



AUSTRALIAN CliMate app

An evaluation for the Managing Climate Variability Program

Managed by the Grain Research and Development Corporation GRDC Project USQ00020

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1 EXECUTIVE SUMMARY

1.1 Introduction

This evaluation of the Australian CliMate app (Version 2) (CliMate) explored its functionality and usability along with the needs of users in adopting the app. It investigated potential benefits of using CliMate in management and decision making in Australian agriculture.

CliMate was developed originally as a smartphone App incorporating historical and current weather (rainfall, temperature, solar radiation) data and climate forecasting indicators into a suite of decision support tools. The app is available on website, iOS and Android platforms. Analyses available include:

- How's the Season – current season's progress compared with previous years;
- How Often? – probabilities of future weather events based on historic data;
- How Wet/Nitrate? – soil water and nitrate gains over a fallow period;
- Yield Potential? - a simple water use efficiency based progressive yield estimator;
- Drought? – current drought status for a selected residence period;
- How Hot/Cold? – risk of heat or cold stress;
- How Likely? – ENSO based seasonal forecast;
- How's El Nino? – ENSO status;
- How's the Past? – views of historic weather patterns; and
- What Trend? – explore trends in weather variables.

The CliMate app was developed by RPS Australia Pty Ltd (V1 2013) and the University of Southern Queensland (V2 2017, 2018) for the Managing Climate Variability Program (MCVP) (<http://managingclimate.gov.au/>).

This evaluation was based on three sources of data including:

- Online survey (97 respondents),
- Interviews with CliMate users (34 participants), and
- User statistics available since July 2017 (web) and Nov 2017 (iOS).

CliMate is a success story. It has been adopted throughout the major agricultural areas of Australia, with particular emphasis on grains and livestock industries as well as crop insurance, government, and agribusiness. There were 20 000 registered users of Version 1 (early 2017). Version 2 (which was released in July 2017) has growing numbers of registrations and accesses (Table 1.1).

Table 1.1 Summary of main user statistics (April 2018) - CliMate Version 2.

Registrations (last 9 months)	4300
Accesses per month	4000
Growth in registrations per month	300

Farmers and advisors represent 70% of users with 70% using an iOS device and 27% use a www browser. Farmers undertake 43% of all app sessions and advisors 28%. Three percent of users are using an Android device.

CliMate's points of differentiation for users beyond other available climate information products include:

- Data is locally-specific to a user's choice of weather station, providing actual, historical data in simple graphical screens, (hiding vast quantities of data); and
- Easily interrogated around a user's specific location and time-based questions, mobile-friendly and portable.

1.2 Barriers to use of CliMate

The increasing user registrations and CliMate calculations (especially in April-May 2018) indicate there are few major barriers to use of this app. The main barrier to use of the app appears to be limited awareness of the app.

A number of users reported difficulties installing and using the app, and similarly difficulties using CliMate data in decisions. The fast growing user base (particularly with seemingly very little promotion or organisational support within industries or at local levels) is evidence of the value of this app. Supporting information may assist users to fully use the app. It is suggested that examples (e.g. case studies) and contact with people may help users to use the app more fully.

Some users have not explored all of the CliMate calculations, and some indicated they do not understand or trust calculations, particularly How Wet/Nitrate, Potential Yield and How Hot How Cold. Some saw Potential Yield, El Nino or Drought as not relevant or did not understand them. Users requested further information and examples of use.

1.3 Outcomes

Table 1.2 highlights the substantial user outcomes associated with use of the CliMate app identified within this evaluation including:

- 65% and 33% of survey respondents indicated that Climate had contributed to positive outcomes and improved income respectively.
- 47% of survey respondents believed that using CliMate had improved their decisions or advice
- 54% of survey respondents believe that using CliMate has resulted in them considering weather data more carefully in their decisions
- 46% of survey respondents believe that using the CliMate app had enabled better monitoring of seasons and enabled more informed decision making and provision of advisory services.

Table 1.2 CliMate app – Outcomes and impact areas

Areas of impact	Respondents who agreed (%)
<i>Overall</i>	
CliMate has contributed to positive outcomes	65
Contribute to maximising production	16
Income is improved by using CliMate	33
<i>Decision Making and management</i>	
Using CliMate has improved decisions or advice	47
Using CliMate has improved business or production planning	27
Using CliMate has helped operate businesses more reliably	27
<i>Practices</i>	
Use Climate to compare current with previous seasons	80
Use CliMate app to review the season and help explain the outcome	63
Consider weather data more in decisions since using CliMate	54
<i>Capacities and knowledge</i>	
Better climate monitoring from using CliMate	46
Improved understanding of weather impacts on business and decisions	38
CliMate enabled more informed decisions or advice	46

(n=97)

1.4 Impacts

The following outlines how using the CliMate app had contributed to the areas of impact identified in Table 1.2.

1.4.1 Enhanced users' knowledge and capacities through:

(a) **Easier access** to historical weather data and enhanced ability to incorporate this data into decisions and advisory processes.

(b) **Improved knowledge** of seasons compared to previous seasons and of the chances and possible future weather scenarios, extent of risks to crops and the feasibility of management options, and the extent of crop and soil responses to specific weather statistics.

1.4.2 The CliMate app is contributing to processes and management by:

(a) More easily and accurately **comparing their current seasons with previous**, and incorporating this in decision making;

(b) **Quantifying the chances** of the range of site-specific weather scenarios and including this information in business discussions, planning and decisions;

(c) Using localised weather data to **explain cropping outcomes** and more thoroughly identify weather scenarios that may impact on production;

(d) Contributing to improving **agribusiness advisory services**;

(e) Contributing to **agricultural research planning, processes and communications**; and

(f) Facilitating business and research **planning, processes and communications**.

1.4.3 The CliMate app has contributed to communication, learning and decision making:

- Within farming businesses;
- Between advisors and clients and contributed to enhanced collaborative and situational learning and decision making;
- Enhanced local farmer group engagement; and
- Enhanced agribusiness knowledge and skilling of staff.

1.5 CliMate app – Strengths, Limitations, Opportunities and Risks

Strengths - CliMate's strength is its **simplicity of use, its portability** and its **simple holistic graphic outputs**. It enables users to interrogate historic and current seasonal weather data in relation to their own location, allowing the user to undertake their own risk assessments.

The app is highly valued for its quick reference ability and to contribute to and **facilitate discussions and decisions making** among farming businesses, between advisor and farmer and within farmer groups. It is making a significant contribution, especially within the agribusiness and crop insurance sectors and is widely used in the grains and livestock production. It has been used to guide key investments (property purchase, insurance) which were not originally envisaged in design planning.

Limitations - Version 2's requirement to **log in to the app** each time of use frustrated many users. Version 2 is seen as more complex for many users. One such complexity was the requirement to **reset locations** each time a different analysis is undertaken. This resulted in a loss of users and has since been improved. In addition, Version 2 contains some **analyses that have little relevance to some users** (e.g. Yield Potential, El Nino).

Some users had difficulties **installing the app, using the app**, understanding the **terminology and graphs**, and using the **CliMate data in decisions**. (Box 1.1). Many respondents in this evaluation requested information, webinars or worked examples to help them gain maximum value from the app. It appears most users did not access the supporting information (online) or the Help section in the app.

Box 1.1 Usability limitations of the CliMate app

Most respondents (86-92%) were able to install and use the app.

15% of farmers (9% of advisors) found it difficult or somewhat difficult to install the app.

20-23% of farmers had difficulties especially in understanding terminology and graphs.

7-9% advisors had 'somewhat difficulty' with terminology and understanding graphs.

20-25% farmers (and 12% advisors) found it difficult to change location

23% of farmers (12% advisors) found it difficult or somewhat difficult to use CliMate data in decisions.

Half of all respondents did not know how to save or transfer CliMate data.

Opportunities - CliMate users would like to **understand more about the data** they are accessing, and would like **more information** about default and input threshold values. They would like to more easily print and share output in report form. There was little evidence in this evaluation of on-farm recording of CliMate data for future reference or using CliMate data in other calculators or budgets. Advisors currently use screen shots from CliMate to incorporate into their reports. There are opportunities for further development in such uses of app data. **Example cases specific to industries** or locations would help users judge the usefulness of the app and better apply the tool to their particular situations.

There are opportunities to consider **further functionalities** or applications (e.g. identify disease risk of provide nitrogen recommendations), and also to apply CliMate in a **broader range of industries and sectors**. A **subscription-based** approach (especially if the app was tailored to particular sectors) or advertising may be a way of funding future maintenance, development and support.

The app's framework, databases and 3-platform delivery mode could be used as a base to **support future app development** in other contexts.

Risks - The largest risk to the future of this app may be a future **lack of ownership and maintenance or support** as potentially may occur in project-based developments, as this will affect users the most. Unclear long term goals, target markets or plans have potential to hinder the future of any app. There is also a risk that added functionality may make the app more cumbersome and complex.

1.6 Recommendations

1.6.1 Current CliMate app (for developers)

Qualifications on data - Assurances and explanations for users will help them to trust that the data they are accessing in CliMate is the best available for their location, especially in relation to each state, local weather data networks and trusted sources of weather data.

Identification of infilled data - A more obvious means within CliMate to identify which data is 'infilled' from historical averages or nearby weather stations is suggested as a key step forward for users in understanding and trusting CliMate data.

Adequate first user information - Ensure adequate information on choosing thresholds and in choosing and saving default locations and on printing CliMate output is included in help and first user files. Provide qualifications regarding the applicability of (especially) El Nino and Yield Potential, along with thresholds, defaults and standards, and how to adapt for individual situations.

Log-in requirement – It is suggested that the developer rethink the requirement to log in to the app each time of use; decisions could be made around the true value from gathering app analytics compared with user simplicity of access.

Locations –an earlier draft allowed users to select different locations for each analysis – this created some confusion for many users. Subsequently, the developers have now made the default one site for all analyses.

Printing CliMate output and reports – provide information for users on how to print or email CliMate data and outputs, and enhance this facility if possible.

1.6.2 Future CliMate app development

Case studies and examples – It is suggested that example case studies be prepared for specific industries and/or farming systems/regions within Australia, each outlining key relevant meteorological factors and technical comment about the application of CliMate app calculations in that location.

Data output and compatibility – Currently each CliMate analysis is lost unless a screenshot is taken and saved as an image. Provision of the output in report and in spreadsheet format would allow it to be incorporated into other calculators, decision tools and budgets. Although this data is available from other sources (SILO), CliMate is now a major interface to this data for users.

Regional or Industry networks – To facilitate adoption and application of climate-based risk assessment in agricultural decisions it is suggested that key organisations who have a vested interest (agribusiness, government, banking, insurance) encourage and support relevant staff (e.g. agricultural extension or development, agribusiness advisory) to provide relevant, regional industry-based seasonal updates from the app through media or in presentations. In some areas, this is already happening (e.g. farmer groups) and is facilitating education and understanding (about why or how to use the app) to a wider community.

Weather station data – Although some participants were asking for wider access to more available weather stations and historical data, it is understood that the current app data may be best suited to historical interrogations and better serve the range of CliMate users. It is recommended though that developers give further consideration to the availability and quality of weather station data in each state in relation to CliMate users' needs.

Evapotranspiration data – that developers consider the addition of evapotranspiration data to the CliMate suite of outputs.

Real time, Real place data – Interrogation of historical data and forecasts to identify location-based weather event probabilities will be more useful to agricultural operators when it accesses more exacting location-based weather data – farmers own rainfall and temperature data, along with potentially the incorporation of paddock aspect and slope information. Current and future technologies may be well-placed to meet this expectation, rather than considering it as further functionalities in current CliMate format.

1.6.3 Other app developers for Australian agriculture

It is recommended that future developers of apps and decision support tools for Australian agriculture clearly identify and segment potential users. In doing so, they must consider the range of currently available data, information and technologies on the topic (including how this might vary between industries, states and farming systems) and position and articulate carefully how the new tool adds value within each environment (industry, farming system). In addition, developers could consider the range of users' education, learning styles, approaches to information use as well as the types of decisions (industry, farm, science, advisory) they are likely to be making that require the new app input.

This market research (outlined above) would be improved if it was accompanied by the development of a brief pilot version of the app, for testing and identification of its value and place with respect to (i) the already existing realm of information and tools, (ii) the issues and decisions faced by potential users and their required data (including the expectation and need for real time/location data), and (iii) other tools and calculators that could and should integrate with the app's data.

It is suggested that the app development timeline include review and testing with users along the way, not only of the initial development, but in subsequent versions. You can't obviously please all of the people all of the time, but it is important to attempt to please the bulk of the potential users in re-development of any product.

The final point has no specific relation to this review or the CliMate app. It is recommended that for future oversight and development of technologies within industries, some coordination and integration take place through potentially a board, sub-committee or review, (to ensure funders are not relying purely on potential developers to highlight and articulate the need for their specific tools). In ensuring a rational and efficient approach to technology development within industries, prior to substantial funding for app development, funders could review (at farming systems level) available and interrelated apps (what is

available and supported, what has worked well) in order to gain economic, knowledge and adoption efficiencies.

1.7 Final

The CliMate app is a success story, making contributions especially in grains and livestock production and agri-businesses throughout Australia in terms of maximising input efficiencies with respect to weather conditions, and identifying and preparing for future seasonal risks.

The fast growing user base (particularly with seemingly very little promotion or organisational support within industries or regions) is evidence of the value of this app. That 65% and 33% of survey respondents indicated that the CliMate app had led to positive outcomes and improved income respectively is a highly commendable outcome for an app. It summarises the widespread very positive responses from a broad range of users. Forty seven percent of survey respondents believed that using CliMate had improved their decision making and advice.

This evaluation raises the possibilities that the CliMate app could have much wider application across more rural industries, in the education sector and in various other sectors in which a knowledge of the risks associated with weather conditions is important to operations.

1.8 Acknowledgements

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1.9 Abbreviations

BOM – Bureau of Meteorology	IOD - Indian Ocean Dipole
DAFWA – Department of Agriculture and Fisheries, Western Australia	MCVP – Managing Climate Variability Program
ENSO – El Nino Southern Oscillation	RDC’s – Research and Development Corporations
HE – Higher Education	VET – Vocational Education and Training
iOS – mobile Operating system developed by Apple incorporating iPhone and iPad.	

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2 Introduction

2.1 Background

Originally released as a smartphone App in 2013, the Australian CliMate app was developed to incorporate a range of weather-based decision tools into a mobile-friendly platform. It is aimed at decision makers requiring an improved understanding of weather probabilities and comparisons. It incorporates historical and near real time weather (rainfall, temperature, solar radiation) data from 4,700 weather stations across Australia as well as a suite of seasonal climate forecasting indicators.

CliMate II builds on Version I of Australian CliMate developed for the Managing Climate Variability Program in the project "Australian CliMate Development" [MCV00028]. Australian CliMate Version I was released in 2013 and Version II released July 2017 (www), November 2017 (iOS) and February 2018 (Android). In addition to weather-based calculators the app incorporated soil water and nitrogen mineralisation calculators (suited to broad acre farming). Version II incorporated three new analyses: a yield potential calculator; drought status and a simple trend analyser.

The app is available for downloading on two mobile device formats (iOS version for iPhone and iPad) and Android, and a World Wide Web version which can be used on any internet enabled device or desktop.

CliMate allows the user to interrogate long-term and recent climate records, asking questions relating to rainfall, temperature, radiation, as well as derived variables such as heat sums, soil water and soil nitrate. The app also provides information on seasonal forecasts based on El Nino Southern Oscillation patterns. The aim is to derive a richer and objective assessment of probabilities of future events and current conditions. Each analysis is cast as a question where variables are selected (e.g. temperature, rainfall, radiation) for a period of interest.

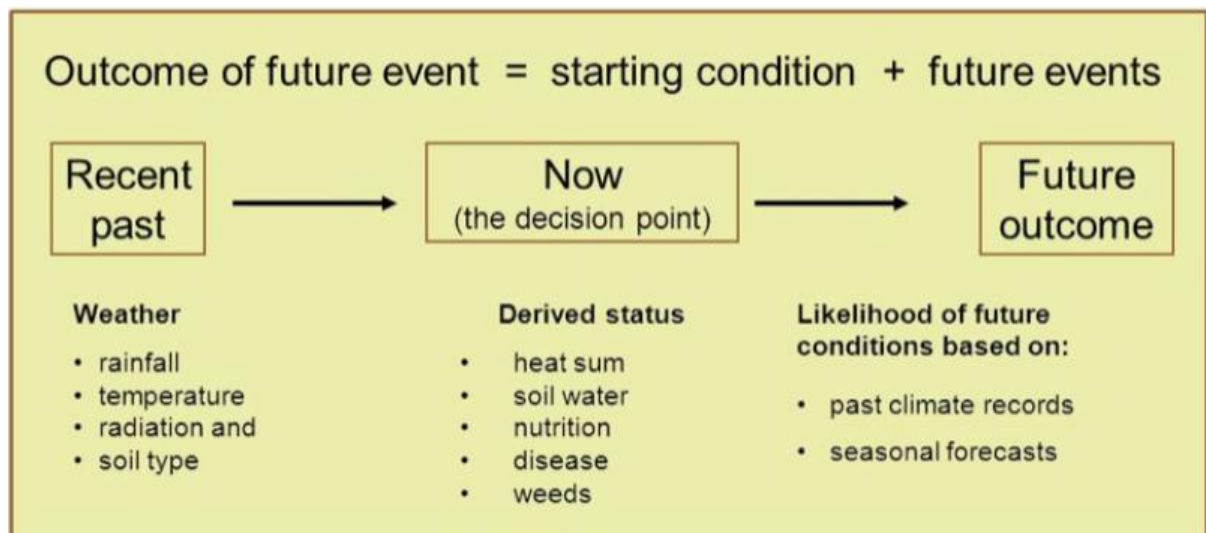
Analyses available on the app include:

- **How's the Season?** – Compares current season's progress in terms of rainfall, temperature, heat sum or radiation compared with previous years. This is useful when adjusting inputs during a crop or pasture season.
- **How Often?** – Identifies probabilities of future weather events based on historic data. It identifies the chance of a sowing event based on amount of rainfall over 5 days? Examples of questions include how often is a heat sum achieved in a set period of time? What is the probability of temperature being below a critical level for germination or flowering?
- **How Wet/Nitrate?** – Estimates soil water and nitrate gains over a fallow period, helping to adjust inputs to better match yield expectations.
- **Yield Potential?** - A simple water use efficiency based progressive yield estimator. This is a re-enactment of the Potential Yield calculator (PYCAL) first developed by S and D Tennant, Western Australian Department of Agriculture in 1993 and 2000.

- **Drought?** – Provides current drought status for a selected location and residence period.
- **How Hot/Cold?** – Risk of heat or cold stress. When determining an ideal sowing date, when are heat and cold stresses lowest for the optimum flowing time?
- **How Likely?** – An ENSO-based seasonal forecast. Based on current ENSO conditions, what is the probability that rainfall or temperature is greater than or less than key thresholds (e.g. terciles, median) and how reliable have these forecasts been in the past?
- **How's El Nino?** – What is the current ENSO status based on key atmospheric and oceanic indicators? What is the Australian Bureau of Meteorology's interpretation of this?
- **How's the Past?** – Views of historic weather patterns. Presents views of monthly and annual rainfall and temperature summaries to allow the exploration of relationships and patterns.
- **What Trend?** – Explores trends in weather records. A time series graph with a line of best fit (least sum of squares), differences from the mean and cumulative differences (residual mass curves) provide other views of long term data.

The CliMate app enables the provision of the following types of information:

- Status of a system (e.g. rainfall to date, heat sum, soil water) at a point in time;
- Probability of future events based on long term climate data (rainfall, temperature, heat sum); and
- Probability of future events based on available forecasts.



Linkages between recent weather, future probabilities and future outcomes in applying weather data to agricultural decision making (Freebairn and McClymont, 2017)

Once users have chosen inputs including location / weather station and time period, the range of analyses can provide the following output screens.

CliMate app output screens

How's the Season?

How is the season going...

for Rainfall (mm) at GARAH POST OFFICE that started 6 mths ago and looking forward 1 mths based on data from 1900 to present

Close to Average

-115mm (-0.95d)

Departure from "Average Rainfall" is -115mm for Dec 2016-Jun 2017 season at GARAH POST OFFICE (12th June 2017)

Accumulated Rainfall for the Dec 2016-Jun 2017 season.

How do we know this?
By comparing data for the current season with all years. Cumulative or average values are used to show differences between this season and longer term trends while the spread in past events is shown with a "horse hair" plot.

How often?

How often do we receive...

Rainfall: more than 25mm over a 7 day period at MULLALEY (GARRAWILLA) between 1 April and 15 May based on data from 1980 to present

In 58% of years.

Occurred in 22 of 38 years, 5.4 times/yr

Highest consecutive 7 day Rainfall totals at MULLALEY (GARRAWILLA), between 1 Apr and 15 May (45 days) each year

Number of times > 25mm Rainfall occurs over 7 days at MULLALEY (GARRAWILLA), between 1 Apr and 15 May (45 days) each year

How do we know this?
Based on a search of the historic record 1980 to 2017.

How Wet/Nitrate?

Soil water gain over the fallow...

Starting 7mths ago at/near MERREDIN with 0% starting SW on a Deep heavy clay PAWC 335 with 50% ground-cover from 1900 to present

Soil profile is 10% full (34mm)

Starting soil water: 0mm
Rainfall: 163mm
Gain in Soil Water: 34mm
Fallow Efficiency: 21.0%
Evaporation: 129mm
Runoff: 0mm
Drainage: 0mm

Fallow Soil-Water during November 2016 to June 2017 up until yesterday

Gain in Nitrate?

Relative fallow nitrate-N accumulation from November 2016 to June 2017 up until yesterday

How do we know this?
These results are based on daily rainfall and evaporation potential for your location and estimates of losses due to evaporation, runoff and drainage for the specified soil. Nitrate accumulation is based on surface moisture, temperature and organic carbon. NOTE: This simple estimate of Nitrate accumulation is based on soil organic matter, daily temperature and surface moisture. It is important to consider this estimate as a measure of departure from the long term average (all years). It does not consider previous crops or weeds.

How Hot/Cold?

What is the likelihood of...

Heat & Cold Stress at MERREDIN on the 1 January with heat stress over 30°C and accepted risk of 1 in 10yrs with cold stress under 0°C based on data from 1980 to present

HIGH risk of Heat Stress

NO risk of Cold Stress

Chance of Heat Stress 77.5% Chance of Cold Stress 0.0%

Probability of Heat & Cold Stress for MERREDIN

How do we know this?
These results are calculated from historical maximum and minimum temperature data. For any day of the year, the historical data is probed to see how many times a threshold is exceeded, and this value is converted into a percentage of the total number of years in the record. This percentage represents the "risk".

Drought?

Australian CliMate

What is the current drought status...
 at **LONGREACH AERO** assessed over **1** Syrs ranked by **Duration**
 with predictions based on **Historical Conditions** from **1900 to present**

A warning is current for LONGREACH AERO affecting droughts averaged over 5yrs.
 A drought-warning status has existed for 10 months. At least 453 mm of rain is required in the next month for the warning to be cancelled. If no rainfall falls within the next 1 month, then drought status will be indicated.

Current status for droughts affecting 5yrs

Potential yield?

Australian CliMate

How is yield potential progressing?
 For a crop planted on **25** Apr **2017**
 which matures **210** days after planting
 a WUE of **10** kg/ha/mm
 threshold of **100**mm
 at **WOMBAT (TUMBLETON)**
 with starting SW of **50**mm
 based on data from **1980 to present**

Yield is around average
 Current yield: **470** kg/ha
 (17/06/2017)

Potential yield: 4066 kg/ha
 Anthesis on **21/11/2017**
 Total Water Supply: **507**mm

Potential Yield (kg/ha) planted 25/04/2017, harvested 21/11/2017, and WUE 10kg/ha/mm

How do we know this?
 Yield potential is related to the amount of water stored in the soil at planting and in-crop rainfall, based on the Water Use Efficiency (WUE) model of French and Shultz (1984).

How Likely?

Australian CliMate

How likely is it that we will receive...
 Seasonal Rainfall: **greater than "tercile1" (86.8mm)**
 at or near **MULLALEY (GARRAWILLA)** during the period **Jun-Aug (3mths)**

Chance is "average"

Probability is 58.5%
 This has occurred approximately 6 out of every 10 years during similar Pacific and Indian Ocean Conditions

Past skill is Medium
 Historically, predictions for this season have been "consistent" 43.3% of the time, "inconsistent" 20.9% of the time, and "near-consistent" 35.8% of the time. (LEPS 4.3%)

Period Rainfall outlook in MULLALEY (GARRAWILLA) based on Pacific and Indian Ocean Sea Surface Temperatures between 1949 and Year

Month-by-Month forecast skill for MULLALEY (GARRAWILLA) predicting 3mth Rainfall

Current "BOM" Forecast

Current "LongPaddock" Forecast

How do we know this?
 From history and statistics! The forecast probabilities are calculated by looking back through history (from 1949) and comparing sea-surface temperatures in the Pacific and Indian Oceans with MULLALEY (GARRAWILLA) Period Rainfall. Statistical analysis is then used to detect patterns in these relationships and return the probability of high, normal and low Rainfall events for the current ocean conditions.

How's El Niño?

Australian CliMate

What is the current El Niño Southern Oscillation status?

Tropical Pacific remains warmer than average (BOM, 23 May 2017)
 The El Niño–Southern Oscillation (ENSO) remains neutral. With the tropical Pacific Ocean warmer than average, and around half the international climate models reaching El Niño levels later in the year, development of El Niño in 2017 cannot be ruled out. The Bureau's ENSO Outlook remains at El Niño WATCH, meaning there is around a 50% chance—double the normal likelihood—of El Niño developing in 2017.

Sea surface temperatures across the central tropical Pacific remained half a degree warmer than average over the past month. This is below the El Niño threshold of +0.8 °C. Further warming in the coming fortnight is unlikely, with trade winds forecast to be stronger than average. All other ENSO indicators are also neutral.

Five of eight international climate models suggest the tropical Pacific Ocean is likely to warm above El Niño thresholds during the second half of 2017. However virtually all models now suggest less warming is likely to occur compared to their previous outlooks, indicating any event may be weak. Models have lower accuracy forecasting El Niño during the autumn months, though accuracy begins to improve from June.

El Niño is often, but not always, associated with a drier than average winter–spring over eastern Australia. Even if El Niño thresholds are not met, Australia may still see some El Niño-like effects if waters in the tropical Pacific Ocean remain warm.

The Indian Ocean Dipole (IOD) remains neutral. Four out of six climate models suggest a positive IOD is likely to develop during winter. A positive IOD is typically associated with a drier than average winter–spring for southern and central Australia.

Last updated **23 May 2017** (Source: www.bom.gov.au/climate/ens0/)

Southern Oscillation Index

30 day average: **-0.1**
 90 days average: **-2.8**
 (Up Until 11/06/2017)

SSTa's (Nino3.4)

1 mth average: **+0.5°C**
 3 mth average: **+0.3°C**
 (Up Until May 2017)

From the atmosphere... 30 day averaged SOI

From the ocean... 20 day avg SSTa (Nino3.4 region)

Sustained positive values of the SOI above +8 may
 Sustained negative values of SSTs in the Niño3.4



(Freebairn and McClymont, 2017)

CliMate was developed by the University of Southern Queensland for the Managing Climate Variability (MCV) program and builds on Bureau of Meteorology data from the Queensland Government's Silo database. CliMate builds on the many ideas developed by climate specialists.

