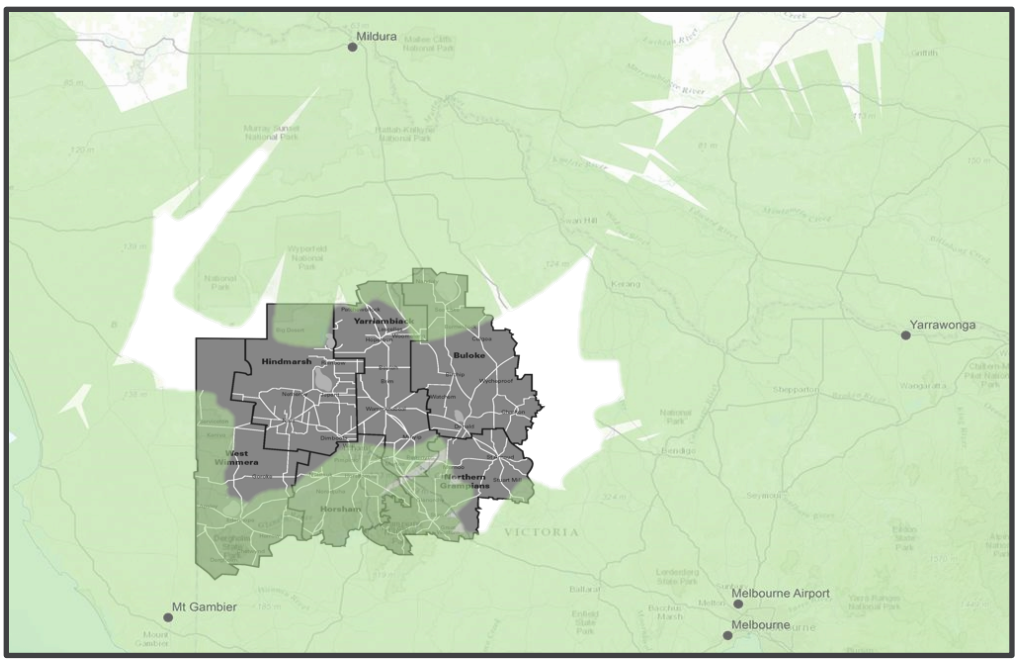
Wimmera Weather



Business Case for Improved Weather Services

December 2015

WDA Wimmera Development Association Inc

THE wimmera Everything you need.

Wimmera Southern Mallee - Victoria's Grains Centre of Excellence

The Wimmera Development Association (WDA) is the peak economic development organisation for the Wimmera Southern Mallee region supporting existing local businesses, and promoting economic development opportunities to investors.

Wimmera Development Association identifies agriculture as a key economic driver of the Wimmera Southern Mallee and the largest industry sector in the region in terms of employment, expenditure, gross revenue and regional exports. Given its significance in the local economy, the Wimmera Southern Mallee continues to be an innovative region, refining practices to increase yields, minimise input costs and reduce the impact on the environment. Improved real time weather services would show significant benefits to the regions agribusinesses.

The attached business case seeks to outline the benefits to the local economy for improved financial sustainability and planning for the regions agricultural sector. In addition to agriculture, improved weather services would assist with emergency management, water resource management and aviation.

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Report compiled by RMCG December 2015

Wimmera Weather

Wimmera Development Association

Business case for BoM Radar Station - 22 December 2015

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1 Weather forecasting and decision making - overview

1.1 A highly productive region

The Wimmera Southern Mallee is a major agricultural and food producing region. It generates $1.6 billion each year in the gross value of agricultural production and supports over 5,800 direct farming jobs, plus further jobs in associated manufacturing and transport. The region produces more than half of Victoria's total grain crop, oilseeds and pulses.

A continuing drive for increased productivity has seen adoption of higher yielding varieties and more complex cropping systems, with investment in precision farming to optimise yields and control costs. However, the increased investment and property size means that cropping enterprises now need to generate a higher return with more certain yields. Farming enterprises therefore need access to the best available data to optimise decision making.

1.2 Weather forecasts & production

Weather forecasts are a critical dataset that farming businesses rely on for investment and operational decisions. Farmers have access to a suite of different weather services from the Bureau of Meteorology (BoM) and private suppliers that support decisions within different timeframes:

- Fixed weather stations provide regular readings of temperature, air pressure, humidity, rainfall, and wind speed and direction. This is helpful in supporting decisions within a few days to a week
- Daily forecasts provide projections for temperature, wind and rainfall. These are used to plan over the following day
- A radar network provides a spatial representation of current and past rainfall over the previous couple of hours. This evidence is used to support decisions over the next few hours.

Currently there are no radar stations located within the Wimmera Southern Mallee itself. The nearest radar stations are in Mildura to the north and in Mt Gambier to the south west. This leaves most of the Wimmera Southern Mallee without service, as the coverage of each radar station is only about 200km.

1.3 Benefits

Assessment of cropping practices has identified two standard activities that are highly sensitive to weather conditions within a short-time frame (ie. within the timeframe supported by radar services), eg:

- Spreading of urea to enhance yield and quality. For this to be effective the application needs to be followed by rainfall within 24 hours to wash the urea into the root zone. In the absence of rainfall the urea left on the surface will volatilise, resulting in wasted product
- Spraying of herbicides. Most herbicides are not 'rainfast' and rely on a period of 1-6 hours after application without rainfall to make sure that the product is not washed off the plant.

The absence of good weather data on rainfall within the following 6-8 hours means that producers can be forced to take decisions based on minimal evidence. That can lead to sub-optimal production and poor commercial outcomes. Provision of better data from a radar weather service would enhance commercial outcomes by reducing wasted input costs, with annual projected benefits of $3.5M, or a present value of $43.6M over 20 years. There is evidence that growers in other regions that are serviced by radar stations make regular active use of the service. Better weather forecasting data would also generate a range of other commercial and public benefits covering emergency management, water resource management, tourism and aviation.

1.4 Proposed investment

This business case seeks investment for a new BoM radar station to service the region to provide the best available evidence from which to make informed decisions to maximise productive outcomes. The BoM endorse the value of the proposal.

The new radar station would be designed, constructed and managed by the BoM to a proven design. It would involve the following costs:

- $5 million in initial capital construction costs and commissioning
- Annual operating costs of $164,360 with maintenance costs of $177,574 every fifteen years. This is equivalent to a present value of $2.26M over 20 years at a 5% discount rate
- Therefore a total project cost of $7.3M as a present value over twenty years
- To be conservative, a value of x2 this cost (or $14.5m) has been assumed for the cost benefit analysis

1.5 Cost benefit analysis

The projected cost of the radar station at $14.5M is equivalent to an annual cost of $1.16M. In order to generate a benefit to cost ratio of x 2 the investment would therefore need to generate an annual return of $2.3M. The region generates a gross value of agricultural production of $1,600M. The investment would therefore need to generate a benefit equivalent to an increase in production of 0.144% to achieve the target of $2.3M or a value of $2/ha over the 1.1 million hectares cultivated in the Wimmera alone. That appears a credible hurdle rate.

The following table summarises the outcome of the cost benefit analysis for the proposed investment.

Table 1: Cost benefit analysis (PV over 20 yrs at 5% discount rate)

Element	Value ($M)
Costs	14.5
Benefits	43.6
Net present value	29
Benefit to cost ratio	x 3

This confirms that the project would generate a positive ‘benefit to cost ratio’ of x 3 and an NPV of $30M. This is a conservative outcome as it has assessed benefits against only a limited set of activities and crops, and has assumed escalation in the costs of the project. On this basis, the business case recommends the proposal as representing a good value investment.

1.6 Funding submission

The Wimmera Development Association (WDA) is the project proponent for the proposal on behalf of the regional agricultural sectors and wider regional partners. The BoM has indicated that it would need to receive funding to cover both the capital and recurrent costs of the installation. Traditionally, State Governments have limited their contributions to the capital costs of infrastructure investments - equivalent to a figure of $5M in this case. Any funding from State or Federal governments or other sources would be forwarded to the BoM to offset the costs they incur in providing the facility. The detail of the funding partnership is being finalised as a separate initiative.

2 Productive base of the region

2.1 Objective

The aim of this section is to establish a robust basis for making projections on the added value of production that will result from the proposed investment. This estimation involves both:

- A 'top-down' approach which will establish a credible upper bound for projected outcomes by reference to aggregate values of production at a regional scale; and
- A 'bottom-up' calculation which will look at the value of production at the paddock scale and estimate the marginal increase in yield or price per hectare resulting from enhanced information for decision making for a suite of standard activities.

This section establishes a clear reference point for the first, 'top-down', approach. Chapter 5 then provides an analysis of the paddock scale costs and benefits of specific standard activities.

2.2 Data sources

The objective of this chapter is to establish indicative values for the main agricultural activities across the region to provide a reasonable basis from which to test assumptions about the value of the outcomes. The data provides an order of magnitude bounds for the major productive activities at a regional scale.

This data has therefore been sourced from the most recent ABS *Agricultural Census Data* from 2011. This gives data by local government area. In this study, data has been selected for the following council areas:

- Buloke Shire
- Hindmarsh Shire
- Horsham Rural City
- Northern Grampians Shire
- West Wimmera Shire
- Yarriambiack Shire

This provides a good representation of the Wimmera Southern Mallee, for the purposes of this study. It is recognised that yields and prices vary between seasons, however, the single year in the ABS Census provides a sufficiently accurate estimate of value for the purposes of this analysis.

2.3 Agricultural commodities produced

In this study we have focussed on the major agricultural commodities produced in the region, representing the core outputs which could benefit from the investment. Those commodities are:

- Cereals, especially wheat and barley
- Legumes, especially lentils
- Oilseed
- Hay
- Meat and wool

These commodities represent the very large proportion of the total value of the production for the region.

2.4 Value of agricultural production

2.4.1 Gross value of agricultural production

The ABS identifies that the region produced commodities with an annual gross value of $1.6 billion in 2010/11, with 64% of that value coming from wheat, barley and meat (mainly sheep). Evidence from the Birchip Cropping Group suggests that grazing has increased in extent over the last five years, but the order of magnitude values from 2011 are still broadly appropriate.

