Participative research on use of enhanced climate variability information within agribusiness*

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Can agribusiness utilise better information on climate variability?

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Abstract

Climate variability impacts significantly on the agricultural service sector, affecting the operations and policies of agribusiness suppliers, banking and insurance companies. For example, bank lending policy and agribusiness advice was likely affected by recent El Niño drought events. Through consultation with agribusiness suppliers, banks and insurance companies, it is clear that their business operations and policies could benefit substantially from access to enhanced processes for dealing with climate variability.

The Agricultural Production Systems Research Unit (APSRU) has demonstrated that farmers can utilise information derived from climate forecasts and simulation models in interpreting past experience, planning and decision making. Variability in production also poses challenges for both input suppliers and firms involved in the value chain from farm to consumer. Bank lending policies, crop insurance policies, product inventories and marketing advice may all be positively influenced through better dealing with climate variability. For example, insurance policies based on the Agricultural Production Systems Simulator (APSIM) model's objective prediction of yields may potentially reduce claimant disputes and cut legal costs, representing significant savings to industry. Likewise, better prediction of seasonal outlooks using the APSIM model, climate forecasts and fallow water reserves would allow farmers and lenders, such as produce suppliers and banks, to negotiate individually-tailored financial packages. APSRU has recently extended risk management tools developed primarily for farmers to agribusiness to determine whether better targeted and cost-effective agribusiness services can be provided for the benefit of agribusiness organisations and Australian farmers.

In this paper we report on our experiences and learnings from our action research approach, where APSRU researchers are working alongside agribusiness staff on relevant case studies to identify the opportunities for and to resolve constraints against implementation of improved agribusiness operations based on climate forecasts and use of the APSIM model. Our collaborators represent a mix of agribusiness organisations, including input suppliers, marketers, banks and insurance companies. The case studies involving our collaborators are described and discussed in the paper, along with results of our initial evaluation. The use of climate forecasts and APSIM has generated interest amongst the agribusiness sector. While the costs of conducting this research are high, we conclude that there are good opportunities for these tools to assist agribusiness operations in providing better services to Australian farmers.

Introduction

Climate variability impacts significantly on the agricultural service sector, affecting the operations and policies of agribusiness suppliers, banking and insurance companies. For example, bank lending policy and agribusiness advice were affected by droughts concomitant with recent El Niño events. The Agricultural Production Systems Research Unit (APSRU) has consulted agribusiness suppliers, banks and insurance companies and clearly these agribusiness sectors could benefit substantially from access to better processes for dealing with climate variability.

APSRU is a joint R&D unit consisting of CSIRO Sustainable Ecosystems and the Queensland Departments of Primary Industry and Natural Resources. APSRU's expertise is in the computer simulation of farming systems targeted at research that impacts on how agricultural production systems are managed. APSRU has developed a set of tools that could assist agribusiness improve the way they deal with climate variability. These include:

- tools to assist farmers and agribusiness to better understand the soil resource in relation to alternative agricultural enterprises (e.g. soil coring equipment, soil resource database);
- seasonal climate forecasts based on the Southern Oscillation Index (SOI) and Sea Surface Temperatures (SST);
- the APSIM cropping systems model.

APSRU's interest in agribusiness stems from eight years of experience in helping farmers deal with climate variability. APSRU's FARMSCAPE[1] (Farmers Advisers Researchers Monitoring Simulation Communication And Performance Evaluation) project has demonstrated that farmers can utilise information from seasonal climate forecasts and crop simulation models to interpret past experience for planning and decision making. Can agribusiness operations and policies also benefit from access to better processes for dealing with climate variability? Variability in production also poses challenges for both input suppliers and firms involved in the value chain from farm to consumer. In what represents an evolution of the APSRU's capability in this area, APSRU has recently extended risk management tools developed primarily for farmers to agribusiness to determine whether better targeted and cost-effective agribusiness services can be provided for the benefit of agribusiness organisations and Australian farmers through the application of climate forecasts and APSIM simulations. With support from LWRRDC's Climate Variability in Agriculture R&D Program, APSRU is exploring delivery of the FARMSCAPE approach for institutional decision making by designing case studies, in partnership with industry, to test the commercial application of the APSIM model.

[1] The FARMSCAPE Project is jointly supported by APSRU and the Grains Research and Development Corporation.