Version 1 (iOS and www) was quickly adopted throughout Australia with approximately 20,000 registrations in its first 5 years. Version 2 has >4000 registered users with 1400 new registrations in the six months to April 2018. Detailed user statistics are available since November 2017.

Appendix 11.1 outlines a brief history of CliMate versions and associated analytics.

2.2 An evaluation

In agriculture, the availability and use of information systems incorporating local, historical weather data and probabilities has potential to improve management decision making and reduce risks (Haigh, Takle, Andresen, Widhalm, Carlton & Angel, 2015; Carr, Fleming & Kalala 2016).

Yet it is suggested that insufficient emphasis has occurred on exploring how people use and interpret weather and climate data (Anderson, Kootval & Kull, 2015), or on seeking evidence in terms of outcomes and impacts at farm level (Tall, Coulibaly & Diop, 2018). It has been suggested that there have been few 'positive tangible outcomes' noted from managing climate risks in agriculture (Hochman and Carberry, 2011, Tall et al., 2018) and yet also that climate risk information is underutilised (Haigh et al., 2015).

Recommendations have been made to incorporate the social and process dimensions of climate services in future evaluations of information and services

(Vogel, Letson & Herrick, 2017), with an increased focus on the user and how the information is used in management to reduce risks.

To optimise technical design and future client uptake of the CliMate app, its technical development therefore needed to be blended with an evaluation of the human interface and application in real world scenarios.

To this end, farmers, agribusiness operators, scientists and other users, as decision makers, participated in this review. The idea is to involve potential users, observe their needs and explore how a new technology might help them.

This report outlines an evaluation of the Australian CliMate app, and contributes to an understanding of the needs of users in adoption, and how CliMate information contributes to decision making. Additionally, feedback on user experience will be used to guide future app developers.

2.3 Research Objectives

This evaluation was commissioned in line with the redevelopment of Version 2 in order to understand how to better meet the needs of users, to identify barriers to adopting the app, and to ascertain how use of the CliMate app adds value to decision making and business success in agriculture.

In particular, this evaluation:

- Collates initial usage statistics and considers implications;
- Identifies areas of application and use of the App and additional functions that could deliver enhanced product;
- Identifies factors associated with usability of the App and its features, and barriers to its adoption and use; and
- Identifies examples of value gained from use of the App in areas such as decision making, advisory services, business processes, profitability and sustainability.
- Considers users' needs with respect to business and production decisions and data management systems and processes.

The project did not quantify economic impacts from use of the CliMate app, or compare the app with other available weather information or apps.

2.4 Overview of Methodology

This evaluation investigated farmer and agribusiness use of the CliMate app and considered this in line with outcomes associated with knowledge, skills, attitude, and practice (Radhakrishna & Bowen, 2010; Bennett, 1975). The project used a combination of metrics (to identify evidence of scale), surveys (to explore opinions and perceptions) and case-based narratives (to understand contextual issues and highlight unique examples) (Penfield, Baker, Scoble & Wykes, 2014; Leith & Vanclay, 2017). It explored and validated outcomes and impacts from use of the app. The concept of impact pathways (Douthwaite, Alvarez, Thiele, & Mackay, 2008) formed a framework for analysis and reporting of outcomes.

Data was collected from one on one interviews, an online survey, and app analytics. It is not intended to provide a comprehensive assessment of the entire

or any representative population of CliMate users, rather it sought to seek opinion from farmers, advisors, and scientists from major areas of use throughout Australia. Appendix 11.2 maps evaluation participants (interview, case studies and online survey) according to their state-based location.

Data sources included:

- (i) Online survey of users

A link to an online survey was developed and sent to approximately 1200 users following pilot testing with agribusiness and farmer representatives. Those who chose to complete the online survey (Respondents [n=97]) were therefore self-selected and they self-reported their use of the CliMate app.

Ninety-seven CliMate users from across Australia responded to the online survey. The range of industries is shown in Figure 2.1 and includes grains, beef, advisory, sheep and wool and government. Further industry and occupation analysis of respondents is provided on survey respondents in Appendix 11.3.

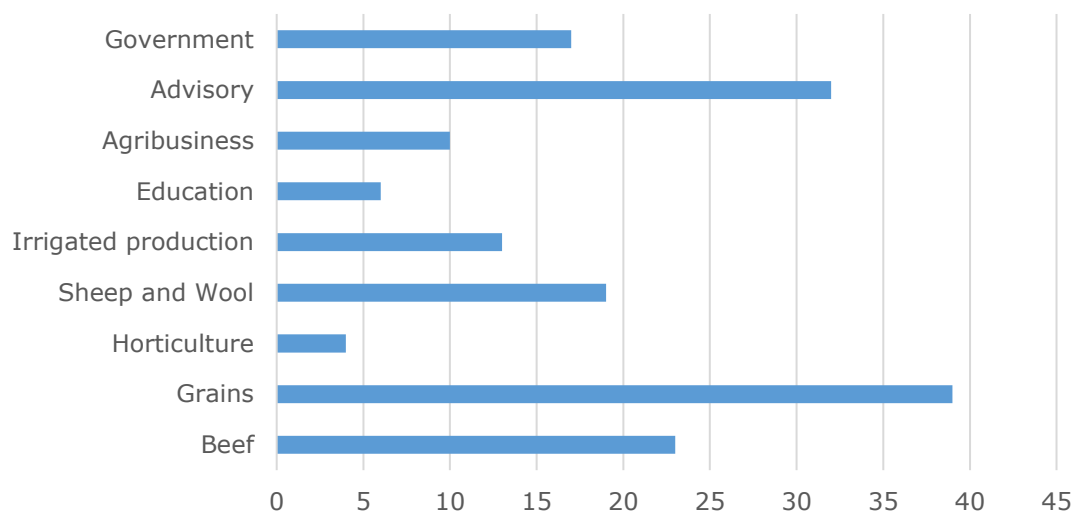


Figure 2.1 Survey respondents - Industries (number) (n=97)

Eleven percent of survey respondents were involved in other industries including Research, Household, Social, General, Sugar cane, Viticulture, Agricultural services, Mining, and Pest animal control.

The online survey was entirely voluntary and anonymous. No personal data on age, gender or nationality was collected. There were 24 question items in the survey with questions on respondents’ reasons for using CliMate app, value of the app calculations, frequency of use, barriers to use, usability, devices and connectivity, outcomes and benefits from using the app, industry and role. Question types ranged included multiple choice, category selection, 4 and 5 point Likert type scales (Allen & Seaman, 2007) and open-ended responses. Data analysis included descriptive statistical analysis, frequency counts, as well as cross-tabulation of findings based on user industry or role. Visual representation of open-ended survey responses are presented as word clouds depicting the main text-based categories of responses in proportion with word size.

Anonymous quotes from survey respondents are included in the report but not attributed.

(ii) In-depth interviews with app users.

Following pilot testing, in-depth interviews were held with a purposively selected sample of 34 users from across Australia to represent farming, agribusiness, science and insurance sectors, and a range of locations. This sample of users however, was not intended to be fully representative of all CliMate app users in terms of location, industry, or demographic factors.

Following an introductory email from developers to all users about the study, potential participants (who ranged from avid to novice and some non-users) were contacted by email inviting them to participate in an interview. Many users who were initially contacted did not respond. Those who did formed the sample of participants in the interviews. Interviews were recorded and transcripts produced and analysed.

Interview participants were asked to describe how they use the CliMate app in their role. Qualitative iterative analysis of interview transcripts investigated participants' use of and attitudes to the app, ensuring that findings were strongly grounded in the data (Corbin & Corbin 1990; Corbin, Strauss & Strauss, 2014) and considerate of user contexts. Categories were identified from within the data and explored to allow a depth of description. Anonymous quotes from interviews are presented and attributed to participant's role and location.

(iii) Collation of app analytics

Collation and description of use statistics available from the system itself. These included data on users and on their use of the various App queries. Initial data on CliMate app users, their industries and roles is presented in Appendix 11.4.

The project operated in accordance with and approved by University of Southern Queensland Ethics Guidelines.

(iv) Case studies

Seventeen participants were chosen as case studies. These descriptive case studies (Yin, 2017) strengthen understandings of the use of the app through additional illustration of its application in each individual context. These cases are presented in Appendix 11.6.

3 CliMate – Adoption, value and barriers

3.1 How CliMate is used

3.1.1 All users

An overview of the range of activities undertaken using the CliMate app is provided in Figure 3.1. Survey respondents indicated that they mostly used the CliMate app to monitor seasonal progress (79% of survey respondents), compare a number of years (69% of survey respondents), explore likely future

conditions (55% of survey respondents), understand and manage climate-based risks (46% of survey respondents), and to better understand weather conditions (46% of survey respondents).

Survey responses indicated strong support for the CliMate app:

I think it was fantastic that the website and app has been made. Has made accessing the data so much easier.

Great app - keep it up.

Great app love it I'm sure the more I use it the better decisions I will make in time.

I appreciate CliMate very much and am happy to speak to you at any time.

Outstanding product and needs to be actively promoted to primary producers....Overall, excellent work!

Interview respondents explained how the app is contributing to building confidence in farm-based decision-making and supporting related discussions:

(CliMate) gives you confidence with decisions you make or you know the compromises. You are going to take on risk, doesn't matter what you do in farming. It's just a matter of being aware of likely outcomes. Agronomist, VIC

CliMate is a handy tool, I can pull out the past, forecast the future based on the past, start a discussion based on the past, have a discussion. Just having rainfall (data), having an idea of how likely a certain rainfall event – may need 40 mm rainfall to plant, can have a discussion with a grower that it might be only 30% chance of that happening. Agronomist, NSW

CliMate is something I refer to (as) a decision making tool...(It) backs up what we're probably thinking a lot of the time. It's good to have it in a chart or a graph – to firm up what we are thinking and what historically has happened in the visual form. I (use it) for the likelihood sort of thing. How's the Season – what's the likelihood of getting x amount of rain between this period and that period. So ... when you are making some of these decisions it just puts it down in front of you in terms of what has happened previously... Mainly for me it's later in the growing season - looking at the possibility of different outcomes in the finish. There's not a lot you can vary up front. Grain grower, WA

Participants though were quick to identify that CliMate output is only information and that it is about something as unpredictable as weather - so it cannot be relied upon:

CliMate information is handy but I'm not going to rely on it. Forecasting is not an accurate thing so (we) take it with a grain of salt. Agronomist, NSW

The following sections outline advisors and farmers use of the CliMate app and its analysis. Information on other sector's (Scientists, Educators, Other) use of the CliMate app is included in Appendix 11.5.

Q1 I use the CliMate App to help with: (please select all that apply)

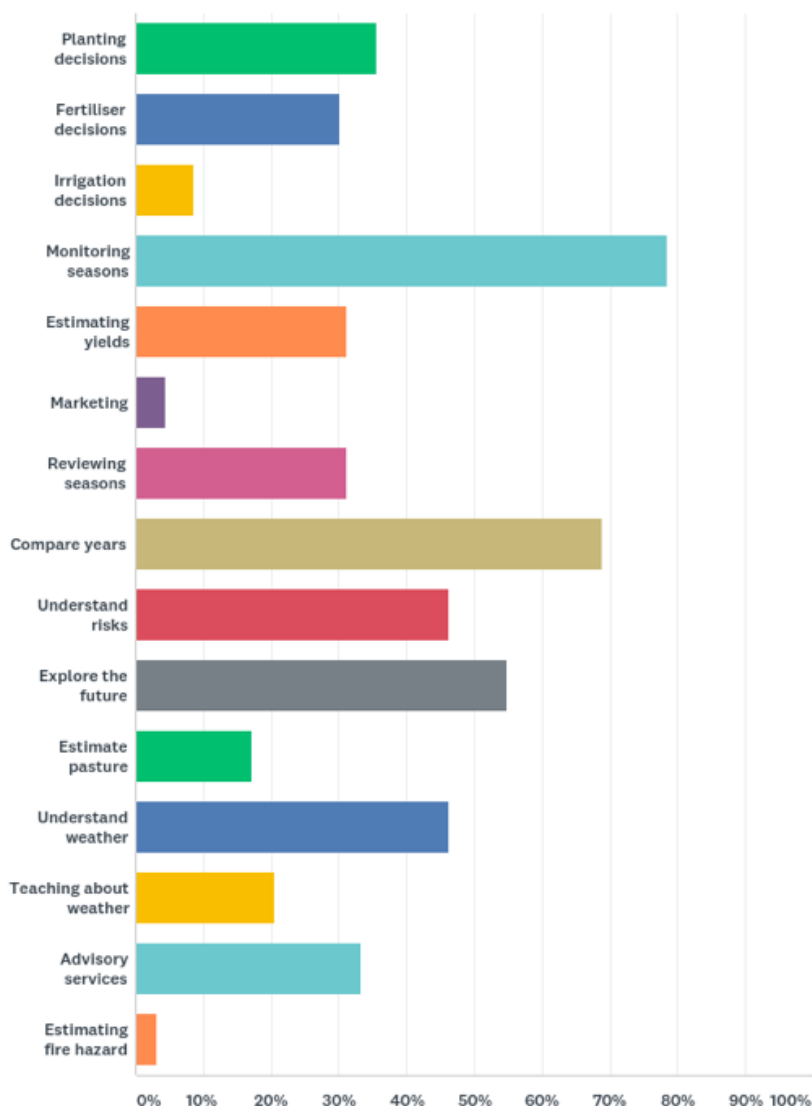


Figure 3.1 Areas of application and use of CliMate app in agricultural decision making (%) (n=97)

3.1.2 Advisors – use of CliMate app

The major areas of focus for advisors was largely to monitor seasonal progress, compare a number of years and explore future possibilities with regards to the current season (Figure 3.2).

Comments

The following advisor comments indicate that the app is contributing evidence to support risk-management discussions in planning and decision making.

Use it to show growers where we are in the season compared to average, then make decisions off that to what the outcome could be.

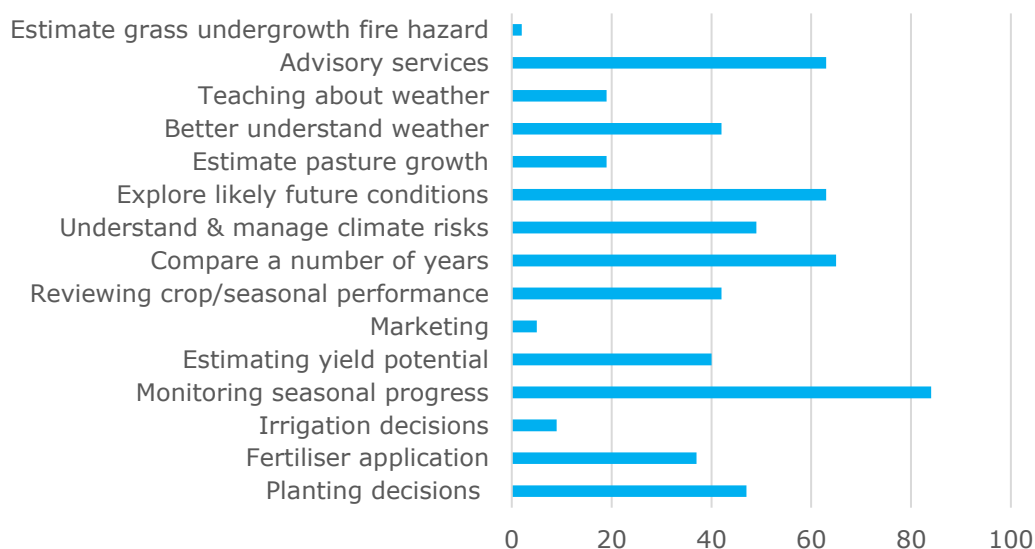


Figure 3.2 Advisors - Reasons for using CliMate app (%) (n=43).

Comparing seasons, estimate stored soil moisture, improve season predictably in conjunction with the French Schultz theory.

Has helped monitor the current season's rainfall and contributed to management decisions based on current situation and seasonal forecast.

Understanding where the real climate risks are in our region.

Helps add another string to the bow when it comes to yield estimates. Also good to help plan how much N to pump into the crop depending on potential.

As an agronomist my main use for it, is as a discussion tool with clients when making seasonal plans and to review seasonal performance. I also use it to determine medium term (2 weeks to 3 months) future potential operations such as topdressing crops, making planting decisions etc.

I use my own spreadsheet tools but it gives a useful quick summary allowing me to quickly and efficiently assess probabilities. This assists me in providing evidence based advice to my clients and supports my production modelling.

Can look at different localities weather data, and gives me more information to advise on cropping plans.

Has helped monitor the current seasons' rainfall and contributed to management decisions based on current situation and seasonal forecast.

Broader understanding of actual season progress across client base.

It shows the historical data and current data quickly and in an easy to present manner. Great for presentations.

A word frequency representation of the main reasons provided by Advisors for using the CliMate app is provided in Figure 3.3, showing a focus on 'understanding' and including 'reviewing' weather and climate data and risk in their advisory and planning roles.

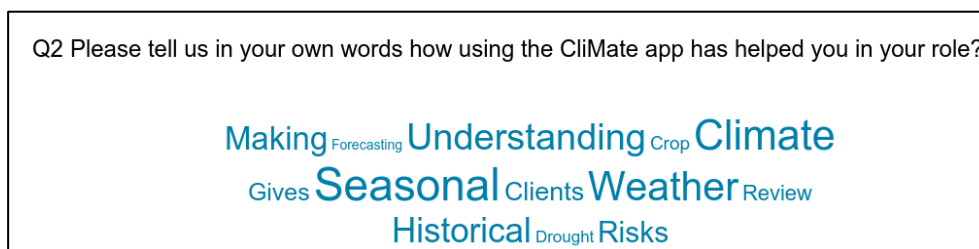


Figure 3.3 Word cloud for advisors - relative frequency of word mentions in user responses about CliMate.

Advisor survey respondents were using the CliMate app largely to explain seasonal outcomes (62%) and to update their skills incorporating weather-based risks into their advice (64%) (Table 3.1). Fifty-eight percent of advisors were identifying the range of future weather possibilities for clients. Forty-six percent of advisors were establishing example scenarios using the app for the various locations they were working in – order to demonstrate or quantify risks associated with possible future weather conditions.

Table 3.1 Advisors – reasons for using the CliMate app (n=42).

CliMate app Activity	Percentage of advisor respondents
Identify future weather possibilities and quantify risks for clients' actual scenarios	58
Establish EXAMPLE scenarios for locations to demonstrate and quantify seasonal risks	46
Explain seasonal outcomes based on weather data	62
Update my skills in incorporating weather-based risks in my advice	64
Create and share location-based CliMate analyses with clients	24
Distribute example CliMate app output through email, social media, presentations	30

Advisors were sharing CliMate app information in presentations, email or via social media (30%). Almost one quarter of all advisor respondents were sharing location-based CliMate app output, some using screenshots.

3.1.3 Farmers – use of CliMate app

Farmer respondents indicated their reasons for using the CliMate app were also based on monitoring seasonal progress, comparing a number of years, exploring likely future conditions and better understanding weather. Understanding and managing climate risks were highlighted; planting and fertiliser decisions were identified as a focus (Figure 3.4). Farmer comments (survey) are listed.

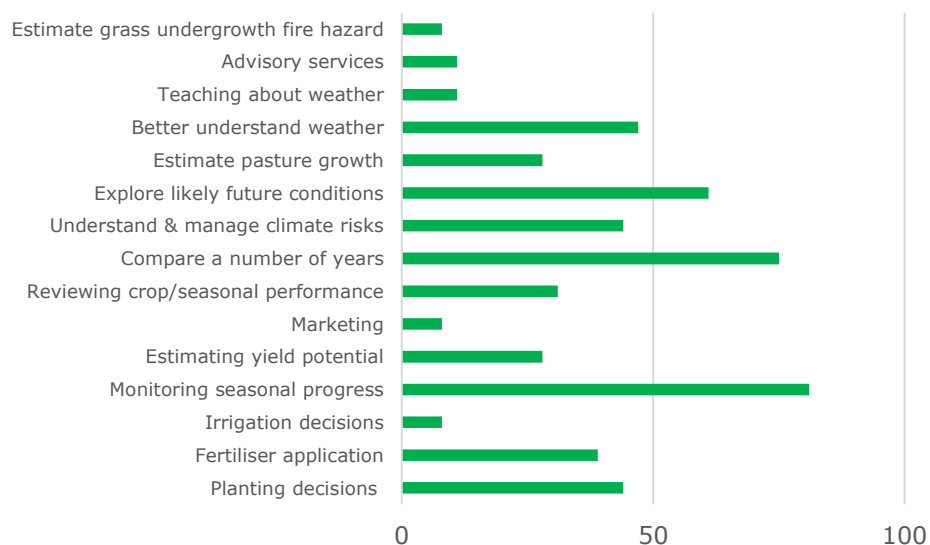


Figure 3.4 Farmers - Reasons for using CliMate app (%) (n=36)

Comments

Estimating chances of rain for planting; rainfall for August for nitrogen decisions; risk of frost and heat in crop.

It along with many other forecast models help to define seasonal forecast prediction and we use these as a guide for fertiliser applications.

I use the historical data to find patterns over a number of years, to estimate the risk of big rain events or dry periods! It seems, the longer the dry period...the bigger the rainfall event.

It's a very intuitive app. Capable of performing analysis much quicker than excel in order to take emotion out of climatic decisions on farm.

I think summer subsoil moisture is critical in determining future cattle selling strategies. i.e. do we hold weaners over winter to sell as yearling?

To help make seasonal decisions around grapevine canopy management.

Helps determine climate risk for placing crops in different geographies.

Understanding seasons' progress and relating to other seasons very useful. Also for comparing different sites (locations) under management.

(The CliMate app) gives me the ability to plan more, reseeding paddocks, stocking and so on.

Gives me rainfall probabilities for decision making.

When looking at buying land in other areas trying to get a reliable rainfall history.

Soundly based, structured tool to quickly get a perspective to assist decision making and general monitoring.

Become more aware of the shift and trends in climate of a period of time.

Provides a little more insight and helps build confidence around decision making.

Very useful for 12 month rolling rainfall totals and likelihood of future rainfall.

Farmer respondents indicated their reasons for using the CliMate app had a strong focus on its use in 'decision making' (Figure 3.5).

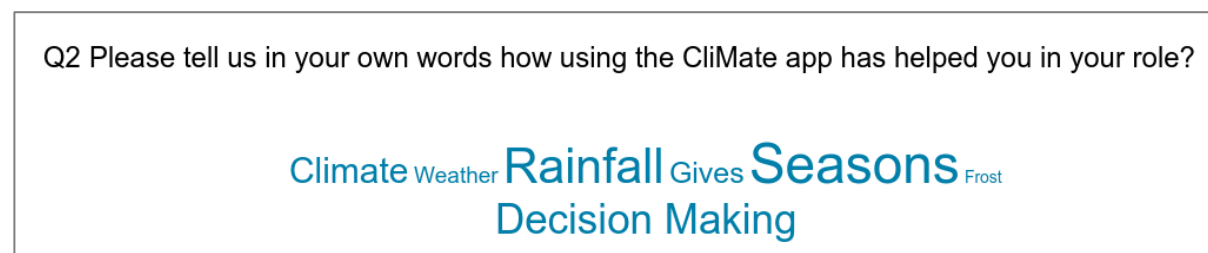


Figure 3.5 Word cloud for farmers - frequency of word mentions in user responses in survey

Additional data on the reasons for using CliMate by other sectors (educators, scientists and other respondents) is included for reference in Appendix 11.5.

3.2 Value of CliMate analyses

The range of analyses in the CliMate app were mostly highly valued by users. Data is presented for Advisors and Farmers.

3.2.1 Advisors – Value of CliMate app analyses

Figure 3.6 indicates that advisor respondents identified that most of the CliMate apps were 'Useful' or 'Very Useful'.

How's the Season (70% of advisors indicated this was 'Very Useful') and How Likely (65% indicated 'Very Useful') are the most valued calculations according to the advisor respondents.

How's the Past (58% of advisors indicated 'Very Useful') and How Often (51% of advisors) were also highly valued.

Advisors' least valued CliMate app was Potential Yield with only 25% of advisors indicating it as 'Very Useful' and 24% indicating it as 'Useful'. Seventeen percent of advisors indicated this tool was 'Of No Use' and 26% indicated 'Of some use'. A low percentage of advisor respondents (ranging from 0 to 7%) indicated they 'Don't know' about particular CliMate apps.

Comments on individual apps are presented in section 5.1.

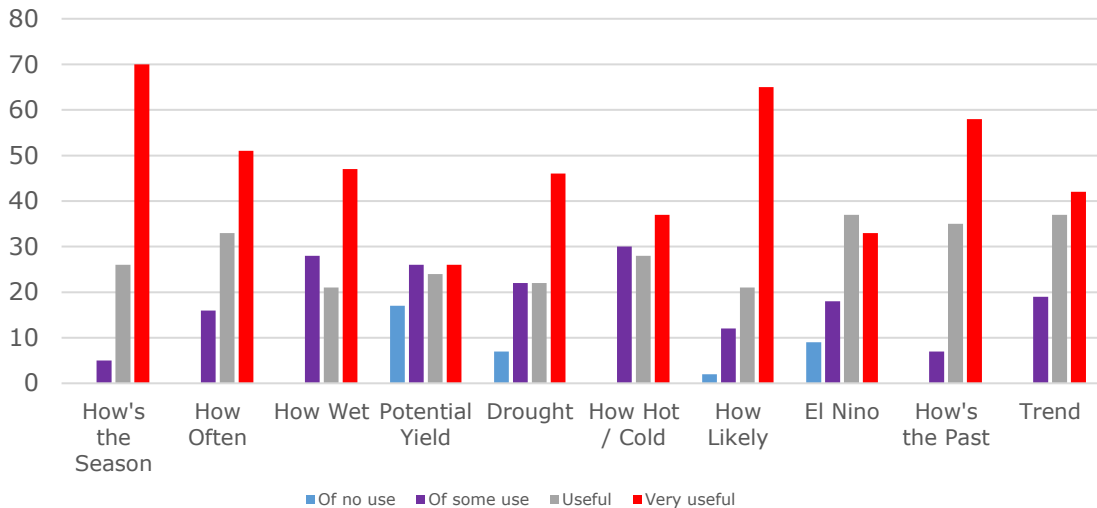


Figure 3.6 Advisors - Value of CliMate app calculations (n=44) (%)

3.2.2 Farmers – Value of CliMate app calculations

Figure 3.7 shows that How Likely (58% found this 'Very Useful'), How's the Season (53% found this 'Very Useful'), How Often (50% found this 'Very Useful') and How's the Past (42% found this 'Very Useful') were the most valued CliMate apps for farmers. This indicates that farmers surveyed are using the app to look forward and identify probabilities and risks of weather possibilities, not just viewing the season's progress.

When positive response data (combined percentages of 'Of some use', 'Useful' and 'Very Useful') were combined, most farmer users fell into this category. The exception were 19% of farmer respondents found Potential Yield 'Of no use', 14% found El Nino 'Of no use', and 11% found Drought 'Of no use'. Further information on individual calculations is in section 5.1.

