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SPEAKERS PAPERS

Speaker

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Title

Economic applications of seasonal climate forecasting at farm level

Session

Climate
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How can we deal better with climatic risk in agriculture?

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ABSTRACT

Climate variability pervades agriculture in Australia. It generates risk. But we have had to live with high climate variability for a long time. Why haven't we been able to come to grips with it better? In this paper I suggest that this is because our instruments to assist managers and policy makers in dealing with climatic risk have not evolved in tandem with advances in underpinning scientific and technological capability. The question of the title is considered with respect to farm managers, agribusiness, and policy makers. It is argued all three have significant opportunities to improve the way we deal with climatic risk in agriculture. Most of these opportunities are associated with improved utilisation of modelling and seasonal climate forecasting technologies. At the farm scale, this mainly relates to better linking of relevant instruments with farm managers and advisers. The participatory processes to achieve this are largely known but have not been widely implemented. At the agribusiness and policy scales, an enhanced role for the private sector is envisaged. Business efficiencies will likely be improved as specific climate risk management instruments are developed. There are also new instruments that could be developed in the private sector to support government policy desires for self-reliance by farmers. This will require public-private partnerships for the effective design of such instruments. There is an on-going role for government intervention in provision of a safety net during exceptional climatic circumstances, in strategic investment in research, and in the development of human capital for dealing with climatic risk.

Introduction

Climate variability pervades agriculture in Australia. It is omnipresent. Its influence is felt by farmers and their advisers managing properties, by agribusiness managers managing their inventories or commodity marketing strategies, and by policy makers in governments setting taxation and drought policies, to name just a few. The common thread across this range of scale in influence is exposure to the chance of making a loss, or risk - not only financial risk but also land degradation, environmental, and political risks. Climate variability generates risk. No one can predict what the next season will be like. Consequently, outcomes of management decisions or policy interventions cannot be predicted with any surety. In fact, with the extent of climate variability in Australia, there is an immense range of possible outcomes in any one year associated with some key decisions. One lifetime is not enough to experience the extent of this climatic variability.

But we have had to live with high climate variability for a long time. Why haven't we been able to come to grips with it better? In this paper I suggest that this is because our instruments to assist managers and policy makers in dealing with climatic risk have not evolved in tandem with advances in underpinning scientific and technological capability. Only part of this relates to slowness in capturing capabilities offered by emerging skill in seasonal climate prediction (McBride and Nicholls, 1983; Stone et al., 1996a). Another key factor is the range of available modelling and analytical procedures that have been under-utilised in the design and implementation of novel instruments for managers and policy-makers (Muchow and Bellamy, 1991; White, 1998; Hammer et al., 2000a). When these factors are combined with a range of communication and institutional barriers it is perhaps understandable that progress has been slow.

The question of the title is considered with respect to farm managers, agribusiness, and policy makers.

Managing Climatic Risk On-Farm

There has been a long history of academic treatment of risk management in farming by agricultural economists (e.g. Hardaker et al., 1997) and approaches to management decision analysis under risk are mature. What remains elusive is their effective connection to decision makers. At the farm management level, the issue reduces to potential shifts in the likely distributions of outcomes and possible changes in the dispersion of those distributions associated with management options. This information must be generated and reduced to digestible form by or for managers. A formal or experiential awareness of historical climatic variability and its effects on management practices provides a basis to formulate the distributions. While there is general acceptance and some subjective use of this approach, the demonstrable risk management value of the information content in these distribution shifts remains poorly tapped.

Despite this general state, management activity at farm scale is the one that has advanced most in the development and implementation of risk management instruments. As part of the revised National Drought Policy (discussed later), there has been over a decade of effort put towards developing self-reliance in farm managers. Much of this effort has focussed on increasing awareness, knowledge and skills in relation to climate variability and risk management. There have been significant developments in agricultural modelling, seasonal climate forecasting, and how to connect them in ways meaningful to managers (various chapters in Hammer et al., 2000b). There have been significant developments of participatory approaches and supporting tools to facilitate linking these analyses with managers and advisers (Meinke et al., 2001; Carberry, 2001; Keating and McCown, 2001; Nelson et al., 2002).

