Climate Risk Management and Agriculture in Australia and beyond: Linking Research to Practical Outcomes

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Abstract

In Australia, like in many other parts of the world, climate is one of the biggest risk factors impacting on agricultural systems performance and management. Climate variability (CV) and climate change (CC) contribute to the vulnerability of individuals, businesses, communities, regions and nations. Extreme climate events such as severe droughts, floods or temperature shocks can strongly impede sustainable development. In recent times, climate knowledge has become an important risk management tools for the agricultural sector. Understanding when, where and how to use this tool is a complex and multi-dimensional problem. Targeted and appropriately conceptualised climate knowledge (including seasonal climate forecasting and scenario analyses) can increase overall preparedness and hence reduce vulnerability. The challenge is to use this climate knowledge operationally to achieve two key outcomes: a) appropriate policies suitable for multi-goal objectives and resulting in rapid, substantial societal benefits and b) risk management strategies that reduce vulnerability for individuals and businesses. Policy formulation and the development of risk management strategies must be coordinated and negotiated to be most effective. The Australian work links strongly with international efforts in Asia and South America.

An integrated approach to climate risk management

The Australian case

'Drought' is undoubtedly the biggest climatic issue in Australia. Strictly speaking drought is a social construct and represents the risk that existing agricultural activity may not be sustainable, given spatial and temporal variations in rainfall and other climatic conditions. The basic philosophy of Australia's federal drought policy is to encourage primary producers to adopt self-reliant approaches in managing the risks associated with climatic variability. The concept of self reliance recognises that producers are responsible for managing the commercial performance of their enterprise and for ensuring agricultural activity is carried out in economically and environmentally sustainable manner. The concept also recognises that Government should not intervene to distort market prices or outputs. The national drought policy is developed in the context of more economically and environmentally sustainable production systems. Key points of the policy are:

- Acceptance of climatic variability, including possible extremes, as part of the commercial risk of farming;
- A risk management approach rather than crisis management approach, at industry and government levels;
- A focus on government policy as it affects individual decision making taking into account the national interest;
- Progressive targeting of commonwealth support and assistance to situations of increasing financial difficulty;
- An adjustment focus, rather than compensation, with assistance provided on an individual needs basis.

To implement these criteria requires objective, quantitative approaches to assess production and environmental risks. This is particularly important considering the likely impacts of CV and CC and the urgent need to implement adaptive responses (Howden et al., 2003). For wheat, for instance, early warning systems that provide probabilistic assessments of likely crop conditions at the regional to national level have been implemented and provide valuable input for the assessment of crop conditions and expected production volume (Stephens, 1998; Potgieter et al., 2002). Figure 1 shows examples of wheat yield forecasts that were provided at the beginning of the wheat seasons in 2001 (Fig. 1a) and 2002 (Fig. 1b), respectively. The simulations take account of starting soil moisture conditions, major soil types in each region and an SOI-based climate forecast (Stone et al., 1996). The forecasts are updated monthly as new information about climatic conditions are received. The early impact of the 2002 El Niño event on Australian wheat yields is clearly visible (Fig. 1b).