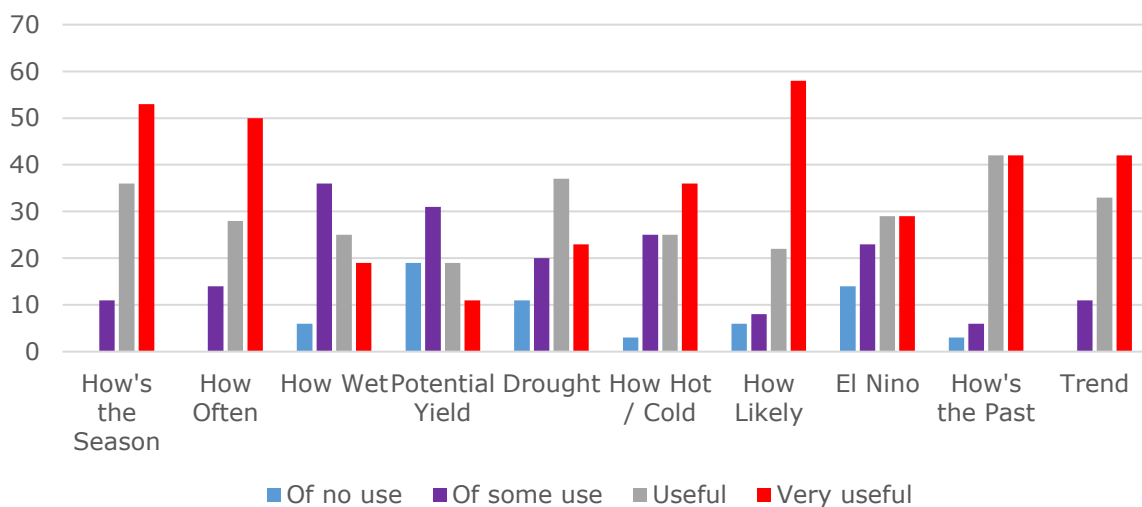


Figure 3.7 Farmers – Value of CliMate app calculations (n=36) (%)

3.3 Barriers to use of CliMate app

Although participants in this evaluation were mostly CliMate users, a small number had never used (or heard of) the app, and some had previously used Version 1. Survey respondents were all registered users of the app. They indicated that the main reason they had not used some app calculations was that they had not looked at them. Five users suggested they did not understand How Wet / N. Six respondents suggested they did not trust Potential Yield app and seven respondents indicated a lack of trust with the How's El Nino calculation. These findings (Table 3.2) were supported in interviews.

Table 3.2 Respondents who had not used Climate analyses indicated reasons for non-use.

Calculation	Have not looked	Insufficient Information	Lack of time	Don't trust	Don't understand	No examples
How's the Season	****	**	**		**	*
How Often	*****	**	**		*	*
How Wet / N	***** *****	*	**	**	*****	
Potential Yield	***** ***** ***** ****	*****	**	*****	**	*
Drought	***** ***** *****	***	***	*	*	
How Hot / Cold	*****	*	****	**	***	*
How Likely	*****	*	***	**	*	*
How's El Nino	***** *****	*	***	***** **	**	
How's the Past	***	**	****		*	*
Trend	***** ***** **	**	****	***	*	*

(n=97) (*=number of respondents)

Comments

I got on there a few times. It gives you more information that's already happened, I've found that as far as a useful tool going forward it's a bit limited....It's only information....You don't base all your decision on it and if you did you wouldn't grow a crop some years. Grain grower, VIC

We don't get too worried about some of the funky features – soil moisture. As good as they may be, there's too many variables that can skew the data..... We don't use it for any futuristic stuff. Insurance industry representative (national)

..I haven't even opened (some of the calculators) I'm not interested in. Just get rid of (some of the calculations). I don't use (them). (They've) complicated it. Scientists...work all that stuff out but practical reality let the farmers do that.

CliMate is a beautiful, graphical interface. This participant suggests that the app should only include actual, historical data rather than predictive functions.
Farmer, NSW

..I use DAFWA weather app. A lot of consultants and a lot of our growers use it.
Extension Officer, WA

I've switched over to soilwaterapp. I used the DAFWA system, we have a network of weather stations and we can go into the site and download the monthly averages. Scientist, WA.

4 Use of CliMate and outcomes

4.1 Example user cases

A selection of examples from CliMate users (interview and survey data) is presented in Appendix 11.6. This demonstrates a range of applications within a variety of industries and locations. The tool is being used as a decision making and discussion tool in relation to planting and frost management, nitrogen application management, radiation, crop monitoring and review, fungicide spray decisions and residual herbicide management, drought management planning, feed needs and livestock sale decisions, and property purchase decisions. The examples also include insurance product pricing, education and decision support for bankers, seasonal monitoring and presentations within the mining industry, agribusiness and agricultural research planning and presentations. The app is also being used for calibrating seasons and locations within horticulture, irrigation decisions within the grains, wine and sugar cane industries, estimating harvest dates in horticulture, and matching flowering timing for seed production. These examples are only a very small subset of the entire users. They indicate that users are developing their own specific uses for CliMate analyses and data.

4.2 Outcomes and impacts

Analysis of interview qualitative responses identified that use of the CliMate app had contributed to various impacts for users and these were validated from survey data. These included four areas of impact: (a) capacities and knowledge, (b) processes and management practices, (c) communication and engagement and (d) overall impacts. These impacts are presented and supported with survey and interview data.

4.2.1 Contribution to Capacities and knowledge

Use of the CliMate app had contributed to improving the following user capacities:

Enabled easier access to locally-relevant and simpler, historical weather data.

Enhanced ability to incorporate historical climate information into decisions and advisory processes and services.

CliMate app users reported that the simple presentation and format of historical data had enhanced their ability to monitor weather data, review past seasons, and compare current with past seasons.

Forty six percent of all respondents indicated that the CliMate app had enhanced their ability to monitor climate (31% indicated 'somewhat' and 20% indicated 'a little'). Only two percent of respondents disagreed (Figure 4.1).

Improved climate monitoring

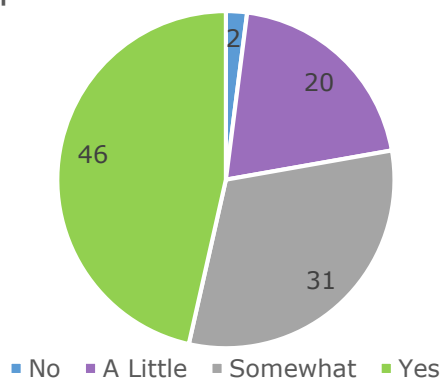


Figure 4.1 CliMate enhanced capacity for better climate monitoring (%) (n=93)

Comments

To a degree. It's one of the tools. That is the idea – have some historical evidence at our fingertips. That's what I like about this. There's a whole heap of good data behind it which is easy to extract and use. I like it because it just saves me mucking around with spreadsheets with years and years of data. Grain grower, WA

Gut feels good but may not be correct. It's good to be able to say, the risk of that is probably fairly minimal. If we say we're sowing our wheat on 20 April but we've got the variety to fit that window. Being able to say, probably to an older generation of farmer that we're pretty right, we know when it's going to flower. The risk of a frost that time of the year is pretty minimal. It's not to say that there is no risk, but maybe if you go back through the data, maybe there's been one or two frosts in the period you've been farming. Agronomist, VIC

(I) just keep going back and having a look (at CliMate through the season). Grain grower, SA

From time to time, I look at CliMate ... to see where I am. Agronomist, QLD

CliMate users reported improved knowledge and understanding about seasons, weather-related risks and crop responses:

Improved knowledge - The CliMate app assisted users to have improved knowledge of individual seasons in relation to historical weather data for their location, and of the chances and range of possible future weather scenarios.

Better understand risks - The CliMate app helped users to better understand the extent of risks and possible future scenarios for crops in a particular location due to weather conditions; and then assess the feasibility of management options.

Understand crop responses - CliMate is assisting users to improve their understanding of the extent of crop and soil responses on their farms, in relation to specific weather statistics.

Survey respondents believed that using the CliMate app had improved their understanding of climate impacts on their business or decisions. Thirty-eight percent of respondents indicated 'yes' and 30% indicated 'somewhat'. Forty-three percent of advisors indicated 'yes' and 36% indicated 'somewhat'. The app had slightly less impact on farmers in this regard – 33% of farmers indicated 'yes' and 33% indicated 'somewhat' (Figure 4.2).

Participants described how as a resource, the Climate app helped improve their understanding of weather impacts on their decisions:

...the confidence. Because it is an intensive trial site there is much measured, there is expectation that I know at any point in time soil water Researcher, QLD

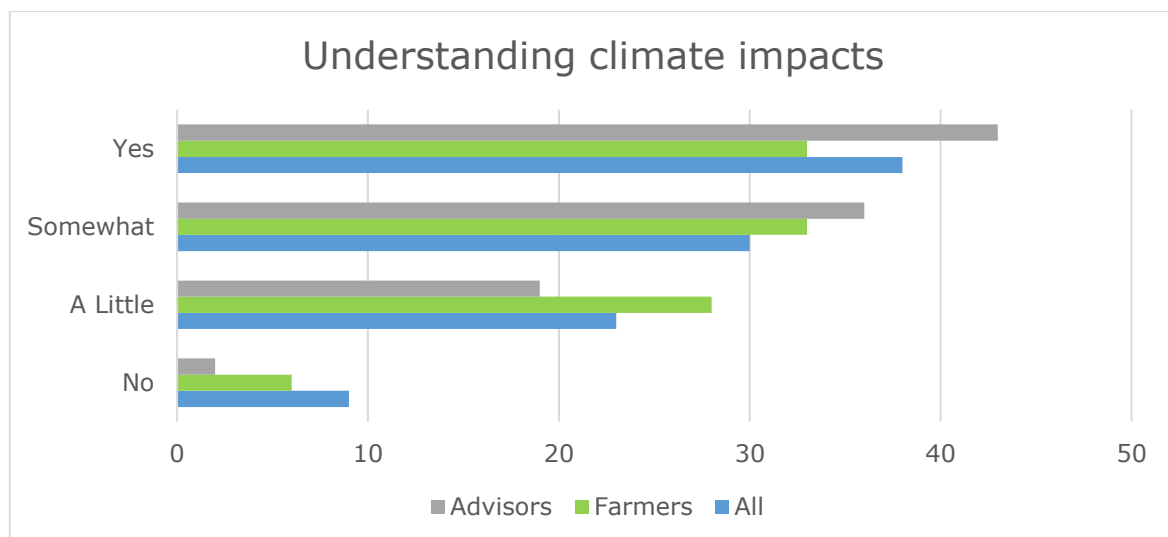


Figure 4.2 CliMate app improved understanding of climate impacts (%) (n=97)

I like looking at how the seasons progressing, following potential trends and help explain some of the things seeing in the paddock as far as temperatures. Advisor, QLD

I like to look at radiation – just to explain things in the paddock – mainly for grain. Last season we were sitting on the lowest sunlight we’d had for quite a while, that we could remember and it matched up with the radiation data too. It was good to be able to explain things in the paddock and why crops were doing what they were doing at a particular time. Advisor VIC

Can look at different localities weather data, and gives me more information to advise on cropping Plans, many farmers do not have the time or understanding

about weather forecasting tools; as such CliMate helps me to make farmers aware of the potential risks associated with rainfall.

4.2.2 Changes to processes and management practices

The following areas summarise the contribution that use of the CliMate app had made to processes and management within agricultural businesses.

Compare seasons - Users of the CliMate app were easily and accurately comparing the current season with previous seasons for their location, and incorporating this in decision making and review.

One of the most common activities with the CliMate app is to compare current seasons with previous seasons. Eighty percent of all survey respondents were using the app for this purpose (86% of advisors and 83% of farmers), along with approximately 8% - 'somewhat' (Figure 4.3).

Comments

Its number one a risk management tool for me. Trying to mitigate/manage risk, even crop rotation choice. Another thing probably use (CliMate) for looking forward rather than looking back. I'm part way through the growing season... The crop might need another 60 mm of rain over the next couple of months. What is the likelihood of receiving that rainfall? What other years did we not or did we get that rain. I won't say it's predictive but I'm trying to get a feel of what sort of situation we're in, what likelihood there is. Farmer, VIC

We use the CliMate app to collect current and historic rainfall data and to look at what the moisture levels are in the ground. We then use the results as part of our decision making process and pricing.. We work out our pricing partly based on the average rainfall for that area. If the actual rainfall is below or above average and if there's any significant changes from the average, that will all affect the decision making and pricing of our product for that area. Insurance Representative

It is always good to have access to historical data. I never throw out data...Certainly those rainfall charts are good too, if you are trying to compare it back to rainfall data over the year and seeing how things stacked moisture wise and when we had a September or years that were similar, these sorts of things where we check back things that have happened in the past.

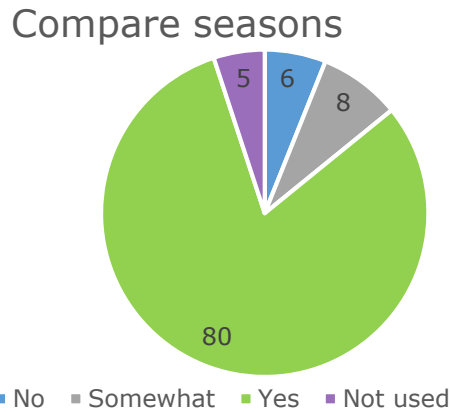


Figure 4.3 CliMate app is used to compare current with previous seasons (%) (n=95)

We use it in its raw form as part of our research. We found it is the single best tool that we have available to use for just measuring the status of rainfall in any area of Australia....

Its current relative to the past – gives you a bit of an indication of what the season might end up. You are really looking at it relative from an average point in time. Relative to other years at that point in time.

Best advantage is that it already does the mathematics of where the season is at any day relative to the average. That's what we like... There's nothing that quite tabulates it the way CliMate does it. You can do it manually but it's across most of the base work for you. It's an important part of our business. Insurance Representative, National

The CliMate app is being used to review the season and explain crop or pasture outcomes. Advisors were more likely to do this (76% indicated 'yes' and 19% indicated 'somewhat'). Fifty percent of farmer respondents used the app to review the season (and 31% of farmer respondents indicated 'somewhat') (Figure 4.4).

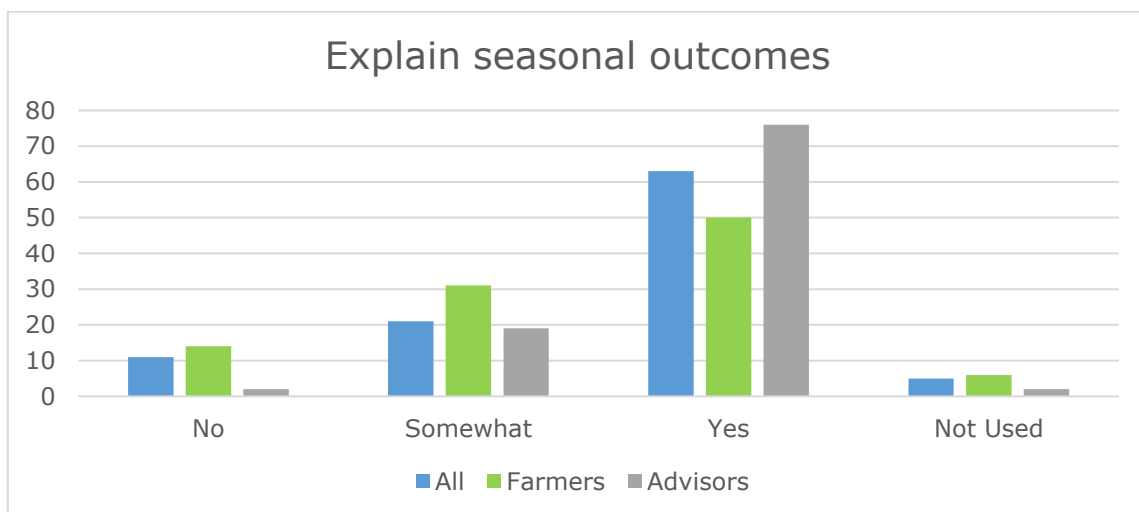


Figure 4.4 Use CliMate app to review the season and help explain the outcome (%) (n=95)

Comments

Last year...we were looking at heat sum graphs to be able to say what's the crop doing at this stage and why is it doing it at this stage because it was so warm in April and May and this is why crops are two weeks ahead of where they should be...Radiation last year sat at the bottom of the plume for sunlight. Agronomist, VIC

The CliMate app was being used to:

Quantify the chances of the range of possible weather scenarios for their location. Users are including this information in their business discussion, planning and decisions.

Explain cropping outcomes - CliMate users are using data to explain cropping outcomes and identify weather scenarios that may impact on production.

Comments

(I can) honestly say I don't think any two years are the same. I might say yes 8-9 years were a bit like this. Might be a little bit like 2011. It's more like - What are the chances of getting 80 mm over the rest of the year. If it comes back and says 24% I don't have a lot of confidence there. If it comes back and says 70-80% of years will get 80 mm for the rest of the season, I think that's good odds, I'm happy with that. That's sort of how I look at it. If you know your starting soil moisture, your sensitivity to risk is different from that point. If I know we've got heaps of soil moisture I'd be happy to take more of a chance based on what CliMate is telling me. But if I know we're getting by on the skin of our teeth, I'll have a look at CliMate and if it's not giving me not a lot of confidence, I've got two reasons to try and be pretty conservative with my selection. Farmer, VIC

This year my agronomist said we were looking at putting a second fungicide on barley. He said you could put fungicide on it. Should I or shouldn't I? I asked. He said - You should if it's going to be wet. Everyone's perception of the likelihood of it being wet are different, it's just another tool that gives you that bit of a hunch at what you think it might do as well as the weather forecast and all that you can look at previous years and the probability from now on. Farmer, SA

(I used CliMate to identify) what's the chances of getting 50 mm this winter - which is what we've had this year - 81% of years we'd get more than what we've had this year. Scientist, QLD

(The benefit of Climate is that it) just made it a lot easier simpler and quicker. You can run a whole lot of scenarios so quickly which makes it, you know you just develop a better picture. (I incorporate) data into budgets and look at extreme scenarios (working with consultant). Grain grower, QLD

Fifty-four percent of respondents indicated they consider the impact of weather more carefully in their decisions since using the CliMate app (28% - somewhat). Nine percent had not made any changes (Figure 4.5).

Consider weather data in decisions

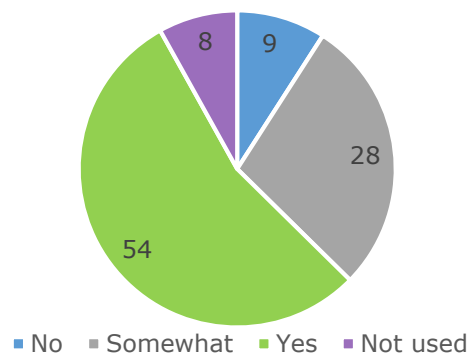


Figure 4.5 Consider weather data more in decisions since using CliMate (%) (n=97)

Improving advisory services - CliMate app has contributed to improving agribusiness advisory services.

Comments

If you look at last year, how the chickpeas were progressing flowering, nothing flowered until temperature hit 15 degrees can track those trends. 2014 didn't get any rain until March, just being able to use the app to show the seasons' progressed - showed fallow soil water efficiencies and potential nitrate mineralisation based on the summer as well. Just handy to show how it generally trends with the season. Agronomist, NSW

With growers talking about the season. I PARTICULARLY like comparing the seasons, all seasons, tracking this year's rainfall vs other seasons rainfall and have a quick snapshot of how this year compares with maybe 3-5 other seasons. It's pretty handy.

Used those just to check on our frost risk but probably used those more just to check on our periods for flowering and heat stress and relate that back to growers. Really just chances. What's the risk?

Some advisers acknowledged that actual risk (probability) data from the CliMate app did not have the major impact on decision making, but rather was only one factor:

We try and make the best decision on the day and try and move forward. It's only one part of the decision process. Not going to hold - because of Climate statistic. Advisor, QLD

In this environment we make a lot of our decisions based on the soil water rather than the forecast at that point. The soil water is determining most of our decisions. Advisor, NSW

Agricultural research and development - CliMate app has contributed to facilitating agricultural research planning, processes and communications.

Couple of hundred agronomists would have seen CliMate screenshots at various presentations over last few years. If there is a story to tell about soil water and it has implication from that long term trial, I am forever taking screen shots and

saving as a photo at particular times with intent to use in presentations if the story allows. I intend to continue to use it. Researcher, QLD

Use it to tweet about it regularly – I’m advertising it all the time. People ask where did you get that information from. Consultant, WA

CliMate – pretty well just frost risk – it’s the only decisions (we’ve made based on CliMate) Development Officer, QLD

From a research point of view...I’ve found it a predictive and scenario planning tool, it is good, but retrospectively. Researcher, QLD

Data? I used the frost risk thing in a presentation for time of sowing to agronomists and growers at GRDC updates. It’s a good visual tool to see where we should be and I overlaid our yield on top of that and it looked really pretty. Scientist, QLD

Business process and communications - The CliMate app has contributed to facilitating other business research planning, processes and communications.

Provided an education for the client team. A reference point. Justification for lending decisions. ... Was mainly wetter seasons then and showed full profile or not full and was able to indicate to the team that this area required around 75 mm of rain in order to plant (looking at it from cash flow perspective rather than new lending). Banker NSW

CliMate is the location we go to to get the rainfall data. I’ve built our business around telling everyone we use CliMate data. We don’t go to BoM, we don’t go to SILO we go to CliMate version of SILO. It’s easy, you know and now there’s 100 years of history....We wouldn’t have developed our risk assessment approach if (CliMate) didn’t exist. It’s a very significant ingredient in (our business). It is an important as flour in bread...That’s how important it is for us. You won’t find a bigger advocate than us in Australia.... I’ve learnt a lot through my association with CliMate. Insurance Representative, National

4.2.3 Communication and engagement

Enhanced communication on farms - CliMate data has enhanced communication, learning and decision making within farming businesses.

Interview data indicated that farmer users were communicating within their farming business using CliMate data to help explain and justify approaches to other business members.

Comments

The agronomist looks at it (CliMate), and we talk about the probably of rain events coming in the future. I’ll tell Dad what I find and he tells me what he finds. Grain grower, SA

We’ve been here since 100 years in 2010. It was also the driest year we’d had on record going back to 1913 or 1912. That got me started to look at rainfall totals and timing of rainfall and I was just looking at the trend over that period

and trying to work out if 2010 is something we should expect to have more of or less of or whatever. Farmer, WA (This farmer used CliMate for many family and friends' locations to monitor their weather data).

Level of discussion (with farmers) goes up a level (with CliMate data) Scientist, SA

'Gut feel (about risk)... may not be correct. It's good to be able to say (e.g. to an older generation farmer)...we're sowing our wheat on 20 April but we've got the variety to fit that window...we know when it's going to flower. The risk of a frost that time of the year is pretty minimal'. Agronomist, VIC

Advisor-Client communications - CliMate data has enhanced communications between advisors and clients and contributed to enhanced collaborative decision making.

CliMate use appeared to enhance advisor learning and the ability of advisors to communicate with their clients for improving understanding and decision making:

Just confidence to be able to say the risk of getting a frost in this window. Having something like CliMate to say here's your frost risk at the end of the year, it matches up with the varieties we grow and the ideal sowing times...(I incorporate CliMate data (e.g. 60 % probability) into the reports. I sometimes send the deciles screenshot through along with it. Agronomist, VIC

It's more just about having a conversation with the growers. I just think the accuracy of all this is not good enough to base decisions on it.... General discussions about season outlooks, 3 monthly outlooks. Nothing specific. If a grower meeting, I might pull specifics out about how the season's progressed and have a discussion about that. Agronomist, QLD

Helping the discussion – absolutely having the data, a figure to show. Agronomist, NSW

My agronomist talks to me about the probability of getting a planting rain by December. They send me the printouts. Farmer, NSW

(If I was going to a field day) I would collect data around their location, (in order to) give a presentation...During the season, (I compile and send out) a newsletter (using our own weather tools)...but it's good to know (I can) look at CliMate... I will use (What Trend, Potential Yield, and How Wet) I might snip a graph out and use in my newsletter. If we want additional information, I might put a link to CliMate for further information. Extension Officer, WA

Farmer group engagement - CliMate data has enhanced local farmer group engagement through the provision of easily accessible, locally-relevant historical weather data assessments.

Comments

Our local agronomy group, our agronomist, he uses CliMate quite often. We've got a meeting next week, he'll put it up and say our rainfall to date has been such and such, soil water is such and such. Then we have our next meeting in

June, once we've put the crop in, he will sit there again and decide will nitrogen be useful or not. Other people are using it. My private agronomist uses it too. We discuss it, where the seasons at and the likelihood of it continuing. Farmer, WA

Provides a discussion point about seasonal conditions and outlook with a group of farmers/graziers. Useful tool to discuss factors affecting climate.

Been sitting in a meeting and (someone) said we'd never get a planting opportunity for that time of year. (Visiting agronomist) punched it into CliMate and said 'Actually in 46% of years you would'. So in a few cases now we will look – at planting opportunities or within a window (using How Often). Development Officer, QLD

Agribusiness knowledge - CliMate app has enhanced agribusiness knowledge and education programs

At my previous bank (non-rural bank) where the credit team had no rural experience, we used CliMate to demonstrate to the team the season's progress so far, what moisture was in the soil and what range of possibilities the future might hold...(CliMate) enhanced my ability to communicate with this team and help to understand variations between regions – Ayr, Wagga and Moree. Banker, NSW

Knowledge is power... The more information you can get out of the website the better, for example, learning about potential yield or how wet...Management showed me areas I had not looked at yet and then we sat down and discovered other little useful areas. Insurance representative

I like looking at how the seasons progressing, following potential trends and help explain some of the things I'm seeing in the paddock as far as temperatures. Advisor, NSW

4.2.4 Overall impacts

The CliMate app has made contributions to rural businesses. Overall the impacts from use of the app are summarised in terms of the following survey respondents' data (Table 4.1).

Planning, decisions and advice

One quarter of survey respondents indicated that using the CliMate app had contributed to their planning with 32% indicating 'somewhat' and 26% indicating 'a little'. Fourteen percent indicated no contribution to planning.

Fifty five percent of advisors indicated that the CliMate app had enabled more informed decisions or advisory services (46% of all respondents supported this and 33% of farmer respondents). Most responses were positive. Eleven percent of responses indicated no benefit.

Similarly a larger percentage of advisors believed that using the CliMate app had improved their decisions or advisory services (52%) compared with all respondents (47%) and farmers (36%).

Table 4.1 Contribution of CliMate to planning, decisions and advice (%) (All = 93, Advisors = 42, Farmers = 36).

		No	A little	Somewhat	Yes
CliMate has improved business or production planning	All	14	26	32	27
	Advisors	12	21	45	21
	Farmers	6	36	31	28
CliMate enabled more informed decisions or advice	All	11	16	26	46
	Advisors	5	10	31	55
	Farmers	11	25	31	33
CliMate has improved your decisions or advice	All	8	22	23	47
	Advisors	2	17	29	52
	Farmers	6	33	25	36

Reliability of business operations

Most advisors (36% - yes and 48% - somewhat) indicated they could more reliably operate their business since using the CliMate app. To a lesser extent 31% of farmers (53% - somewhat) indicated similarly. Seven percent of agronomists and 11% of farmers did not record any impact of the CliMate app on their ability to reliably operate their business. Overall data is presented in Figure 4.6.

