Agricultural Competitiveness White Paper – Submission IP691
Bureau of Meteorology
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Submission by the Bureau of Meteorology

to the

Agricultural Competitiveness Taskforce

in response to

the Agricultural Competitiveness Issues Paper

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KEY MESSAGES

- Weather, climate and water information relevant to farmer decision-making can greatly enhance agricultural competitiveness and productivity.
- Farmers need the skills, education and training necessary to equip them with a sound understanding of this information, including its limitations, and of how it can be appropriately and effectively used to make decisions and manage risks.
- The Bureau of Meteorology, through its existing products and services, provides an extensive body of information that supports agricultural production decisions and assist in creating a stronger and more competitive agricultural sector.
- The Bureau is committed to improving the information it provides to the agricultural sector and enhancing its impact through:
    - strengthening engagement with the agricultural sector to ensure information best meets farmer and other decision maker needs;
    - focusing on information that enables farmers and other decision makers to manage risks relating to high impact weather and climate events, including extremes such as drought;
    - implementing scientific and technical advances as resources allow, particularly in relation to seasonal forecasting; and
    - promoting adoption and understanding of our information through effective communication and education.

INTRODUCTION

Agriculture is highly sensitive to weather, climatic conditions and water availability. The high variability and extremes of Australia's climate, especially when compared to many other countries, pose particular challenges to Australian agriculture and its competitiveness.

The Bureau of Meteorology's mission is to provide Australians with environmental intelligence for safety, sustainability, well-being and prosperity – the information and insight needed to manage and live within this highly variable environment. Specifically in relation to agriculture, the Bureau has a long and proven record of providing critical and trusted information to farmers, and the agricultural sector more generally, to inform production decisions and assist the management of the risks posed to production by our challenging climate.

The Bureau of Meteorology (the Bureau) provides weather, climate and water information relevant to agriculture through a range of products and services:

- monitoring and reporting on past and current conditions;
- analysis and explanation of climate variability and trends; and
- forecasts, warnings and long-term outlooks;

The Bureau strives continuously to improve these products and services through seeking to improve both their accuracy and relevance. The Bureau is committed to providing the agricultural sector with weather, climate and water information that is based on the best available science and best meets user needs. This includes working with the sector to enhance the understanding, uptake and use of our information.

Agricultural competitiveness is influenced by many factors. This submission focuses on the critical role of weather, climate and water information through addressing four of the questions posed in the Agricultural Competiveness Issues Paper where the Bureau's role is relevant:

- Do farmers have access to timely, relevant and accurate information to fully inform production decisions to meet domestic and global food demands?
- What tools, skills and advice do farmers need to effectively adapt and respond to the risks they face?
- What approaches could be used to encourage improved drought preparedness?
- During drought, what measures are most effective in supporting long term resilience?

RESPONSES TO QUESTIONS FROM THE ISSUES PAPER

1. Do farmers have access to timely, relevant and accurate information to fully inform production decisions to meet domestic and global food demands?

For information to be effective for decision-making it needs to be timely, accurate and accessible, and tailored to the needs of end users in their decision-making process. The Bureau's weather, climate and water information products undergo continuous evolution, seeking to leverage science and technology improvements and responding to our growing understanding of end user requirements.

Timeliness of information

The Bureau seeks to understand farmer timeliness requirements for information to inform their production decisions through extensive engagement with the agricultural sector, including with individual famers.[1] It endeavours to meet those timeliness requirements in so far as scientific and technical capability allow.

To that end the Bureau's products and services cover a number of time scales, providing:

- **perspective on the past** through analysis of past events, variability and trends, and production of climatologies and maps of recent conditions;[2]
- **situational awareness in the present** through real time observations[3] from weather stations, radars and satellites, including placing them in a historical climate context, and monitoring of weather, climate and hydrological conditions across Australia and of the state of the key drivers that impact Australia's climate, particularly El Niño and La Niña; and
- **foresight for the future** through issuing of warnings and alerts for various weather related hazards, weather forecasts from hours out to seven days, seasonal forecasts which currently provide information on temperature , rainfall and streamflow outlooks for the coming three months, and information on the forecast state of key climate drivers out to nine months.[4] The Bureau also contributes to work undertaken by CSIRO to provide climate projections at timescales of decades.