The case with the use of ‘skip-row’ sorghum production systems in NE Australia exemplifies the point (Routley et al., 2003; McLean et al., 2003). Sorghum is the main dryland summer crop grown in NE Australia. Production is characterised by poor yield reliability associated with seasonal variability. In seasons with low in-crop rainfall, soil moisture reserves are often fully utilised by anthesis and low yields or total crop failure can result. In recent years, ‘skip row’ configurations have been trialed as a risk management measure aimed at improving yield reliability. A common skip row configuration is double skip (DS) where two rows are planted and two not planted. A base row spacing of 1.0 m is commonly used in the solid planted (SP) configuration. Skip row configurations are thought to improve yield reliability by delaying utilisation of soil moisture in the centre of the skip area until late in the growing season when the soil water extraction front extends into this area. As a result, soil moisture in the centre of the skip is more likely to be available during the grain filling stage allowing higher yield and increased harvest index in moisture limited growing conditions. In growing conditions with more favourable moisture, DS yields are likely to be less than SP yields due to the reduced crop leaf area and associated light interception and likely greater soil evaporation.

A number of experiments have been conducted to enable modelling of skip-row production systems. A simulation study using long-term historical climate data for a marginal cropping location in SW Queensland shows how the distribution of outcomes associated with skip row management is modified in a way that reduces risk (Fig. 1). The dispersion of the distribution is significantly reduced with DS and there are far fewer failed crops. However, there are also fewer high yielding crops and the distribution is shifted so that the overall mean performance is lower. Hence, the reduction in risk occurs at a long-term cost in profitability (all other factors being equal).

This sort of information is now available for many management decisions and is in a form suitable for discussion with growers and advisers about the risks and trade-offs associated with various decisions. Managers are able to assess trade-offs objectively and attach their own risk preferences in reaching a decision. The general risk-averse nature of farmers (Hardaker et al., 1997) indicates that they will be prepared to trade-off some return for a reduction in risk, but the extent to which this will be acceptable depends on the degree of their risk aversion. In some situations, the addition of seasonal climate forecasting knowledge can influence this trade-off. The chances of either high- or low-yielding years are modified by the state of the Southern Oscillation at the time of planting. It is possible to use this additional information to reduce risk without the concomitant trade-off in loss of productivity (see examples in Hammer et al., 2000).

National development projects with the support of the Managing for Climate Variability Program (co-ordinated by LWRRDC) are now commencing to enhance the adoption of this technology. The research and development phase has shown the feasibility of these approaches via detailed case studies. The private sector is now being engaged as a key player in the process of broadly implementing this technology with growers and their advisers. The research frontiers have now shifted to issues associated with dealing with climate trends and the possible skill in climate prediction at the decadal time scale. The agricultural system modelling tools are available for researching possibilities, but their effective use awaits more concise definition of effects on the climate system, particularly in relation to changes in rainfall. However, some climate trends, such as quantified shifts in minimum temperature (Stone et al., 1996b), can already be incorporated meaningfully in studying adaptive management of agricultural systems.

Managing Climatic Risk at Industry Scale

Various forms of agribusiness (e.g. commodity and input handling) that are directly influenced by climatic risk are also struggling to come to grips with how to effectively utilise probabilistic information in their business decisions. There have been significant developments in relevant agricultural modelling capability at this broader scale (Stephens, 1995) and in implications of seasonal climate prediction (Potgieter et al., 2002). It appears, however, that there has been little development in how to connect these capabilities in ways meaningful to business managers. While there may well be considerable hidden activity on this latter aspect inside the commercial environment of relevant companies, it appears that private investment in novel analysis and planning instruments is largely lacking. It is possible that a public-private partnership would be appropriate in developing novel instruments so that the relevant mix of knowledge and human capital can be brought to bear.