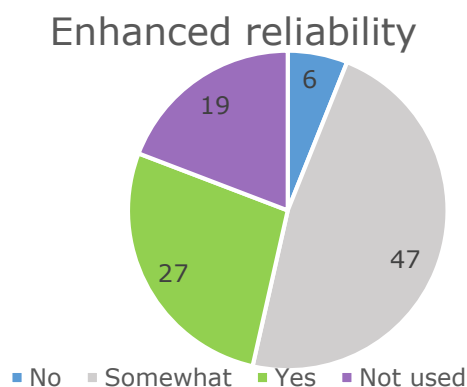


Figure 4.6 More reliably operate business with CliMate data (%) (n=97)

(CliMate has) just made it a lot easier simpler and quicker. You can run a whole lot of scenarios so quickly which makes it, you know you just develop a better picture. Grain grower Qld

Maximise production

Twenty-two percent of farmers believed the CliMate app had helped to maximise production. Half of advisors (and one third of farmers) believed the app had 'somewhat' helped. Approximately one third of all respondents did not believe

that the CliMate app had helped to actually maximise their production (32%). (Figure 4.7).

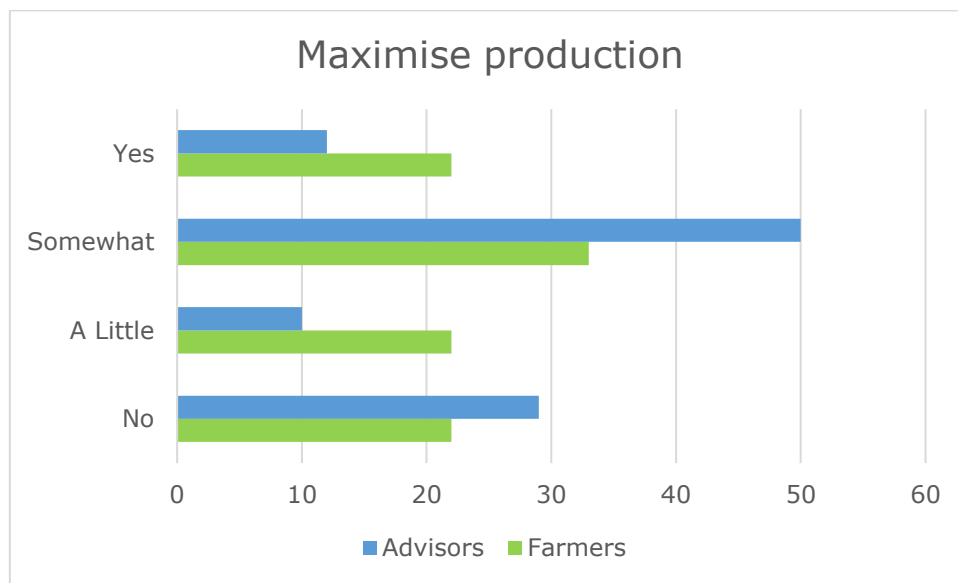


Figure 4.7 CliMate app has helped maximise production (%) (n=97)

Outcomes from using CliMate

Sixty-seven percent of advisors and fifty-three percent of farmers believed that using CliMate had contributed to positive outcomes for their business (7% of advisors and 8% of farmers strongly agreed). Very few respondents disagreed with this statement. Twenty-six percent of advisors and 36% of farmers declined to commit a response (Figure 4.8).

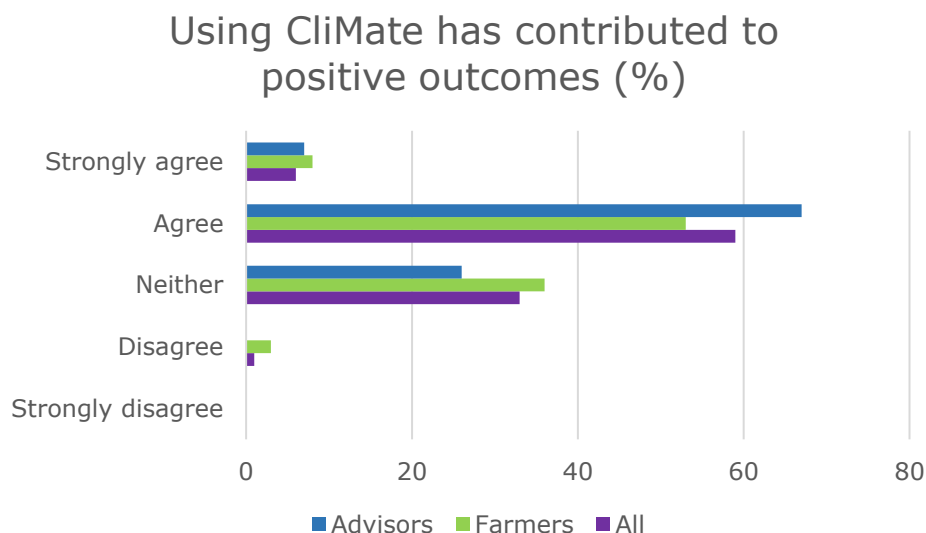


Figure 4.8 CliMate app has contributed to positive outcomes (n=97)

Business incomes

Thirty-six percent of farmer respondents (and 29% of advisors) indicated that their business income had improved by using CliMate. In addition, six percent of farmers and five percent of agronomists strongly agreed. A large proportion of

survey respondents (61% of all, 64% of advisors and 53% of farmers) declined to commit to a particular response to this question (Figure 4.9).

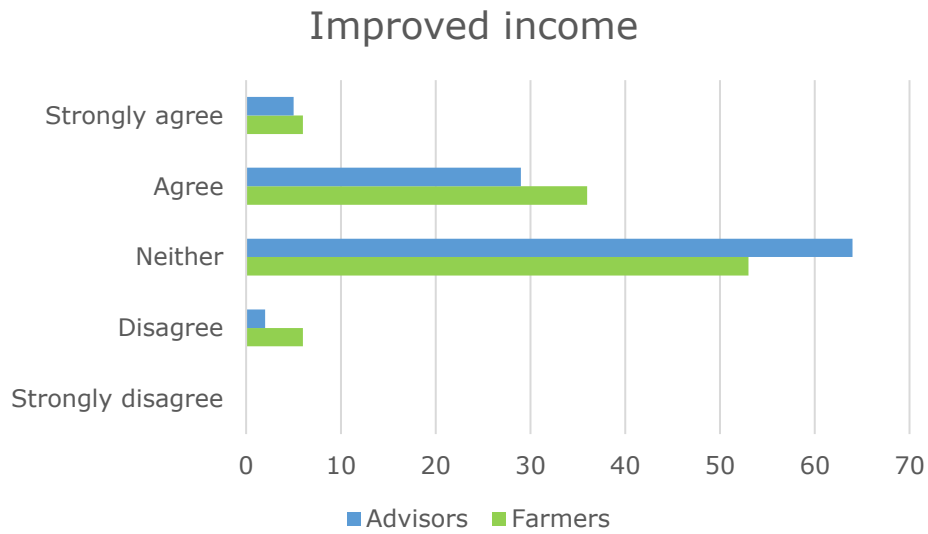


Figure 4.9 Income is improved by using CliMate (%) (n=97)

5 CliMate analyses and usability

5.1 Individual CliMate Analyses

This section reviews statistics and feedback on the ten applications (analyses) within CliMate, and explores a suite of operational factors within the app.

5.1.1 How's the season?

This is a very well-used and valued analysis to track current season with previous seasons. It is used throughout the year but appears to be especially in February and August months. Greater than 14,000 calculations have been undertaken over the last 6 months and 93% of user respondents found the analysis 'Very Useful' or 'Useful'. Growers are using the analyses to look at possible weather conditions from part way through the season, and also when conditions are poor. Advisors are using the analysis to keep in touch with seasonal progress at each of their client locations, and also as a (visual and comparative) base for discussions with clients. This analysis is also used by advisors and clients to review the season and explain outcomes.

(No negative feedback was received on this analysis).

Figure 5.1 demonstrates the statistics that are presented for each calculation in Appendix 11.7.

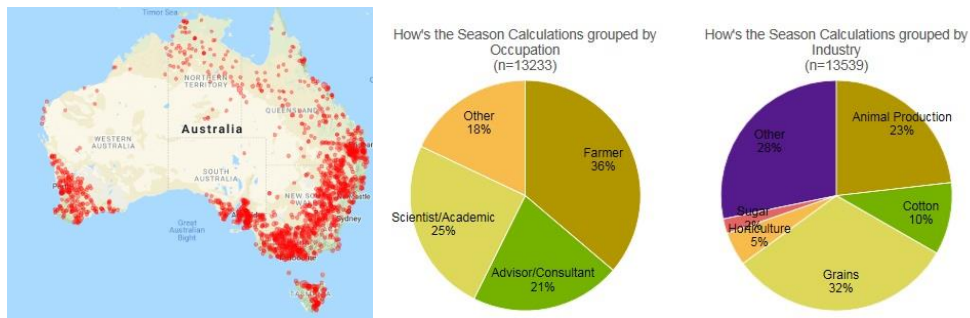


Figure 5.1 Example data available for each analyses (see Appendix 11.7 for detail)

Comments

How's the season – We started in the top decile for rain in the autumn, but by the end of this month we will be crossing over the bottom side of the average line again. That tells me the season started out fairly strong but with growing season rainfall we could end up well below average. Grain grower, VIC

The seasons' progress stuff is good, where we're tracking at currently and you always want to refer to historical stuff, (e.g.) 1956 was a dry year. Advisor, VIC

I start looking half way through the season when things are looking pretty grim.. just wondering what might happen for the rest of the reason. Grain grower, WA

5.1.2 How often?

This analysis is useful in providing statistical detail based on historical weather data for particular timeframes. It recorded 14,000 analyses over the last 6 months (similar to How's the Season) and over 80% of users found this analysis 'Very Useful' or 'Useful'.

There were some difficulties understanding the graphs in this analysis, and whether the data presented was averaged or actual data. Non-users suggested they had not looked at it, did not have time or there was a lack of information about using it.

Comments

I..use it to look forward a bit. (How Often have we had) X mm of rain over this period. Grain grower NSW

I (was) just looking at probability of how often we get a certain amount of rain in May or June... for planting; or looking at average amount of rain in August, for nitrogen decisions. And definitely frost and heat stress (in crop). Grain grower, WA

How often do we get 30 mm in October? Back in August, (I'll be) trying to get an understanding of what my confidence level should be to finish our crops. I think how often do we get say 60 mm of rainfall during the growing season? Grain grower, VIC

5.1.3 How wet / N?

There were over 4000 calculations of How Wet/Nitrate since Version 2, and 58% of respondents found this analysis 'Very Useful' or 'Useful'. There are a number of alternatives to using How Wet/N within the grains industry. Participants

indicated they used SoilWater App to estimate soil water and other tools were used in nitrogen estimations. Non-agricultural users (who may not be aware or familiar with SoilWater App) are happy to use this analysis. Some non-user participants suggested they did not understand the calculation, and had less trust in the estimation in the How Wet/N compared to the historical data available in the other analyses. Some participants were interested to check the output against other similar tools or measurements.

Comments

Typically we'd only get 1-3 summer rainfall events so you pretty much know what (soil water) you've got...I look at the accumulated N...between seeding through to 6-8 weeks to see what its telling me about the effect of summer rain - if we had a v wet summer and to look at what mineralisation had occurred. We might not change the seeding rate of nitrogen but maybe the top ups if there's not a huge amount in the system. Grain grower, WA

I have used the How Wet Nitrate to get a bit of a gauge of where the soil moisture is but if I generally prefer to use the SWApp if I'm going to use something which models where I'm at and I've set up some scenarios previously. Agronomist, VIC

'Don't understand – don't use that section'

There's no verifiable statistics behind it.....Best to understand what CliMate is. Insurance Representative National

We would generally use How wet if unsure of one area...e.g. what was it like May to November, was there enough soil moisture last year, has there been enough rainfall over the last period to give enough soil moisture for this year. Insurance Representative

Nitrogen calculations are quite good the way it is set up...needs some checking with how the calculations work for some predicted levels....need to check the calculated level with some of (our) measurements. Scientist, WA

5.1.4 Potential yield?

Potential Yield has only been available in Version 2 and so many users were not familiar with this analysis. Although approximately 30% of survey respondents indicated this analysis was 'Useful or Very Useful' (there were 4,500 calculations undertaken in this analysis to date), many users (over 20% in the survey) indicated this analysis was not relevant to them, largely as they were not cropping. Non-users suggested that variable weather influences were too great for this tool to have any value for them. Some agribusiness indicated they were not trusting predictions made with long term average yields and believed they had little relevance with their clients. Users have questions around how to choose inputs for this analysis. Extension officers mentioned the simplicity inputting data compared with Yield Prophet they were using and suggested they would use Potential Yield in the future.

Comments

Not relevant to my needs or those I speak to (farmers).

Too many other factors come into play and long term average yields don't relate to what I see with my clients.

Yield is too strongly influenced by meteorological conditions during flowering and grain fill. However, this service will be very important for other parts of the agricultural industry such as banking and insurance.

There's a whole lot of other people have yield predictors. There's too much variability you can get a frost, a storm, all these other things that have nothing to do with rainfall that can affect it.

5.1.5 Drought?

The CliMate Drought calculator is new to Version 2 and therefore also had fewer participants who were aware of it or who had used it. Sixty three percent of survey respondents found this analysis 'Useful' or 'Very Useful' and 3,200 calculations had been undertaken since Version 2 was released. However, participants especially in southern and Western Australia were less interested in 'drought'; rather would prefer to interrogate true historical rainfall records and undertake their own analysis. Many respondents indicated that they have other sources of drought information.

Comments

I haven't looked at drought.....The Bureau come out with their drought maps.

We've had droughts – we've had dry years but we don't call them droughts. I don't like using the word because it gives you stress.

This is just sort of cut and pasted from the BOM.

Too complicated, not for farmers

5.1.6 How Hot / Cold?

Seventy percent of survey respondents found this analysis 'Useful' or 'Very Useful' and 3,200 analyses have been undertaken since release of Version 2. This tool is used quite extensively in relation to understanding frost risk for winter crops and heat stress risk for summer crops. Some users would like to see actual daily temperatures and dates of frost events. In some states, other tools exist, and often the data might not change decisions, but it appears useful to be aware of risks. Non-users had not looked, reported a lack of time or that they didn't understand the analysis.

Comments

The temperature outlooks are pretty handy, especially with irrigation, we do utilise that a bit. (If it looks like it's going to be) a hot season, we'll avoid planting too early.

CliMate is probably the only place where you can get frost risk.....All the people from way back know you plant and harvest on that day (to avoid frost). My generation..I think that message got lost in time...They're not actually thinking about this (or) knowing this paddock is hotter or colder.

We can suffer badly from spring frosts at flowering....we are a little torn between getting early establishment and getting frost damage in spring. I've been particularly looking at it because there's been a massive increase in the number of frosts recently.....started looking at other towns around and they are showing the same thing....looking at minimum temperatures early to mid Sept.

(This) doesn't quite work – trying to put probabilities and everything into it – we want to see the absolute. One of the simplest ways to do it – just display to the industry when the event occurred. Farmer, NSW

Frosts are a problem but to tell us the cold will be below average means nothing.

BOM site not that reflective of my farms, especially frosts which are very paddock specific usually.

5.1.7 How Likely?

Over eighty percent of respondents found this analysis 'Useful' or 'Very Useful' and 800 calculations have been performed within this analysis. This analysis is one of the keys to success of the CliMate app, because it allows a forecast specific for the users' location and inputs. However the terminology can be complex for novice weather data watchers. Non-users reported they had not looked at the analysis, and a lack of time.

Comments

This is exactly what we use the CliMate app for – for any given point in the season, doing the how likely scenario e.g. Say in August, we've got a reasonable crop there, how likely we're going to get 30 mm in September and then 30 mm again in October...Got some level of confidence you're going to receive that rain over those two months. Farmer, VIC

Based on average soil water, I can grow a crop with 200mm of growing season rainfall. At sowing time, I think how likely are we to get 200mm of rainfall from April and the end of October. That's one you might peg against your starting soil water. If you're starting with a high figure, you can get away with less growing season rainfall. You work those two different sources of info together to get an overall level of confidence. Grain grower, VIC

When we are seeding canola (and) its bone dry and its fairly early, I might get on there and see what are the chances of getting x amount of rain in the next 2 week period. Grain grower, WA

How likely – we use that in May – how likely to get a 20 mm rainfall event over the next 15 days. (It is) a good demo tool. Agronomist, NSW

5.1.8 How's El Niño?

Sixty-five percent of respondents indicated this analysis was 'Useful' or 'Very Useful' and 4000 analyses have been performed. Participants though, largely indicated they can get this type of information from the Bureau and from other sources and that these sources were more tailored to their location than was available in the CliMate app. Whilst technical advice to this review indicated that El Niño had for example, very little relevance to weather in Western Australia, there were users from that state accessing and using this

information. This is of concern as the app has no such information to guide users.

Comments

...you can go to BOM, going to BOM every day of the week.

I get this information from other sources.

El Nino has virtually no bearing on our farms as we are too far west in west of SA. IOD is a much stronger influence on our weather.

Believe that El Nino has strong influence on coastal weather, but not much effect on weather in western NSW or south western Qld.

Not really important for Western Australia.

Can't find this elsewhere I want it.

5.1.9 How's the Past?

Almost 90% of respondents found this analysis 'Very Useful' and 'Useful' and there have been 800 analyses, and although highly valued, this analysis screen appears very complex and possibly confusing. Users value the ability to access this data. The ENSO analysis (presenting annual rainfall from April to March) is difficult to understand.

Comments

The only time I use this is to compare what's already happened this year to other years. If I got a flood rain, it's been known to have 200 mm over 24-36 hours period (which is very unheard of down here), I might think, when did that happen in history before. Not used on a day to day decision making basis. Grain grower, VIC

I like that because it gives you a picture of what happens if you were interested in farming.

I think we need to look ahead with a changing climate, the past does not mean much.

5.1.10 What trend?

This analysis is another recent addition to CliMate and fewer participants had experience with it. Although 75% of user respondents suggested this analysis was 'Very Useful' or 'Useful', and 6000 analyses had been undertaken, most participants in interviews had not seen this. Participants had positive comments about this analysis and were impressed at their ability to choose a specific time frame (e.g. season) and location for the trend analysis. Its value as an educational tool was identified.

Comments

A little bit messy. But this is good because we're using Jan to Dec...look at that, we can actually select May to October which is our growing season which is interesting.

I like that trend slope, its excellent, especially with our farmers - they don't believe in climate change but if we look at winter time, and if we look at summer it might be different.

It's great you can get it down to seasons. See it's a little bit wetter in summer.

This would be a very good tool at Universities, educating people. We get a lot of queries.

5.2 Usability

Overall data on usability of the CliMate app indicates mostly good ratings. However some users had difficulties installing the app, using the app, understanding the terminology and graphs, and using the CliMate data in decisions. A summary of difficulties is shown in Box 5.1.

5.2.1 Install CliMate

Most respondents found installing the CliMate app easy (75%) or somewhat easy (11%); seven percent found it somewhat difficult and two percent (2 respondents) found it difficult. Six percent of farmer respondents found it difficult to install the CliMate app (Table 5.1).

Table 5.1 Ease of installing and using CliMate (%) (n=97)

	Difficult	Somewhat difficult	Somewhat easy	Easy	Don't know	
Install CliMate						
All	2	7	11	75	5	n=95
Advisors	0	9	9	77	5	n=43
Farmers	6	9	14	69	3	n=35
Use CliMate						
All	1	3	19	75	2	n=95
Advisors	2	5	16	74	2	n=43
Farmers	0	6	34	60	0	n=35

5.2.2 Ease of use

Most respondents found using the CliMate app easy (75%) or somewhat easy (19%); three percent found it somewhat difficult and one percent (1 respondent) found it difficult. Although two percent of advisor respondents (2 respondents) found it difficult to use the CliMate app (no farmer respondent indicated it was difficult, but 6% indicated it was somewhat difficult), farmers overall indicated it was less easy to use the app than advisors. Thirty four percent indicated it was only 'somewhat easy' to use the app (60% indicated 'easy') and 16% of advisors indicated this (74% indicated 'easy') (Table 5.1).

5.2.3 Understand terminology

Most respondents found understanding the terminology in the CliMate app easy (62%) or somewhat easy (23%); twelve percent found it somewhat difficult and one percent (1 respondent) found it difficult. Advisor respondents found it easier

than farmer respondents. Twenty percent of farmer respondents found it 'somewhat difficult' (7% of advisors) and 3% found it 'difficult' to understanding the terminology (0% of advisors). Forty-six percent of farmer respondents found it easy to understanding the terminology (c.f. 67% of advisor respondents) (Table 5.1).

Box 5.1 Summary of CliMate usability issues

Most respondents (86-92%) were able to install and use the app.

15% of farmers (9% of advisors) found it difficult or somewhat difficult to install the app.

20-23% Farmers had difficulties especially in understanding terminology and graphs.

7-9% advisors had 'somewhat difficulty' with terminology and understanding graphs.

20-25% farmers (and 12% advisors) found it difficult to change location

23% of farmers (12% advisors) found it difficult or somewhat difficult to use CliMate data in decisions.

Half of all respondents did not know how to save or transfer CliMate data.

Table 5.2 Understanding and use of CliMate data (%).

	Difficult	Some what Difficult	Some what Easy	Easy	Don't Know
Understand terms					
All (n=95)	1	12	23	62	2
Advisors (n=43)	0	7	23	67	2
Farmers (n=35)	3	20	29	46	3
Understand graphs					
All (n=95)	2	17	26	57	2
Advisors (n=43)	0	9	30	58	2
Farmers (n=35)	3	17	29	49	3
Use in decisions					
All (n=95)	3	12	29	46	11
Advisors (n=43)	5	7	33	51	5
Farmers (n=35)	9	14	31	43	3

5.2.4 Understand graphs

Most respondents found understanding the graphs in the CliMate app easy (57%) or somewhat easy (26%); seventeen percent found it somewhat difficult and two percent (2 respondents) found it difficult. Advisor respondents found it easier than farmer respondents. Seventeen percent of farmer respondents found it 'somewhat difficult' (9% of advisors) and 3% found it 'difficult' to understand the graphs (0% of advisors). Forty nine percent of farmer respondents found it easy to understand the graphs (c.f. 58% of advisor respondents) (Table 5.2).

5.2.5 Use in business decisions

Many respondents found it easy to use CliMate data in their business decisions (46%) or somewhat easy (29%); twelve percent found it somewhat difficult and three percent found it difficult. More advisor respondents found it easier than farmer respondents. Fourteen percent of farmer respondents found it 'somewhat difficult' (7% of advisors) and 9% found it 'difficult' to use the information in business decisions (5% of advisors). Forty three percent of farmer respondents found it easy to use the data (c.f. 51% of advisor respondents) (Table 5.2).

5.2.6 Choose a new location

Although most respondents found it easy (65%) or somewhat easy (19%) to choose a new location in CliMate, 12% of advisor respondents and 20% of farmer respondents did not. More advisors found this easy or somewhat easy compared with farmers.

5.2.7 Change question details

Most respondents found it easy (58%) or somewhat easy (22%) to change inputs on questions; advisors (58%) finding it easier than farmers (46%).

5.2.8 Save and send graphs and data

Twenty four percent of respondents found it easy or somewhat easy to save or send graphs or data. (Twenty seven percent found it difficult or somewhat difficult.) Fifty percent of respondents indicated they did not know about this. Advisor and farmer responses were similar.

5.2.9 View on iPhone, iPad

Most advisors (72%) indicated it was easy or somewhat easy to see the output on iPhone or iPad. Only 47% of farmers indicated this. Forty one percent of farmers and 23% of advisors did not know.

5.2.10 Additional data – Apple Store Feedback

CliMate user reviews (dating back to 2013) from the Apple app store are included in Appendix 11.8. The app rates 4.3 out of a possible 5, with 8 very positive and 2 negative comments.

5.3 Problems and suggestions

Problems and suggestions contributed by participants in this evaluation are summarised in the following sections. The major problem areas identified by participants in using the CliMate app were related to understanding and using the app data, the requirement to login each time of use, and having to re-select locations in the new version for each new calculation. These are outlined briefly below. A number reported minor errors and malfunctions, possibly associated with internet connections. Some recommendations to developers in response are outlined in this section.

5.3.1 Problems

Data concerns

There is some uncertainty among users in the veracity of CliMate data (when it was updated, is it true to location, or is it infilled until field records are entered by BoM).

Source of data

Some users were unsure of the source of CliMate data and how it compares with the BOM available weather data. Some indicated data can be different in both.

Some WA users were not sure if CliMate data uses 'Patch point' data or not

Gaps in data

WA – gaps in data which could be more complete if the CliMate weather data source was linked to the up to date and more widespread Patch point data system.

Trueness of location data

The issue of 'infilling' of missing data emerged. For one site where the rainfall data was known not to be updated in the BOM system – CliMate was showing incorrect rainfall for the location and appeared to be filling in data using data from nearby weather stations.

Local variability of rainfall meant that users' CliMate output may not be relevant to their exact location because nearest weather stations can be kilometres away.

Difficult for users to identify if data in CliMate is actual or averaged data as users are not advised if the weather station is open or closed. They are required to go to BOM site to check.

CliMate data sometimes had changed 1-2 months afterwards as data is updated in BOM – this was a slight concern for users especially in the corporate world who may have used the original data in their own calculations.

Ability to download and print data

Some organisational users (e.g. Insurance, agribusiness advisors) requested the ability to download historical data in spreadsheet files. Many agronomists requested easier print options for the output and to present CliMate data in report format.

Timeframes for presenting data

Annual data is presented in April to March format in How's the Past? Some users found this confusing as it does not align with other annual reporting. This also delays access to availability of the previous year's annual data until at least the following April and may have limited the ability to use this data in other tools.

Choosing thresholds

Choosing a threshold value in some analyses (e.g. Potential Yield?) can be difficult for users – as they are not sure what is required and thresholds appear to vary. Some users report searching online to try to find some information to assist in choice of thresholds.

Multiple forecasts

It was suggested that the forecasting functions in CliMate were additional to the multitude of weather forecasts already available and potentially added to the confusion for some users.

Login and passwords

Users routinely questioned why login and passwords were required each time they wished to interrogate CliMate data.

App malfunctions

The main malfunction issues identified by participants in the study were the error messages on particular calculations. There was some difficulty in selecting a default location.

5.3.2 Suggestions

User suggestions for future development of the CliMate app were based around functionality, usability, training and communication, data, and platform.

Functions

Additional data - Evapotranspiration

There was the suggestion that CliMate could include evapotranspiration data from BOM which could then be used in irrigation scheduling.

Additional searching functions

Retrospective searching for rainfall or other weather data during a previous finite period.

Some users suggested that it would be good to be able to compare two locations on the one screen.

Additional default values and information about data

There were requests to add default values for data and base temperature data for heat sum calculations in crops (e.g. wheat, sorghum) – this may help users to understand the implications of the temperature data for different crops.

Rainfall inputs and formats

It was suggested that users could be able to incorporate their own rainfall as input into the app; also requests to present data in rain chart format.

Forecasting function

Suggestion that the CliMate forecasts could be removed from the app so as not to add to confusion for users.

Usability

Choosing locations

It was suggested that choosing locations may be improved through the provision of a map showing the location of each of the weather stations – to assist in choosing sites and locating nearby sites. Alternatively the provision of prefixes to help initially choose the region in which locations are based.

Locating the app, website and help files

Users suggested the app should be easier to locate on both Apple and Google sources. They also wanted easier access to help files and for these to include worked examples.

Layout and time data presentation

Radiation data is presented but users suggest they must estimate this to provide it quantitatively.