The Agricultural Production Systems Simulator (APSIM)

The Agricultural Production Systems Simulator (APSIM), represented schematically in Figure 1, is a model that uses various component modules to simulate cropping systems (McCown *et al.*, 1996)[2].

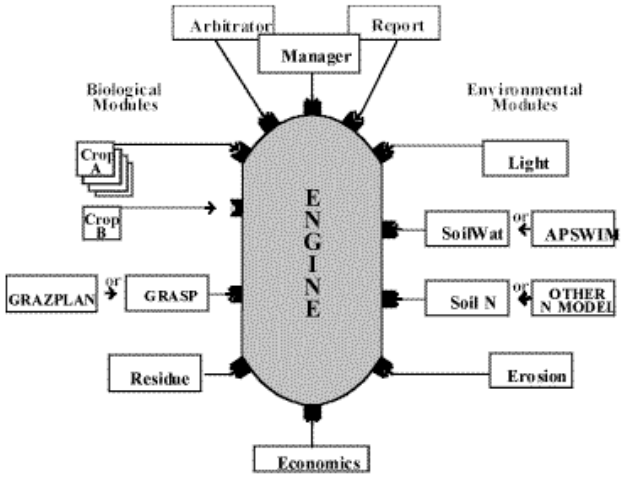


Figure 1. Schematic representation of APSIM.

The simulation capacity of APSIM is limited only by the availability of modules to simulate the processes peculiar to the system of interest. APSIM has the ability to simulate the growth of a range of crops in response to a variety of management practices, crop mixtures and rotation sequences, including pastures and some aspects of livestock production. Importantly, this is accomplished in such a way that the soil accrues the effects of the different agricultural practices such as cropping, fallowing, residue management and tillage. In this way, APSIM can simulate long-term trends in soil productivity due to fertility depletion and erosion. APSIM contains modules that permit the simulation of soil organic matter rundown, nutrient leaching, soil erosion, acidification and soil phosphorus. There is however no current capability to deal with effects of salinisation, insects, diseases or biodiversity loss. Simulated outputs can include yield and gross margin (returns, cash flow and risk probabilities) and other systems consequences such as soil erosion or acidification etc.

APSIM has been specified for, and its simulations tested against, a range of crop and farming systems. Over the past 6 years, a number of commercial crops have been monitored and used to test APSIM simulations. In most cases, these tests have confirmed that APSIM is able to simulate commercial crop production –accounting for over 80% of the observed variation in crop yields. For most of those crops where predictions were significantly different, we have been able to determine the reasons for the discrepancies – most are due to impacts of factors not accounted for in the models (eg. severe pest damage).

[2] McCown R.L., Hammer G.L., Hargreaves J.N.G., Holzworth, D.P. and Freebairn D.M. (1996). APSIM: A novel software system for model development, model testing, and simulation in agricultural systems research. *Agricultural Systems*, 50: 255-271.

APSIM is currently being used and tested in all cropping regions of Australia, and in a number of international collaborations, and has been used in a range of research and pilot commercial activities. Formal evaluation of the current uses has demonstrated impacts on participating farmers and advisers. For many farmers and consultants, APSIM has proved credible enough to be relevant to commercial cropping practices and they now want to use it in benchmarking the performance of their own crops and in exploring alternative management strategies. The demand for simulations has increased rapidly to the point where APSRU can not meet that demand, nor justify providing a "commercial" delivery service.

APSRU is currently transferring APSIM to the commercial sector via an Accredited Adviser Network for delivering simulation and related products such as soil monitoring, seasonal climate forecasts, analysis of relevant management scenarios and "what-ifs, analysis and discussion" to farmer clients in the northern cropping region. A number of agribusiness and private consultants are being accredited and supported in implementing this approach within their business practices.

Engaging with agribusiness

Prior to this research, we had no significant previous experience in dealing with the agribusiness sector. We obtained assistance from Rabobank Australia (specifically, Rabobank Australia Ltd's Agribusiness Consulting and Research Services) to identify potential applications for APSRU tools within the agricultural value chain and prospective companies that may benefit from access to these tools. The Rabobank consultancy delivered on providing us with access to senior managers of a number of agribusiness companies with possible interests in APSRU tools and capabilities. We also independently approached a number of agribusiness firms including banks, insurance and input suppliers.