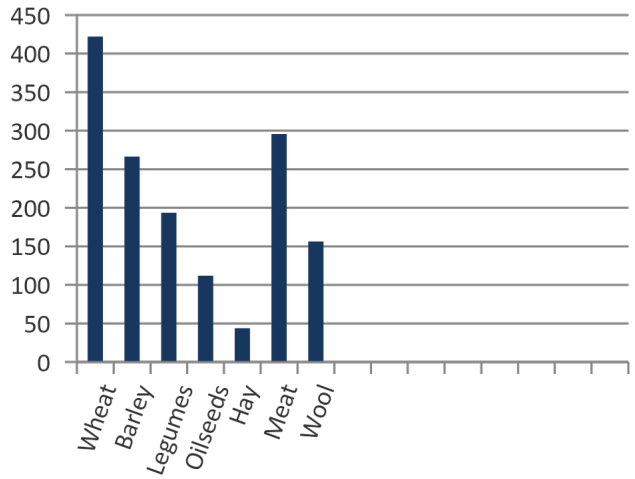
Table 2: Gross value of Agricultural Commodities produced ($M)

Commodity	Value	Value	Percentage
Cereals	718		46%
Wheat		422	27%
Barley		266	17%
Legumes	194		12%
Oilseeds	112		7%
Hay	44		3%
Meat	296		19%
Wool	156		10%
Other	72		5%
TOTAL	**1,591**		

Source: ABS (2011), *Value of Agricultural Commodities Produced, Australia, 2010-11*

The relative significance of the major commodities is clear from a graphical representation:

Figure 1: Gross value of main commodities produced ($M)

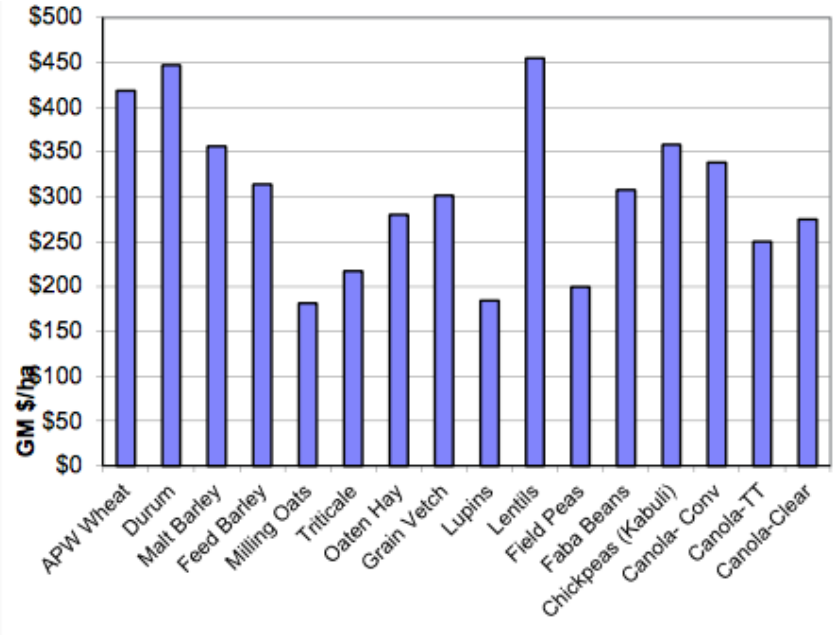


Source: ABS (2011), *Value of Agricultural Commodities Produced, Australia, 2010-11*

2.4.2 Gross margins

Cropping can generate gross margins of between $100/ha and $700/ha, depending on the crop type, soil conditions and rainfall. Higher value crops, such as lentils, provide a higher return but also require higher inputs and involve greater risks. The following chart confirms typical gross margins for standard crops in a medium rainfall zone.

Figure 2: Cropping Gross Margins - medium rainfall[1]



2.5 Other activities

It is also important to recognise that the region also supports a wide range of other commercial and public service activities that also make significant demands on weather forecasting services. This includes:

- GWMWater: the regional water corporation that uses weather information to help take decisions regarding the management of its headworks and projections on likely customer demand
- Emergency services: regional services who rely on high quality weather forecasting both to plan and to respond to possible risks, eg from thunder storms creating bushfires or flooding
- Tourism: tourism is now a major source of economic activity across the region. Good information on short and medium term weather projections are increasingly valued by service providers to support recreational activities
- Aviation services: air services are used both for personal travel, commercial transport of goods and spraying services. All rely on good quality data regarding projected weather conditions.

[1] GRDC (2015), *Farm Gross Margin 2015 - A gross margin template for crop and livestock enterprises*

3 Weather forecasting and decision making

This chapter sets out the different weather services available in different locations and their uses. It identifies the current limitations within the region and confirms the scope of the proposed investment.

3.1 Bureau of Meteorology

The Bureau of Meteorology (BoM) provides a suite of services to the region. These involve different data sets provided in different formats to meet different requirements. Information on these services was provided in an extensive letter and supporting annexes from BoM.[2]

3.1.1 Automatic Weather Stations

Automatic Weather Stations are designed to provide data for BoM's forecasting, warning, and information services, as well as providing data for BoM's climate database.

Automated one-minute instrument readings are made of temperature, air pressure, humidity, rainfall, and wind speed and direction. These are made available to the public every 30 minutes through the Bureau's website. There are Automatic Weather Stations in the Wimmera at Warracknabeal, Nhill, Horsham Aerodrome, Longerenong, Edenhope, Kanagulk, Mt William and Stawell.

These stations collate data in terms of actual events.

3.1.2 MetEye

The BoM collates and presents data across a range of parameters in both data and mapped format for state and local areas. Tabular forecasts include 1-7 day summary forecasts for all mainland Australia and detailed 1-7 day forecasts for selected locations including data on:

- Max/min temperatures
- Temperature (3-6 hourly time steps)
- Relative humidity
- Apparent temperature
- Chance of any rain
- Weather
- Wind

3.1.3 Rainfall forecasts

The BoM website also presents a suite of forecast rainfall maps. The site uses "an ensemble of numerical models to produce maps of forecasts for 1-8 days for the Wimmera and Mallee and other regions."

3.1.4 Weather warnings

"Weather warnings" provides information to allow the community to respond to significant weather events.

[2] BoM (2012) letter from Dr Ray Canterford, Deputy Director Services to WDA, 9 February 2012.

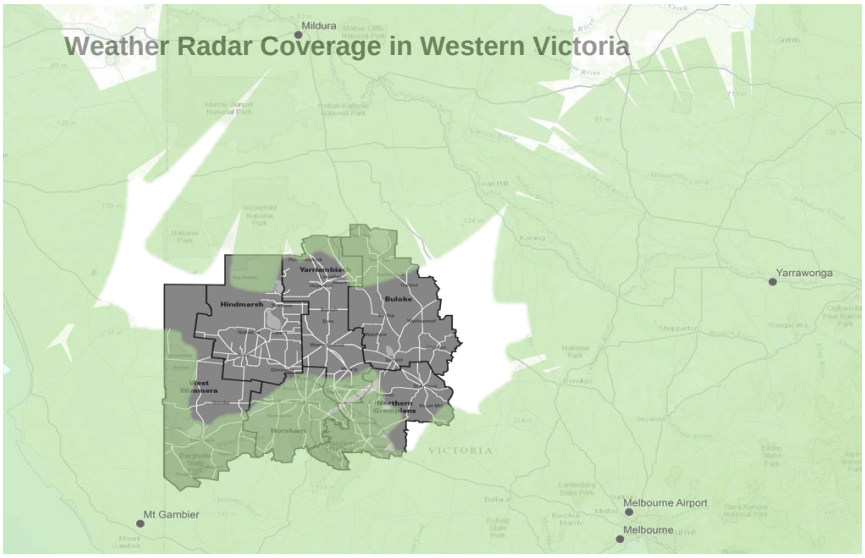
3.1.5 Weather radars

The Bureau also provides information on real-time weather events, in particular temperature, wind and rainfall. This is through radar stations that provide a visual representation of approaching weather systems. The BoM has indicated that:

The Bureau currently uses radar data almost exclusively for Nowcasting — predicting what will happen during the short-term (next several hours over scales of a few kilometres). Nowcasting systems use high resolution radar data to provide a detailed forecast for the next hour or two. These techniques are crucial as Numerical Weather Prediction (NWP) which is used for predictions beyond the Nowcast period, can be of somewhat limited value in the first 6 hours of the forecast period.[3]

It is this short-term weather prediction that farmers across the region seek. There are multiple radar sites across south eastern Australia as shown in the following figure from the Bureau's website.

Figure 3: BoM Weather Radar Coverage



The Bureau comments that:

As shown in the diagram, there are many areas which are not covered by radar observations, including the coverage gap in the Wimmera Southern Mallee (op cit).

The significance of this gap in the radar was confirmed during a recent storm event earlier this year, on Sunday 14 June, when the BoM tracked a major storm-cell from south-west NSW down across western Victoria. This was picked up by the radar station in Mildura at 9am in the morning, then vanished off the southern edge of the radar at 1.30pm before re-appearing an hour and a half later on the Mt Gambier radar station coverage at 3pm. In the intervening hour and a half, the storm had dropped 18mm of rain on Longerenong in the middle of the Wimmera, but farmers in the region had had no capacity to track this major rainfall event due to the absence of a regional radar station.[4]

This gap in the coverage is an anomaly given that the Mallee and Wimmera regions together account for about 75% of total Victorian wheat production.

[3] http://www.bom.gov.au/australia/radar/about/srep.shtml
[4] BoM (2015), Tom Butcher, email 26 November 2015

3.1.6 Satellite data and images[5]

Since July 2015, the BoM has been receiving satellite observations data from Himawari-8, a geostationary satellite operated by the Japan Meteorological Agency (JMA). Himawari-8 and its sister satellite, Himawari-9, are the successors to JMA's Multi-functional Transport Satellites (MTSAT), and offer significant improvements in frequency, resolution and precision. They are situated 35 800 km above the equator at longitude 140.7°E (above the western Pacific, in line with Japan, Papua and central Australia) and so provide excellent coverage of the Australian region.

Data from Himawari-8 data is used to assist in real-time analysis and forecasting, and is fed into the Bureau's numerical weather prediction (NWP) and forecasting models. The satellite feed is also used to provide a suite of imagery services including:

- **Infrared images:** These images provide information on the temperature of the underlying surface or cloud. IR images are available 24 hours per day because temperatures can always be measured. This is in contrast to visible images, which are only available during daylight hours.
- **Visible images:** Visible (VIS) images are a record of the visible light scattered or reflected towards the satellite from the Earth and clouds. They give meteorologists extra information that may not appear on infrared images. For example, fog appears in visible images, but may not show up in infrared images as its temperature is very close to that of the land below. Visible images are only available during daytime, as at night there is no reflected sunlight.
- **Clouds/surface composite:** The clouds/surface composites are created by combining information from two images. The Earth's surface (land and oceans) is a static image from NASA's Blue Marble image set. The cloud cover, which is overlaid on top of this surface image, is derived from a greyscale infrared image (see Infrared Images), by removing the temperature range associated with the surface. While a clouds/surface composite gives a good indication of the current cloud cover, it should not be confused with a true visible image.

3.2 Other weather forecasting services

Growers across the region rely on a wide range of different service providers beyond the Bureau, most of whom access, collate and re-package data from the BoM and other sources.