Non-standard intervals are shown for time in days on some calculations. Users indicated some difficulty comparing CliMate data with other time-based data (e.g. soil probe readings), and in discussions and planning (suggest 10,20,30 days would be simpler).

Some users found the input/output screen in CliMate to be too busy and complicated, requesting a simplification.

Data

Users suggested that CliMate could be linked with additional weather data networks (beyond the BOM sites) which might include state and local networks.

They suggested that live or real-time data would make CliMate very useful.

Training and communications

- Common request for training, webinars, worked examples
- News, examples on functions in App [emails, blog, Twitter]
- Android version not well publicised
- Worked examples requested

A significant number of users in the survey identified that they had difficulty understanding the graphs and information provided in the app. They were requesting webinars or seminars on graphs, deciles and risk levels, more information on how to interpret the data, information about what the app is going to do and expected outputs. Some users could not locate the Help section.

In addition, there was a request to present CliMate probability data not quantitatively (or as a deviation from the median), but low, medium, better than average or good.

5.3.3 Recommendations for developers

Qualifications on data

Assurances and explanations for users will help them to trust that the data they are accessing in CliMate is the best available for their location, especially in relation to each state, local weather data networks and trusted sources of weather data.

Identification of infilled data

A more obvious means within CliMate to identify which data is 'infilled' from historical averages or nearby weather stations is suggested as a key step forward for users in understanding and trusting CliMate data.

Adequate first user information

Ensure adequate information on choosing thresholds and on choosing and saving default locations and printing CliMate output is included in help and first user files. Provide qualifications regarding the applicability of (especially) El Nino and

Yield Potential, along with thresholds, defaults and standards, and how to adapt for individual situations.

Log-in requirement

It is suggested that the developer rethink the requirement to log in to the app each time of use; decisions could be made around the true value from gathering app analytics compared with user simplicity of access.

Locations

An earlier draft allowed users to select different locations for each analysis – this created some confusion. Subsequently, the developers made the default one site for all analyses, highlighting that added flexibility does not always lead to better function. A map interface was added to “new site selection” during this evaluation to avoid incorrect site selection. An enhanced map interface would still improve usability.

Printing CliMate output and reports

Provide information for users on how to print or email CliMate data and outputs, and enhance this facility.

6 Use statistics

This report incorporates data and analytical capacity incorporated into CliMate Version 2 which was released in July 2017. These analytics are collected automatically each time a user accesses CliMate and provides a rich picture of spatial and temporal use of the app.

6.1 Spatial distribution

At the time of report finalisation, there were 4250 registered users of the CliMate App Version 2, 127 of which occurred in the past 7 days. Figure 6.1 shows the geographic spread of the sites registered by users.



Figure 6.1 Distribution of registered users (primary site) of CliMate July 2017 –April 2018, n=3300.

Users are undertaking CliMate calculations based on sites across the eastern, western and southern grain production areas. There is high use in Adelaide and Brisbane centres and surrounds. There is widespread use across Victoria and Tasmania, and consistently throughout northern Queensland and Northern Territory. Registrations by state, industry, occupation and platform are shown in Figure 6.2.

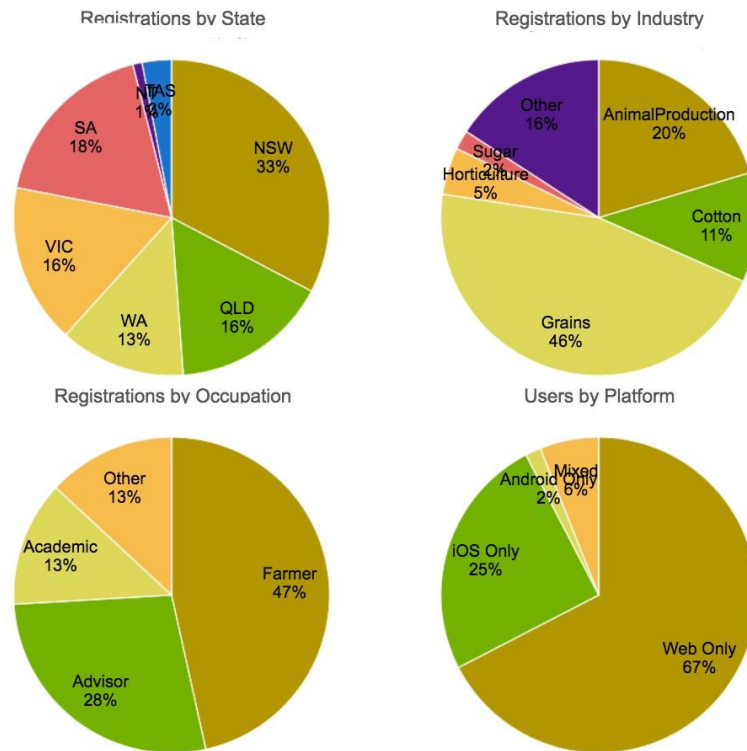


Figure 6.2 CliMate users classified by state, industry, occupation and app platform, July 2017 –April 2018.

Statistics available for CliMate Version 1 (from iTunes Connect [iOS devices]) accounted for approximately 18,000 downloads; there were also approximately 2,000 registering for the www version (2013-2017) (Appendix 11.9.1).

6.2 Types of users

6.2.1 User domains

The main web domains used to access CliMate Version 2 are public domains (gmail.com, bigpond.com, hotmail.com); state Government Departments and universities (Figure 6.3).

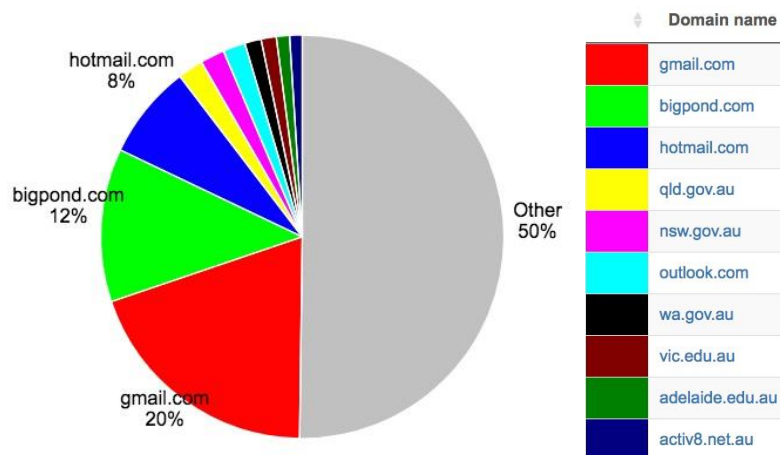


Figure 6.3 CliMate users classified by registration domain for the top 10 domains, July 2017 –April 2018.

6.2.2 Industry

Registered users by industry as at April 2018 were Grains (46%), Cotton (11%), Animal Production (20%), Sugar (2%), Horticulture (5%) and 'Other' industries (16%) were identified. Survey data indicates that 'Other' industries included Education, Agribusiness, Dairy, Viticulture and Mining.

6.2.3 Occupation

Farmers represent the largest group being approximately 47% of all users with consultants 28% and academia 13% (students, academics). A recent increase in University-based registrations came from at least two student classes now using CliMate.

6.3 Growth in users

Since its release, Version 2 has seen significant growth. The Android version was released in January 2018 (Figure 6.4).

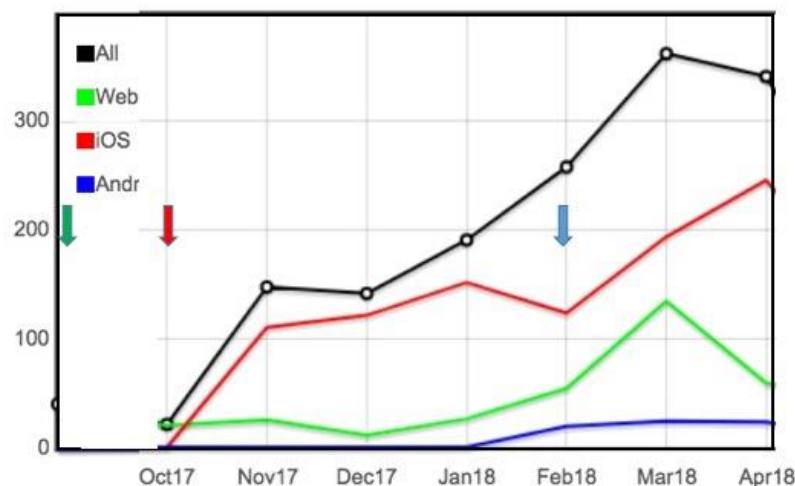


Figure 6.4 Registered users Oct 2017 to March 2018, showing releases of v2 for www, iOS and Android platforms. Note that there were ~18,000 registrations of the iOS version and ~2000 of the www version from 2/2013-2/2017.

6.4 Sessions

A 'session' represents a visit to the app for a minimum of 30 seconds and is a measure of how often the app is being used. Total sessions from December 2017 to April 2018 are shown in Figure 6.5. This period was selected as the beginning of complete analytics across the three platforms. At the time of this report (end April 2018) registered users were accessing CliMate >5000 times/month.

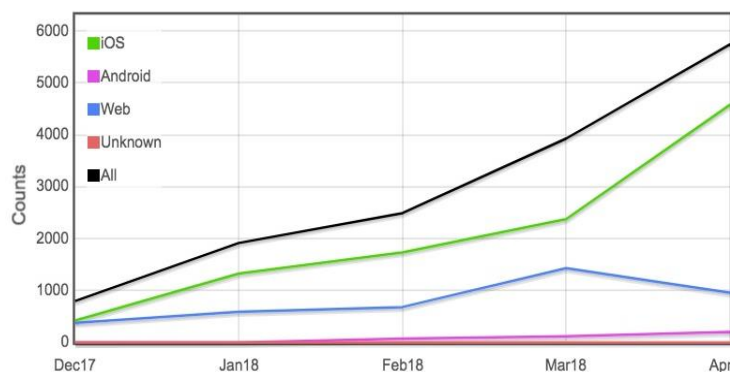


Figure 6.5 CliMate sessions Dec 2017- April 2018 (n=16177).

The location of all sessions is shown in Figure 6.6

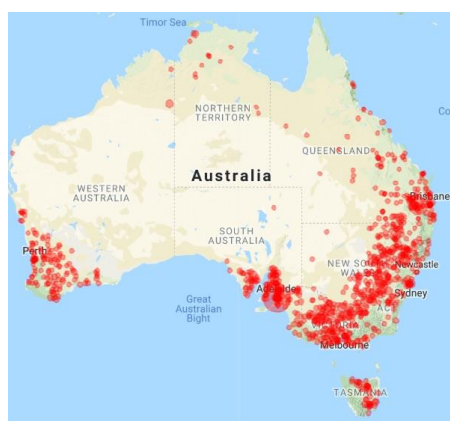


Figure 6.6 Distribution of CliMate sessions Dec 2017- April 2018 (n=16,177).

Segregation of sessional data into state and industry shows the major users of the App Version 2 were in New South Wales (36%) with Queensland, Victoria, South Australia and Western Australia all between 10-19%. The grains industry accounts for most uses (45% of all sessions) with animal production and cotton industries also being large users (Figure 6.7).

Farmers undertake 43% of all sessions and advisers undertake 28%, with 70% using an iOS device while 27% use a www browser. At this stage only 3% of users are using an Android device.

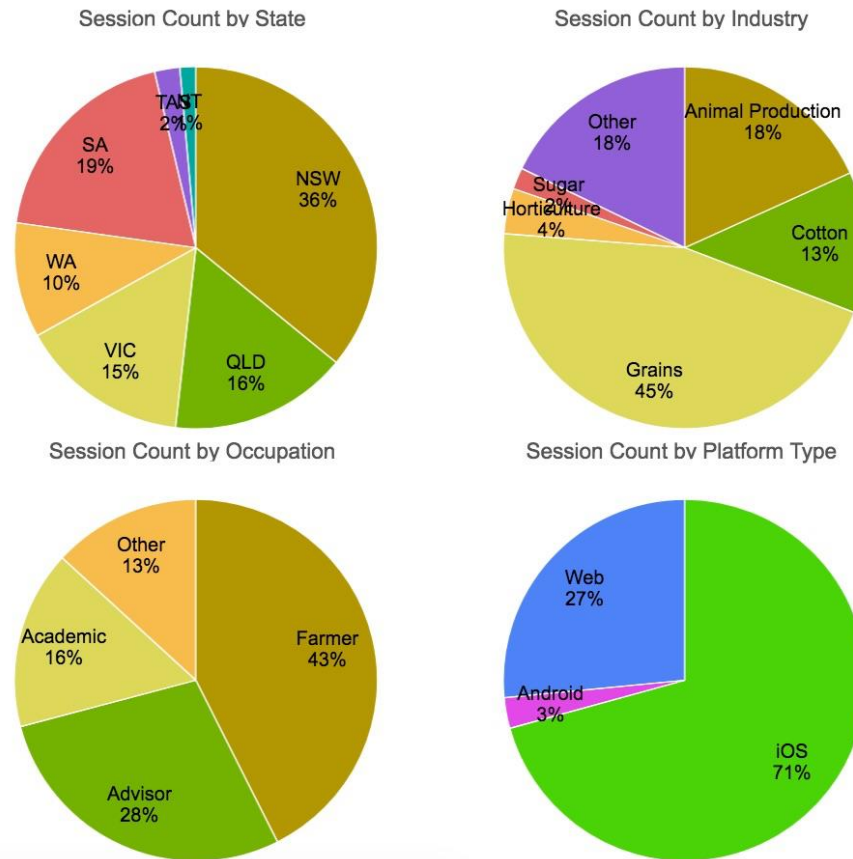


Figure 6.7 Distribution of sessions by state, industry, occupation and platform Dec 2017- April 2018 (n=16,177).

Figure 6.8 shows the distribution of accesses across the varying CliMate analyses. How's the Season? and How Often? have the highest number of accesses.

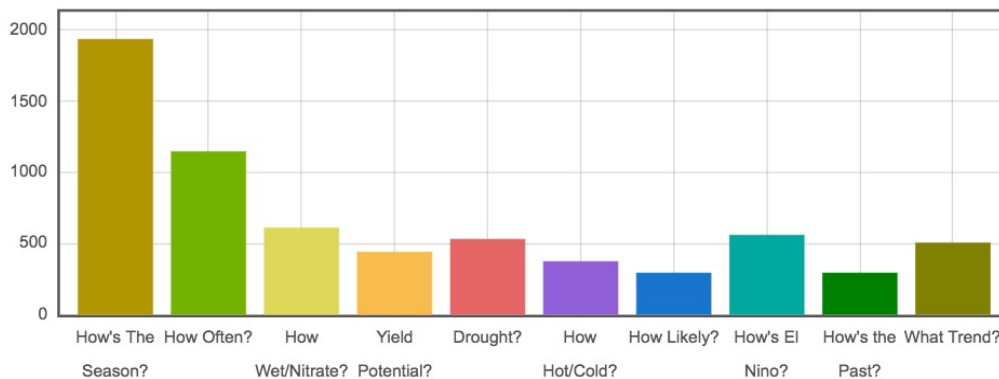


Figure 6.8 Distribution of accesses by analyses in CliMate Dec 2017- April 2018 (n=6,684).

"Calculations" indicate how often input variables are changed and is a measure of the degree of interaction within each analyses. Figure 6.9 shows the distribution of calculations across the varying CliMate analyses. How's the Season? and How Often? similarly have the highest number of calculations.

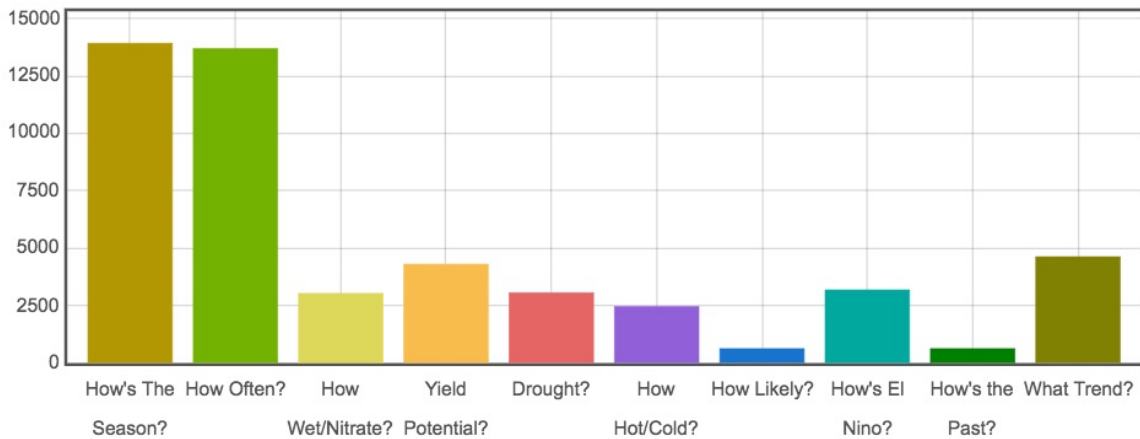


Figure 6.9 Distribution of calculations by analyses in CliMate Dec 2017- April 2018 (n=49,506).

Statistics on usage of the various calculators varies with time of year. This data was gathered from July to March and therefore may not indicate use of some of the calculators in the Autumn-Winter period.

6.5 Frequency of use of CliMate app

Figure 6.10 shows that How Often, How's the Season and How Likely are the most frequently used calculations. It also indicates that 20-25% of respondents don't use El Nino, What Trend, Drought and How Wet, and over 50% did not use Potential Yield.

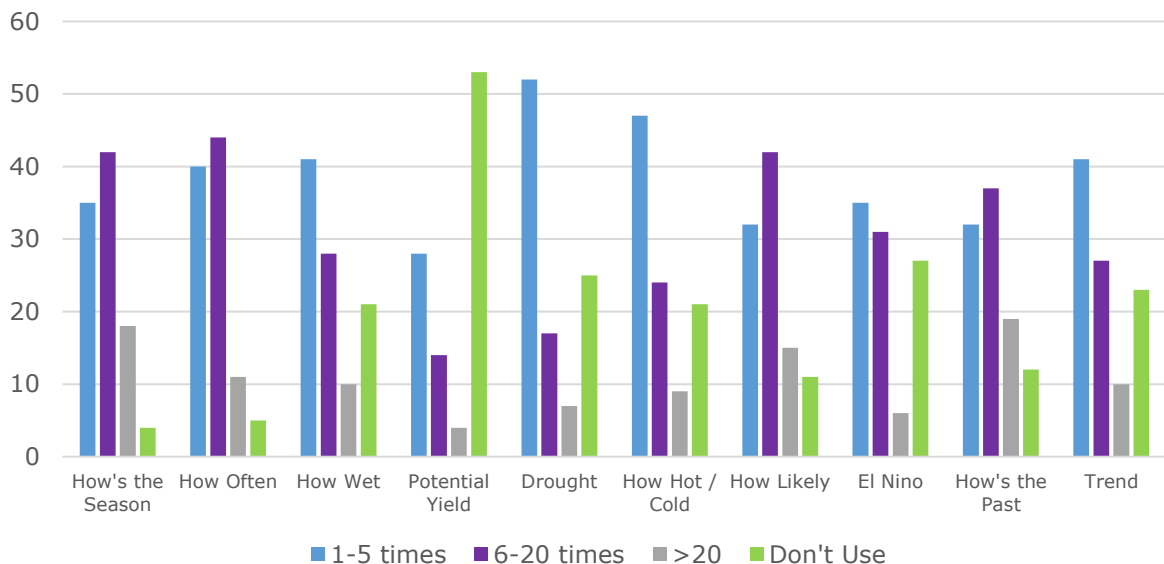


Figure 6.10 CliMate app - frequency of use (per year) (%) (n=97).

Advisors

Figure 6.11 indicates strong regular use by advisor of most analyses within CliMate.

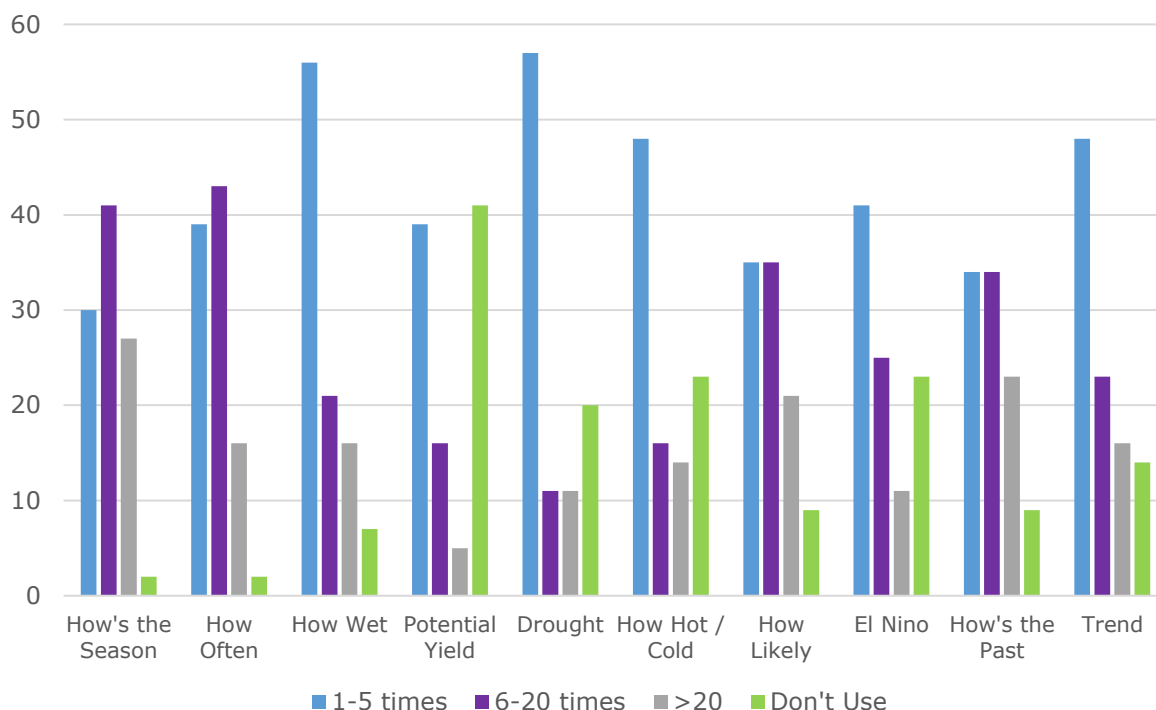


Figure 6.11 Advisors - CliMate app Frequency of use (per year) (n=44).

Farmers

Farmer respondents' nominated frequency of use (Figure 6.12) shows strong use of How's the Past, How Likely, How Often and How's the Season.

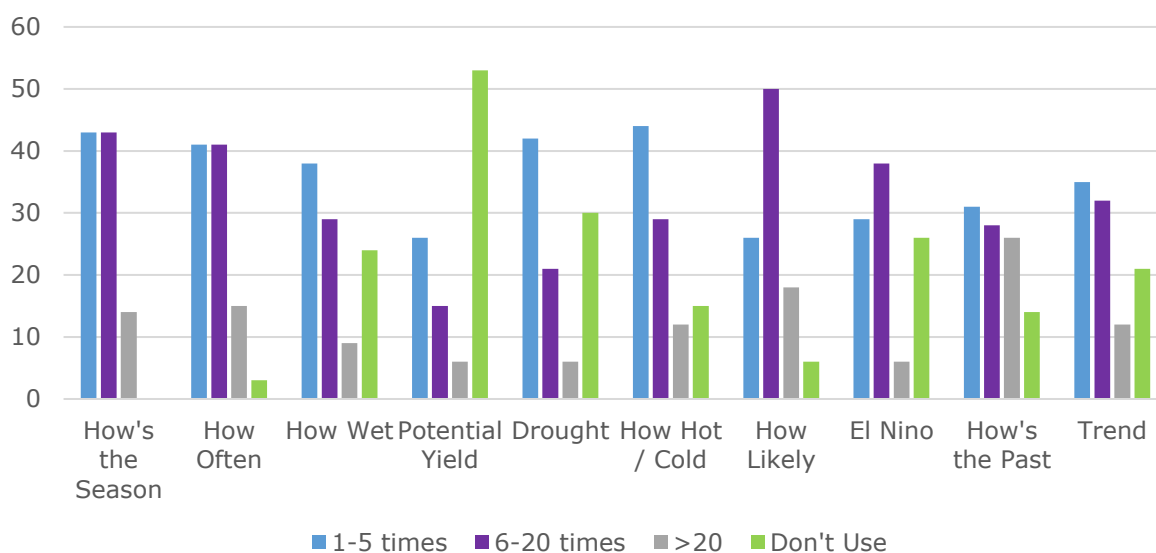


Figure 6.12 Farmers - CliMate app Frequency of use (per year) (n=36) (%)

6.6 CliMate app locations

Most users have between 1 and 5 locations set up in the app but 12% advisor users and 15% of scientists had 6-10 locations set up. Three percent of both advisors and scientist users had over 30 locations set up (Figure 6.13).

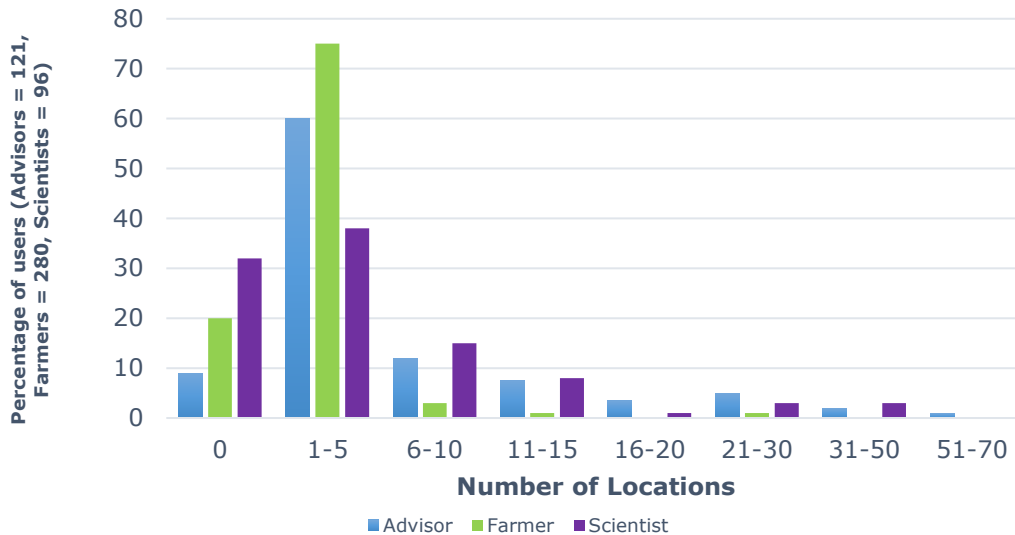


Figure 6.13 Actual number of locations set up – Advisor, Farmer and Scientist users – January 2018 CliMate user data.

Users (approximately 70) who had set up greater than 20 sites comprised insurance, government agency and agribusiness users. This reflects the model of operation of agribusiness having multiple clients to service.

The majority of animal production (64%), grains (55%), horticulture (67%) and other (72%) users had 1-5 locations set up within the app Table 6.1. With the exception of the sugar industry, greater than 30% of users from within each agricultural sector had more than 6 locations set up. Note that a large percentage of cotton (50%) and sugar (66%) users had no locations set up.