Potential client segments that were identified include:

- Suppliers of genetics
- Other input suppliers & retailers such as fertilizer, chemical and crop care companies
- Primary producers
- Corporate producers and marketers (e.g.: cotton companies, feedlotters)
- Agents and wholesalers who (may) interface between producers and early stage processors (e.g.: soft commodity merchants)
- Early stage processors (e.g.: abattoirs, millers)
- Late stage processors (e.g.: Kelloggs, Goodman Fielder)
- Retailers
- Service providers such as insurance, finance, and logistic companies

In Rabobank's assessment, APSRU's value to industry is largely driven by the challenge to many CEOs of managing risk, especially understanding supply and biological risk of the agricultural production base. Relevant APSRU capabilities in this respect are:

- Recurrent annual production assessment
- Assessment of yield variability
- Simulating historical records
- Reconstruction of the past
- Assessment of new technology
- Assessment of new crop varieties
- Assessment of new (alternative) land uses
- Assessment of risk through the early stage production chain
- Synthesising the link between production and the environment

These capabilities could be converted to benefits to industry in the following ways:

- Ability to forecast supply – quality and yield – for a given area
- Ability to conduct crop assessment
  - existing crop in a new region
  - current crop with new technology in an existing region
  - potential versus current performance in an existing region
  - new crop in a new region
- Ability to reconstruct the past and determine what went wrong and why
- Ability to forecast environmental impacts
- Ability to assess water utilisation
  - develop more efficient utilisation of water and
  - assess impacts of increasing water price
- Ability to contribute towards the development of new risk management (insurance) and financial products.

Case studies

After initial interactions with agribusiness we sought to develop case study concepts based on matching APSRU's capabilities and proposed solutions with anticipated industry needs. Interest generated among agribusiness was high (all approached companies through Rabobank agreed to consider developing case studies as part of the CVAP project). However, there were differences in the level of enthusiasm and attractiveness of possible case studies. We have reflected on the reasons for this in the "Learnings" section of this paper.

In exploring potential applications within industry, we have adopted an action research approach, where APSRU researchers work alongside agribusiness staff in order to test the feasibility of an agribusiness firm, if it did have the in-house capability, utilising climate forecasts and APSIM simulations in designing and implementing improved marketing, finance and insurance packages. Thus, potential applications within industry will emerge via interactions with managers working in this area.

In adopting an action research approach, we are making a clear distinction between the mode of research, called 'policy' research, that most economists would be more familiar with. The distinction is based on Oquist's[3] (1978) typology of research. The output of 'policy' research is knowledge to guide best practice, based on theoretical

[3] Oquist, P. (1978). The epistemology of action research. *Acta Sociologica*, 21(2).

possibilities and limitations, ie theory-based models. This corresponds to much of the research conducted by Australian agricultural and resource economists. Action research is also concerned with the production of knowledge that guides best practice but instead of guidance being based solely on reference to theory, it takes the latter as a reference point, along with the experience of our agribusiness partners, and searches for a 'best practice' in the practical situation. In action research, modifications in 'real world' practice occur *as part of* the research process, rather than *subsequent* to the research as is the case for policy research.

A high emphasis has been placed on evaluating the success of and reporting of learning from innovative application of improved information and tools in agribusiness. Baseline interviews of key stakeholders were completed at the commencement of the research, and then on an annual basis.

APSRU has been able to engage with several companies to explore the use of APSRU tools within their business operations via in-house case studies. Three areas of involvement with agribusiness are discussed below:

Portfolio management

Value from access to APSRU tools at the farm manager level was recognised in our discussions with managers of two companies involved in large corporate farming operations with portfolio management demands across a range of districts and enterprises. Twynam is Australia's largest cotton producer and the second largest cotton producer in the world. In addition to cotton, Twynam has corporate farms spanning several states with significant interests in rice, dryland cropping and livestock production. Incitec is one of Australia's largest fertilizer suppliers, with operations in all States except Western Australia. Incitec are a basic provider of agronomic packages to most of the leading rural resellers in eastern Australia, but are also becoming directly involved with large corporate farming operations in advice on planning and portfolio management across a range of districts, with the aim of meeting shareholder expectations of stable returns.

For both companies, an agreed area of mutual interest was to explore whether APSRU tools could focus on the next level in management in corporate farming, i.e. assist such companies to manage their extensive corporate farm portfolios at a level above day to day farm management. A relevant question was "in an upcoming year of current low commodity prices, what mix of enterprises should the company consider across several properties and seasons?". There was also interest in obtaining crop yield and probability predictions to assist in the management of input supplies in large-scale operations.

