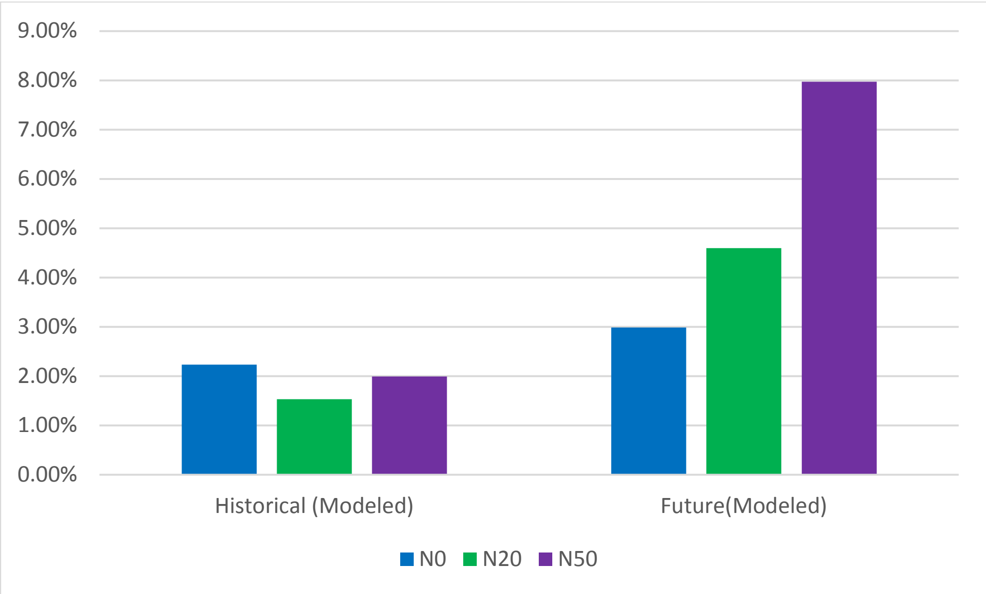
The impact of future climate on business risk

The financial risk to the farm business needs to relate the likelihood and size of profit and loss to the working capital available to maintain liquidity. While the modelling was not able to show the impact of successive large losses from any particular strategy we have some indication of the impact of different profit distributions by calculating the ratio of expected profit to working capital for each of the N levels, to demonstrate the relative risk of higher and lower input strategies.

In Graph 10, it can be seen that the ratio of average expected loss over working capital falls slightly with N20 and not as much as with N50. It is a low percentage of working capital because losses still occur in less than 20% of seasons. Actual losses of about 30% of working capital imply that two or three bad seasons in a row would not drive the business into insolvency.

The financial risk in the future climate scenario compared with historical climates is almost doubled at low N levels but is quadrupled at the higher N50 rate. This makes the necessity of a low input approach in the future very difficult to avoid, if financial security is important.

Graph 10. Financial risk between N rates between historical and future climates



Conclusion

Some farmers, as the one in this case study, appear to be “ahead of the game” in the sense that their experience of a higher frequency of adverse seasons in recent years has propelled their adjustment to their more risky environment. They have been forced by circumstance to adopt strategies that lower their business risk. The use of financial and climate scenario modelling confirms the worth of this farm’s low input farm business strategy.

The broad implication of this study’s findings are that as climate change unfolds, then in the absence of risk-reducing and/or productivity-enhancing technical innovation, farmers will be forced to adopt a strategy of reduced purchased inputs. Any different strategy that involves continued high use of inputs will only expose traditional dryland crop-dominant businesses to further indebtedness and a greater risk of becoming unviable.

A more precise estimation of the level to which nitrogen levels can be sustainably and profitably reduced will require some refinement to the approach taken here, but the incorporation of future climate scenarios into broad estimates of business risk supports what would otherwise be a purely intuitive approach to increasingly risky business decisions.

APPENDIX 1

Data and research methods

The farm business upon which the modelling is based has grown from 4000 hectares in 2006 to the present size of 10000 hectares by leasing then acquiring neighbouring properties. Gearing ratios of around 30% has been supported by Bank loans, off-farm contracting and retained profits.

Present and the future climate was simulated using a climate file from the Everfarm project with simulated climate for Cunderdin in the Western Australian wheat belt from 1900 to 2098.

Farm outline

- Large scale (10000 Ha,. 2x average farm size)
- All crop, no sheep. 50% wheat. Plus barley, canola, peas, oats and fallow in rotations.
- Two soil types. (Medium loam, Light sand)

Crop Yield modelling

The APSIM wheat yield simulation model was used to estimate crop yields for 3 sets of climate data:

- Historical (observed) from 1970 to 2011 (40 years) with current co2 level (his)
- Model simulated climate for 1970 to 2011 with current co2 (csim)
- Model simulated climate for 2012 to 2051 with high co2 (440 ppm) (fsim_co2)

Three nitrogen treatments (N0, N20, N50) were specified for model runs to depict the low input fertiliser strategy- ranging from zero to the typical rate in the region according to Planfarm benchmarks (2013).

The model runs with the same number or years allowed comparison between runs. The GCM was found to be reasonably accurate in its simulation of climate in the 1971-2011 period. The APSIM simulation modelling used climate files from the Everfarm climate project (Muhuddin, 2013).

The validated crop simulation model APSIM-Wheat (v.7.4.) (Keating et al., 2003) was used to obtain simulated wheat yields for different scenarios. The APSIM-Wheat model simulates daily values of root growth, biomass and grain yield based on information on daily weather, soil type and crop management. It calculates the water-limited potential yield of the site, that is, the yield not limited by weeds, pests, and diseases, but limited only by temperature, solar radiation, water, and nitrogen supply at that site.

The wheat model was run for 41 year periods with three sets of climate data: 1) Historical climate for the period 1971 to 2011 with current level of CO2 of 350 ppm; 2) current simulated climate for the same period and 3) future simulated climate for the period 2012-2052 with expected CO2 level of 440 ppm. The current and future simulated climate files were derived from downscaled simulations of the SRES A2 scenario from the CSIRO Mk3.5 Global Climate Model.

Simulations were run for Cunderdin, in the central wheatbelt of Western Australia with mean annual rainfall of 275 mm. Four representative soil types, a duplex (Plant-available water (PAW) = 81 mm), a clay (PAW=108 mm), a sand (PAW = 55 mm) and a loamy sand (PAW= 139 mm) soils were used for the simulations. Simulations were performed for periods of 12 or 30 years assuming the soil was dry at 1st January each year. Sowing time was controlled by a sowing rule. Every year sowing occurred in the first sowing opportunity between 15th April and 10th June as soon as cumulative rain over 5 days exceeded 10 mm. A medium season wheat cultivar (Wyalkatchem) was sown. The amount of nitrogen (N) in the soil at 1st January was assumed to be 50 kg N/ha. Three N fertilizer treatments were simulated: N0 (no fertilizer applied), N20 (20 kg N/ha of N applied at sowing) and N50 (50 kg N/ha of N applied at sowing).

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