Table 6.1 CliMate locations in use by agricultural industries (%)

Locations (number)	Animal Production	Cotton	Grains	Horticulture	Sugar	Other
0	0	50	7	0	66	0
1-5	64	0	55	67	43	72
6-10	18	25	17	0		17
11-15	18	25	7	33		5.5
16-20			2			0
21-30			7			0
31-50			5			5.5

6.7 Where do users use the CliMate app

Eighty-nine percent of user respondents indicated they mostly use the app in the office, 17% use the app in the work vehicle, 16% in the paddock and 2% in the tractor (Figure 6.14).

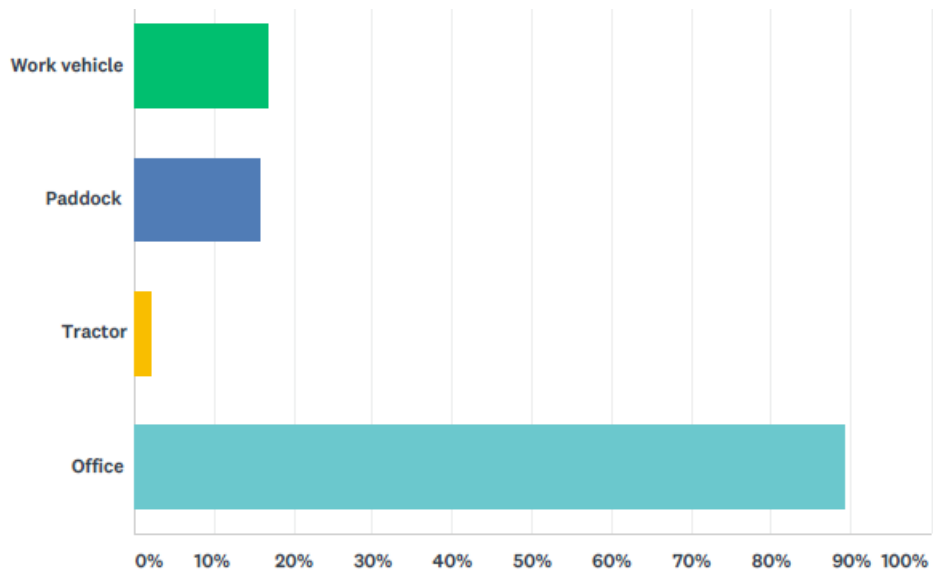


Figure 6.14 Location of use of Climate app (%) (Survey Respondents).

Additional statistics on CliMate (Versions 1 and 2) is available in Appendix 11.9.

7 Information, education and awareness

Consideration was given to how users became aware of the CliMate app, their needs for information and support in adopting the CliMate app, and in considering and applying CliMate data.

7.1 Awareness of the CliMate app

Survey respondents first heard of the CliMate app largely through colleagues (25%), articles (21%) or presentations or seminars (19%) (Figure 7.1).

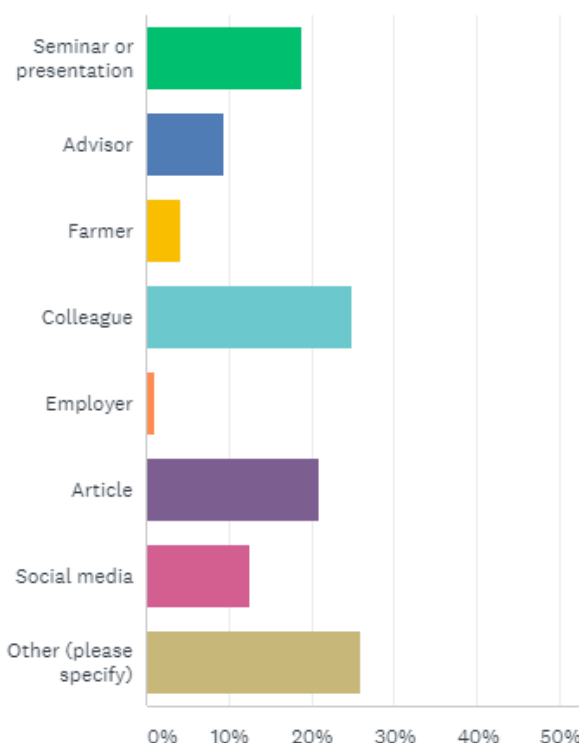


Figure 7.1 How CliMate survey respondents became aware of the CliMate app (%) n=96

Twenty-six percent of respondents indicated they heard of the app through other means shown in Table 7.1.

Table 7.1 Other sources of information about CliMate

Studies, excursions to progressive farmer (2 respondents)	CRDC newsletter, GRDC publication, GRDC update
Family member	Searched Apps, App store
Meat & Livestock Association	Twitter
Web/Google search (5 respondents)	David Freebairn
Follow on from "Rainman"	Random

7.2 Access and sharing CliMate information

Most respondents (74%) believed there was sufficient information available to start using CliMate (7% strongly agreed). Figure 7.2 presents this data

segmented for Farmers and Advisors. There were some differences. More advisors (than farmers) agreed that information was sufficient to start using the CliMate app, but more farmers strongly agreed. Also 2% of advisers strongly disagreed that the information was sufficient to start using the app (no farmers strongly disagreed).

More advisors discuss CliMate output than farmers and interestingly almost 20% of farmers do not discuss or share CliMate output with anyone (Figure 7.2). Thirty-four percent of all respondents (and five percent strongly) agreed that they would like more opportunities to discuss climate information in relation to their businesses. (Fifty-three percent of the respondents declined to commit in this question). Figure 7.2 depicts advisor and farmer responses.

Help and Library information

Most survey respondents had not used the Help information (67%) or the Library of supporting information available on the website (61%). Twelve percent found the Help section useful (15% somewhat useful) and 23% found the Library of supporting information useful (11% somewhat useful). Six percent of respondents did not find the Help section useful and five percent did not find the library of information useful (Figure 7.3).

Value from using CliMate

Thirty-seven percent of all respondents agreed that they were getting the most value from using the CliMate app (17 percent of respondents indicated strongly). Fifteen percent of all respondents did not believe they were getting the most from the app. Forty-three percent declined to commit to a response (Figure 7.4).

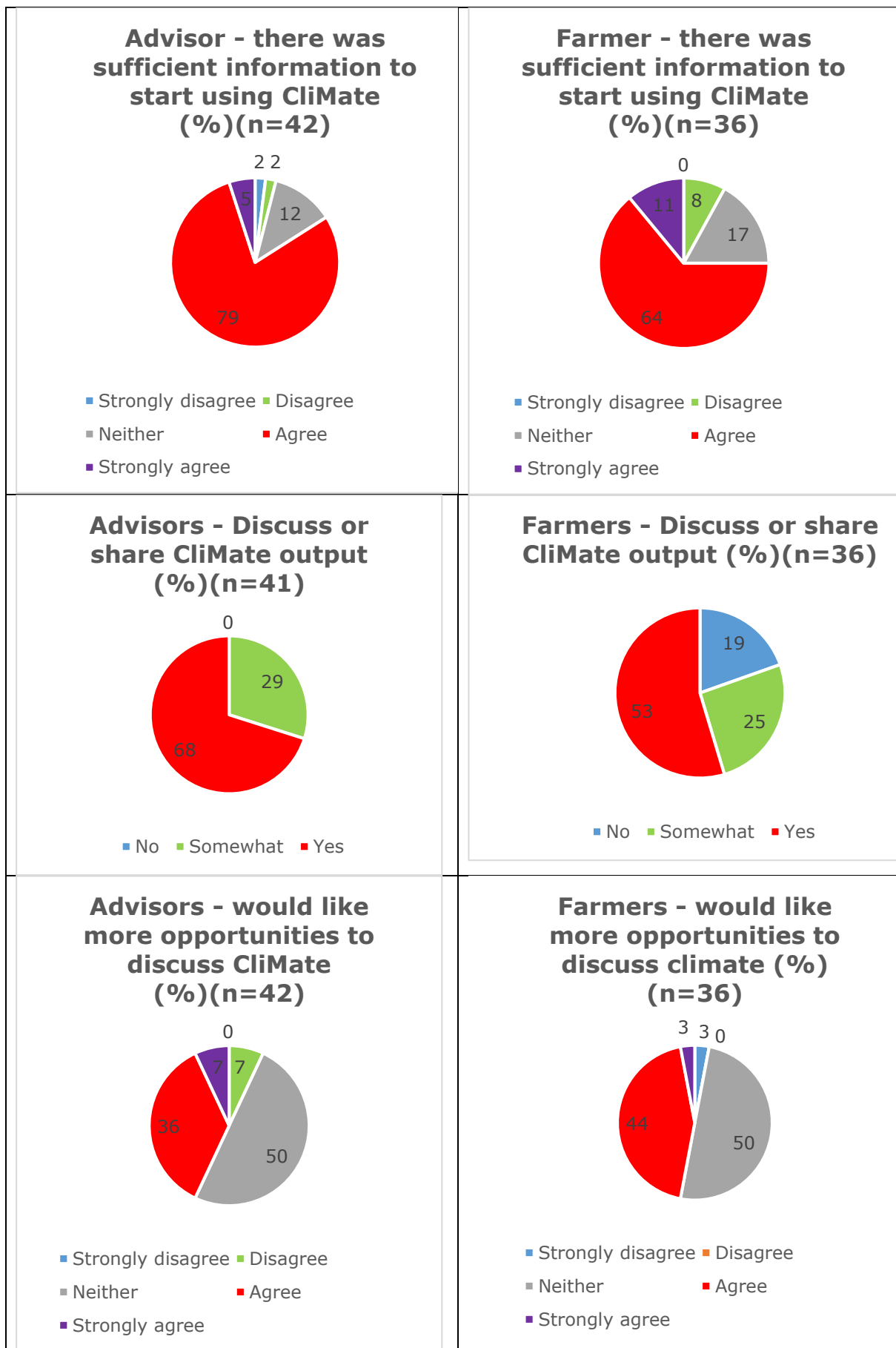
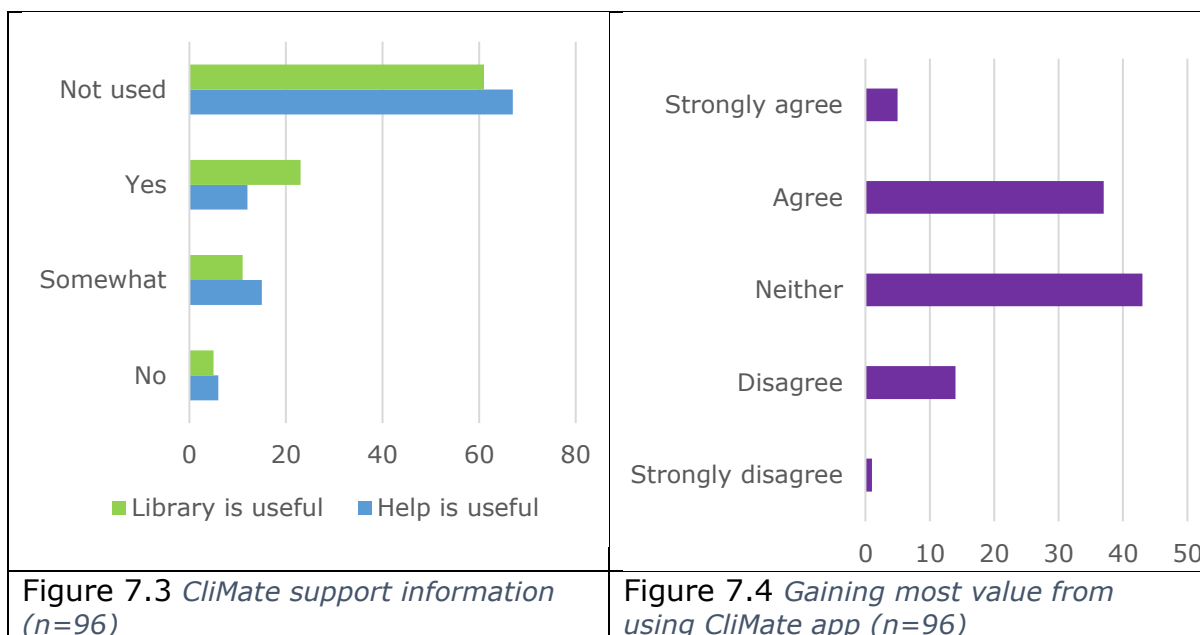


Figure 7.2 Advisor and Farmers – Information and sharing - CliMate app (%)



8 Discussion

8.1 CliMate - a success story

The CliMate app is a web and mobile app presenting locally-based historical weather data in a graphical output with the ability to interrogate this data to graphically present probability of weather events. This evaluation has identified that this app is a success story for users due to its simplicity of use, its visual presentation of data and the ability to interrogate historic, local data easily.

The main value of the app for users is in monitoring current seasons, comparing these with previous seasons, and interrogating historical data – in order to highlight potential future issues related to weather conditions that may arise later in the season.

CliMate has been welcomed in Australia since 2013 and particularly within the grains and livestock industries, but also within other industries such as crop insurance, government, and agribusiness. CliMate’s points of differentiation or advantage within the wide mix of climate information and tools are:

- Locally-specific to a user’s choice of weather station, providing actual, historical data for their location.
- Ability to be interrogated around a user’s specific location-based question in relation to weather conditions
- Mobile-friendly and portable
- Simple screens that show the output graphically, (hiding vast quantities of data)

The CliMate app was developed by RPS Australia Pty Ltd (V1 2013) and the University of Southern Queensland (V2 2017, 2018) for the Managing Climate Variability Program (MCVP) (<http://managingclimate.gov.au/>).

Since its release mid 2017, CliMate Version 2 has seen 4300 registrations and 4000 accesses per month. The >300 new registrations each month is evidence of its growing value and role among users. Version 1 was well established with in the order of 20 000 registered users.

8.2 Decision making and discussion tool

The tool is being used as a decision making and discussion tool in relation to planting and frost management, nitrogen application management, radiation and crop monitoring, fungicide spray decisions and residual herbicide management, drought management planning feed needs and livestock sale decisions, and property purchase decisions.

It is also used extensively in insurance product pricing, and increasingly in education and decision support, presentations and discussions within agribusiness.

A key theme throughout the evaluation is that CliMate app data has been used to facilitate discussions within advisory firms among advisors, between advisors and clients and within farming businesses. The identification of a locally-specific, numerical value of potential risk of weather effects is the key to moving these discussions 'up a level'.

In addition, the app has been used to support training and learning – about weather, data and its effects on specific agricultural contexts - within VET and University contexts, within banks, within agribusiness organisations and on farms.

8.3 Barriers to use

The increasing user registrations and CliMate (Version 2) calculations (especially in April – May 2018) indicate there are few major barriers to use of this app. However, limited awareness of the app may be an initial barrier to its use. This was noted among both farming community, agribusinesses and agricultural organisations. Users of the app were largely individuals who had heard of the app and put in the effort to evaluate and become familiar with using the app. There appears very little local or industry based initiatives to support or resource individual users in starting to use the app. This may limit some potential users in adopting the app. Users though indicated good support was provided by the developers in this regard.

A number of users reported difficulties installing and using the app, and similarly difficulties using the app data in decisions. Lack of supporting information may be a barrier for users in fully using the app, however it is suggested that it is the lack of examples (e.g. case studies) and contact with people in understanding how to use the app that is the major barrier here.

Some users have not explored all of the CliMate calculations, and some do not understand or trust calculations, particularly How Wet/Nitrate, Potential Yield and How Hot How Cold. Some saw Potential Yield, El Nino or Drought as not relevant or did not understand them.

8.4 CliMate Versions

Australian CliMate Version 1 was released in 2012 and Version 2 released July 2017 (www), November 2017 (iOS) and February 2018 (Android) In addition to weather-based calculators the app incorporated soil water and nitrogen mineralisation calculators (suited to broad acre farming). Version 2 incorporated three new analyses: a yield potential calculator; drought status and a simple trend analyser. Version 1 (iOS and WWW) was taken up quickly with ~20,000 registrations in its first 5 years. Version 2 has >4000 registered users with 1400 new registrations in the six months to April 2018. Detailed user statistics are available since November 2017.

Although Version 2 was developed as a significant improvement, for some users, it was initially considered a limitation by quite a number of users.

Version 1 iOS users did not have to register thus little was known about who, where or what they were using within the app users. Version 2 users are required to set-up an account – entering personal data (email, industry, role), enter a password and often needed to reset the password. Quite a number of users somewhat resented this. Many users found Version 2 different, with more complex data input and this has been somewhat of a limitation. The need to reset location each time a new tool was interrogated was a particular step backwards according to many users [subsequently reverted to original style]. However, with the significant rises in sessional use and registrations, the enhancements in Version 2 appear now to be mostly considered by avid users to far outweigh the drawbacks.

8.5 Outcomes and impacts

This evaluation has highlighted that the CliMate app has contributed to enhancing capacities of users, adding value to their current decision making processes and adding value to communication and discussions. These are summarised below.

8.5.1 Capacities and knowledge

- (i) Easier access to locally-relevant and simpler, historical weather data.
- (ii) Enhanced ability to incorporate historical climate information into decisions and advisory processes and services through the availability of the CliMate app.
- (iii) CliMate users have knowledge of individual seasons in relation to historical weather data for their location, and of the chances and range of possible future weather scenarios.
- (iv) CliMate users understand the extent of risks and possible future scenarios to crops or pastures in a particular location due to weather conditions; they can then assess the feasibility of management options.

- (v) CliMate is assisting users to improve their understanding of the extent of crop and soil responses on their farms, in relation to specific weather statistics.

8.5.2 Decision making, processes and management

- (i) Users of the CliMate app can easily and accurately compare the current season with previous seasons for their location, and incorporate this in decision making and review.
- (ii) CliMate users quantify the chances of the range of possible weather scenarios for their location. Users are including this information in their business discussion, planning and decisions.
- (iii) CliMate users are using data to explain cropping outcomes and identify weather scenarios that may impact on production.
- (iv) CliMate app has contributed to improving agribusiness advisory services
- (v) CliMate app has contributed to facilitating agricultural research planning, processes and communications.
- (vi) CliMate app has contributed to facilitating other business research planning, processes and communications.

8.5.3 Communication and engagement

- (i) CliMate data is contributing to communication and decision making within farming businesses,
- (ii) CliMate data is contributing to communications between advisors and clients and contributed to enhanced collaborative and situational learning and decision making.
- (iii) CliMate data is contributing to local farmer group engagement through the provision of easily accessible, locally-relevant historical weather data assessments.
- (iv) CliMate app is contributing to agribusiness knowledge and education programs

The series of impact areas identified in this evaluation (Table 8.1) are a significant achievement for this app. In the order of 20 – 60% of user respondents identified positive outcomes and improvements in their operations and businesses. These emerged in light of the ability to better quantify weather-based risks associated with their particular location, and consider these in terms of management options. The fast growing user base (particularly with seemingly very little promotion or organisational support within industries or at local levels) is evidence of the value of this app.

Table 8.1 CliMate use outcomes and impact areas

CliMate app use – OUTCOMES AND IMPACT AREAS	
	Percentage of evaluation project participants (*)
Overall	
CliMate has contributed to positive outcomes	65
Contribute to maximising production	16 (37)
Income is improved by using CliMate	33
Decisions, Management	
CliMate has improved decisions or advice	47 (23)
CliMate has improved business or production planning	27 (32)
Operate businesses more reliably	27 (47)
Practices	
Use Climate to compare current with previous seasons	80 (8)
Use CliMate app to review the season and help explain the outcome	63 (21)
Consider weather data more in decisions since using CliMate	54 (28)
Capacities, Knowledge	
Better climate monitoring from using CliMate	46 (31)
Improved understanding of climate impacts on business and decisions	38 (30)
CliMate enabled more informed decisions or advice	46 (26)

(*) – Data presented is 'Agree' or 'Strongly Agree'. Data in brackets is 'Somewhat Agree'.

8.6 Awareness and promotion

The CliMate app has been promoted through presentations in numerous rural media (newspapers, radio, GRDC Ground Cover), at cotton and grain industry updates and twitter "conversations". Version 1 was taken up widely with little formal advertising beyond normal communications in mobile device and online networks.

The issue of awareness is highlighted in this study. As with any information or tool – its adoption is dependent initially not only on awareness but some understanding of how the tools works along with the potential (and bespoke) benefits that may be gained from its use.

In the case of CliMate, any public promotion of the tool mostly occurred within the grain and cotton industries, and user statistics identify approximately 50 percent of users within those industries. Survey and user data is suggesting the CliMate has significant potential within a much wider range of agricultural industries, and for many Australians and Australian sectors beyond agriculture (e.g. education, insurance, medical, real estate). In fact, any industry relying on weather for its operations may have a use for this app. The following question is

posed: *Is there scope to inform the wider Australian public about CliMate as a locally-specific weather data interrogation tool?*

8.7 Source of CliMate data

CliMate and weather data is of high interest to many sectors. Australian government's BOM is the premier source of climate information within Australia. The Australian Government spends \$ 279 million annually to provide forecasting, and locally-specific weather (and climate) data to the nation.

A number of interviewees suggested that, for their needs, the CliMate app interface was more user friendly than interrogating BOM databases. Yet some users in various states have questions as to the data source used in the CliMate app – is it linked to BOM data? Is the data as up to date as the BOM data? Whilst CliMate users who are avid weather data watchers may be familiar with how CliMate data compares with BOM weather data, there are users and potential users who are not.

It is recommended that the source of weather information in CliMate, in particular, how it relates to Bureau of Meteorology data and weather stations, and state-based weather station networks should be made more clear to users.

8.8 Large array of climate tools

In addition to the Australian Government's BOM service:

- Individual State Governments have various climate-based initiatives, information and tools – all specifically developed for their locations. These are promoted and used by government staff and industry in each state.
- Agricultural R&D Corporations through national Managing Climate Variability Program initiatives have developed websites, information and tools to inform, educate and assist decision makers to use climate information.
- Private providers and consultants in various locations throughout Australia have developed their own climate information products or tools – targeted specifically to locations and industries.

This highlights the large number of weather and climate-based services and information available to the Australian public, especially within agriculture. The CliMate app has been developed and 'overlain' onto the current suite of climate information and services, leaving the potential user to try to understand its relevance, value and its relative place (as occurs with any new app). This is not an insignificant charter for users, particularly if they have to technically assess the relevance of each CliMate analysis in relation to their own State and Region's current resources and recommendations.

In WA for example, there is a suite of climate and agricultural decision support tools specifically developed (by Government and private providers) for the state's agriculture. Government staff, consultants and farmers alike are aware of these tools, they are aware of the relevance of these tools to their situation, and they are supported in their use of them. CliMate has been targeted within WA within the grains industry (presentations at GRDC updates), and within that

industry appears to be finding its way. However this evaluation has highlighted that some of the CliMate calculations (e.g. El Nino) may not have a great deal of relevance for WA users.

It is suggested that further consideration should be given to evaluating and confirming the technical suitability of analyses (particularly El Nino, Potential Yield, Drought, and How Wet/N) in line with technical recommendations for each state. Following this, additional information and commentary on this should be provided to help guide app users. To further support this, the identification of key, qualified and skilled users within each state and industry can help to provide this commentary about the technical suitability of the app.

8.9 Use of CliMate data

CliMate data was being shared by some advisors as screenshots and in reports (although 50% of users did not know how to do this). Only one interview participant indicated using CliMate data to adjust budgets. Mostly there were very few examples where CliMate data was used in other tools or recorded. The exception was in the insurance industry where users recorded volumes of CliMate statistics for use in other programs. The issue of integration of data from various agricultural apps and tools is an emerging one and should be considered in future app development.

There are many aspects to decision support, discussion and learning that have not been fully investigated in this project. The nature of such a tool incorporating historical, local weather data is that – placed in the hands of a skilled user – it can be a powerful tool to facilitate local, situated, context-based, experiential learning and all that supports this (discussion, communication). There is potential to further explore how this app is contributing to this learning and how this can be further enhanced. Social aspects to learning through discussion, benchmarking and stimulating reflection, are areas that could be further enhanced through additional research and development support of the app. One such area of application is in communication between farmers and banks. It is expected that CliMate-based risk data could enhance these discussions. This did not emerge in the study (but may still be occurring). Another is ensuring that there are key skilled users situated within industries and locations across Australia who can act as resources to support the further development of learning and innovation associated with use of this app.

8.10 Developing personalised applications

Beyond the numerous grain examples identified in this study and the entrenched insurance applications, there were a small number of interesting examples where users had applied CliMate. Survey data identified that some users in horticulture were using the app successfully for their specific purposes. This suggests that although there were only small numbers of horticulture registered users, there may be potential for more application within this or other industries but the extent of this relies currently and solely on the individual producer or consultant to drive this.

The survey identified that some respondents, (especially livestock producers) were requesting guidelines and examples to help them gain the most benefit from applying the app for their needs.

In this regard, it is worth noting the relatively small number of regular sugar industry app users, compared with the much larger number who appear to have registered to use the app. This was not further investigated in this study.

8.11 Applications beyond agriculture

CliMate user data suggests it is being used as an educational tool within only a few schools and Universities. This appears to depend on the interest and understanding of individual teachers and lecturers. There is scope to promote the tool widely within the agricultural education sector.

CliMate survey data suggests there is potential to use the tool in decision making around property and real estate purchase. There is scope to promote this tool within this sector – as a tool to go beyond using weather data that is based on averages in site selection, to potentially more powerful investigations that include risk assessment.

Is there (impetus/scope) to provide educational and user information (e.g. for specific agricultural industries), or examples of applications within various sectors beyond agriculture?

8.12 Maintenance and support

The future of maintenance and support for the app is unclear. Whilst within a funded project, support has been provided to users and the app is receiving ongoing maintenance to support and manage functionality issues. Respondents in the survey were very happy with the support received from the developers. It is unclear however, knowing that this is all undertaken from within a funded project, how this will be continued.

Should a future business model include a subscription-based service or advertising to fund future maintenance and support?

8.13 Communication with users

The large losses of users between Version 1 and Version 2 leads to questions about effective communication between developers and users. This should be enhanced through required registering of users in Version 2. It would be enhanced further if industries or local organisations took on intermediate communication and resource roles to support individual users in continuing to apply the app to their situation.

8.14 Strengths, limitations, opportunities and risks

Discussion points are summarised based on strengths, limitations, opportunities and risks.

Strengths

- CliMate's strength is its simplicity of use, its portability and its simple holistic graphic outputs.
- Focus on interrogating and presenting historic and current seasonal weather data (How's the Season, How Likely, How's the Past, How Often, What Trend) appears unique and useful.
- Question focused, aiming for the user to cast their issues in the context of risk assessment and their location
- Ease of access and use, with large increases in usage in last 6 months, and particularly in April-May period (2018).
- Facilitates interrogation of local, historical weather data, the identification of possible patterns in weather-based on the past, and the identification of future possibilities and likelihoods and boundaries of these.
- Positive feedback on the value of these tools as quick references and for use in grower discussions and educative activities was received among extension officers due to their simplicity.
- The app is making a significant contribution, especially within the agribusiness and crop insurance sectors and is widely used in the grains and livestock production.
- Applied to key investments beyond agriculture (land purchase, insurance) not envisaged in design. Also note that Version 1 had large numbers of users registered from the medical [hospital and aged care] sectors).