We negotiated case studies with both companies to explore the use of APSRU tools (seasonal climate forecasts and APSIM) in a portfolio management role. We define "portfolio management" in the context of a) an informed selection of enterprises and b) allocation of inputs across a multi-farm / multi-location business.

An example of the output from APSIM that managers in one company found valuable in planning and managing risk associated with enterprise and input selection is shown below in Figures 2(a)/(b) and 3(a)/(b). Discussions with these managers were based

on simulated yields and gross margins for wheat sown at five nitrogen fertilisation rates (0, 40, 80, 120, 160 kgN/ha). This information was presented in several different ways. Fig. 2(a)/(b) shows wheat yields and gross margins for one fertiliser rate at one location[4]. Results for all regions and all fertiliser rates are summarised in Fig. 3(a)/(b). The gross margin in this graph is based on a single crop price, but other prices were also discussed. The managers said this information aided their thinking about the potential for exploiting differences in yield potential and input costs across regions. They also gained new insights into risk that would help them plan the next season's cropping.

The process of interaction with staff from this company involved many small steps and frequent communication. The APSIM model simulations were initially performed on existing cropping activities as a credibility-building step before further model runs were generated. Work with this company is still continuing and we (the researchers and our agribusiness collaborators) still feel that we are yet to fully realise the potential of APSRU tools in a relevant economic analysis framework in portfolio management. A positive side-effect from exploring portfolio analysis is that other useful applications of APSIM in the company's business operations have been identified.

Crop insurance and Crop Loss Assessment

Baseline interviews revealed that insurance managers were attracted by any new technology which enables them to more objectively quantify crop-losses as part of a continual quest to find methods of quantifying claims objectively. They identified a need to replace subjective ideas by objective data collected in an independent way to stop litigation, a task requiring access to respected technology.

APSRU have worked with crop loss assessment company, ALM, to provide estimates of potential crop yield based on APSIM simulations for the purpose of crop insurance. In other words, APSIM was used to establish the crop yield loss relevant to an insurance claim either resulting from natural events or liability. Such information has then been used to aid the resolution of disputation regarding the amount of compensation that should be made for crop losses. Initial demonstrations of the use of simulations for insurance assessment has been undertaken in five case studies over the past 12 months. It is relevant that the APSIM model contributed to a negotiated settlement claim in at least three of these cases. As an outcome of such preliminary case studies, loss assessment firms have expressed interest in further exploring the application of APSIM and climate information in crop insurance claims. The current status of interactions is that several loss assessment cases studies have been successfully completed and there is expressed interest in pursuing commercial application of APSIM in loss assessment cases.

Financial assessment

Prior to establishing a case study in the rural banking industry, a meeting with representatives of several banks was held to discuss the use of climate information and tools by the banking industry. There was general agreement among local and

[4] For confidentiality reasons, actual locations, fertiliser rate, crop input and production prices are not presented.

senior managers that impacts of recent El Niño events were undoubtedly factored into lending policy and that such events were having a huge influence. Bank representatives agreed that banks are raising the demand for information from clients all the time, e.g. asking for cash flow information, and that information about monitoring and simulation related to individual clients applying for finance would be beneficial to both the banking industry and its clients – a better understanding of risk can benefit all parties. The same sentiments were expressed in the baseline interviews conducted at the start of the project. Linking APSIM physical forecasts with financial projections was seen as having real potential. As a tool for risk management and forward planning of yield, the following possible APSIM applications relevant to banking were suggested by banking representatives:

- Assisting bank staff to ask more pertinent questions about the farm business when assessing for loans.
- Assisting bank managers to determine which businesses are financially feasible and assess existing customers' ability to service new liabilities.
- Helping bank clients look at options other than more debt.

The positive reaction resulted in expressions of interest by National Australia Bank (NAB) with support from National & State Managers. Participation was negotiated for four local Rural Finance Managers (RFMs) to collaborate in developing relevant case studies for the application of APSRU tools. The proposed research methodology was for APSRU researchers to work alongside the RFMs on several case studies in order to test the feasibility of the bank, if it did have the in-house capability, utilising seasonal climate forecasts and APSIM simulations in designing and implementing improved financial services. NAB's contribution was the involvement of their staff and contact with their farmer clients.