- **Weatherzone:** Weatherzone is a private service provider, previously known as the Weather Company. It aggregates up data from a range of sources including the Bureau. *Weatherzone hosts its own weather site which combines their own content with Bureau of Meteorology information and that from several other providers into a more user friendly and customizable interface.*
- **Elders Weather:** Elders is a private service run as part of the wider Elders business "*a leading Agribusiness and an iconic brand in rural and regional Australia*". Elders weather provide weather forecasting targeting:
  - Current day
  - 4 day forecast
  - 28 day forecast
- **Willyweather:** Willyweather is a private forecasting service that provides weather data on wind direction and speed, rainfall, temperature pressure and UV for multiple locations with forecasts for:
  - 1 day
  - 3-day

[5] This is section is drawn largely from www.bom.gov.au/australia/satellite/about_images.shtml

  - 5-day
- **Kaniva Weather (Landmark):** This website provides live and historical weather data, for the town of Kaniva in the west Wimmera. Data is presented on a range of parameters including:
  - Temperature
  - Dew
  - Chill
  - Wind direction and speed
  - Rainfall

  Data on the site is updated once every 30 seconds, although graphed data may take up to 10 minutes to refresh, with forecasts for the next 48 hours and 6-10 days.
- **AccuWeather:** AccuWeather is a US weather site which also covers Australia. It provides current data and projections over a 5-45 day period for a standard range of parameters.
- **YR:** YR is a joint service run by the Norwegian Meteorological Institute and the Norwegian Broadcasting Corporation. It provides a standard suite of current data related to temperature, rainfall, wind speed and direction etc with forecasting for both a 3 and 10 day period.

3.3 Current limitations

The current range of weather services provides good coverage on current weather at a regional scale, and projections for the following 48 hours and succeeding days. That provides support for decision making within the timeframe of the next few days to a week. However, there are no current forecasting services available in the region that support decision making 'within-day' in a timeframe of 30 minutes to a few hours.

The BoM has radar stations that provide this service located outside the boundaries of the region in Mount Gambier and Mildura. However, the Bureau itself and regional farmers confirm that the information from these radar stations is not accessible for decision making within the region.

4 Proposed investment

4.1 The proposed investment

This business case makes a proposal for the BoM to provide enhanced short-term weather forecasting data across the Wimmera Southern Mallee through the construction of a new radar station in the region. The new radar station would be designed, constructed and managed by the BoM to a proven design and would be part of the 'next generation' radar that will be installed by BoM from 2017-18, when existing radars in the Bureau's network are replaced. This will be more modern than most radars in the network as the Bureau is about to commence the procurement process for such radars.

BoM endorses the proposal and has committed to working in partnership with regional stakeholders to deliver the project. *The Bureau will work with the community, through Wimmera Development Association and Horsham Rural City Council, to explore business models to strengthen the services in the Wimmera Mallee region.*[6]

4.2 Costs

Costs are provided below both for: [7]

- the upfront capital construction and commissioning costs
- the ongoing operations and maintenance costs

4.2.1 Up-front capital construction costs

The up-front capital construction and commissioning works would involve costs of $5M.

The indicative costing includes provision for:

- Site selection that gives optimal coverage for the weather watch function
- Design and project management
- The associated tower, radar dome and radar hut
- Power and communications connections
- Project initiation costs covering legal, equipment procurement, etc
- Integration of the radar with Bureau forecasting and warning services and display on the Bureau's public website

This costing does not include:

- Site leasing (or purchase) costs
- Site signage
- Additional information service delivery enhancements or location-specific specialised delivery above current services.

It is assumed that the radar station will be located on public land, therefore no costs have been included for site purchase or lease. In any event its footprint would be immaterial in terms of total project costs.

[6] BoM (2015), *Strengthening Weather Services in the Wimmera Southern Mallee Region*, Memo of 29 March 2015
[7] BoM (2015), *Improved Wimmera Weather Monitoring,* Michelle Hollis, Anthony Rea, Tom Butcher, Memo to WDA, 15 October 2105

4.2.2 Operating costs

Costs are also estimated for the ongoing operation of the site, routine maintenance and return-to-service when failures occur. In this section these costs are presented on a discounted cash-flow basis as a present value of the costs over a twenty year timespan with a discount rate of 5%. This allows the stream of costs to be compared with the projected stream of benefits over time in the cost benefit analysis.

These on-going costs are:

- Annual operating costs of $164,360
- Maintenance costs of $177,574 every fifteen years
- This cost stream is equivalent to a present value of $2.26M over 20 years at a 5% discount rate

4.2.3 Total costs

The analysis therefore suggests a total project cost of $7.25M.

Under the BoM's costing methodology, the total cash costs of the project would be $9.48M combining both the up-front capital costs of $5M plus the undiscounted sum of twenty years of O&M costs in 'nominal' terms taking account of inflation at 2.5%/yr.

For the purposes of this business case, and as a risk management approach, it is assumed that the costs that eventuate are higher than those assumed, at x 2 those calculated and a total of $14.5M, to provide a buffer for the cost benefit analysis.

4.3 Governance and risk

It is proposed that the Wimmera Development Association is the sponsor for the project on, behalf of the Wimmera Community, and develops a 'heads of agreement' with the Bureau of Meteorology to project manage, design, install and operate the Wimmera radar.

Allocated funding may need to be held by Commonwealth Treasury and allocated to BoM through their normal funding arrangements.

WDA would also monitor the progress of the installation and conduct baseline and future research as to the efficiencies gained through the increased access to real time weather information. (Similar research and base line studies have been conducted with the new stations in the WA examples and it is hoped to develop a working relationship with appropriate tertiary research institutions both locally and in WA.)

There would be low risk to the investor or the regional community in terms of the design of the radar station as the installation would comprise part of a suite of similar stations being installed by the BoM to a proven design. Equally, responsibility for the station operation, maintenance and reporting would all be carried by the Bureau.

4.4 BoM policy on radar stations

The BoM owns and operates a suite of weather stations and other facilities across jurisdictions. The following section confirms the policy of the BoM regarding the management of its radar stations.[8]

[8] www.bom.gov.au/australia/radar/about/srep.shtml

In the 2009-10 Federal Budget the Bureau received $48M over seven years for the installation of four new radars, the installation of a verification network for each new radar, and to improve the underlying science for extreme weather forecasting [the Strategic Radar Enhancement Project (SREP)].

These new installations will significantly improve the existing weather radar coverage by closing significant gaps in the existing network and help to deliver enhanced warnings and forecasts for Australia.

The Bureau currently uses radar data almost exclusively for Nowcasting — predicting what will happen during the short-term (next several hours over scales of a few kilometres). Nowcasting systems use high resolution radar data to provide a detailed forecast for the next hour or two. These techniques are crucial as Numerical Weather Prediction (NWP) which is used for predictions beyond the Nowcast period, can be of somewhat limited value in the first 6 hours of the forecast period.

This quote confirms the underlying rationale for this investment proposal as it sets out clearly the limitations of the current forecasting techniques and the added value that radar stations can provide as a means to provide a prediction of *what will happen during the short-term (next several hours over scales of a few kilometres)*.

The following section reports on the BoM's current approach to the future management and expansion of this radar network.[9]

The Bureau's current strategy for the radar network is to modernise and consolidate the existing network. This has seen the closure of radars at Eucla and Tennant Creek, and of a further three backup radars in capital cities. Replacement of existing radars is funded through the Bureau's Departmental Capital Budget, with between one and three radars generally replaced in any one financial year. Operating expenses for the radars are included in the Bureau's operating budget.

At this time, the Bureau has no plans for expansion of the radar network. In the past, new radars have been funded through commonwealth government budget decisions providing initial capital and ongoing operating budgets.

The BoM has no budget available to fund the construction, or operation of the proposed weather radar installation in the region for the next 5-10 year period and is unlikely to do so. In the absence of securing external funding, this project will not proceed, nor will the regional economic benefits be realised.

The only way that this project can proceed is through access to joint funding from both the Victorian and Commonwealth Governments from appropriate regional development, jobs or agricultural grant programs.

It is also worth noting that parallel developments in Western Australia were fully funded out of the Royalties for the Regions fund.[10]

[9] *Pers comm*. Tom Butcher, Business Development Manager BoM, email dated 15 December 2015.
[10] http://www.drd.wa.gov.au/royalties for the regions

5 Impact scenarios & benefits

This chapter identifies the standard farming activities commonly carried out in the region, where access to better weather data 'within-day' would enhance decision making and result in more productive outcomes. The study reviewed a range of activities:

- Fertiliser spreading
- Herbicide spraying / fungicide application
- Sowing/Harvesting
- Hay making
- Stock management

In practice, the majority of the potential benefit was recognised as coming from the first two activities.

5.1 Fertiliser application

5.1.1 The activity

Fertiliser application (mainly urea spreading) is critical for crop yield and quality:

- Application early in the season bulks up the plant mass and so the later crop yield
- Application later in the season increases protein and so the unit price realised

Urea is spread on an opportunistic basis during the season to coincide with projected rainfall. Practice varies across the region depending on location, rainfall, soil quality and farming practice. So, growers in the southern Wimmera on good soils may apply 120kg/ha three times a season, whereas in drier areas in the Mallee, growers may make only one application at 50kg/ha. In the analysis below an average application rate has been assumed.

The table below confirms the benefits of fertiliser application for wheat production, with the potential to generate a 23% increase in value, of $114/ha (from $500/ha to $614/ha) through an increase both in the yield and the unit price. An averaged regional value has been adopted for wheat production, at 2.5 t/ha, which in practice can vary between 1.5t/ha to 3.5t/ha depending on soils and rainfall. The costs of fertiliser typically represent 14% of total farm income[11] so any opportunity to reduce costs and increase effectiveness are of real value for farm profitability.

Table 3: Potential benefits of fertiliser application for wheat production

Parameter	Metric	Base	Plus fertiliser	Benefit
Area	Ha	100	100	
Unit yield	Tonnes/ha	2.5	3	0.5
Total yield (100ha)	Tonnes	250	300	50
Unit price	$/tonne	$200	$230	30
Gross income (100ha)	$	$50,000	$69,000	$19,000
Unit cost fertiliser	$/ha	$0	$76	
Cost over 100ha	$	$0	$7,600	$7,600
Net income (100ha)	$	$50,000	$61,400	$11,400
Net income/ha	$	$500	$614	$114

[11] ORM Pty Ltd (2015), *Cost of production and enterprise risks*

5.1.2 Weather sensitivity

Table 3 shows the potential benefits that can be realised. However, for this increased return to be achieved in practice the application needs to be followed by good rainfall within 24 hours, to wash the urea into the root zone to maximise availability and uptake. The absence of this rainfall can be detrimental:

- Urea left on the ground surface will volatilise, resulting in wasted product at $76/ha
- Too low a rainfall leads to a high concentration in the root zone and so damage to the crop

The grower therefore needs good 'within-day' rainfall data to optimise a decision on whether to apply urea. Many growers will plan fertiliser application a week or so in advance and have the spreader ready in the paddock, and then rely on short-term weather forecasts to decide whether to apply on a particular day. In areas that are serviced by radar growers rely heavily on radar images when deciding whether to spread fertiliser or not.