Limitations

- Predictive tools (How Wet/N and Potential Yield) are not unique as there are other tools that do similar analyses [Note – these were added by request of previous users].
- Combination of tools (not just weather; some are specifically for grain) may have devalued the app.
- Some complexity of graphs and inputs (and for some insufficient help and explanatory files)
- No local or industry specific support or guidelines for use
- Many users do not like the necessity of registering and logging on
- Difficulties with logins and loss of functionality faced by current users

Opportunities

- CliMate development and application in more industries and sectors. Some industries may consider a subscription-based approach for a tailored version of the CliMate app. This would allow for future maintenance, development and support of the app.
- Demonstration of value to current clients and industries through case studies
- Added functionality: e.g. links to associated disease risk, nitrogen recommendations
- Given CliMate accesses databases and delivers on three platforms, it could be used as a framework for future app development (similar or completely different client and issue focus)

Risks

- Unclear long term goals, target markets or plans for any app have potential to hinder future development and application.
- Lack of maintenance or support for this app (as may occur in light of the project-based funding focus) is seen as the largest threat – and this will damage users the most.
- Added functionality making the app cumbersome or complex
- Lack of future ownership by a committed funding body or organisation will result in little legacy (and potentially lack of support or maintenance) by an established funding agency or organisation.

9 Conclusions

CliMate app is a success story with over 4300 registrations and growing (>300 new registrations each month), and 4000 monthly accesses. It is making significant contributions to farming and agri-businesses throughout Australia in terms of maximising input efficiencies with respect to weather conditions and identifying and preparing for future seasonal risks. The app is making significant contributions, especially within the agribusiness and crop insurance sectors and is widely used in the grains and livestock production.

The increasing user registrations and CliMate (Version 2) calculations (especially in April – May 2018) indicate there are few major barriers to use of this app. Lack of awareness, insufficient information about the app and how to use the app, and lack of obvious organisational support or examples within industries (or regions) are the main limitations in its adoption. Notwithstanding, Version 2 of the CliMate app is going from strength to strength.

This evaluation has identified some of the successes from the adoption and application of the CliMate app. Widespread and continued adoption and application of such tools (especially with changing versions, and adding functionalities) is not a given, and may require good targeted information, support, and ongoing user assessment.

There is little doubt that CliMate Version 2 has been well accepted. The fast growing user base (particularly with seemingly very little promotion or organisational support within industries or at local levels) is evidence of the value of this app. That 65% and 33% of survey respondents indicated that the CliMate app had led to positive outcomes and improved income respectively is a highly commendable outcome for an app. It summarises the widespread very positive responses from a broad range of users. Forty seven percent of survey respondents believed that using CliMate had improved their decision making and advice.

This evaluation raises the possibilities that the CliMate app could have much wider application across more rural industries, in the education sector and in various other sectors in which a knowledge of the risks associated with weather conditions is important to operations.

10 References

- Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality progress*, 40(7), 64.
- Anderson, G., Kootval, H., Kull, D. (Eds.), 2015. Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services. World Meteorological Organisation, Geneva, Switzerland.
http://www.wmo.int/gfcs/sites/default/files/wmo_1153_en.pdf
Accessed 2/4/18.
- Bennett, C. (1975). Up the hierarchy. *Journal of Extension* [On-line], 13(2). Available at: <http://www.joe.org/joe/1975march/75-2-a1.pdf>
- Carr, E.R., Fleming, G., Kalala, T., 2016. Understanding women's needs for weather and climate information in agrarian settings: the case of Ngetou Maleck, Senegal. *Weather Climate and Society*, 8 (3), 247–264. <http://dx.doi.org/10.1175/WCAS-D-15-0075.1>. Accessed 2/4/19.
- Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, 13(1), 3-21.
- Corbin, J., Strauss, A., & Strauss, A. L. (2014). *Basics of qualitative research*. Sage.
- Douthwaite, B., Alvarez, S., Thiele, G., & Mackay, R. (2008). Participatory Impact Pathways Analysis: A practical method for project planning and evaluation. Available at https://cgspace.cgiar.org/bitstream/handle/10568/70093/ILAC_Brief17_PIPA.pdf?sequence=1&isAllowed=y Accessed 30/5/18.
- Freebairn, D. and McClymont, D (2017) Australian CliMate II Factsheet. <https://climateapp.net.au/Uploads/Documents/170621%20Australian%20CliMate%20Factsheet.pdf> Accessed 2/4/18.
- Haigh, T., Takle, E., Andresen, J., Widhalm, M., Carlton, J. S., & Angel, J. (2015). Mapping the decision points and climate information use of agricultural producers across the US Corn Belt. *Climate Risk Management*, 7, 20-30.
- Hochman Z. and Carberry P.S. (2011). "Emerging consensus on desirable characteristics of tools to support farmers' management of climate risk in Australia". *Agricultural Systems*. 104, 441-450.
- Leith, P., & Vanclay, F. (2017). Placing science for natural resource management and climate variability: lessons from narratives of risk, place and identity. *Sociologia Ruralis*, 57(2), 155-170.
- Likert, Rensis (1932) 'A Technique for the Measurement of Attitudes', *Archives of Psychology*, 1932, Vol. 140, No. 55.
- Penfield, T., Baker, M. J., Scoble, R., & Wykes, M. C. (2014). Assessment, evaluations, and definitions of research impact: A review. *Research Evaluation*, 23(1), 21-32.
- Radhakrishna, R., & Bowen, C. F. (2010). Viewing Bennett's hierarchy from a different lens: Implications for Extension program evaluation. *Journal of Extension*, 48(6).

Tall, A., Coulibaly, J. Y., & Diop, M. (2018). Do climate services make a difference? A review of evaluation methodologies and practices to assess the value of climate information services for farmers: Implications for Africa. *Climate Services, 11*, 1-12.

Vogel, J., Letson, D., & Herrick, C. (2017). A framework for climate services evaluation and its application to the Caribbean Agrometeorological Initiative. *Climate Services, 6*, 65-76.

Yin, R. K. (2017). *Case study research and applications: Design and methods*. Sage publications.

11 Appendix - CliMate Evaluation

11.1 CliMate version background

Web Analytics

- (V1) since Feb 2013 - registrations only - missing metadata
- (V2) since July 2017 - full analytics - some missing metadata

iOS Analytics

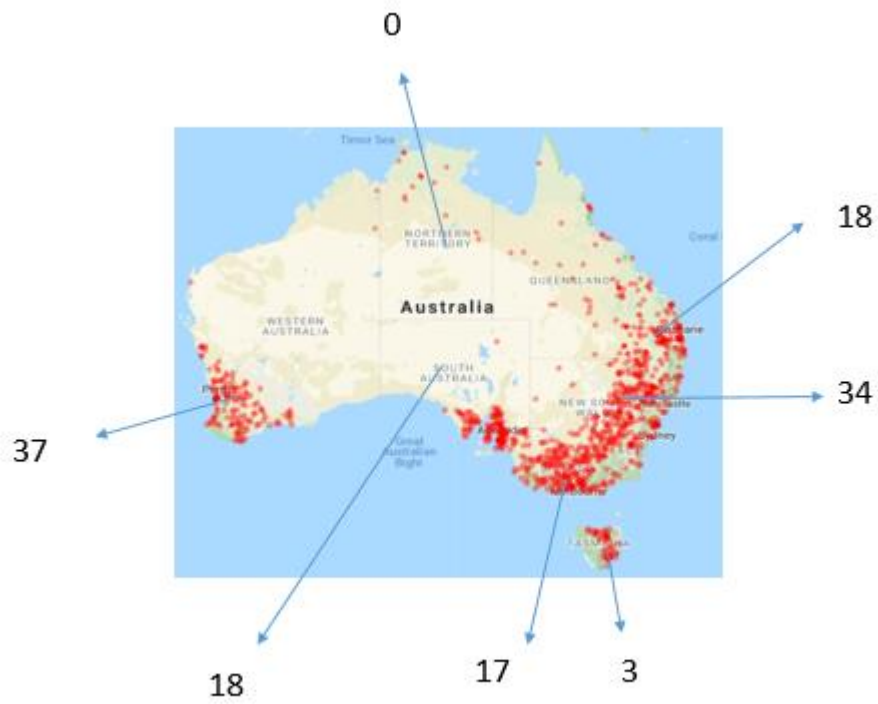
- (V1) since Feb 2013 -from iTunes Connect only, 18,000 downloads not recorded here
- (V2) since 17th Nov 2017 (full analytics)

Android Analytics

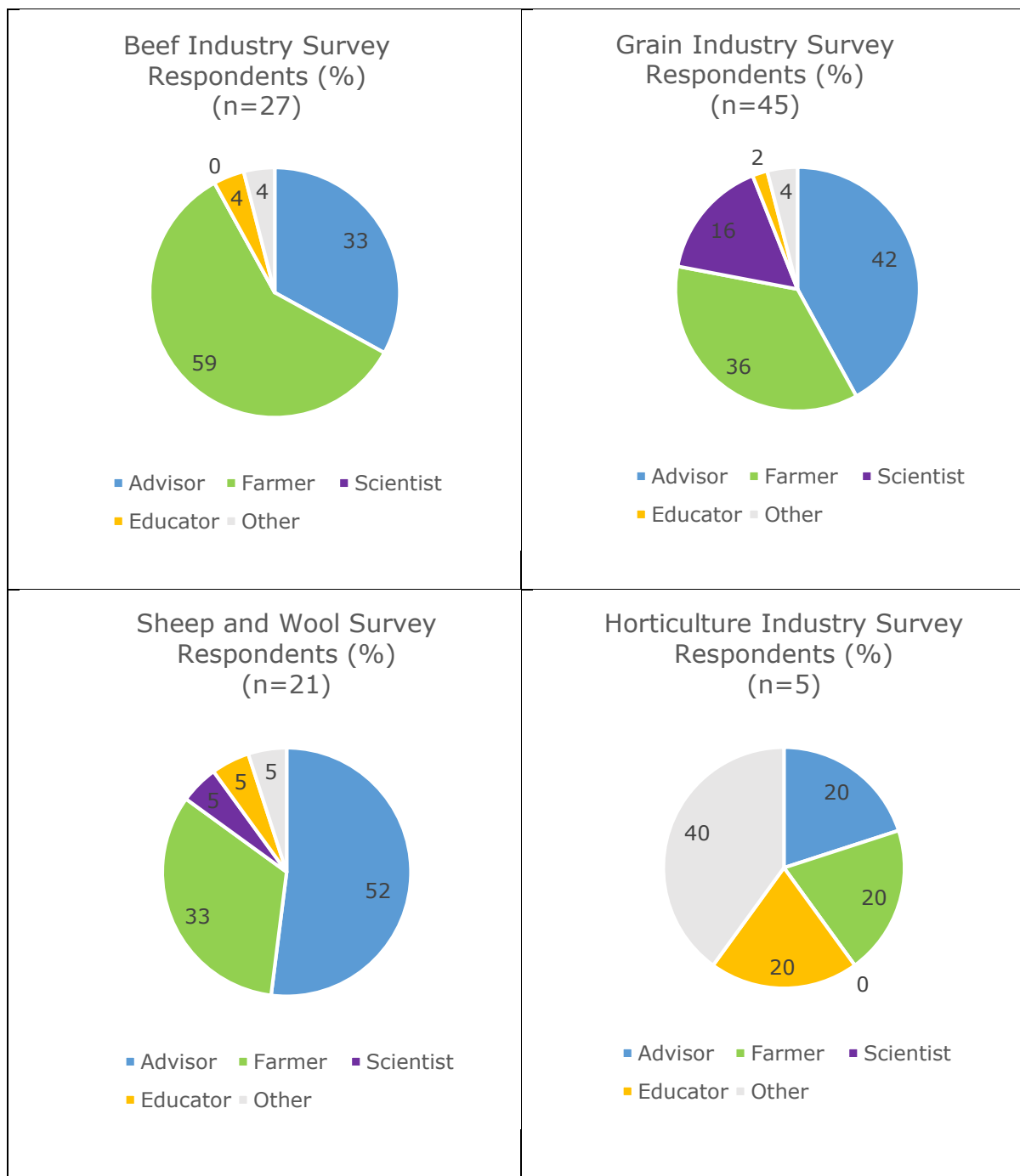
- (V1) Version 1 NOT released on Android
- (V2) since 14 February 2018 (full analytics)

Note 1: Registration information has been collected since February 2013, while "session analytics" have only been collected since July 2017.

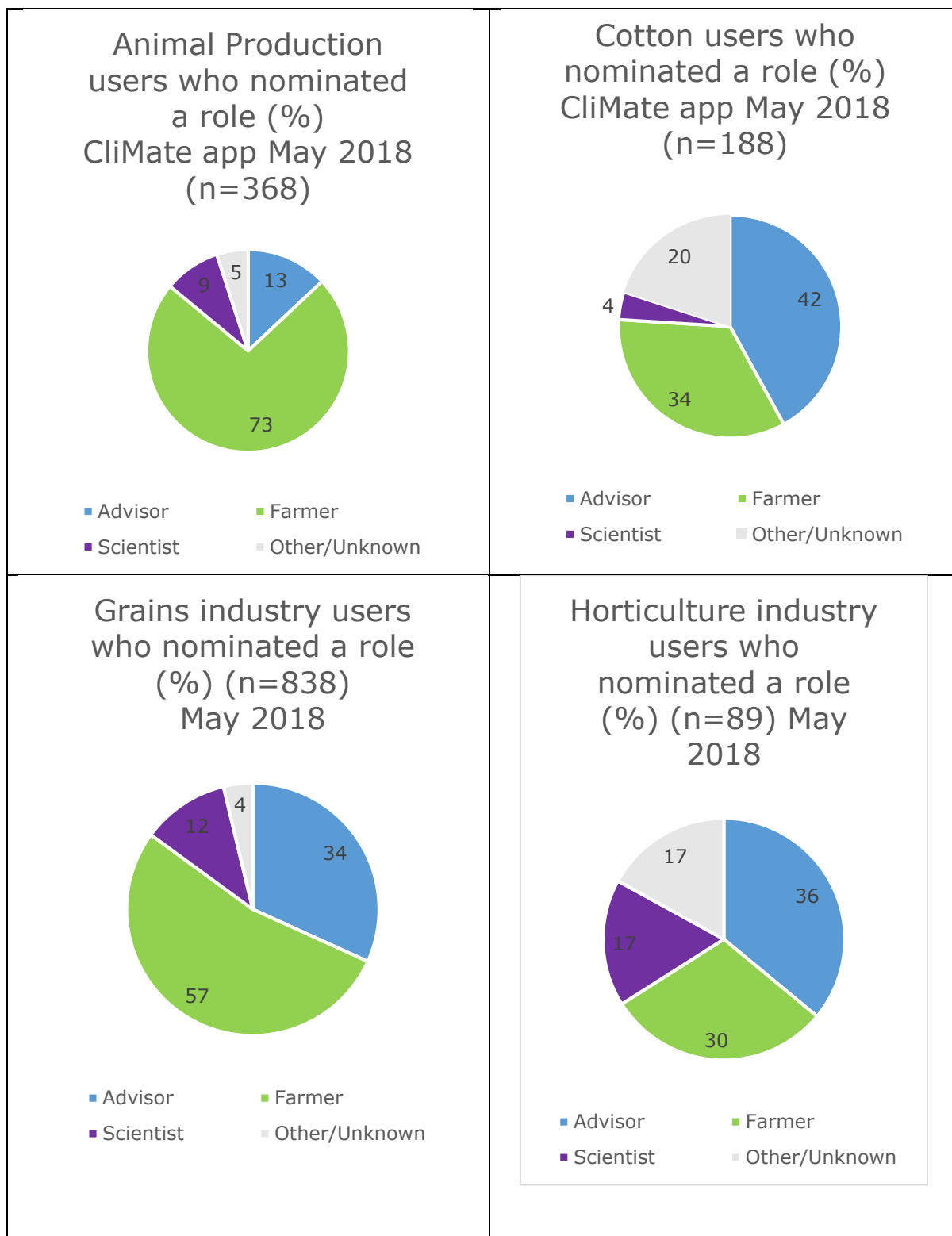
11.2 CliMate evaluation participants (survey and interview)

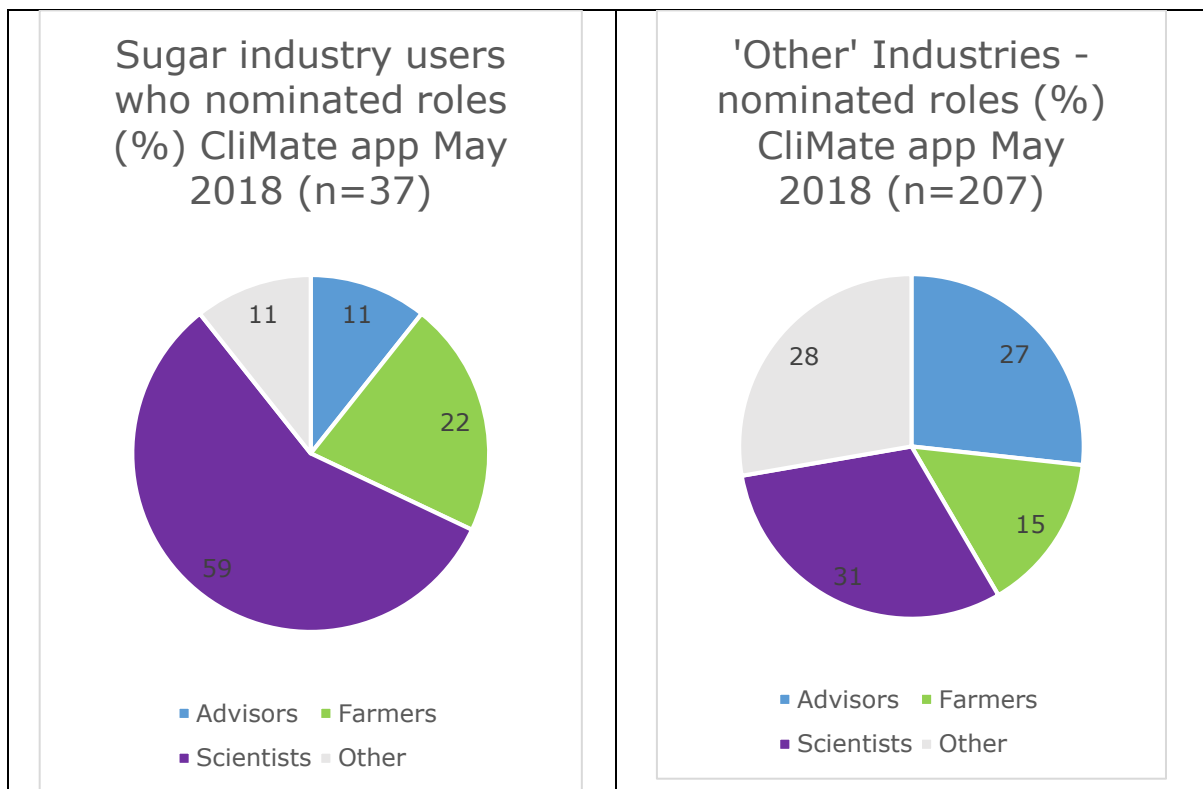


11.3 Survey respondents – Main industries and occupation



11.4 CliMate Users – Industry and Occupation (May 2018)





Animal Production – Registered users

Most registered users working in animal production industries were farmers (73%) or advisors (13%). Ten percent of users working in the animal production industry identified as scientists.

Cotton - Registered users

Thirty four percent of cotton industry registered users who nominated a role were farmers, 42% identified as advisors and 4% as scientists.

Grains – Registered users

Farmers were 57% of the registered users and Advisors were 34% of registered users from within the grains industry. Twelve percent of users identified as Scientists. Four percent of users identified as 'Other' roles.

Horticulture – Registered users

Of the 89 users who nominated as from within the horticulture industry at May 2018, farmers (30%) and advisors (36%) were the major registered users with 17% of users identifying as Scientists and 17% identifying as 'Other'.

Sugar – Registered users

Fifty nine percent of users who identified as belonging to the sugar industry, identified as scientists, 22% as farmers and 11% as advisors.

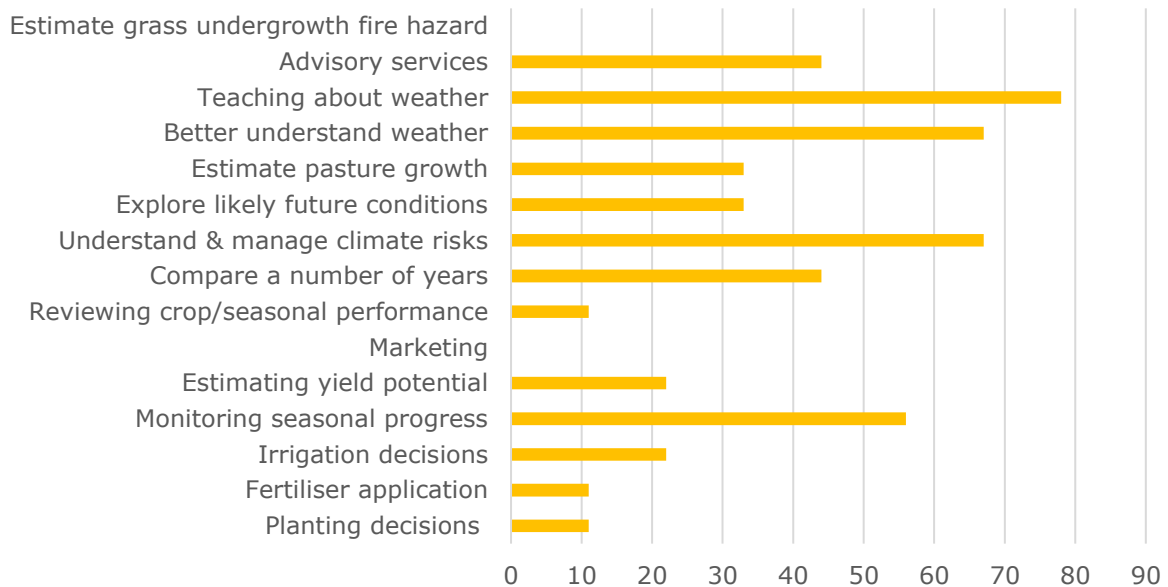
'Other' – Registered users

Registered users who identified as belonging to 'Other' industries indicated that 31% of these worked in roles which included banking, insurance, water management); 28% were scientists, 27% were advisors (e.g. legal, viticulture, land management systems, water management) and 15% were farmers.

11.5 Other sectors' use and impacts (survey data)

11.5.1 Educators' use of the CliMate app

Educators - Reasons for using CliMate app
(%)(n=9)



Educator comments

Excellent resource for your Diploma level training

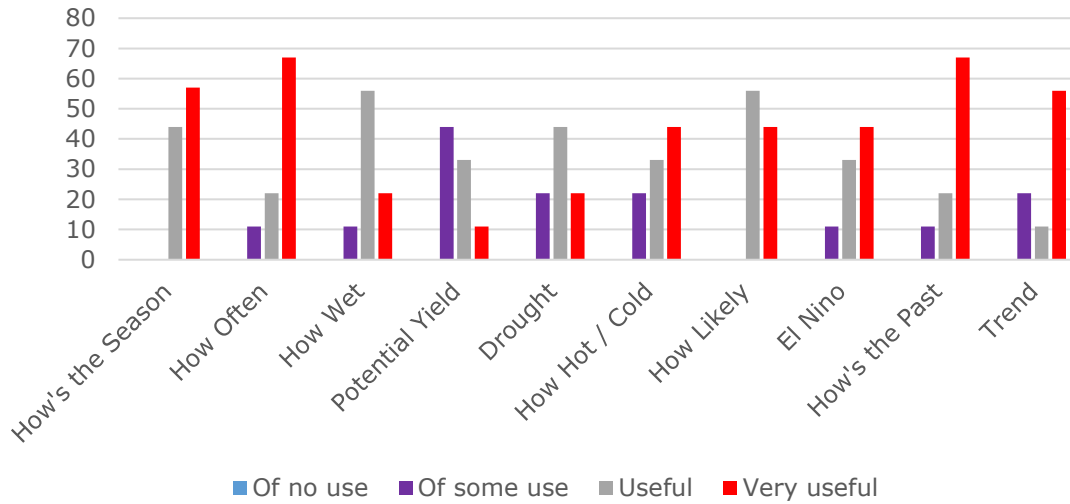
Provides a discussion point about seasonal conditions and outlook with a group of farmers/graziers.