Through this collaboration, forecasts of cropping options for 10 NAB farmer clients were undertaken prior to the 1999/2000 summer season and provided to the RFMs and the participating farmers. This activity was seen as an initial step in building confidence in the accuracy of APSIM among bank staff and clients while exploring its potential value to the bank's business. Subsequently, one of these farmers has keenly sought further interactions. We have characterized his soil and are providing him with customized simulations for this season. He has suggested that we meet with his RFM to discuss how useful the information is viewed.

While there has been some effort placed in licensing and training bank staff in the use of APSIM, developing an in-house capacity to generate such information has proven difficult, the main reason being that the APSIM model is complex software and requires significant allocation of time of already busy people.

Our reflections on this case study to date have led us to conclude that the information on crop and seasonal climate forecasts would be of benefit to bank clients and could be valued by lending managers. However, while interested in the data on seasonal cropping outlooks for individual farmer clients, there currently does not seem to be a practical and facilitated way for the bank to generate such information for individual clients on their behalf. It would be much better for bank clients to come with this information to NAB. The recently initiated FARMSCAPE Training and Accreditation program which has been established to train and support four agribusiness companies

to use APSRU tools in their commercial advisory services, can be a way for farmer clients to access these technologies. NAB viewed this most positively.

Learnings

Opportunities for engaging agribusiness

We believe that opportunities abound for engaging agribusiness in exploring the role for seasonal climate forecasts and simulation models in their business operations. There has not been one company that was approached that has not demonstrated at least some interest in becoming involved in this project. All companies that have been approached for collaboration (subsequent to an initial contact) have agreed to invest their own resources (mainly in terms of staff time) in project activities. At least two companies have indicated willingness to contribute small amounts of funding to progress this research activity. The breadth of businesses within which there are possible uses for seasonal climate forecasts and simulation models covers the agricultural value chain.

We have found that the insurance industry and corporate farming operations have been most receptive to the opportunities presented by this project and are at a stage of wanting to adopt the new technologies. For crop insurers, simulation is seen as an improved method of loss assessment and seasonal climate forecasting combined with simulation is being assessed as a methodology for developing innovative insurance schemes.

Agribusinesses have existing ways of dealing with climate variability within their operational systems. Consequently, there is significant inertia against consideration of new systems. For instance, we found that companies with the need for commodity forecasting system showed a lack of enthusiasm for a new commodity forecasting system using such tools as SOI and simulation. Companies with this need have existing systems that appear to be flexible, based on information networks, are fairly transparent and seem to work well enough for their needs. It is hard to see how a simulation forecast could do better than these systems which have such a strong field informant basis. One exception to the point above is an apparent need to forecast quality grades, an attribute missing from current systems. This area may be an opportunity for research intervention.

The engagement process

We were able to approach agribusiness companies with a proposal for collaborative research that may benefit the companies in areas of mutual interest. This only possible with financial support from the CVAP program. Significantly less interest would have been generated from approaches to companies where commercial funding was sought as part of the collaboration. While many of the companies may have been willing to contribute funds in addition to staff time to joint activities in the future, they do require an introduction to what's possible before reaching this stage. We found that engagement with agribusiness benefited from the credibility with agribusiness created by APSRU projects with farmers such as FARMSCAPE. Another important factor was being able to approach agribusiness companies at high levels within their management structure. In this regard, the Rabobank consultancy which targeted

introductions to agribusiness companies was very successful – APSRU gained access to the senior executives of a number of companies.

Dealing with agribusiness requires new ways of research engagement that differ to typical researcher-funder relationships and we were faced with bridging differences between organisational cultures and protocols, i.e. a bureaucratic *versus* a commercial culture. These ways were unknown at the initiation of the project and have had to be learnt on the run. For example, frequent low level iterations of engagement are preferred to infrequent detailed meetings. Researchers need to be proactive in the collaboration and communication as the project is on the periphery of most agribusiness collaborators' work and thus needs to be placed into view regularly. Operating in a learning mode *versus* operating in a commercial mode, both within a commercial environment creates challenges.

Participatory action research framework

The Participatory Action Research (PAR) framework used by the project has been an appropriate methodology in which to pilot interactions and the strong emphasis on evaluation has provided baselines of stakeholder views as well as feedback on progress. That said, working with agribusiness in a PAR mode is time-consuming, stressful, and confronting, (especially when activities don't work as expected) – not surprising considering that action learning is about developing actions and methods which are imperfect at the start but successful at the end.