These various products and services provide timely information for decision-making across a range of agricultural planning horizons. There are currently, however, gaps at intra-seasonal timeframes (between seven days and three months), and at longer inter-annual to decadal timeframes. The former gap will begin to be bridged through the introduction of multi-week climate forecasts in the second half of 2014 as part of a Bureau project to refresh the current Seasonal Climate Outlook. This has been enabled by the move to a dynamic climate model as the Bureau's operational model in mid-2013[5] which provides a capability for intra-seasonal forecasts.

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[1] The Bureau has agricultural consultative committees in place in most states. It also undertakes occasional stakeholder workshops, surveys, and focus groups involving farmers, as well as regularly attending agricultural field days.

[2] Based on the Bureau's collecting, curating and publishing of past weather observations to form Australia's historical climate record.

[3] Provided through the Bureau's own observational network and access to international observational networks.

[4] Underpinned by the use of advanced computing to run numerical weather prediction and seasonal forecasting models.

[5] The Predictive Ocean Atmosphere Model for Australia (POAMA) became the Bureau's operational model for seasonal forecasting in May 2013. Development of multi-week forecasts is being partially funded through the Managing Climate Variability Program.

Timeliness is particularly critical around information concerning weather events with the potential for high impact on agricultural production, especially extremes such as frosts. The Bureau provides a number of warnings and alerts for the agricultural sector specifically designed to provide information with a timeliness that allows farmers to take action to mitigate the impact of the particular event or extreme. Examples include frost warnings issued when conditions suitable for significant frosts are forecast, and the sheep grazier alert put out for cold, wet and windy weather conditions dangerous to new-born lambs and recently shorn sheep.

Accuracy of forecasts

As with all information used for decision-making it is important that users have a good understanding of not only the value of the information, but also its reliability and limitations. The Bureau understands that this is particularly important in the case of forecast information and strives to equip farmers with the tools needed to evaluate forecast uncertainty. The Bureau undertakes continuous verification of its weather forecasts and seasonal climate outlooks; two very different types of forecasts.

Weather forecasts are deterministic or categorical forecasts of standard meteorological variables for up to seven days ahead. They are now provided on a roughly 6x6 km grid across the nation. For example, such a forecast might say that in three days time the Melbourne CBD will experience clear skies, light winds, no rainfall, a maximum temperature of 30°C and a minimum temperature of 15°C. Because they are categorical, the accuracy of these weather forecasts can be objectively assessed as being 'accurate' or 'in error to a defined degree'.

Seasonal climate outlooks on the other hand are probabilistic forecasts of the odds of exceeding historic averages of temperature and rainfall in a region for the three months ahead. They do not specify a particular temperature or rainfall amount, but rather the odds of a departure from the historic average values for a particular location and time of year. For example, such a forecast might say that there is a 70% chance that the total amount of rainfall in south-east Queensland in the three months ahead will exceed the long-term median value for that time of year. Although this forecast points to wetter than normal conditions it also allows for the possibility that it will be drier (in this example there is a 30% chance of that outcome).

Over recent decades great strides have been made in the accuracy of the Bureau's seven-day weather forecasts. For example, the skill of a forecast five days ahead for maximum temperature at Melbourne is now about equal to the skill of a three-day forecast in 2005. Similarly, the skill of a three-day forecast is now about equal to the skill of a one-day forecast in 1999.