Wimmera growers reported that, in the 2015 growing season, the 4-day weather forecast had indicated a 90% probability of 10-20mm of rainfall on a number of occasions and so urea had been spread, but in practice less than 2mm had been received - resulting in wastage of much of the fertiliser. If growers had access to a more accurate within-day weather forecast then they would have not applied urea on these occasions.

5.1.3 Benefit calculation

The provision of enhanced weather data for urea spreading decisions can therefore result in two benefits:

- A reduction in wasted application and so wasted costs, at $76/ha
- An increase in productive capacity at a premium yield of $114/ha.

It would be possible to attribute both benefits to the enhanced weather data. However, for the purposes of this study it is assumed that repeated urea applications would be made until a successful outcome is achieved, so the production benefits are included in the basecase. The primary benefit from the provision of the enhanced weather data is therefore assumed to be the reduction in wasted time and cost.

The study undertook a survey amongst wheat cropping properties across the region about their approach to urea application. This asked the following four questions:

- What is the area of wheat grown?
- What % of this area is urea applied to?
- How often in a year is urea applied to this area?
- What is the current failure rate due to absence of rain?

Table 4: Urea applications parameters - survey results

Survey respondents	A	B	C	D	E	F
Area wheat grown (ha)	550	450	1,000	200	1,100	300
% of area urea applied to	15%	100%	50%	100%	50%	100%
Frequency (per year)	0.1	1-3	1	2-3	2	1
Current failure rate	10%	50%	20%	10%	30%	80%

The answers varied very widely between properties, depending on location and soil type, with properties in higher rainfall areas and more loamy soils applying urea more often and over a larger proportion of the property. The failure rate also varied widely, with higher failure rates in drier areas.

For the purposes of this business case, a set of standardised average production parameters were assumed that took a conservative estimate of the range of results. It was also assumed that only 50% of current failures would be avoided from the provision of better 'within-day' weather data.

Table 5: Benefit from urea application for wheat production

Parameter	Value	Result (ha)
Total area wheat grown (ha)		414,580
Proportion urea applied to (%)	50%	207,290
Frequency of urea application (#/yr)	1	207,290
Current failure rate (%)	20%	41,458
Reduction in failure rate (%)	50%	20,729
Reduced wastage ($)	@ $76/ha	= $1.5M

This suggests that enhanced weather data on 'within-day' rainfall, provided by a radar station, would generate annual benefits for wheat production across the Wimmera of $1.5M, from a reduction in wasted applications and so result in lower input costs and higher returns.

This is a conservative estimate as it only covers wheat production and applies the benefit only in the Wimmera, as this is the primary crop and location where urea is applied. Therefore the total regional benefit should be higher, as urea is also applied to Barley and Canola production. It also ignores the reduction in adverse impacts for production and the environment of poorly dissolved urea entering the root zone, when inadequate rainfall occurs after spreading.

5.2 Spraying

5.2.1 The activity

Spraying is a standard activity for cropping properties and is used to apply herbicides, fungicides and pesticides for crop protection and to enhance yields. Herbicide application has become more intense with the adoption of conservation farming, as weeds are no longer controlled through ploughing.

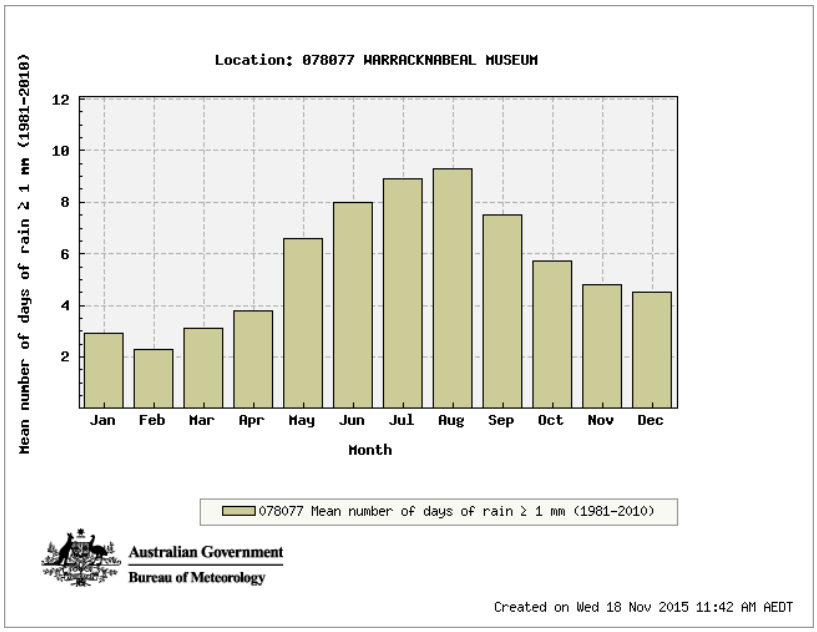
5.2.2 Weather sensitivity

Weather conditions are critical for effective spraying:

- Sprays cannot be applied in completely still conditions as the droplets do not settle or disperse. Or spray drift may occur. This is where spray hovers above the crops in very still conditions and can drift across onto another paddock with a gentle breeze and then drop on another crop
- On the other hand, sprays cannot be applied in windy weather because the droplets disperse too widely, with risks to neighbouring properties/paddocks
- Most herbicides are not 'rainfast' and rely on a period of between 1-6 hours without rainfall after application to make sure that the product is not washed off the plant
- Fungicides are rainfall sensitive:
  - Fungicides for legumes require rain splash to disperse the droplets amongst the canopy, but
  - Cereal fungicides need rainfast time as they need to be translocated into the plant prior to rainfall

Most herbicide application is in the winter/spring period, particularly as part of conservation farming, where herbicides are applied to control weeds early in crop life to maximise crop yield potential. However, the winter/spring period is also the time of year with the most frequent rainfall across the region. The BoM data at **Figure 4** confirms that rainfall occurs, on average, every three to four days at Warracknabeal, over the period from June to September.

Figure 4: Average rainfall at Warracknabeal (mean number of days)[12]



If a window of several hours is required to optimise herbicide effectiveness then radar images regarding wind speed and rainfall are critical to optimise business decisions. Many cropping properties leave spray equipment in the paddock ready to operate, with the boom loaded and only the chemical left to add, so they can take advantage of short-term weather forecasts.

As noted, unexpected rain or wind can render spray application ineffective. This can have multiple adverse outcomes, both financial and in terms of yield:

- Wasted costs of application
- Failure to kill weeds leads to greater competition for soil moisture and light leading to reduced yields
- Failure of fungicide application means new foliage will be unprotected, reducing yields
- Failure to catch weeds early means a heavier application is needed later in the season at a higher cost, and with higher risk of seed setting and so a greater burden the following season
- Failure of application later in crop growth may have a long-term impact on yields as there are strict with-holding periods for crops

5.2.3 Benefits calculation

As with the urea application, the benefits assessment could claim attribution both of increased yield and reduced wasted costs. However, this business case assumes that repeated applications would be made until the spray was successful, so the only benefit claimed is for the reduction in wasted costs from failed applications where rainfall washes the herbicide from the crop. The costs of chemicals typically represent 14% of total farm income[13] so effective controls are important for profitability.

A standard herbicide such as RoundUp has a unit cost of application at around $100/ha, which includes both the cost of the herbicide itself and the fees of the contractor who applies the spray (Table 6).

[12] BoM, Climate Statistics for Warracknabeal Museum - accessed 18 November 2015.
[13] ORM Pty Ltd (2015), *Cost of production and enterprise risks*

Table 6: Cost of herbicide application ($/ha)

Value	Metric
250	$
20	litre drum
12.50	$/litre
3	litres/ha application rate
37.5	**$/ha for product**
120	$/hour spray contractor
0.5	hours/ha
60	**$/ha for application**
97.5	**$ total cost/ha**

This value is adopted in the following assessment as a conservative estimate, as many fungicides and specialist products are more expensive.

The following table provides an estimate of the value of the benefits from reduced wasted applications, and follows discussions with agronomists and producers across the region about standard spraying activities:

- 75% of the total cropped area in the region is sprayed at least once a year
- A current failure rate of 10% is assumed. This failure rate is less than for urea spreading as spraying occurs throughout the year including times when rainfall is uncommon
- Croppers assumed that in 25% of those cases of failure, better data on rainfall would have prevented wasted costs as there is often a limited window for spraying.

Table 7: Benefit for crop spraying

Parameter	Value	Result (ha)
Total area cropped (ha)		1,103,678
Percentage of area spray applied (%)	75%	827,759
Frequency of spray per paddock	1	827,759
Current spray failure rate (%)	10%	82,776
Reduction in failure rate (%)	25%	20,694
Reduced wastage ($)	@ $100/ha	= $2M

This suggests that enhanced weather data on 'within-day' rainfall, provided by a radar station would generate annual benefits from a reduction in wasted spray applications of $2M. In this calculation the total area of cropped land has been limited to the Wimmera, as there is some capacity in the Southern Mallee to access the existing radar station at Mildura.

5.3 Other activities

Most other mixed farming activities could also benefit from more accurate projections regarding 'within-day' rainfall, eg:

- **Sowing**: accurate projections on future heavy rainfall would prompt completion of sowing in advance of the rainfront that would otherwise prevent future paddock access
- **Harvesting**: the timing and length of harvesting within a day would be accelerated if there were more accurate projections on probable rainfall. Once wet, it can take 2-3 days for the crop to dry sufficiently to allow continued harvesting. This is particularly critical for legumes such as lentils that can be easily knocked down by heavy rainfall.
- **Hay-making:** accurate projections on future rainfall would trigger decisions regarding the timing and intensity of hay-making to reduce risks of product wastage.

- **Shearing:** most shearing is now contracted-out. If sheep get wet before shearing then they cannot be sheared, disrupting the program and losing a contracted period. If sheep get badly wet after shearing then they can get cold and lose condition.

In all of these cases, better data on within-day rainfall and wind direction would improve business decision making. However, these benefits are less significant and more difficult to quantify than for urea spreading and herbicide spraying, therefore these secondary potential benefits are not explicitly included in the calculation of benefits for the purposes of this business case.

5.4 Total agricultural production benefit

The enhanced weather forecast information from the radar station has the potential, therefore, to improve decision making by farmers that will enhance yields and reduce wasted costs.