While industry is responsive to issues and opportunities, it is often lacking in research expertise and has limited investment in longer term strategic R&D. This is often because any one company does not have the scale of operation to support such investment. The case study on the feed grains industry in NE Australia is pertinent. Reliability of supply of feed grain has become a high priority issue for industry in the northern region. Expansion by major intensive livestock and industrial users of grain, combined with high inter-annual variability in seasonal conditions, has generated concern in the industry about reliability of supply. A modelling study was undertaken to analyse the reliability of supply of feed grain in the northern region (Hammer et al., 2003). Feed grain demand was calculated for major industries (cattle feedlots, pigs, poultry, dairy) based on their current size and rate of grain usage. Current demand was estimated to be 2.8Mt. With the development of new industrial users (e.g. ethanol) and by projecting the current growth rate of the various intensive livestock industries, it was estimated that demand would grow to 3.6Mt in three years time. Feed grain supply was estimated using shire scale yield prediction models for wheat and sorghum that had been calibrated against recent ABS production data. Other crops that contribute to a lesser extent to the total feed grain pool (barley, maize) were included by considering their production relative to the major winter and summer grains, with estimates based on available production records. This modelling approach allowed simulation of a 101-year time series of yield that showed the extent of the impact of inter-annual climate variability on yield levels. Production estimates were developed from this yield time series by including planted crop area. Area planted data were obtained from ABS and ABARE records. Total production amounts were adjusted to allow for any export and end uses that were not feed grain (flour, malt, etc). The median feed grain supply for an average area planted was about 3.1Mt, but this varied greatly from year to year depending on seasonal conditions and area planted (Fig. 2). These estimates indicated that supply would not meet current demand in about 30% of years if a median area crop were planted. Two thirds of the years with a supply shortfall were El Nino years. This proportion of years was halved (i.e. 15%) if the area planted increased to that associated with the best 10% of years. Should demand grow as projected in this study, there would be few years where it could be met if a median crop area was planted. With area planted similar to the best 10% of years, there would still be a shortfall in nearly 50% of all years (and 80% of El Nino years).

Market dynamics and pricing are likely to be able to accommodate much of this variability in supply. There is considerable opportunity for supply of feed grain to the northern region from southeastern Australia. The southeastern Australian market is an important source to supplement local supplies in the northern market. There is nearly always a surplus in the southeastern market. However, in years of shortfall in the northern market, the price of feed grain will increase in line with the cost of transport. The continuing growth in intensive livestock and other feed using industries suggests that they will be able to absorb these extra costs. Further analysis to incorporate considerations of supply and demand in other parts of Australia and potential and cost of inter-regional flows are being undertaken by connecting this analysis with the ABARE national feed grain industry model (Connell and Hafi, 2003), which does not incorporate climate variability effects on supply. This would also provide a basis for analysis of pay-off to possible investment in more efficient intra-national transport systems. Given the spatial coherence of the effect of El Nino in some years (Potgieter et al., 2002), there may still be occasions where the southern market is unable to meet the shortfall. It will be necessary to ensure that procedures to facilitate safe import of feed grain are in place as an ultimate back up.

While market signals via increased grain price can likely generate satisfactory solutions in the short term, there are clearly efficiencies to be gained by seeking solutions at a level of co-ordination that is beyond the level of operation of the market. For example, there is considerable opportunity to expand supply in the region via both planted area and yield per unit area by investing in innovative technologies to produce improved varieties and production systems. Further, given that the shortfall is episodic in nature, there are opportunities to explore inter-seasonal and inter-annual transfer systems using innovative concepts in grain storage. Developing such innovations could be pursued via public and private investment in research and development, as there are public benefits in regional development and national prosperity as well as benefits to specific industry players. Such analyses provide a means to link industry and policy considerations.

Policy Interventions to Manage Climate Risk

There has been a long history of government policy intervention associated with climatic risk in agriculture, in particular, drought relief measures. As Anderson (2003) notes, “there has been a tendency for emotion and public outcry to drive a process that leads governments to intervene in ways that, with the wisdom of hindsight, are demonstrably ineffective and distorting of individual incentives to plan more carefully for what in many situations are inevitable occasional bad outcomes.” Fortunately, drought policy in Australia has emerged from this state into a more reasoned position (see papers in White (1998)). The National Drought Policy (NDP) initiated in the early 90’s sought self-reliance by primary producers. The policy was supported by instruments such as Farm Management Deposits (FMDs), which facilitated spreading risk across years, and enhanced, albeit modestly, funding for underpinning R&D and property planning training. The policy also incorporated safety net financial assistance during Drought Exceptional Circumstances (EC), the invocation of which required the relevant State Government to demonstrate to the Federal Government that an area was experiencing a 1 in 20 to 25 year drought.