On the other hand, advances in the accuracy of seasonal climate outlooks have been steady but more modest, reflecting the lesser maturity of longer range forecasting. With the move in 2013 from a statistical to a dynamic climate model, the Bureau now has a state of the art seasonal forecast system that provides a good foundation for future improvements. This model has been shown to have greater overall skill and reliability than the Bureau's previous statistical climate model.[6] While this means greater assistance for decision makers using the model over the longer term, this does not mean that every forecast in every location will

[6] Information on the accuracy of the dynamic model is provided at: http://www.bom.gov.au/climate/ahead/rain_ahead.shtml#tabs=Outlook-accuracy

correctly favour the subsequent outcome.[7] Our experience is that seasonal climate forecasting models perform best when there are clear climate influences operating, such as a strong El Niño Southern Oscillation (ENSO) signal, a strong monsoon signal or a strong Indian Ocean Dipole (IOD) signal. Conversely, the models perform less well when these various climate drivers are weak (or neutral) and hence random fluctuations in weather dominate. The Bureau is striving to improve awareness amongst end users regarding the link between forecast skill and the state of climate drivers, so that they have a better basis upon which to assess forecast certainty.

The Bureau's seasonal forecasting model is undergoing continuous research and development and its accuracy is expected to increase over time with advances in the science of seasonal prediction, improvements in the observations and how they are assimilated into the model, as well as increases in supercomputing power which will enable higher model resolution. Despite these expected improvements over time, seasonal forecasts will remain probabilistic due to the inherent limits on the predictability of the climate system, and need to be understood and interpreted accordingly.

To provide a meaningful basis for decision-making, probabilistic forecasts need to be used within a risk management framework, with their full benefit being realised when they are used multiple times over an extended period, rather than one-off use. A recent report[8] on the use of seasonal climate forecasts as a basis for decisions around nitrogen fertilizer application on crops in the West Australian wheat belt, indicated the payoff time for using such a forecast to be seven years at 95% confidence, or three years at 80% confidence.

Access to information

With continuing development in digital data delivery, more detailed and accessible weather, climate and water information can be made available to the agricultural sector. The Bureau is positioning itself to deliver its products and services through a variety of channels to inform on farm decision-making.

While the media, particularly the ABC and rural press, remains a significant channel for farmers to access Bureau information, the primary channel for accessing Bureau information is via the internet, and increasingly will be through mobile platforms. The Bureau's Water and the Land (WATL) webpage[9] was developed as a one-stop-shop information resource for people involved in primary production and natural resource management. Farmers can also access relevant product and services via email alerts and Rich Site Summary (RSS) feeds.

A significant advance in access to forecast information is being provided through the implementation of the Next Generation Forecast and Warning System (NexGenFWS) which provides forecast information on a six kilometre grid across Australia out to seven days, and a geospatial visualisation system known as MetEye (soon to cover all of Australia). These

[7] This was illustrated by the August to October 2013 rainfall outlook which indicated that a wetter than normal season was likely (with a greater than 60% chance) for most of mainland Australia while the outcome was particularly dry across much of eastern Australia. This example highlights that seasonal forecasts must be used with care, particularly in the absence of a clear signal from major climate drivers. In this instance, with weak climate drivers operating in 2013, the spring outlooks did not identify a late drying trend associated with the cooling Indian Ocean and the relevant seasonal forecasts were poor as a result.

[8] McIntosh, P.C. et al., 2011: Improving Seasonal Forecasts for SWWA. Final Report on the Managing Climate Variability project for GRDC.

[9] http://www.bom.gov.au/watl/index.shtml

systems provide a comprehensive seven day Australia wide weather forecast service and also present an opportunity for the Bureau to improve its agricultural warning and alert services.

2. What tools, skills and advice do farmers need to effectively adapt and respond to the risks they face?

One of the most significant risks that farmers face is that posed by the high variability of Australia's climate and, particularly, the hazards due to extremes. To adapt and respond effectively to these risks, farmers need tools that provide information around weather and climate extreme risks, covering all timescales from days to seasons. They should be user-focussed and integrated, bringing together the range of weather, climate and water information needed to assist in decision making and managing risk.