The sections above have reviewed two critical regular activities, urea spreading and herbicide spraying and identified the potential commercial benefits that could reasonably be attributed to improved decision making from the enhanced weather forecast information. This suggests annual benefits of $3.5M.

Figure 5: Total projected benefits

Activity	Benefit	Value ($M)
Urea spreading	Reduced wasted costs	1.5
Herbicide spraying	Reduced wasted costs	2.0
Total annual benefits		**3.5**

These estimates of the potential benefits are conservative as they are:

- Limited to only two key activities
- Limited to urea spreading for wheat alone and not to barley or canola
- Based on conservative estimates of reduced losses
- Applied only to the Wimmera, as this is the area where greatest production benefits are available.

This provides confidence that the projected benefits are likely to be exceeded in practice.

5.5 Threshold analysis

The projected costs of the radar station involve a present value of $7.27M taking account of both capital and operating costs over twenty years. It is assumed for risk management purposes that the total costs in practice are twice this value at $14.5M. This value is equivalent to an annual cost of $1.16M. In order to generate a benefit to cost ratio of x 2 the investment would therefore need to generate an annual return of $2.3M. The region generates a gross value of agricultural production of $1,600M. The investment would therefore need to generate a benefit equivalent to an increase in production of 0.144% to achieve the target of $2.3M or a value of $2/ha over the 1.1 million hectares cultivated in the Wimmera alone. That appears a credible hurdle rate.

5.6 Other benefits to the region

The investment will also generate a range of other public non-monetary benefits covering eg:

- Emergency management
- Water resource management
- Aviation

5.6.1 Emergency management

The proposed radar weather forecasting will also provide enhanced services for emergency management. The Country Fire Authority (CFA) in a letter[14] to the Wimmera Development Association confirmed that:

The Country Fire Authority has a genuine interest in your submission and is fully supportive of it. The requirement to have accurate and timely weather data cannot be overstated:

- *It will enable the Fire Services to adjust preparedness levels for the approaching weather ie. thunderstorms and lightning. (On 14 February this year the BOM forecast a lightning activity level of 1 which indicates one or two lightning strikes are possible, more than 80 fires were started by lightning that day).*
- *It will enable the State Emergency Services (SES) to issue more timely warnings and public advice in regard to storm and rain events which could lead to flash flooding, riverine flooding and hail and storm damage.*
- *Real time weather data is an essential component of the many weather products produced by the Bureau of Meteorology and this will improve the accuracy of their products.*

The value of additional 'within-day' weather information was also supported by the then Department of Sustainability and Environment.[15]

The department (DELWP) would benefit greatly from an improved weather forecasting service. In particular in regards to our emergency management responsibilities centred around fire management on public land. One of the major drivers of fire behaviour is weather, and accurate forecasting and measurement of the current weather situation is vital for the proper management of both bushfires and planned burning.

In regards to bushfire suppression in the past we've experienced difficulty in tracking storm systems in summer where it's important to know whether rain is falling as part of the system. The current radar does not accurately pick up rain. We have a fairly accurate lightning tracking system, being able to overlay this information with rainfall in real time would give us an increase ability to respond to where we are getting dry lightning (ie. where lightning falls without associated rain). Historically these are the types of weather systems which give us the most cases of bushfires, our ability to quickly and accurately direct resources to these fires is critical in controlling them. In addition rainfall assists greatly in putting out fires and forewarning of rain helps us adapt our fire control strategies.

An improved radar system would also help during our planned burning program especially in identifying where burning opportunities exist. It would be of great benefit to us to be able to see where rain has fallen during a given weather system to help guide where we may or may not be able to burn. For example while one part of our district may have received rain other parts may not have, it is not currently possible to accurately measure spatially where rain has exactly fallen.

In general it would also benefit our day to day works program, because of the outdoors nature of our program often we divert work and resources depending on weather, (particularly over the Winter, Spring period), based on our prediction of what the weather is doing. A more accurate idea of weather will help us be more efficient in directing our resources.

A copy of supporting evidence is appended as Annex A.

[14] CFA (2013), letter from Dale Russell, Operations Manager, District 17, 14 August 2013.
[15] DSE (2013), letter from Glenn Rudolph, Wimmera District Planning Manager - Department of Sustainability and Environment

5.6.2 Water resource management

GWMWater provides water and wastewater services to around 70,000 customers over a geographic area of 62,000 square kilometres, which is about 30% of Victoria. This area is similar in size to Tasmania and covers 13 municipalities either fully or partially. GWMWater currently relies on radar coverage from Melbourne, Mildura and Mount Gambier to assist with its day-to-day business activities. None of these stations cover GWMWater's full operational area, indeed, radar coverage is at its poorest over the major population centers of Ararat, Horsham and Stawell and the Grampians reservoir system, where the bulk of the region's water resources are situated.

GWMWater has provided formal support for the proposed investment on the basis that:

The short term weather and longer term climate characteristics are of great importance to GWMWater and form an integral part of the way we manage our region's precious water resources and undertake our day to day business activities. We also understand the importance of good weather services to the broader region for agricultural, environmental and even emergency management reasons.

It is GWMWater's view that improved radar coverage would enable better and more timely decisions to be made in resolving weather related difficulties and risks to our services and general operations. We also believe that any investment in weather services will add benefit in terms of understanding the regional climate patterns and trends, and in formulating strategies to combat climate uncertainty into the future.[16]

GWMWater advises that better radar coverage over the GWMWater operational area will:

- Provide improved data collection to assist in the understanding of climate patterns and trends for the region. This has important longer term benefits.
- Enable improved decision making around water resource management and reservoir operations. During times of heavy rain, decisions are made on how to best manage the water resource and how best to staff these activities. Optimising the release of water from reservoirs can save GWMWater millions of dollars and maximise the security of supply to GWMWater customers. Every megalitre of water released unnecessarily involves a loss of around $2,500 in revenue. The release of thousands of megalitres per day add to very significant business decisions having to be made during times of heavy rain or threat of flood.
- More effective and efficient response to adverse weather would advantage GWMWater considerably in planning and responding to weather related events. Better coordinating daily work activities and associated staff resourcing can potentially save hundreds of thousands of dollars of staff productivity and equipment running and maintenance costs. Staff safety is also paramount during times of severe weather.
- Provide ability to better respond during times of flood. This is particularly useful in the interagency response context where GWMWater provides an important support role to the overall flood response. The Wimmera-Mallee headworks systems is a complex network of 9 reservoirs, associated weirs, structures and interconnecting channels and waterways located in and around the Grampians National Park. This reservoir system is situated on the upper reaches of the Wimmera and Glenelg Rivers and their tributaries, and many of these catchments are not covered by any formal flood warning network. Improved radar service would prove immensely useful in better understanding the pattern and magnitude of rainfall which would assist in preparing for any flood response.

Further supporting evidence is provided in Annex B.

[16] GWMWater (2015), *Letter from Mark Williams, Managing Director,* 9 December 2015

5.6.3 Aviation

Local private aircraft owners and operators contacted during the consultation for this submission all agreed that better real time data would be very advantageous. These operators are engaged in leisure flying, commercial tour operations (e.g. tours to the outback), aircraft maintenance and flying training. Operators are based at Horsham and Stawell airports.

A significant factor in attracting new operators to our region or extending the range of services available is the need for accurate weather information.

A significant factor for these local operators is that they are all VFR (Visual Flight Rules) operators. This means that they do not and cannot legally rely on instrument flying in the event of inclement weather. Aircraft need to be specially equipped for IFR (Instrument Flight Rules) and the pilot needs to be specially rated to fly in instrument conditions. This increases the reliance by our local light aircraft operators on good weather forecasting and real time data.

Further supporting evidence is provided in Annex C.

6 Supporting evidence

This chapter provides evidence to demonstrate that the new service would be accessed and that farmers will use the data to enhance decision making. There are several sources of evidence:

- Case-study arguments: evidence from existing farmers and agronomists within the region confirming the value of the proposed additional evidence
- Evidence from farmers with cropping and grazing properties closer to Mt Gambier and Mildura on the active use of radar data for decision making where it is already available as a service.
- Data on internet access for the BoM radar services in Mt Gambier and Mildura to show the frequency of usage that can be extrapolated to the Wimmera Southern Mallee.
- Evidence on best practice from competitor regions internationally.

6.1 Evidence from farmers in the Wimmera Southern Mallee

Numerous case-studies were developed as part of the development of this proposal from growers across the region. The following is an example developed by the Birchip Cropping Group to represent a standard mixed cropping and grazing farm enterprise in the region. Copies of a number of case-study submissions are provided at Annex D.

Case Study - A mixed farming scenario in the Southern Mallee/Northern Wimmera.

More accurate localized weather information could significantly improve grower profitability and reduce environmental impacts by encouraging timely input applications and discouraging those that are inappropriate or wasteful. Below are some key examples illustrating the ways in which a radar station could improve grower decision-making.

Spray Applications: *More timely and effective spray application would be a key outcome of localized and accurate weather information.*

Fertilizer Applications: *Nutrients, especially Nitrogen, are an essential component in crop and pasture production. If the urea application is not followed by at least 5mm of rain the fertilizer can be lost to the atmosphere in the form of nitrous oxide. Localised rainfall information will arm farmers with the information necessary to prevent poor urea application decisions or will give them the confidence to go ahead.*

Hay Cutting: *Hay production is a common practice in the Wimmera and Southern Mallee, both in the form of specialized hay crops or as a risk management tool. Rainfall following cutting a crop for hay can downgrade the quality and decrease its value. Localized weather information could prevent a farmer from cutting a crop for hay, or delaying the operation, to avoid the reduced quality.*

Organizing Contractors: *Harvest is an extremely important time of the year for farmers. Timely harvest can have a significant impact on farmer profitability. If growers are aware of an impending rainfall event, they can often organize contractors or enlist the help of neighbours at the last minute to get maximum amount of crop off before the rainfall event arrives.*

Keeping Grain Receival Sites Open: *A common problem for growers during harvest is that grain receival sites close in preparation for what they believe is an approaching front. They do this based on a weather forecast which can often be incorrect. If the silo operators were able to use more localized weather information, they could remain open, allowing growers to deliver grain right up to the point when a rainfall front arrives.*

Paddock Selection for Lambing: *Much of the sheep industry in the southern Mallee and Wimmera is devoted to the production of prime lambs. Paddock selection during lambing can greatly influence the survival of newly born lambs. If growers are aware of an approaching cold rain front, they may have the capacity to move sheep to a more protected paddock.*

Dry Sheep for Shearing/Crutching: *Two of the most time-consuming operations on a sheep farm are shearing and crutching. Wet sheep cannot be crutched or shorn. If growers knew about an approaching rainfall event, they could put the sheep under cover before the front arrived.*

6.2 Existing Radar Stations

We have letters from agronomists in Mildura and Mt Gambier who advise that their clients routinely rely on access to the BoM radar service for decision making.