While the NDP policies have been a great improvement over previous distorting subsidies, there remain some problems with objectivity in defining EC. Ideally such definitions should be based on outcomes (e.g. farm income) rather than on events that might (or might not) be associated with cause (e.g. meteorological drought). For example, the worst crop production outcomes do not correlate well with the worst seasonal rainfall situations. Keating and Meinke (1998) (in White (1998)) found that only about half of the lowest 10% crop production years were in the worst 10% of rainfall years. Simple, broadscale modelling tools are now available to monitor crop status throughout the season (Fig. 3). They provide robust early warning and objective quantification of likely EC. The models can integrate effects of fallow and cropping season conditions and allow for rainfall timing effects. The inability to better utilise these technologies in EC considerations is more related to institutional impediments between levels of government than to logic. Further, recent studies have suggested that such biophysical models can be linked with ABARE’s farm financial performance model (Kokic et al., 2000) to generate credible estimates of farm income. This would provide even greater relevance to EC considerations.

Beyond the obvious direct role for government intervention in relation to safety-net provisions via EC, there is an on-going policy role in supporting R&D on managing climatic risk in agriculture along with development of associated human capital (scientists and decision-makers). It is likely that market failure will continue in both these potentially high pay-off areas. A recent attempt to establish a CRC in this area (see www.crcclimaterisk.org.au) is one means to enhance the meagre investment by government in this field to date. However, it is likely that the private sector can (and should) play a greater role in development and delivery of climate risk management instruments. Policies encouraging such private sector involvement would be appropriate. For example, weather derivatives are used in the energy industry to hedge against unusually warm or cool conditions that directly relate to business performance. Similar products related to rainfall have been suggested for risk management in agriculture. However, there are significant problems in relating rainfall to business outcomes at farm and agribusiness scales. Research focussing on better-designed products (e.g. using modelled outcomes) might be more worthwhile than research on how to best use a poorly designed product. Partnerships with private sector players would be needed to achieve this.

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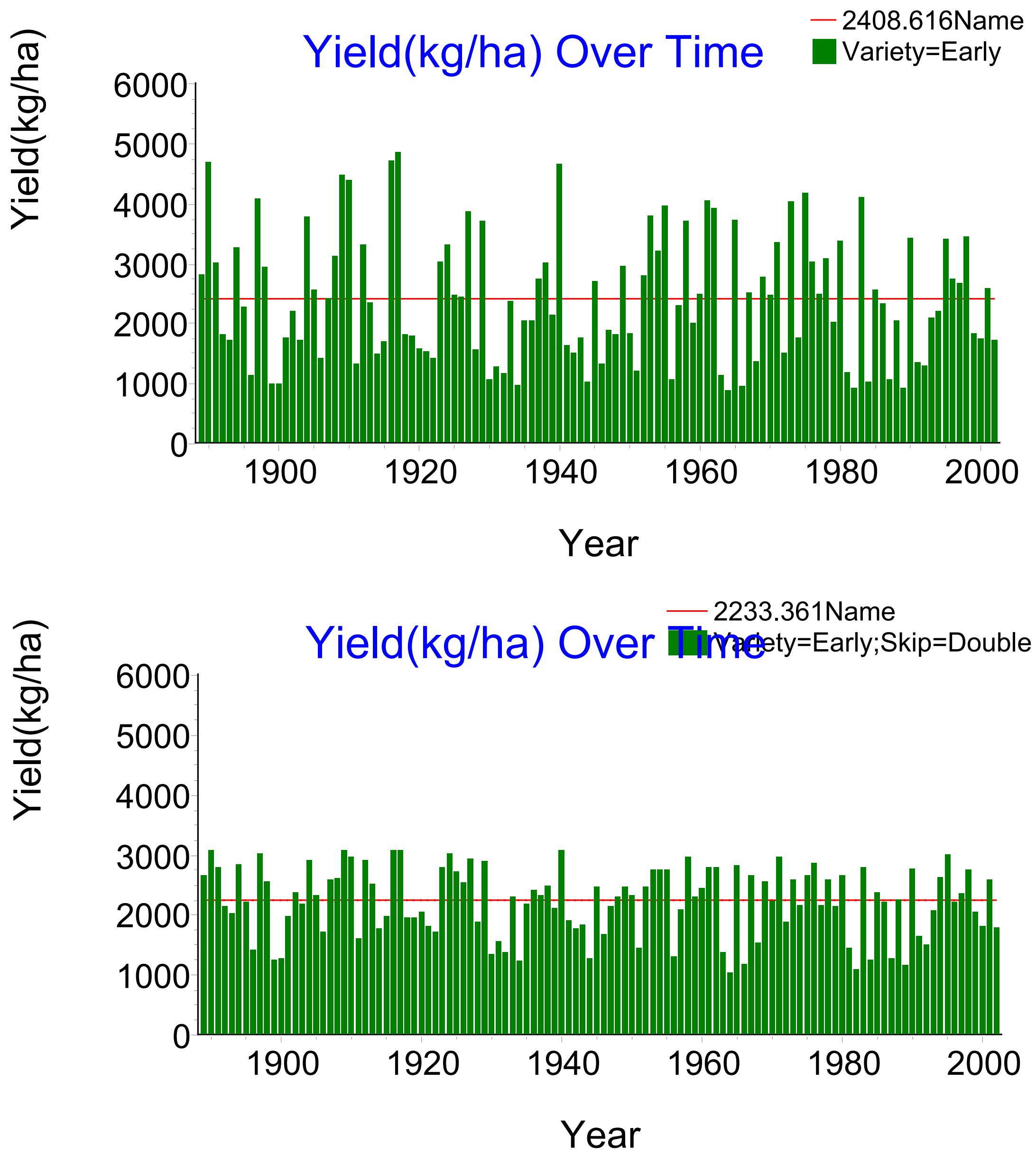