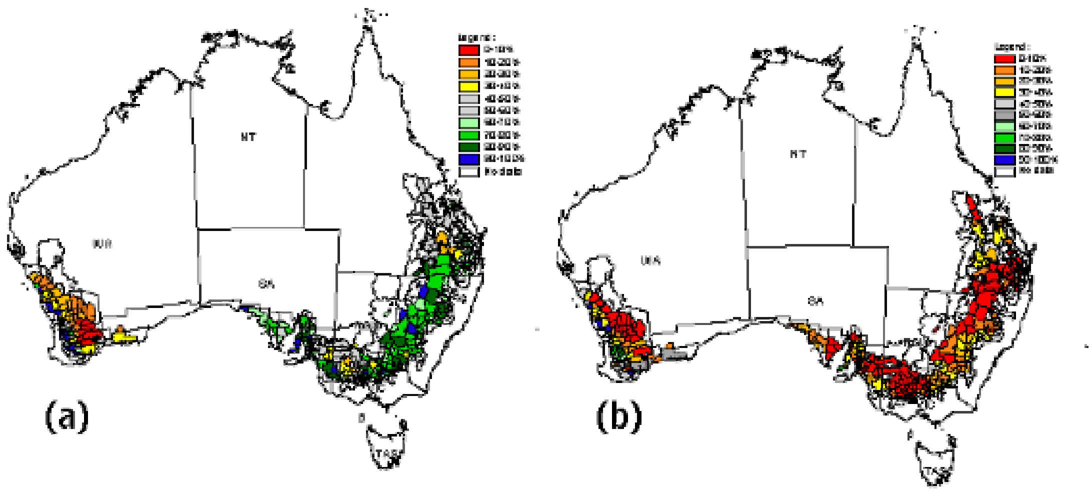

Figure 1: Probabilities of exceeding long-term median wheat yields for every wheat producing shire (= district) in Australia issued in July 2001 (a) and 2002 (b), respectively.

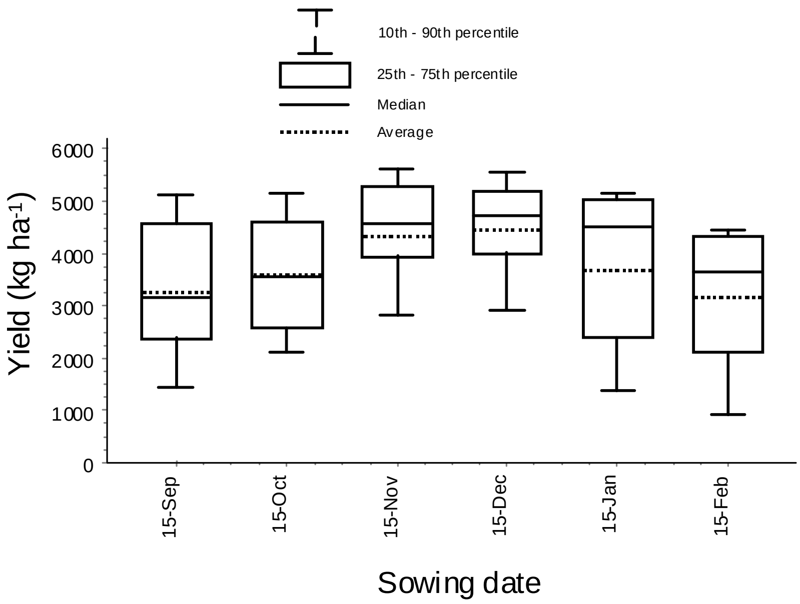

Figure 2: Distributions of simulated sorghum yield at one particular location and for a range of sowing dates for years associated with a consistently positive September-October phase of the SOI (reproduced from Nelson et al., 2002).

At the field and farm level, discussion support tools based on simulation analyses are available that provide objective assessments of management alternatives for specific crops and locations (Keating and Meinke, 1998; Nelson et al., 2002). Figure 2 provides an example for sorghum (reproduced from

Nelson et al., 2002). It shows how expected sorghum yields will differ for different planting dates, taking account of location, soil type, starting soil moisture, sorghum cultivar and seasonal forecast. These quantitative assessments of decision options provide the basis of informed discussion support with farmers as outlined by Nelson et al. (2002).

Figures 1 and 2 provide examples how an integrated research and delivery framework can provide relevant, user-specific information at vastly different spatial scales. Such successful climate applications have highlighted the need for effective collaboration and communication. Agencies across Australia are now engaging in participatory, cross-disciplinary research that brings together institutions (partnerships), disciplines (eg. climate science, agricultural systems science, sociology and many other disciplines) and people (scientists, policy makers, farmers and agribusiness representatives) as equal partners to gain maximum benefit from agricultural systems and climate research. Climate science can provide insights into climatic processes, agricultural systems science can translate these insights into management options and social scientists can help to determine the options that are most feasible or desirable from a socio-economic perspective (Fig. 3a). This approach facilitates informed discussions and allows for objective evaluations at policy and resource management level (eg. Potgieter et al., 2002; Nelson et al., 2002). Any scientific breakthroughs in climate knowledge are much more likely to have an immediate and positive impact if they are conducted and delivered within such a framework (Meinke and Stone, 2004). Most importantly, the concept that has proven valuable to reduce vulnerability in agricultural systems is applicable for any sector exposed to climate induced risks, as outlined in Fig. 3b.