6.2.1 Dodgshun Medlin - Mildura

Dear Sirs,

This letter provides my views regarding the benefits available from use of the Mildura weather radar, following up from our phone conversation of 5 November 2015.

I am Head of Strategic Farm Management at Dodgshun Medlin and work with grain farmers in the Mallee, an area which is served by the weather radar in Mildura. I also run a farm at Sea Lake.

The Bureau of Meteorology's Mildura weather radar provides a valuable service to farmers and is widely used. In my experience 100 per cent of farmers use the service. It is hard to believe that the farmers in the Wimmera do not have access to the same service. The value of the radar was demonstrated recently when it was out of service over a weekend when rainfall was forecast, as it made it very difficult to judge when the weather front would reach specific properties.

The radar is used to provide an updated forecast of rain over a period of time up to 6 hours in the future. A visual inspection of the radar image to the west and extrapolation eastwards can produce a more accurate forecast of rain over this period than can the daily forecast. The benefits of the radar are lower input costs and higher productivity. These are realised through use of the radar to plan spraying for weed control, applying fertiliser and crop harvesting. Each of these benefits is explained further below.

- *Spraying: Herbicide will be washed off and rendered ineffective if it rains shortly after it is applied. This is a waste of herbicide, time and also damaging to the environment. The advantage of having the radar is that it is possible to spray even if rain is forecast, up until the rain is visible on the radar. This allows farmers to manage their time better and spray when it is optimal. Alternatively, it can rain even when the forecast is fine. In this case the input would be wasted.*
- *Fertilising: Farmers will always have a spreader ready to fertilise their paddocks in the event that rain is on the way. The radar allows more accurate prediction of rain over the next few hours. If rain is visible on the radar then farmers will start spreading fertiliser and conversely if the rain is dissipating they will stop spreading. The radar allows for less wasted fertiliser.*
- *Harvesting: If it rains before harvest then the quality of grain, and the return to the farmer, is reduced. Having a reliable forecast of rain in the next 4 to 6 hours from the weather radar means that farmers are able to make decisions on whether to speed up harvest or continue to harvest through the night.*

Yours sincerely, Danny Conlan

6.2.2 AGRIvision Consultants - Swan Hill

Dear Sirs,

This letter provides my views regarding the benefits available from use of the Mildura weather radar, following up from our phone conversation of 30 October 2015.

I am the General Manager of AGRIvision Consultants and am based in Swan Hill, Victoria. I have been advising growers in agronomic matters since the early 1990s. I work with farmers in the Mallee, which is served by the Mildura radar. On days when there is rain forecast I estimate that at least 80 per cent, if not all, Mallee growers would be watching the radar to see where the rain is and when it will arrive. The radar gives a much better forecast of rain than the daily BoM forecast.

Rain is critical to many farm activities. Herbicide will wash off if it rains after application, so farmers will stop spraying if rain is coming. On the other hand, rain is necessary for fertilising crops, so farmers will be ready and waiting to see rain coming before actually spreading fertiliser. Rain also affects baling and harvesting and farmers use the radar to plan their time when conducting these activities.

Yours sincerely Kent Wooding

6.2.3 Evidence from Mt Gambier

A survey was completed of growers and agronomists in south eastern South Australia through the MacKillop Farm Management Group to assess their use of the existing radar service at Mt Gambier. This confirmed the same overall messages as for farmers serviced by the Mildura radar station.

For example, Matt Ballantyne at Landmark Millicent reported that:

Most farmers have the BoM on their mobile phones in their pockets. Almost all farmers are looking at the radar morning, noon and night - on a daily basis – the area is high rainfall and the rain is quite unpredictable.

The radar is used extensively to plan spraying, which is the most common use of the radar. Should they spray this morning, afternoon or later in the day? We only get 6-10 perfect spray days per year.

Radar is not used so much for harvest - this involves more judgment on humidity and temperature.

6.3 Radar-station access data

The BoM has two existing radar stations in the wider regional area at:

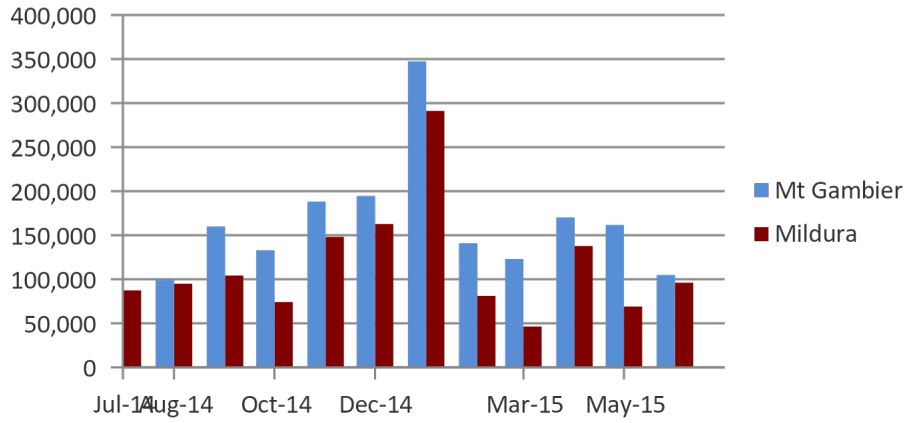
- Mt Gambier in southern South Australia
- Mildura in north western Victoria

The BoM has provided the study with evidence on web-access data records for these two radar stations. This shows regular consistent monthly access (

Figure 6).

Clearly a proportion of this access is related to tourist visitors over the summer months but a major component of the regular monthly base level of demand represents routine farm business management access. This is particularly true of Mt Gambier which has a smaller tourist market than Mildura.

Figure 6: BoM radar-station web-access data[17]



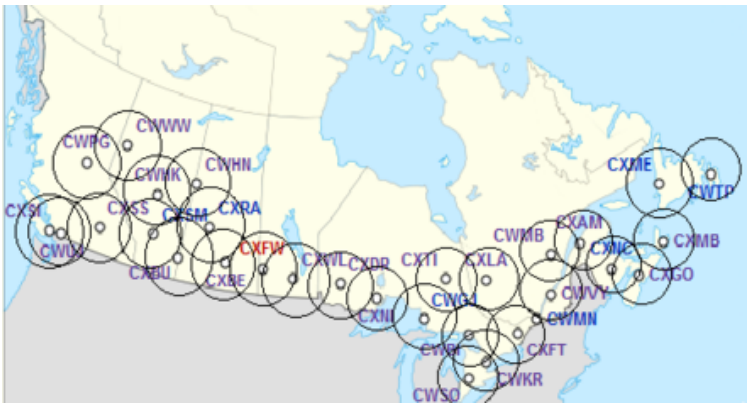
Given the production characteristics of the Wimmera it seems probable that any new radar station would command at least 150,000 hits a month.

6.4 International best practice

The Wimmera Southern Mallee exists in a highly competitive international market for grain products. The following section confirms that competitor regions both in Australia and more widely are now adopting radar stations as best practice in weather forecasting for cropping decision-making:

- Western Australia has promoted a major investment in radar and other weather stations through the Royalties for the Regions initiative. *Royalties for Regions underpins the State Government's long-term commitment to developing Western Australia's regional areas into strong and vibrant regional communities that are desirable places to live, work and invest. Since December 2008, Royalties for Regions has invested $4.2 billion of the State's mining and onshore petroleum royalties to more than 3,500 projects across regional Western Australia.*[18]
- Canada is a major competitor for Australia in international grain markets. In 2013 Canada produced 37.5 million tonnes of wheat in comparison to Australia's aggregate production of 22.9 million tonnes. Canada has invested heavily in radar weather capacity with a string of such stations now covering all the major cropping regions in the Canadian wheat belt.

Figure 7: Location of Canadian radar weather stations



[17] BoM (2015), data from Tom Butcher, Business development Manager, BoM, - 26 November 2015.
[18] http://www.drd.wa.gov.au/royalties for the regions

7 Cost benefit analysis and conclusion

This chapter pulls together the evidence on the costs and benefits of the proposed investment.

7.1 Costs

Section 4.2 confirms the projected costs of the proposed investment of:

- Up-front capital/construction costs at $5M
- On-going O&M costs of $2.26M as a present value over 20 years at a 5% discount rate
- A Present Value cost over 20 years of $7.3M. For the purposes of this analysis a figure of $14.6M has been adopted to ensure a conservative risk profile on exposure to possible future cost escalation.

7.2 Benefits

This section summarises the evidence on the projected benefits:

- **Top down:** this involves a "Threshold Analysis". Section 5.5 confirms that the project would need to generate a benefit equivalent to an increase in production of 0.144% to achieve the target of $2.3M, or a value of $2/ha over the 1.1 million hectares cultivated in the Wimmera alone. That appears a credible hurdle rate.
- **Bottoms up:** Section 5.3 identifies an annual benefit of $3.5M from enhanced decision making related to time-critical standard activities. This is equivalent to a PV of $43.6M when calculated over 20 years at a 5% discount rate.
- **Other benefits to the region:** The investment will also generate a range of other commercial and public benefits covering essential regional services and activities:
  - Emergency management
  - Water resource management
  - Airflights

7.3 Cost benefit analysis

The following table summarises the outcome of the cost benefit analysis for the proposed investment.

Table 8: Cost benefit analysis (PV over 20 yrs at 5% discount rate)

Element	Value ($M)
Costs	14.5
Benefits	43.6
Net present value	29
Benefit to cost ratio	x 3

This confirms that the project would generate a positive 'benefit to cost ratio' of x 3 and an NPV of $30M. This is a conservative outcome as it has assessed benefits against only a limited set of activities and crops, and has assumed escalation in the costs of the project.

7.4 Market failure

If significant commercial benefits from the provision of an enhanced weather service are likely then it is reasonable to ask why the private sector has not already provided the service and why the public purse should contribute to its costs. The rationale for this contribution is that there are significant failures in providing this service through the private sector:

- There is no credible private sector provider with the standing and credibility of the BoM

- Much of the benefit of the new radar service comes from its integration into the wider network of other stations and servicers already run by BoM
- The multiple users across the region mean it is only viable to provide this service at a whole of region scale
- There is no mechanism for individual growers to pay for a new radar station as separate customers
- BoM could not validate the proposed investment on the basis of contracts with multiple small-scale customers
- The proposed investment will generate significant non-monetary benefits for public sector entities as well as for private sector enterprises
- The weather forecasting service therefore has strong public good characteristics as it is "non-rivalrous" and "non-excludable".