It is clearly easier for researchers to undertake research on the role for seasonal climate forecasts and simulation models within a policy / operations research framework – i.e. one step divorced from real clients. As a consequence, there is a real lack of incentive for researchers to address this work area – evidenced by the relative numbers undertaking policy analyses versus engaging directly with clients.

Negotiations to gain approval for collaboration and to design operations have taken significantly more time than envisaged. This is often also a result of still being in an exploratory frame of mind, of not yet having set firm boundaries and not having reflected on what it is that is likely to be learned and thus needs to be. The time taken to learn about dealing with agribusiness has meant that some activities have fallen short of collaborator expectations. Perceived poor performance may spoil real opportunity and more time and investment is required to capture and respond to the major opportunities with agribusiness.

Commercialisation issues

There is a need to address legal issues, client confidentiality, and ownership of intellectual property developed throughout the case study process. Clarification of the internal and intra-organisational management procedures for developing long-term arrangements and agreements required for the use and further development of APSIM beyond the current project, will be required should results of our research warrant this. We also require a clear understanding with case study clients as to the anticipated boundaries about the point at which the case study would cease and the next stage of commercial transactions might be entered into.

Conclusions

Our experience to date suggests that bank lending policies, crop insurance policies, product inventories and marketing advice could all be positively influenced through better dealing with climate variability. For example, insurance policies based on the Agricultural Production Systems Simulator (APSIM) model's objective prediction of yields could potentially reduce claimant disputes and cut legal costs, representing significant savings to industry. Likewise, better prediction of seasonal outlooks using the APSIM model, climate forecasts and fallow water reserves would allow farmers and lenders, such as produce suppliers and banks, to negotiate individually-tailored financial packages.

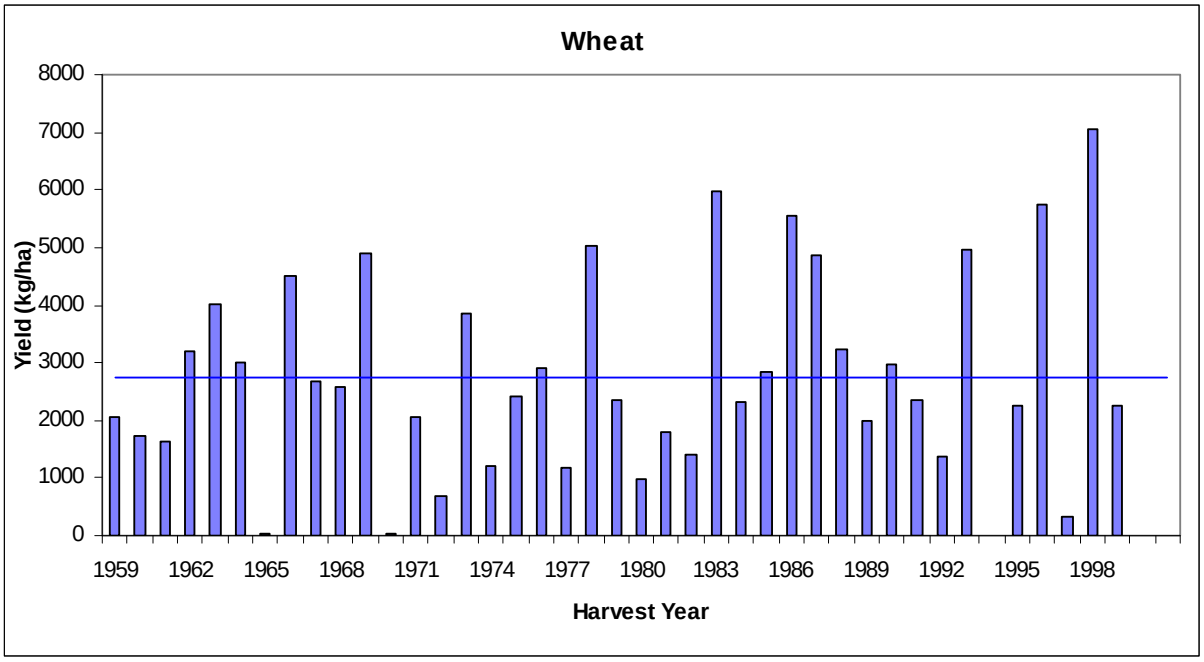
While discussions with agribusiness indicate keen interest in such tools and information, they have yet to have impact on policy and operations. While clear outcomes have been seen in some areas of engagement (e.g. insurance/loss assessment), other collaborative efforts have only progressed some way to exploring the role for seasonal climate forecasts and simulation models in their business operations (e.g. banking, portfolio analysis). More time and investment is required to capture and respond to the major opportunities with agribusiness.