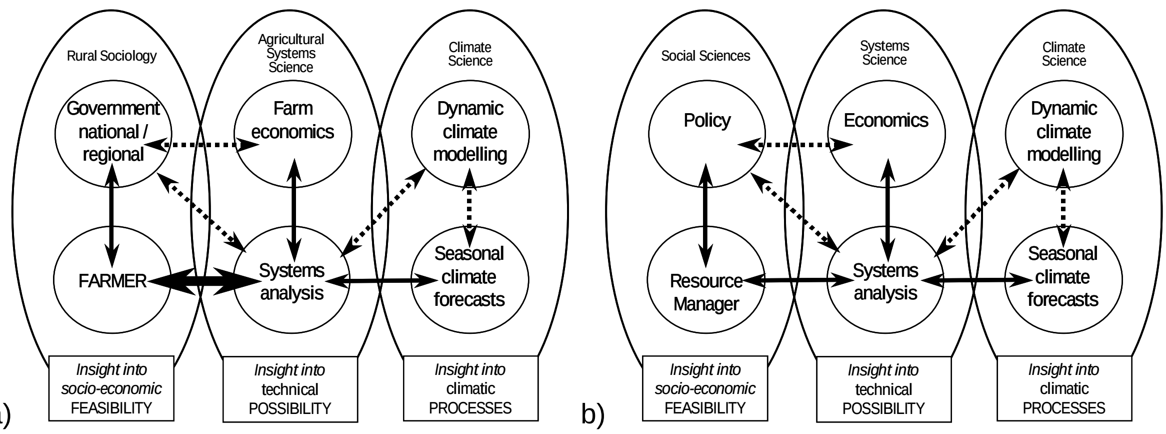

Figure 3: (a) Outline of an interdisciplinary, participatory research approach to climate risk management in agriculture (reproduced from Meinke and Stone, 2004). The diagram shows disciplines, relationships and linkages for effective delivery of climate knowledge in agriculture. Operational links are indicated by the solid arrows and show connections that have already proven useful; dashed arrows indicate areas where operational connections still need to be better developed. The basic principle of the concept (i.e. the requirement of cross-disciplinary research for effective development and delivery of climate knowledge) is generic and independent of the target discipline. The generalisation of the concept for any system (e.g. health, tourism, energy and many more) is shown in (b).

International developments

Using such an interdisciplinary framework helps agricultural decision making regardless of geographical location and socio-economic conditions (Hammer et al., 2000; Meinke et al., 2001). An interdisciplinary systems approach to research and development assists in capturing our ever-increasing understanding of the physical and biological systems components. This must be complemented by participatory communication methods that ensure the on-going connections between decision makers, advisors and scientists. Examples of decisions aided by simulation output range from tactical crop management options, to commodity marketing and to policy decisions about future land use (Hammer et al., 2000). It is beyond the scope of this outline to comprehensively review the vast literature on this subject.

The global impact of climate variability has contributed to the establishment of pilot programmes around the world that aim to bring about significant societal benefits through targeted adaptation to CV and CC. These pilot studies bring together climate scientists, agronomists, crop modellers and farmers to discuss adaptation options and their consequences. Hence, Australian scientists have established collaborative links with, for instance, the International Research Institute for Climate Prediction (IRI) at Colombia University, NY, and many scientists in developing countries (Meinke and Stone, 2004). With the help of many agencies and the international climate and agricultural modelling community these pilot projects provide a means to assess the potential value of climate knowledge to agricultural in developing countries (Sivakumar, 2000). This has lead to the establishment of a loose network, known as RES AGRICOLA (Latin for Farmers' business), that draws on the collective expertise of the global research community to develop resilient farming systems (Meinke and Stone, 2004). Currently, RES AGRICOLA has active nodes in Asia, Australia, South America and US.