7.5 Financing and funding

The Wimmera Development Association (WDA) is the project proponent for the proposal on behalf of the regional agricultural sectors and wider regional partners. WDA will source full funding from a combination of suitable State and Federal grant programs for this project

The above sections on the costs confirm the projected figures for both the capital and operating costs of the proposed installation:

- Capital costs including commissioning of $5M
- Annual operating costs of $164,360
- Maintenance costs of $177,574 every fifteen years
- This cost stream is equivalent to a present value of $2.26M over 20 years at a 5% discount rate. This is the economic value used in the discounted cashflow cost benefit analysis
- BoM calculate the cash-cost for future O&M at $4.475M as the sum of the annual costs over 20 years including a 2.5% annual inflator to present the figures in nominal terms.

In other locations, similar installations have been funded either out of the BoM's own budget from Federal Funding, or from regional funding programs such as Royalties for the Regions, as in the case of Western Australia. The BoM informed the project that no funding was available to cover the costs of the proposed station in the Wimmera South Mallee Region.

The BoM therefore seeks a contribution to cover both the up-front capital costs and the future operating costs of the proposed radar station. Any funding from State or Federal governments or other sources would be forwarded to the BoM to offset the costs they incur in providing the facility. Traditionally, State Governments have limited their contributions to the capital costs of infrastructure investments - equivalent to a figure of $5M in this case. The detail of any funding partnership is being finalised as a separate initiative.

Table 9: Possible funding sources

Source of Funding	Capex	Opex & Maintenance
Victorian State Government • Agriculture Infrastructure and Jobs Fund or • Regional Jobs & Infrastructure Fund	Up to $5m	
Commonwealth • National Stronger Regions Fund	Up to $5m	$2.7m

WDA will contact both State and Commonwealth Agencies to identify the most appropriate funding programs and submit full applications as required and discuss the proposed weather station installation with local Federal and State MPs to secure their further support.

7.6 Conclusion

The above business case and cost benefit analysis confirm that:

- There are standard cropping activities which would benefit significantly from access to better weather forecasting data within a 6 hour window, to support enhanced decision making
- This better 'within-day' weather data is available from BoM radar stations
- Growers in the region do not have access to this weather data from a BoM radar station
- Growers in areas provided with radar services make regular daily use of this evidence to support decision making
- Provision of this service would promote productive outcomes with a dollar value many times the cost of the proposed service
- Public investment is warranted due to market failure risks and the public good outcomes.

On this basis this section recommends that the proposed investment has considerable merit.

Appendix A – Emergency Management

Department of Environment,
Land, Water & Planning

110 Natimuk Road
Horsham Victoria 3400
(03) 5362 0718

Wimmera Development Association
62 Darlot Street
Horsham Victoria 3400

REF: IMPROVED WIMMERA WEATHER SERVICES

Dear Mark

Thank you for the opportunity to provide information for improved weather services in the Wimmera.

The Department (DELWP) would benefit greatly from an improved weather forecasting service, in particular in regards to our emergency management responsibilities centred around fire management on public land.

One of the major drivers of fire behaviour is weather, and accurate forecasting and measurement of the current weather situation is vital for the proper management of both bushfires and planned burning.

In regards to bushfire suppression in the past we've experienced difficulty in tracking storm systems in summer where it's important to know whether rain is falling as part of the system. The current radar does not accurately pick up rain which is important for us to get a better idea of where bushfire ignition sources may pop up. We already have a fairly accurate lightning tracking system, being able to overlay this information with rainfall in real time would give us an increase ability to respond to where we are getting dry lightning (ie. where lightning falls without associated rain). Historically these are the types of weather systems which give us the most cases of bushfires, our ability to quickly and accurately direct resources to these fires is critical in controlling them. In addition rain fall assists greatly in putting out fires and forewarning of rain helps us adapt our fire control strategies.

An improved radar system would also help during our planned burning program especially in identifying where burning opportunities exist. It would be of great benefit to us to be able to see where rain has fallen during a given weather system to help guide where we may or may not be able to burn. For example while one part of our district may have received rain other parts may not have, it is not currently possible to accurately measure spatially where rain has exactly fallen.

In general it would also benefit our day to day works program, because of the outdoors nature of our program often we divert work and resources depending on weather, (particularly over the Winter, Spring period), based on our prediction of what the weather is doing. A more accurate idea of weather will help us be more efficient in directing our resources.

Yours sincerely

Russell Manning
Fire and Land District Manager, Wimmera
15/1/2016

Our Ref:
Enquiries:
Telephone: (03) 5362 1700
Fax: (03) 5382 2774
Your Ref:

14 August 2013

Mrs Jo Bourke
Executive Director
Wimmera Development Association
62 Darlot Street
Horsham Vic 3400

Dear Jo,

Re: Wimmera/Southern Mallee Submission for BOM radar

Thank you for forwarding to me your submission to the Bureau of Meteorology in relation to improved weather services for our region. I have read your document and agree that if this facility is constructed it will enhance the Bureau of Meteorology's ability to accurately forecast the weather in the western half of Victoria. This is of particular importance for the following purposes:-

- It will enable the Fire Services (Country Fire Authority and Department of Environment and Primary Industries) to adjust preparedness levels for the approaching weather ie: thunderstorms and lightning. (On 14th February this year the BOM forecast a lightning activity level (LAL) of 1 which indicates one or two lightning strikes are possible, more than 80 fires were started by lightning that day).

- It will enable the State Emergency Services (SES) to issue more timely warnings and public advice in regard to storm and rain events which could lead to flash flooding, riverine flooding and hail and storm damage.

- Real time weather data is an essential component of the many weather products produced by the Bureau of Meteorology and this will improve the accuracy of their products.

- *PHOENIX RAPIDFIRE* was developed by Melbourne University and the Bushfire Co-Operative Research Centre and is a dynamic fire modelling tool. Besides taking into account topography, vegetation and fire history, this tool is reliant on accurate actual and forecast weather elements which then provides fire controllers with strategic advice for planning purposes. This tool assists fire controllers in their decision making as to resources and equipment required, protection of assets in the path of the fire, warnings to the public and evacuation potential.

- Attached is fire note 109 issued by the Bushfire Co-Operative Research Centre and the Australasian Fire and Emergency Service Authorities Council which outlines the research and development of "The Fire Impact and Risk Evaluation Decision Support tool" which is an advanced software program that can be used to understand the potential impacts a bushfire may have on community assets, infrastructure and people.

The requirement to have accurate and timely weather data cannot be overstated.

The Country Fire Authority has a genuine interest in your submission and is fully supportive of it.

Yours Faithfully

Dale Russell
Operations Manager
District 17

DISTRICT17

Headquarters
19 McLachlan Street, Horsham Vic 3400
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Appendix B – Water Resource Management

file note

GWMWater

Certified to best practice standards
ISO 9001 / 14001 and AS/NZS 4801

GWMWater Case Study

GWMWater operates over a geographic area of 62 000 square kilometres or about 30% of Victoria. Long term average rainfall varies from around 300 mm per year in the north to over 800 mm per year in the south around the Grampians region. Recent history highlights the extreme variations in weather that can occur with record drought conditions between 1997 and 2009, record breaking floods in January 2011, and now record breaking El Niño and drought conditions returning. Our range of operations also vary from the management of water and wastewater treatment plants, thousands of kilometres of rural pipeline network and a complex array of reservoirs and headworks structures in and around the Grampians region.

The supply of water and collection of wastewater is an essential service to the region and severe weather and rainfall can often impact significantly on the provision of these services. This could be damage to our infrastructure, hazards to our staff, and increased difficulty with decision making due to uncertainty with weather conditions.

GWMWater recognises that much of our operational area, including the important Grampians based reservoir system, is at the distant edges of radar coverage from the Mt Gambier, Mildura and Melbourne systems. It is frequently the case that staff lose track of patterns and movement during weather events as rain moves across our operational area from the west. The increased certainty of rainfall and associated weather movement, and greater penetration of radar into the Wimmera and Grampians regions in particular, would be very welcomed by GWMWater.

Dr Andrew Barton
Manager Water Resources

Wimmera
Catchment
Management
Authority

Our Ref: WCMA-17735 - Letter of Support re. Bureau of Meteorology Weather Radar1
Contact: David Brennan, Chief Executive
Date: 5 August 2011

Ms J Bourke
Chief Executive
Wimmera Development Association
62 Darlot Street
HORSHAM VIC 3400

Hi Jo

WIMMERA SOUTHERN MALLEE
REGIONAL PLANNING WORKING GROUP

On behalf of the Wimmera Catchment Management Authority (WCMA) I would like to thank you for identifying the importance and necessity to establish a Bureau of Meteorology weather radar.

The WCMA strongly supports the establishment of a weather radar in the Wimmera.

We have undertaken an internal review of the September and January floods and are providing a submission to the Environmental and Natural Resources Committee Inquiry into improving flood mitigation and monitoring infrastructure. We have identified towns like Natimuk, Hall's Gap and Navarre as being specifically susceptible to flash flooding with limited warning, as they are a long distance (over 200 km) from other radars, which can limit accuracy in terms of forecasting rainfall intensity, for these towns.

A weather radar would improve overall hydrologic information. For example it would increase the amount of warning time and the ability to predict where heavy rainfall events are occurring and in turn create more awareness of any pending flooding event.. From an operational perspective if the WCMA was able to identify the specific creeks and catchments in the Wimmera that was receiving heavy rain we would be able to quickly plan, predict and enact specific flood response measures.

We thank you for driving this initiative.

Yours sincerely

DAVID K BRENNAN
CHIEF EXECUTIVE

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Appendix C - Aviation

Local private aircraft owners and operators contacted during the consultation for the 2012 submission all agreed that better real time data would be very advantageous. These operators are engaged in leisure flying, commercial tour operations (e.g. tours to the outback), aircraft maintenance and flying training. Operators are based at Horsham and Stawell airports.

A significant factor in attracting new operators to our region or extending the range of services available is the need for accurate weather information.

The financial implications of poor weather information included the cost of having to cancel activities due to sudden changes in the weather. A scheduled delivery, an aircraft which had completed a maintenance overhaul, or an aircraft flying into Horsham or Stawell for maintenance - the inability to plan with confidence due to weather changes is a cost to regional businesses. At both Horsham and Stawell there are aircraft maintenance specialists who have contracts to maintain aircraft based at considerable distance from the Wimmera. For example one Horsham aircraft maintenance business has a contract to service aircraft based at William Creek near Lake Eyre in South Australia. Scheduling maintenance can incur additional costs if access is delayed due to unforeseen weather events, especially if they could have been avoided with real time weather information.

A Stawell operator engages in outback tours for small groups and can incur significant expense and inconvenience if a scheduled departure cannot occur due to weather influenced delays.