Farmers also need to know how to interpret weather, climate and water information appropriately for their decision-making, including awareness of any limitations. Inappropriate use of this information can result in poor outcomes. Previously state-based agricultural extension services provided advice and training in this area. A reduction in these services over recent years has created a communication gap. We need to find new channels for providing farmers with the skills to use weather, climate and water information well. This is especially the case with seasonal forecasting information, where the probabilistic nature of the information is sometimes misinterpreted.

The Bureau is seeking to improve the information it provides to farmers and the wider agricultural sector, to ensure that they have tools and advice to adapt and respond effectively to these risks. This entails:

- strengthening engagement with the agricultural sector to ensure information best meets farmer and other decision maker needs;
- focusing on information that enables farmers and other decision makers to manage risks relating to high impact weather and climate events, including extremes such as drought;
- implementing scientific and technical advances as resources allow, particularly in relation to seasonal forecasting; and
- promoting adoption and understanding of our information through effective communication.

As an example, the Bureau has been rebuilding its Seasonal Climate Outlook (SCO) service to improve the seasonal forecast advice we provide to farmers and the wider agricultural sector. Framed by extensive stakeholder engagement and consultation, this has involved the "back end" change from a statistical to a dynamic climate model mid last year, along with a complete redesign of the SCO "front end" using a user-focussed design process. This new user interface is scheduled for release in the second half of this year. All this is aimed at improving the accuracy, relevance, uptake and understanding of the Bureau's seasonal climate forecasts - one of the most significant tools the Bureau provides farmers to assist them more effectively manage the risks arising from Australia's highly variable climate.

3. What approaches could be used to encourage improved drought preparedness?

Drought is a prolonged, abnormally dry period when the amount of available water is insufficient to meet normal use. As water is used in so many different ways, there is no universal definition of drought. Meteorologically, the Bureau measures the extent and severity of drought in terms of rainfall deficiencies,[10] with rainfalls in the lowest five percent of historical totals labeled severe,[11] and those between five and ten per cent as serious. The impact on agriculture is mediated by soil moisture levels at critical points in production for dry land farming and by water availability in storages for irrigated agriculture. Drought can, therefore, be defined agriculturally in terms of its impact on primary industries, hydrologically in terms of ground water and water storage levels, or even sociologically in terms of economic and social impact. Whatever measure of drought is used, Australia's relatively low average rainfall, accompanied by its variability on inter-annual timescales, means that the prospect of drought is one constant faced by Australian farmers and therefore one for which they need to prepare. Improving drought preparedness can make a strong contribution to agricultural competitiveness.

Planning is critical to preparedness. Weather, climate and water information, when properly understood and used, can enhance drought preparedness by providing past perspective, situational awareness and foresight, to effectively inform planning across various timeframes.

Historical weather, climate and water information for a location provides a valuable perspective on the long-term climatological risk of drought. For example, the rainfall history for a location can provide farmers with knowledge and insight into their long-term average rainfall, its historical variability, including the severity, length and frequency of extended dry periods, and whether there are any long-term trends. On the basis of this knowledge of climatological drought risk, farmers can make long term planning decisions to strengthen their preparedness.

Weather, climate and water information around current and future conditions can alert farmers to approaching periods of heightened drought risk and so enable farmers to prepare through short to medium term planning and operational decisions. For example, since El Niño is often associated with widespread drought in eastern Australia, the emergence of pre-cursor conditions in the Pacific Ocean accompanied by model forecasts of an El Niño is a strong indicator of heightened drought risk. Farmers can use this information in a risk management framework to make decisions that prepare their enterprises for the possible emergence of drought in the months ahead.

Of course, even the best information is of little value unless it is taken up and used appropriately in decision making. One critical approach, therefore, to improving drought preparation is encouraging both greater uptake and understanding of relevant weather, climate and water information through farmer education and training around the appropriate use of such information to manage risk and make decisions around drought.