Fig.1. Simulated sorghum yield by year for conventional (SP) (top panel) and double skip row sorghum (DS) (lower panel) for a site in SW Queensland. The red line shows the median yield, which is 2.4 t/ha for SP and 2.2 t/ha for DS.

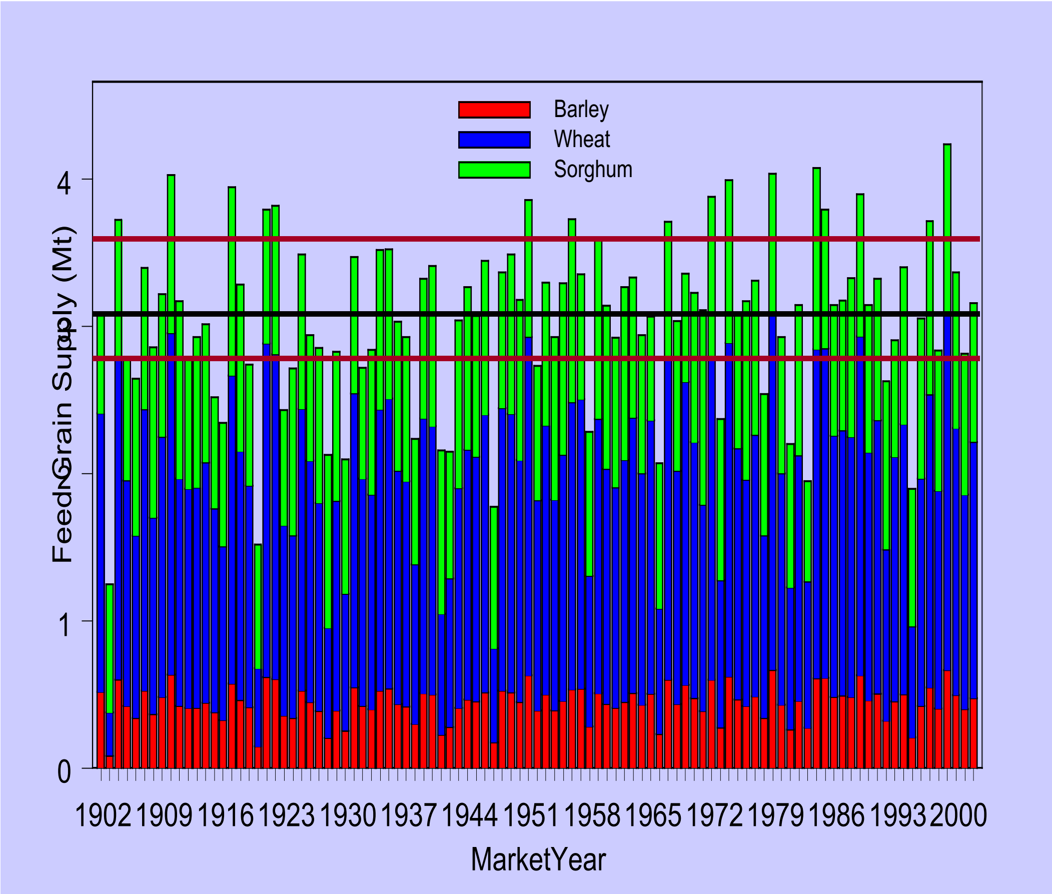

Fig.2. Variation in simulated feed grain supply with year in the northern grain region. The black line shows the median supply level (3.1Mt). The lower red line is the current level of demand (2.8 Mt) and the upper red line the demand project in 3 years time (3.6 Mt).