The outcomes of this research will determine whether better targeted and cost-effective agribusiness services can be provided to Australian farmers through the application of climate forecasts and APSIM simulations. The two major beneficiaries of this project are companies involved in agribusiness and Australian farmers. The major output of this project will be well documented, pertinent experiences, obtained under realistic institutional conditions, on whether better targeted and cost-effective agribusiness services can be provided to Australian farmers. In doing this, we recognise the importance of resourcing the client interface during the life of the case studies i.e. with a strong evaluation process and regular status reports. Ultimately, a successful project will see the adoption of climate forecasts and simulation within the agricultural service sector beyond the life of this project

Acknowledgements

This activity is supported by the Agriculture, Forestry and Fisheries Australia and Australia's rural R&D Corporations under the Climate Variability in Agriculture Program (LWRRDC). We also gratefully acknowledge the support of our agribusiness collaborators.

Figure 2(a)/(b): Simulated wheat yields and gross margins (based on a constant price) for one fertiliser application rate for 41 years (1959 – 2000) at one location. The horizontal bar represents the mean.



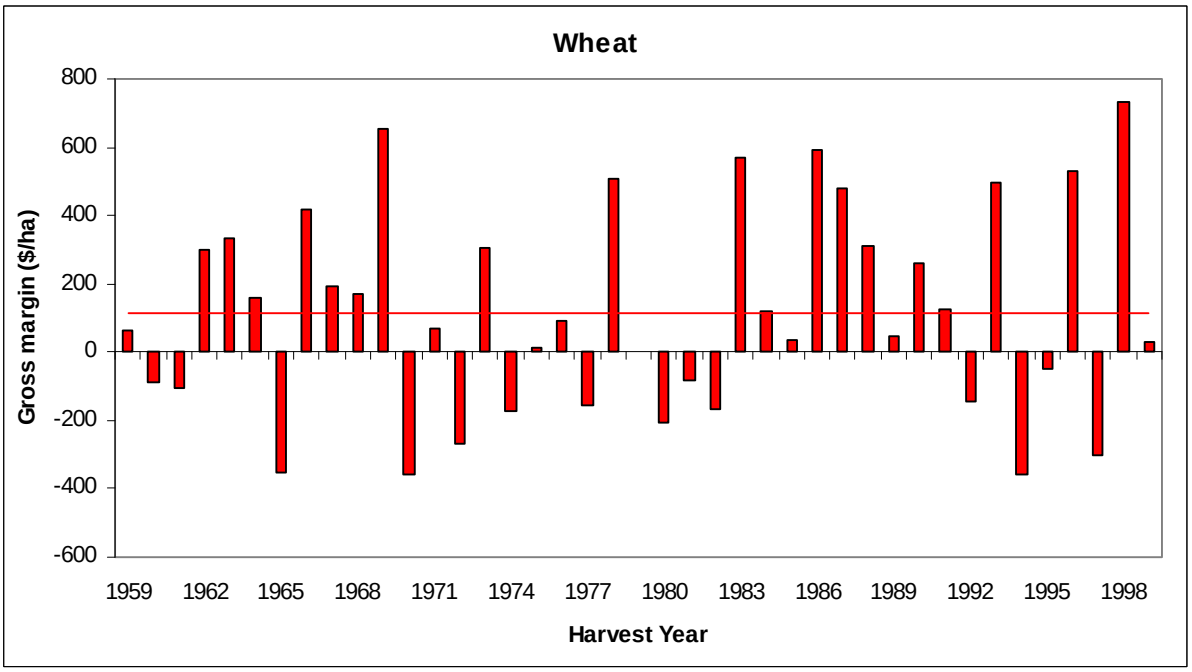


Figure 3 (a)/(b): Summary of simulated wheat for 41 years (1959 - 2000) at farms at three locations. For each N fertilisation rate x location the bars represent average yields and gross margins (based on a constant price) for all 41 seasons. Each vertical line indicates the level of risk for each scenario, represented by the 10th and 90th percentile in simulated yields, and the marker on the bar indicates the median.