Training schools operate from both Horsham and Stawell and offer the region an opportunity for growth. Unforecasted weather changes can be critical for trainee pilots. Flying instructors need access to the best weather information when sending their students off on first solo navigation exercises.

A significant factor for these local operators is that they are all VFR (Visual Flight Rules) operators. This means that they do not and cannot legally rely on instrument flying in the event of inclement weather. Aircraft need to be specially equipped for IFR (Instrument Flight Rules) and the pilot needs to be specially rated to fly in instrument conditions. This increases the reliance by our local light aircraft operators on good weather forecasting and real time data.

Case Study 11 – Air Traffic Control

The Wimmera is over flown daily by numerous large jet aircraft en route to Darwin and Asia. While not of importance to the regional economy it is worthwhile noting that these aircraft also need the best available weather data to avoid costly track diversions because of weather.

In discussions with air traffic control (ATC) at Tullamarine control centre, it was noted that controllers would find it useful in planning the arrival sequence of aircraft inbound from those Asian and northern departure points if they understood the real time weather information in western Victoria.

In terms of national cost benefit, avoidance of wasteful diversions is tangible - considering the cost of operating a jet aircraft is over $10,000 per hour for a B747. There are significant national cost savings possible with improved weather data informing air traffic control movements.

Appendix D – Evidence from the WSM Agricultural sector

19 January 2016

To Whom it May Concern

As the Chief Executive Officer of the Birchip Cropping Group, (a Not-for-Profit agricultural research organisation based in the Wimmera Mallee), I am writing to express my full support of the business case for locating a weather radar in the Wimmera/Mallee.

Currently farmers in this region access radars at Melbourne, Mildura, Mt Gambier and Adelaide for their weather information, leading to inaccuracies with the forecasts and current weather observations. By providing real time weather information via a new radar, and closing the gap for coverage of this region, farmers and the local economy will benefit in many ways.

Farmers rely on weather data to make decisions about many key aspects of their farming businesses. Fertiliser and herbicide application is one such key decision. Knowing exactly where rain is expected to fall can mean the difference between an increased yield and an unnecessary input expense.

Farmers will be able to achieve optimal efficiency by minimising waste and off site impacts whilst achieving increased yields. This will enhance the credentials of our region for producing high quality produce in a sustainable manner. The quality of hay production will also improve, benefitting both the domestic and export markets. As the agricultural sector moves towards precision agriculture and Big Data, accurate weather information will be a vital feed into a complex system that enhances on farm productivity and profitability.

In addition to the benefits I have already outlined, Work Health and Safety on the farm will also improve as a direct result of the introduction of a radar. Currently, farmers need to visit their paddocks to check environmental conditions to help them make decisions. These decision are made both day and night depending on the operation. If a reliable radar were in place, the majority of these visits would not be needed, and would lead to a direct reduction in fatigue, and thus to a safer working environment.

In conclusion, I fully support the efforts of the Wimmera Development Association as they seek the placement of a weather radar in the region. Any program that can help our farmers make better decisions about their businesses will benefit our economy and the community at large

Yours sincerely

Chris Sounness
CEO Birchip Cropping Group

PO Box 85, Birchip Vic 3483 | P 03 5492 2787 | info@bcg.org.au | www.bcg.org.au | Inc. No: A0035543W

PERENNIALPASTURESYSTEMS
MAKING PASTURE GO THE DISTANCE

20th October 2015

Mark Fletcher – Project Officer
Wimmera Development Association
62 Darlot Street
Horsham Victoria 3400

Mark,

The Perennial Pasture Systems (PPS) group has become aware of the WDA initiative to seek funding for Bureau of Meteorology weather radar to be placed in the Wimmera region. The PPS group was formed in 2007 in the Upper Wimmera and Central Victorian region to conduct farmer based research, education and extension into pasture systems, encompassing roles formerly undertaken by State and Federal Government bodies.

Since its inception 120 farm enterprises have joined PPS as well as several agribusiness and agronomic representatives. PPS members farm 131,025 hectares and have approximately 483,000 sheep and 9,200 cattle as part of their businesses as well as areas of both cereal and hay cropping.

Despite the current period of lower than average rainfall and challenging seasons PPS members are committed to increasing productivity as well as enhancing positive environmental on their properties.

A key factor in this process is accurate weather forecasting, currently farmers in this region have internet access to weather radars situated at Mt Gambier, Mildura and Adelaide; while these are useful in assessing weather events they often don't illustrate the conditions that are experienced.

For this reason the PPS management committee has unanimously endorsed the WDA initiative to bring a weather radar to service the Wimmera region. It would be an important tool in fine tuning strategic farming operation such as spraying, hay and silage making as well as tool in improving animal welfare by helping predict extreme weather events. It would also play a vital role in bushfire control.

On behalf of the PPS management committee and members, I would like to offer the group's support to the WDA in their efforts to bring a radar station to service the Wimmera farming sector and the wider community.

Regards

Rob Shea
Project Manager
Perennial Pasture Systems

CASE STUDY

December 2015

Wimmera farmer adapts to climate in the north and west

By Melissa Pouliot, for Wimmera Catchment Management Authority

The past several years have been challenging for the Wimmera, with an extended dry taking its toll on rivers, agriculture, retail businesses and the community.

Farmers, land and water managers, businesses and individuals are looking to the sky for what has become increasingly elusive in the region – rain.

This year the region experienced the driest spring on record, and for the agricultural sector, rain didn't fall at the right time.

Climate plays an integral role in the success or failure of the Australian agricultural industry, and farmers are adapting to remain sustainable and productive.

West Wimmera farmer Danny West has lived his whole life on the land, growing up on his family's farm at Patyah, northwest of Edenhope. Danny works the farm with his brother Rowan and son Brad where they have mostly sheep and some cropping. They also lease extra land in the West Wimmera district.

The southwest Wimmera has an abundance and diversity of wetlands like nowhere else in Victoria. Depending on prevailing climatic conditions, they can remain wet or dry out completely for years at a time. Danny says their shallow swamps are dry this year, but generally get water each year. He feels in general that their seasons are getting drier, and only a handful of swamps in the West Wimmera have water.

Several years ago they purchased a property at Beulah, as part of their long-term plan to manage the changing climate. Danny says they figured if it was too wet in the west, it would be dryer in the north. The Beulah property has also allowed them to increase their area under crop as well, giving them added diversity within their farm business.

Danny says the past couple of years have been particularly tough at Beulah, with climate change resulting in lower productivity. He says they don't have a large amount of flexibility within their farming system, but there are things they can do to manage and adapt to climate change. They are also keen to learn about new technologies and ways to improve their long-term sustainability.

"We're looking for suggestions and new ideas all the time for what to do on the farm and when. By having country in different climate zones, we've got to learn that the seasons are coming forward a bit and we have to adjust. The seasons are also getting drier, so we need to adjust to that as well. For example, we put our rams out a week or two earlier and we've got to sow on the early side of the right time."

Danny says a big part of their planning comes down to weather forecasts, but forecast accuracy presents a challenge due to Wimmera weather forecasts coming from radars at Mildura, Mt Gambier and Melbourne.

Wimmera Development Association has been advocating to the Bureau of Meteorology for improved 'real time' weather for the region for several years, something Danny agrees would help with their farm planning and overall efficiency. He welcomes a commitment by the State Government, announced as part of a mid-November drought package, to support the development of a business case for the Wimmera Weather radar.

"I watch the weather all the time, on my iPad, particularly around shearing and sowing times. It's a fair way away where we get our forecasts from, and the forecasts are a bit irregular.

"The weather forecasts help us plan our sowing and are a big part of shearing for things like cold snaps and making sure our shorn sheep aren't going to die of cold."

Wimmera Development Association is preparing a business case on the benefits of improved 'real time' weather data in the agricultural sector. Visit their website www.wda.org.au for more information.

Wimmera CMA

CASE STUDY

December 2015

Northern Wimmera farmers welcome trials and new technology to adapt to drier climate

By Melissa Pouliot, for Wimmera Catchment Management Authority

Warracknabeal East farmer David Nitschke sums up the biggest change he's noticed in his lifetime on the land in fairly simple terms. It doesn't rain anymore.

David returned to his family farm to work full-time about 18 years ago and says they've been through 'the most challenging and difficult period of all time' with successive dry years impacting significantly on productivity.

He says to adapt to the drier climate, they have sought better ways to farm their soils. They've changed from conventional farming to a no-till, controlled traffic farming (CTF) system which works on the principle of retaining stubble and driving all machinery on the same permanent wheel tracks in paddocks.

The system enables growers to retain more moisture and improve the biology of their soils, leading to higher yield potential, particularly during dry seasons. They have also widened their row spacings to promote a better finish to their grain at the end of the growing season.

He says changing to no-till CTF is a big part of the reason they are still on the land.

"I think changing and adapting our farming system to better suit the drying climate has made a big difference. Changing our practices has played a big part in still being here," he says.

David is also president of the Warracknabeal East Conservation Farmers Group, a new group that formed to expand on activities of the area's old TopCrop group. He says the group's importance is two-fold - having a social outlet to get off the farm and into a social setting and increasing members' access to tools and information to adapt to a variable climate.

Group secretary Jamie Saines, who moved to the area five years ago, agrees. He says the group also provides opportunities for trial work, and has close links with Farm Tree and Landcare Association, Birchip Cropping Group, the Department of Economic Development, Jobs, Transport and Resources and Wimmera Catchment Management Authority.

Weather is a big focus, and David and Jamie both welcome news the State Government has committed to the development of a business case for a Wimmera weather radar. The closest radars are Mildura and Mt Gambier.

"Accurate forecasting is very important. One rain event this year was interesting when the Mildura radar was out of action and we just didn't know it was coming. You might not realise how much you look at the weather, but it's so important for the way we farm to have some idea of what's coming. We use a lot more in-crop nitrogen in our no-till CTF system, which is activated by rain, and a lot of money is tied up in that so it's important to have accurate forecasts," David says.

Group members also have a strong interest in soils and welcome trials that gather local information to improve soil management. Jamie says they attracted funding for soil moisture probes and other soil testing work through the Australian Government's National Landcare Programme via Wimmera CMA and the ANZ Seeds of Renewal Program. They have also taken over the weather station 18 kilometres east of Warracknabeal.

Probes at the weather station plus probes five kilometres north and five kilometres south, measure varying levels of moisture to one metre deep. This enables farmers to monitor below surface conditions to help make cropping decisions. Farmers can also access weather information remotely such as rainfall, humidity, temperature and wind, plus historical data.

"Farmers draw on all sorts of information to make decisions, and these soil moisture probes are just another set of data they can look at. It can be particularly useful if it's a difficult year to predict and the more data we've got, the more confidence we can have when making decisions," Jamie says.

This proposal has been prepared by:

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ISO 9001
International Standards
Certifications

Project no: 27-W-08