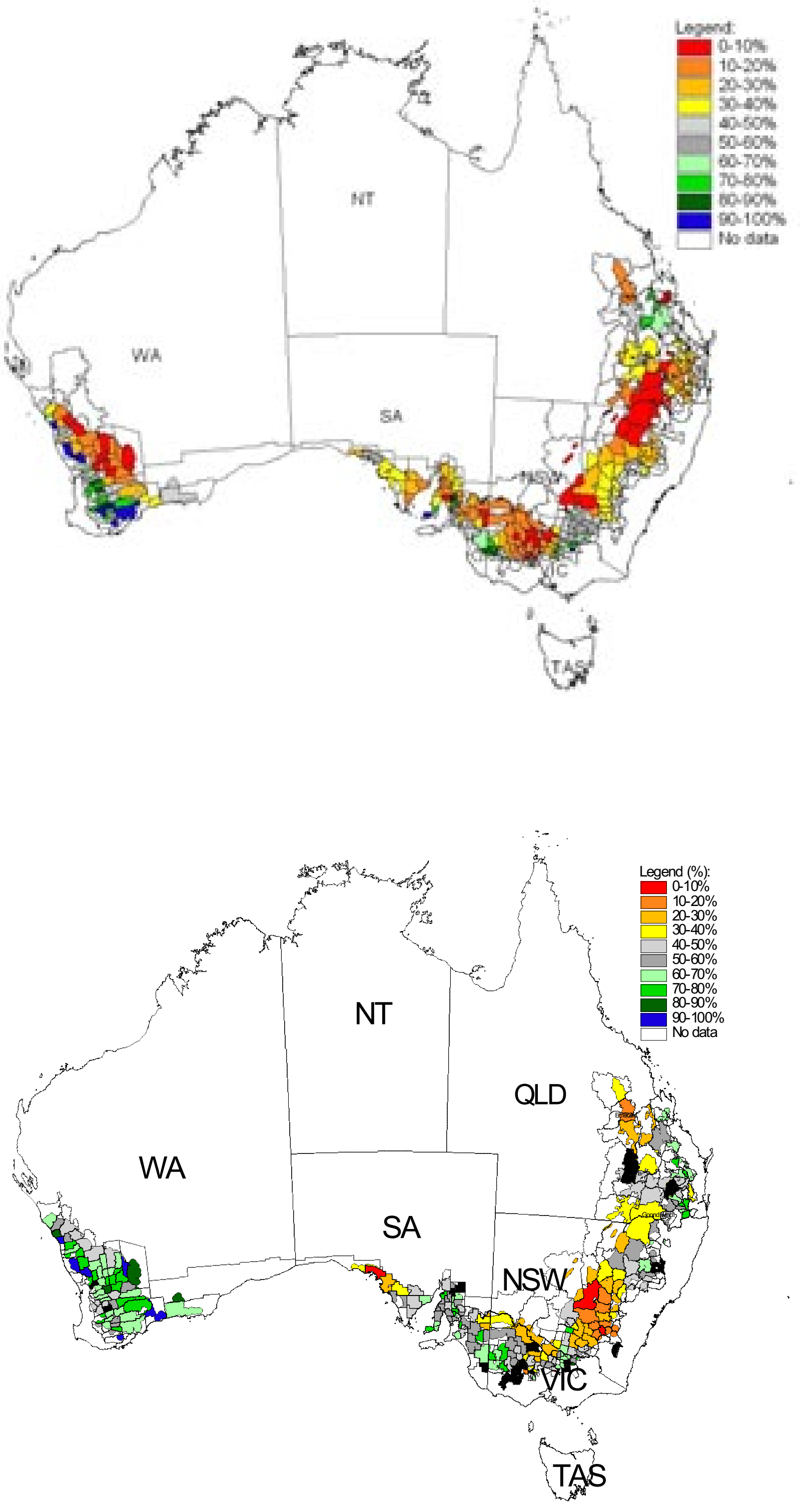

Fig.3. Probability of exceeding median shire yield for wheat in Australia at beginning of June in 2002 (top panel) and 2003 (lower panel). Probabilities were calculated relative to a 100-year simulation using a shire wheat yield model (adapted from Stephens (1995)).