Following is a brief example that illustrates the modus operandi of these community-focused pilot studies in developing countries:

In June 2002, in the village of Thamaraikulam, Tamil Nadu, India, the forecast of a greater chance of below normal summer monsoon rainfall (June-September) based on the April/May (falling) and May/June (negative) SOI phases (Stone et al., 1996) was discussed with nearly 30 farmers in group sessions. Simulated crop yields from the cropping systems model APSIM (Keating et al., 2003) was used to discuss crop management options to reduce risk (e.g. crop choice, planting density). The simulations indicated high chances of reduced peanut yield that could be mitigated by reducing plant populations. The model further suggested sorghum as a viable alternative to cotton under very dry conditions. These simulation outputs were discussed in village meetings and the discussions had significant impact. The options derived from simulation model output and used as a basis for an informed debate ('discussion support', Nelson et al., 2002) have demonstrably changed the cropping area. Many farmers changed from growing cotton in June to early sorghum, while others also reduced population densities, harvesting at least 0.8 t/ha of peanut. However, crop choice decision was key with more that 70% of farmers growing some sorghum instead of cotton. The ca 20% of farmers, who took the risk and planted cotton had to abandon their crops by August, loosing all their input costs. These changes in management practice were clearly the result of using quantitative data from simulation models as discussion support.

This simple example demonstrates that the combination of systems analysis, climate science, quantitative simulation tools, discussion support and community interactions can be an extremely effective way to reduce vulnerability to climate risks and to realise societal benefits based on climate knowledge.

Acknowledgements

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References

Hammer, G.L., Nicholls, N. and Mitchell, C., 2000, Eds. Applications of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems – The Australian Experience. Kluwer Academic, The Netherlands, pp 469.

Howden, M., Ash, A., Barlow, S., Booth, T., Charles, S., Crimp, S., Gifford, R., Hennessy, K., Jones, R., Kirschbaum, M., McKeon, G., Meinke, H., Park, S., Sutherst, B., Webb, L. and Whetton, P.,

2002. An overview of the adaptive capacity of the Australian agricultural sector to climate change – options, costs and benefits. Major Report commissioned by the Australian Greenhouse Office (AGO), 157pp.

Keating, B.A. and Meinke, H., 1998. Assessing exceptional drought with a cropping systems simulator: a case study for grain production in north-east Australia. Agricultural Systems, 57: 315-332.

Keating, B.A., Carberry, P.S., Hammer, G.L., Probert, M.E., Robertson, M.J., Holzworth, D., Huth, N.I., Hargreaves, J.N.G., Meinke, H., Hochman, Z., McLean, G., Verburg, K., Snow, V., Dimes, J.P., Silburn, M., Wang, E., Brown, S., Bristow, K.L., Asseng, S., Chapman, S., McCown, R.L., Freebairn, D.M. and Smith, C.J., 2003. An overview of APSIM, a model designed for farming systems simulation. European Journal of Agronomy, 18: 267-288.

Meinke, H. and Stone, R.C., 2004. Seasonal and inter-annual climate forecasting: the new tool for increasing preparedness to climate variability and change in agricultural planning and operations. Climatic Change, in press.

Meinke, H., Baethgen, W.E., Carberry, P.S., Donatelli, M., Hammer, G.L., Selvaraju, R. and Stöckle, C.O., 2001. Increasing profits and reducing risks in crop production using participatory systems simulation approaches. Ag Systems, 70: 493-513.

Nelson, R.A., Holzworth, D.P., Hammer, G.L. and Hayman, P.T., 2002. Infusing the use of seasonal climate forecasting into crop management practice in North East Australia using discussion support software, Ag. Systems, 74: 393-414.

Potgieter, A.B., Hammer, G.L. and Butler, D.: 2002, 'Spatial and temporal patterns in Australian wheat yield and their relationship with ENSO'. Aust. J. Agric. Res. 53: 77-89.

Sivakumar, M.V.K., 2000, Eds. Climate prediction and agriculture. Proceedings of the START/WMO International Workshop, Geneva, Switzerland, 27-29 September 1999. Washington DC, USA, International START Secretariat.

Stephens, D.J., 1998. Objective criteria for estimating the severity of drought in the wheat cropping areas of Australia. Agric. Systems 57: 315-332.

Stone, R.C., Hammer, G.L. and Marcussen, T., 1996a. Prediction of global rainfall probabilities using phases of the southern oscillation index. Nature 384: 252-255.