[10] An area experiences a rainfall deficit over a period when the total rain received is less than the average rainfall for that period.

[11] Rainfall deficiencies can be measured over varying time periods, but for a 12-month period a sever deficiency corresponds to a 1 in 20 year occurrence.

The Bureau currently provides information that can assist farmers in preparing for and assessing and managing risks associated with drought through a range of products. Many of these are consolidated in an existing drought information service on the Bureau's website.[12] The core elements of the existing service are:

- the Drought Statement which monitors and reports on the extent and severity of drought on the basis of rainfall deficiencies. It is issued monthly when extended abnormally dry periods are occurring in Australia;
- various other rainfall and soil moisture monitoring products which are updated regularly; and
- seasonal temperature, rainfall and streamflow outlooks, issued monthly for the coming three months.

This existing drought information service and related information is currently being reviewed with a view to enhancing the service through:

- further consolidating relevant weather, climate and water information from across the Bureau;
- assessing whether this information best meets the needs of farmers (and other users) to support their decision making and management of risks associated with drought;
- determining whether there are significant gaps that can be met by existing or anticipated Bureau capability; and
- considering how to improve uptake and appropriate use of the information provided.

A significant driver for the review has been the development of the Drought Reform Package, with its focus on assisting farmers to manage risks associated with drought, particularly through its fifth element: *tools and technologies to inform farmer decision making.*

As a key component of this review, the Bureau is currently undertaking consultations with existing and potential users, including farmers. The objective of these consultations is to better understand user needs for weather, climate and water information to assist preparation for and management of risks associated with drought with a view to scoping and informing an improved drought information service. These consultations include the holding of a drought service workshop in each jurisdiction in the first half of 2014. These are being arranged in consultation with key stakeholder agencies and organisations, including the Commonwealth Department of Agriculture and state and territory equivalents, and include representatives from governments and relevant agencies, sector peak bodies, water managers, as well as individual farmers.

[12] At http://www.bom.gov.au/climate/drought/.

4. During drought, what measures are most effective in supporting long term resilience?

Weather, climate and water information can support long-term resilience during drought through:

- support of sound decision making to minimise economic loss and long term degradation of the natural resource base; and
- enabling farmers to be prepared to take advantage of improving circumstances moving out of drought.

The Bureau provides extensive information in support of situational awareness during drought through its ongoing monitoring of weather, climate and water availability. In particular, the Drought Statement[13] provides an analysis on the severity and extent of drought as measured by rainfall deficiencies. This product is issued regularly while abnormally dry conditions persist in any part of the country.

The Bureau also provides information around water availability, including streamflow observations and water storage level information. This situational awareness during drought can assist planning and decision making around water management for regional town supply and for irrigated agriculture. Decisions about allocation of water for irrigation and environmental flows are typically taken weeks and seasons ahead of release of water. Irrigated farming requires information about rainfall and drought indicators for their ordering of water. Improved products for monitoring and forecasting of drought would allow both water authorities and farmers to make much better use of this valuable and sometimes scarce resource.

Perhaps the most important weather, climate and water information that can be provided during drought is forecast information. Expected improvements in seasonal climate and hydrologic forecasting will enable the development of longer lead time alerts for agriculture, which will help to enhance resilience to climate variability as well as preparedness for extreme weather. Any foresight that can be provided at the seasonal timeframe, through seasonal outlooks and related information, on whether and when drought conditions are likely to end or ameliorate is of high value in managing drought. Such information enables farmers to plan and be prepared to move quickly to take advantage of improving conditions. Weather forecasts on the timeframe of days can also be useful in allowing farmers to be alert to and take tactical advantage of opportunities provided by individual favourable weather events during drought.[14]

[13] See the response to the previous question from the Issues Paper.

[14] Likewise, for multi-week forecasts as they become available.