Useful tool to discuss factors affecting climate

I give a lot of talks and use climate to get an understanding of the way the season is going in the places I visit

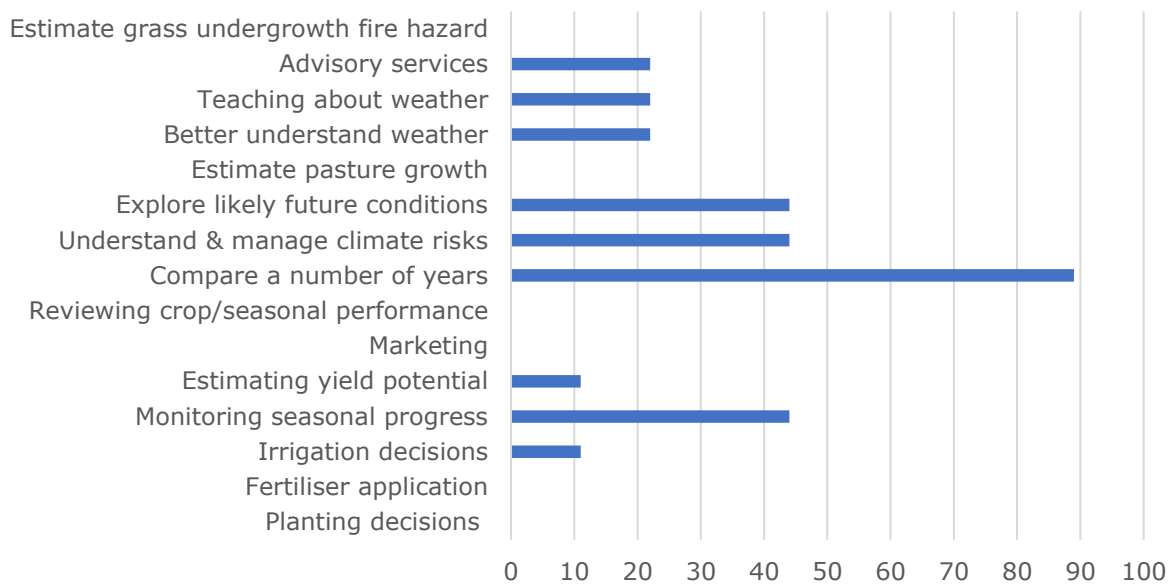
Researching and teaching whole farm planning to VET and HE students

Educators - CliMate app calculations (n=9)(%)



11.5.2 Other roles – use of the CliMate app

Other roles - Reasons for using CliMate app (%)(n=9)



Other roles – comments on use of the CliMate app

Helped decide where to purchase property

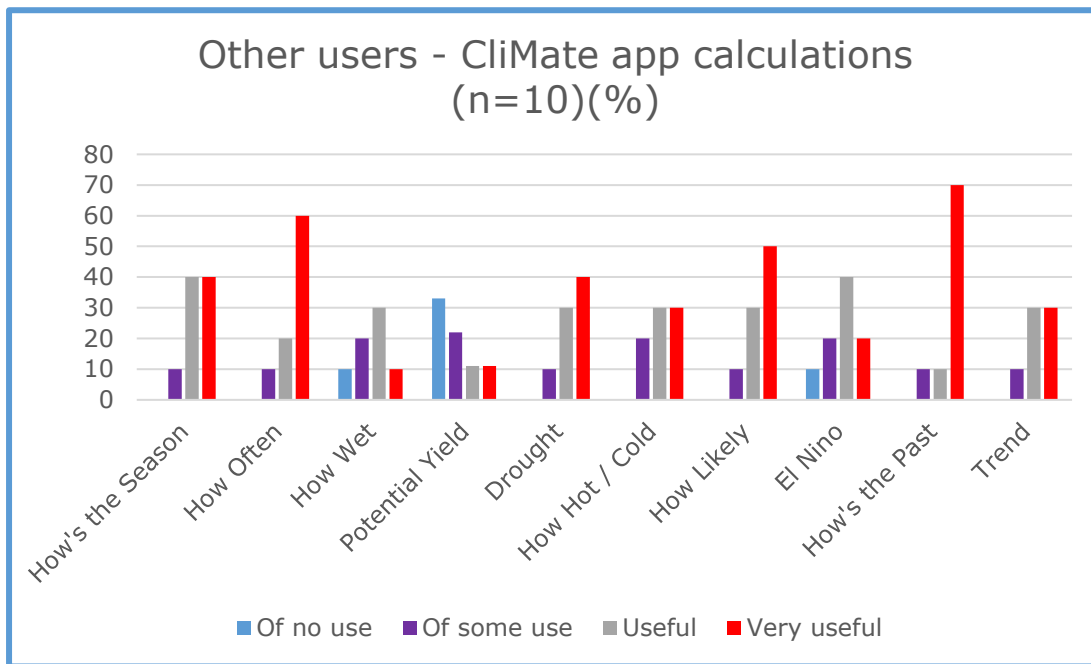
Specifically, being able to view yearly rainfall figures in different areas of the state and being able to see rainfall patterns/ likelihood of rainfall events

Understanding weather patterns in relation to insect pest populations

Climate app is a great visual tool for looking back, across time to see trends etc which has been very useful in a farm business advisory role

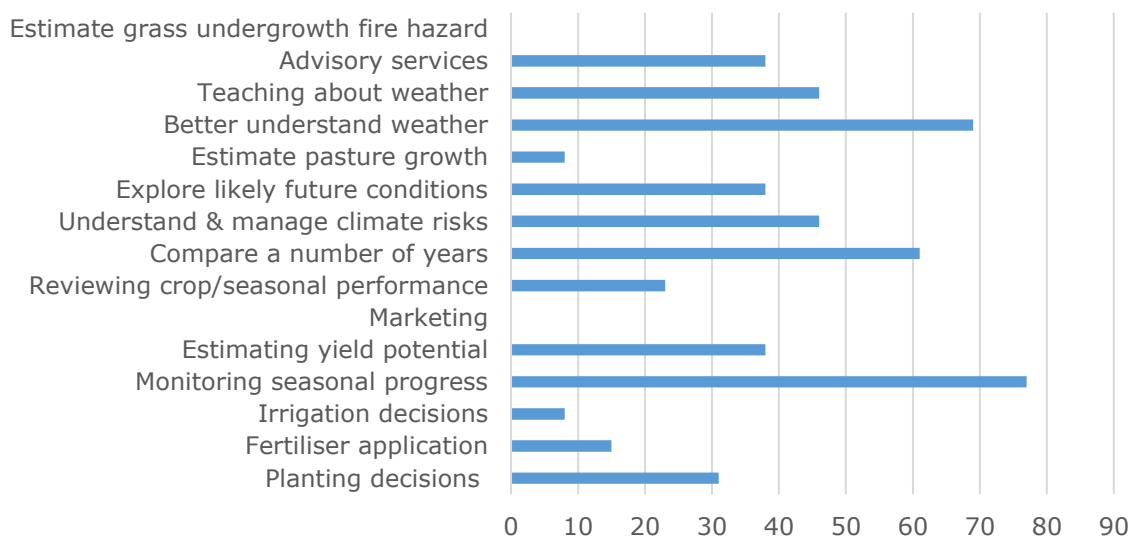
Being able to accurately confirm statements such as 'worst drought in 30 years'. The data in the app provides the statistical accuracy I require

(CliMate) is a single location to get a wealth of information quickly, I use the data in reports, project proposals, presentations etc



11.5.3 Scientists – use of the CliMate app

Scientists - Reasons for using CliMate app (n=13) (%)



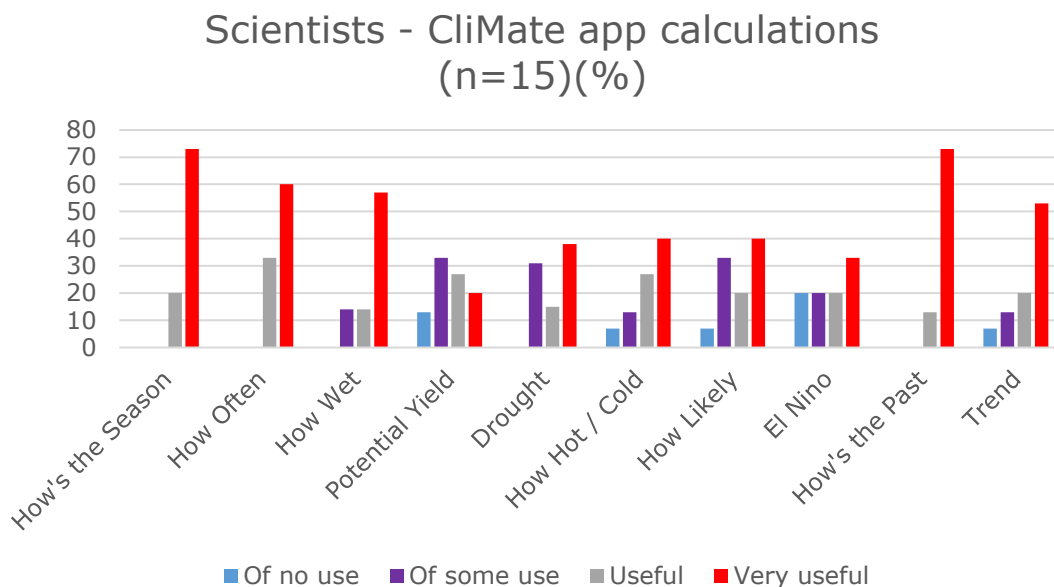
Comments – Scientists’ use of the CliMate app

Able to model seasonal variations in research

Much easier review of seasonal conditions at multiple locations around Australia has improved the understanding of treatment effects in research trials.

Enable ease of analysis & data mining, display of major patterns of climate wet/dry etc

It helps me visualise climate data



11.6 Examples from CliMate users

Grain grower, Dryland Wheat, Cotton, Chickpea – 2000 ha QLD

This participant believes he can fill the soil profile in 12 months but can't guarantee a planting rain. He suggests tools like CliMate are very useful.

'..The What If's (in CliMate)...It's really powerful. Yes I use them all, I love them all. Mainly moisture related...Little bit for the spread of risk. Probably don't spend a lot of time with that.'

'Biggest one for me is our system revolves around resistant chemical. So when I'm looking forward for the end of these crops, I am planning ahead for the next planting opportunity and residual chemical particularly for the summer weeds.... How Often – what's the opportunity of getting so much rain in that period of time – has a double effect, it's a planting opportunity and when does the residual chemical stop, when do I have to reapply and at that point, if I put on a particular chemical, am I cutting myself out of a planting opportunity.'

'CliMate has just made it a lot easier, simpler and quicker. You can run a whole lot of scenarios so quickly...you know you just develop a better picture'.

This participant incorporates CliMate data into his budgets, including extreme scenarios. He talks to his agronomists about Climate output.

Agronomist, NSW

'I like looking at how the seasons progressing, following potential trends and it helps explain some of the things I'm seeing in the paddock as far as temperatures. If you look at last year, how the chickpeas were progressing flowering, nothing flowered until the temperature hit 15 degrees. You can track those trends. 2014 didn't get any rain until March, just being able to use the app to show the seasons' progress.

I can show fallow soil water efficiencies and potential nitrate mineralisation based on the summer as well. (ClimMate is) just handy to show how it generally trends with the season.

(It is) more in the background and creating and helping the discussion with growers....absolutely (it's about) having the data, a figure to show. I think the temperature outlooks are pretty handy, too, especially with irrigation, we do utilise that a bit.

I use Seasons Progress, How Wet, How Often, Temperature, How Likely – we use that in May – how likely to get a 20 mm rainfall event over the next 15 days that's a good demo tool. And How's the Past.

(ClimMate is) a handy tool, I can pull out the past, forecast the future based on the past, start a discussion based on the past, have a discussion. Just having the rainfall, having an idea of how likely a certain rainfall event is, e.g. need 40 mm rainfall to plant, can have a discussion with grower - it might be only 30% chance of that happening'.

Farmer, 1500 ha grain (also livestock) VIC

During the growing season, this grower will consider how well crops are going to finish and try to tailor some inputs based on that. '(I) try to model, looking forward what likelihood what yield levels we might be expecting and try to match nitrogen decisions during the growing season to that. If we've got good levels of soil water, I would top dress urea. I am not wanting to apply too much nitrogen because that might risk having hayed off crops and that's not very economic. We're trying to gauge what confidence levels are at those (decision) points'.

This participant uses ClimMate in making crop rotation choices, Nitrogen rate decisions, and fungicide spray decisions, and uses How Likely at sowing time, 'I think based on average soil water, I can grow a crop with 200mm of growing season rainfall. I think how likely are we to get 200mm of rainfall from April to the end of October. That's one you might peg against your starting soil water. If you're starting with a high figure, you can get away with less growing season rainfall. You work those two different sources of information together to get an overall level of confidence'.

'For any given point in the season, (I am) doing the How Likely scenario e.g. say in August, (I've) got a reasonable crop there, (I'm)... thinking how likely we're going to get 30 mm in September and then 30 mm again in October. The ClimMate App averages those months. (You've) got some level of confidence you're going to receive that rain over those two months'.

Contractor and farmer, grain, cattle, contract spraying SA/WA

This participant's family were looking to purchase another grain farm. He used the ClimMate app (which he heard about when he attended ag college) to check the average rainfall and distribution of average rainfall throughout the year for

each location where he considered purchasing a property and set up his contracting business.

CliMate was the only source of weather information he checked for each potential property and it was the first thing he checked on.

Using How's the Past he identified that locations across the southern wheat belt actually had slightly differing rainfall distributions; his family purchased a property in a location which had slightly more reliable and regular winter rainfall.

He plans to use the App to help potential clients consider weather probabilities more seriously in their spray decisions.

Banker, NSW

At his previous (non-rural) bank the credit team had no rural experience and the CliMate app was used to demonstrate the season's progress so far, what moisture was in the soil and what range of possibilities the future might hold. It provided a level of detail and back up evidence in terms of cash flow budgeting (beyond a push probe)... and justification also for lending decisions. This occurred mainly in wetter seasons and showed full profile or not full and this participant was able to indicate to the team that this area required around 75 mm of rain in order to plant (looking at it from cash flow perspective rather than new lending).

The app was used in Mackay, Rockhampton, Moree, Dubbo, and Tamworth. It enhanced the team managers' ability to communicate with this team and help to understand variations between regions – such as Ayr, Wagga and Moree. This participant believes it would be great if rainfall could be imported from farmer weather stations. A farmer could have 3 properties in all different directions, each with their own weather station. The participant is also wondering how the different apps and technologies are going to be synchronised.

Beef Cattle Producer and irrigated forage crops, NSW

This participant uses CliMate to provide rainfall probabilities to help with decision making. *'Just last week (we) looked at probabilities of major rain events e.g. the chance of 100mm between 28 Jan and 28 Feb for decisions on selling our breeding cattle in the current drought. Given the serious drought condition now and the very low probability of major rain events which are needed to alleviate these severe conditions (with less than 5% chance) we made the decision to sell. Happy with this data and help (for) us (to) make an informed decision'.*

The producer uses How's the Season, How Often, How Likely and How's the Past most often. He finds most actions in CliMate easy but has some difficulty understanding graphs or saving graphs and some difficulty seeing the output on the iOS mobile phone. He has not used help or library links.

Salad Vegetable Growers

Use the CliMate app to predict the harvest date of crops. Use How Likely, El Nino, How's the Past and What Trend to help with production of leafy salad vegetables. *'It hasn't impacted yields but has been very useful in justifying yield estimates and for determining if this year is an anomaly or not and should the "days to maturity" recorded this year be used as a proxy for next growing season or is it an outlier and should be removed from the dataset when predicting next year's harvest dates and yields'.*

They don't use How Hot How Cold, How Wet or Potential Yield – because they don't understand these. The participant has used the Help files.

Beef Producer, NSW

Plant approximately 100 ha of oats each year. The main reason for using CliMate is to predict during autumn if there will be sufficient feed over winter. *'If we think there will be enough feed over winter we will keep our weaner steers to be sold as yearlings; if the soil moisture levels are low during autumn we will sell the steers at the weaner sales'.*

The participant uses How's the Season, How Often, How Wet, How Likely, How's El Nino, How's the Past, and What Trend. They indicate they have some difficulty understanding graphs. They initially heard about the app when studying at Tocal College. They suggest worked examples may help people understand how Potential Yield is used.

Beef Advisor, NSW

Last spring in Wagga, moisture was declining and feed was declining. This participant used CliMate to look at probable rainfall to assist with feed budgets. Their client had 1000 cow herd. He bought feed in September to get him through the next 6 months. He got more rain than projected so didn't need feed but the cost of tactical management insured against far greater potential losses if no action.

Mining, WA

This participant works in the mining industry and uses CliMate to access historical data and current data quickly and easily. They use the app to track the current season and to provide data for presentations. They heard about the app from a colleague. Generally they find graphs 'somewhat easy' to understand.

Wine grape grower, VIC

This participant uses How's the Season, How Often, How Likely, How's the Past, and El Nino. The tool helps with irrigation decisions and planting. They are currently looking at a project to estimate harvest dates based on heat sum and averages for wine grapes across cool climate regions of Victoria. The grower uses the web version of the app, heard about it firstly on social media, and mostly finds it 'somewhat easy' to use.

Consultant, Sugarcane, QLD

'Many farmers do not have the time or understanding about weather forecasting tools; as such CliMate helps me to make farmers aware of the potential risks associated with rainfall'.
(I've used CliMate in) 'sugarcane, 3000 ha, making decisions about likely irrigation allocation and how to manage the predicted limited irrigation allocation prior to it occurring'. This participant particularly likes How's the Season, Drought, How Likely, El Nino and What Trend.

Insurance user

Operates across the grain belt from Qld through SA and WA with wheats, lupins, canola, vetch, oats, barley, canary, triticale, rye, broad beans, faba beans, chickpeas, hay etc.
We use the CliMate app to collect current and historic rainfall data and to look at what the moisture levels are in the ground. We then use the results as part of our decision making process and pricing...We work out our pricing partly based on the average rainfall for that area. If the actual rainfall is below or above average and if there's any significant changes from the average, that will all affect the decision making and pricing of our product for that area.

Knowledge is power... The more information you can get out of the website the better, for example, learning about potential yield or how wet...Management showed me areas I had not looked at yet and then we sat down and discovered other little useful areas.

We would generally use How wet if (we were) unsure of one area...e.g. what was it like May to November, was there enough soil moisture last year, has there been enough rainfall over the last period to give enough soil moisture for this year'

Vegetable seed producer

This producer heard about CliMate from an article. They use the CliMate app to 'help determine climate risk for placing crops in different geographies. We produce hybrid vegetable seed, and need to get the parent lines flowering at the same time. We run flowering trials in one location, and need to interpret that information to other regions, and use CliMate to help extrapolate. If we don't get flowering to match, we can be heavily penalised for yield or inbreds'.

This grower uses How Hot/Cold, How Likely, How Often, How's the Season.

They believe there is insufficient information available for them to use the 'Drought'. They've had some difficulty choosing a new location and have found the Help section 'somewhat useful'

They suggest it would be useful to compare two locations on the one graph, e.g. in How's the Season, to compare 2 locations in a single year. 'Also, it would be nice to see a map with the weather station locations.'

Agricultural Researcher, QLD

This researcher manages a series of long term trials and seasonally presents to 100-200 growers and advisors. He uses CliMate to provide seasonal information for presentations 'When I say I am using CliMATE, everyone seems to nod and say Ok - he's using something acceptable. If I was asked what I am using and I said just nothing specific, the credibility would be much reduced'.

He also uses CliMate to plan out planting times and crop rotations - 'We're at x soil water now what is the likelihood of getting to Y soil water in 2 months time. That's a little bit around the planting trigger but also around the tactical, should I apply in-season N. That is the likelihood. Will we get 8 inches of rain to plant our next crop?... There is no recording in climate, it is all what if scenarios.

The only suggestion - retrospectively I'd love to have a selection of dates where I can choose anything in the history of my subscription or use of the app - what is the cumulative rainfall for this date to that date, what was evaporation, run off. That way it could calculate a fallow efficiency or estimate; or I can't remember writing down the starting soil water for sorghum 2 years ago - at that planting date for the preceding fallow, can I go back to access that. That would be useful for me.

From a research point of view...as a predictive and scenario planning tool, it is good'.

Agronomist, NSW/QLD

'With growers talking about the season. I PARTICULARLY like comparing the seasons, all seasons, tracking this years' rainfall vs other seasons' rainfall and having a quick snapshot of how this year compares with maybe 3-5 other seasons. It's pretty handy.

Growers have been around for a while, if you pick a year, 1998, 99, it was a wet winter, 2002 – 2003 dry period. It's nice to map it. This year is like 2007, it was a dry year.

We look forward. We'll see what happened in those years, e.g. in 2007 it broke in December... We try not to make too many management decisions.

It's more just about having a conversation with the growers (based on CliMate stats)'.

Agronomist, VIC

This participant works with grain growers and grower groups and uses the CliMate app to see where the season is in terms of historical rainfall. He looks at historical instances of frost or heat – the risk profile of things happening from previous years. (You) *'don't have that with the BOM sites. Historically it is hard to bring it up with BOM'.*

He looks at radiation to explain crop performance. *'Last season we were sitting on the lowest sunlight, solar radiation levels we had been for quite a while, that we could remember and it matched up with the radiation data too. It was good to be able to explain things in the paddock and why crops were doing what they were doing.'*

'(It) gives you confidence with decisions you make or you know the compromises... you are going to take on risk, doesn't matter what you do farming. It's just a matter of being aware of likely outcomes..... As long as you have the information there, you know where you are at before you started.

'Gut feel (about risk)... may not be correct. It's good to be able to say (e.g. to an older generation farmer)...we're sowing our wheat on 20 April but we've got the variety to fit that window...we know when it's going to flower. The risk of a frost that time of the year is pretty minimal'.

He incorporates CliMate data into his reports and sometimes sends screenshots to growers.

Grain grower broad acre Cropping 5000 ha WA

A big decision during the growing season is top up nitrogen in cereals and canola crops, and how much and how often to apply, especially towards the season's end if it is particularly good. *'Mid July is typically the top up of nitrogen but if we make a decision to apply more it could be August if the season is looking really good. That would be a top up above our budgeted application. .. The last application might be up to 20 units if the season is looking really really good. That probably only happens 20 or 30 % of the time....There's a lot of variables to consider.*

That's where decision making tools like (CliMate) can help because we can look at the year to date and see what the chance is of getting x more mm of rain according to historical information or the models.

Mainly for me (using the CliMate app) - it's later in the growing season, to look at the possibility of different outcomes in the finish. There's not a lot you can vary up front.

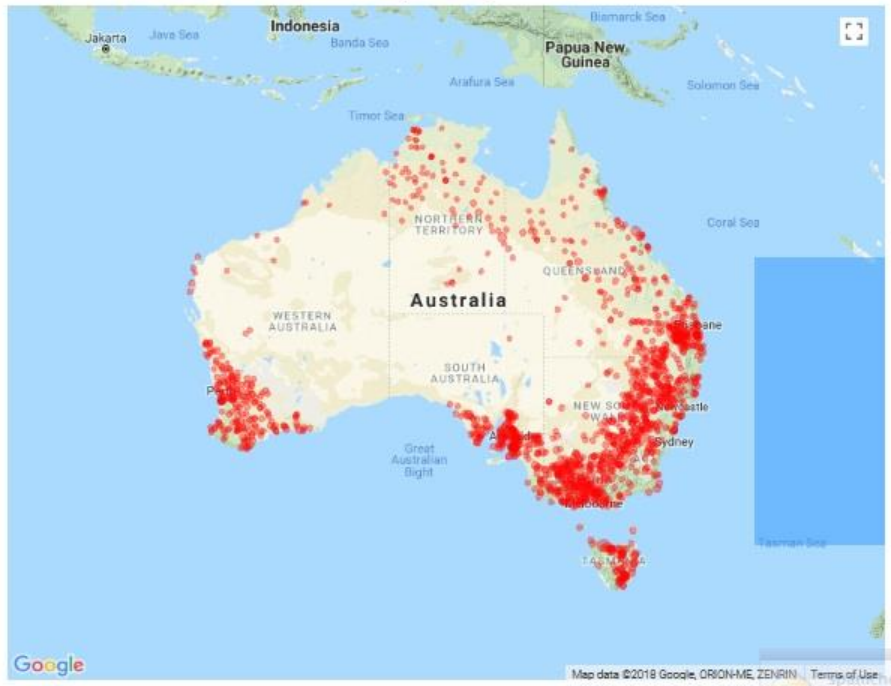
We can suffer badly from spring frosts at flowering.....we are a little torn between getting early establishment and getting frost damage in spring. I've been particularly looking at (CliMate) because there's been a massive increase in the number of frosts recently.

The idea (is) – have some historical evidence at our fingertips. That's what I like about this. There's a whole heap of good data behind it which is easy to extract and use. I like it because it just saves me mucking around with spreadsheets with years and years of data.....good to have it in a chart or a graph...(to show) historical data in the visual form'.

11.7 CliMate Individual Analyses statistics

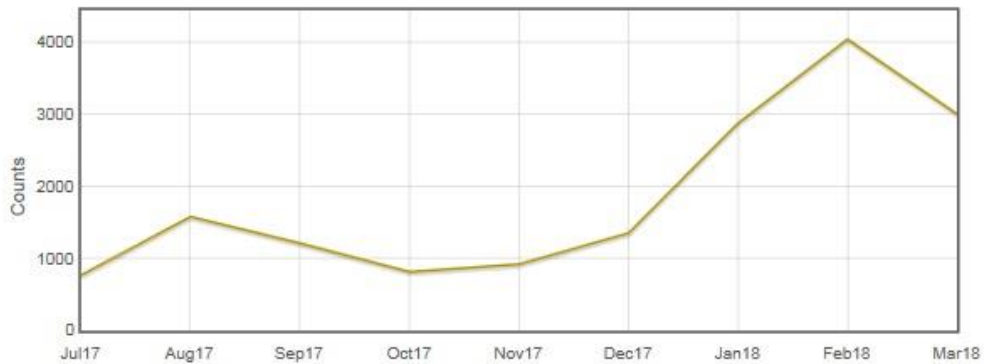
11.7.1 How's the Season

How's the Season Calculations
(n=16610)

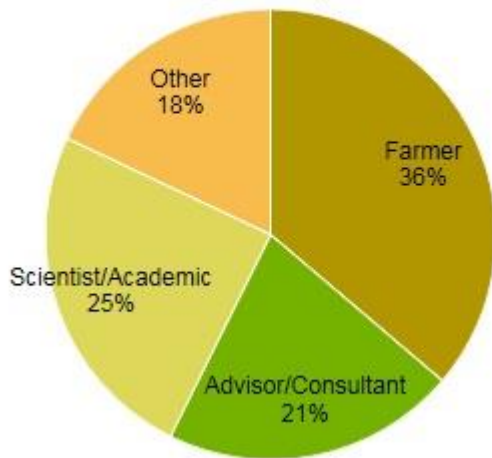


Analytics Reporting Period: July 2017 to March 2018

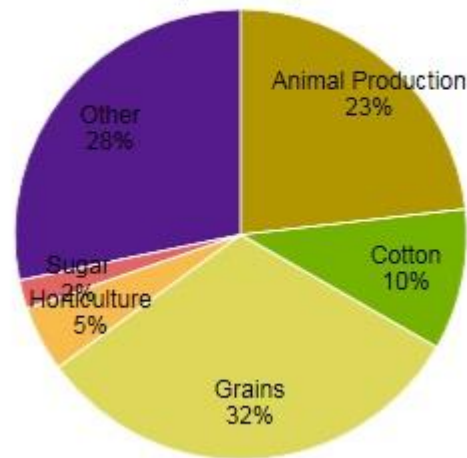
How's the Season Calculations
(n=16610)



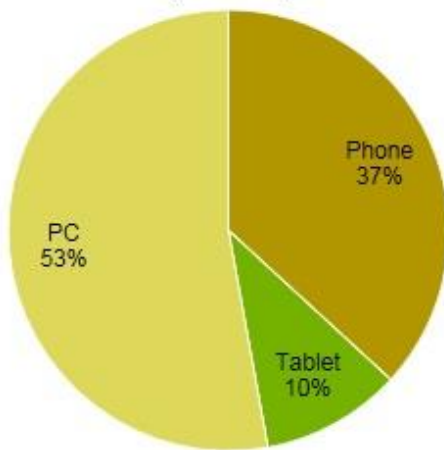
How's the Season Calculations grouped by Occupation (n=13233)



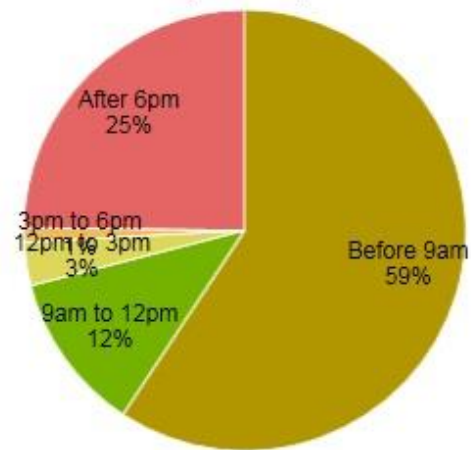
How's the Season Calculations grouped by Industry (n=13539)



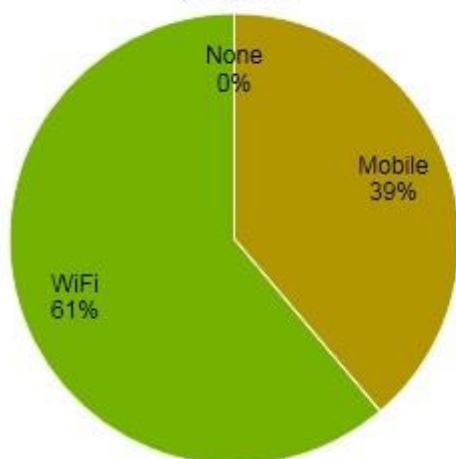
How's the Season Calculations grouped by Device Type (n=16410)



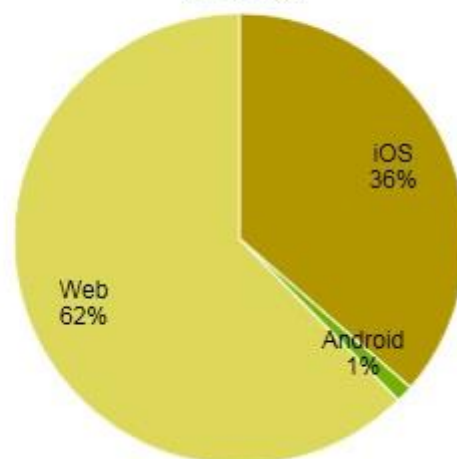
How's the Season Calculations grouped by Time of Day (n=16610)



How's the Season Calculations grouped by Connection Type (n=5929)

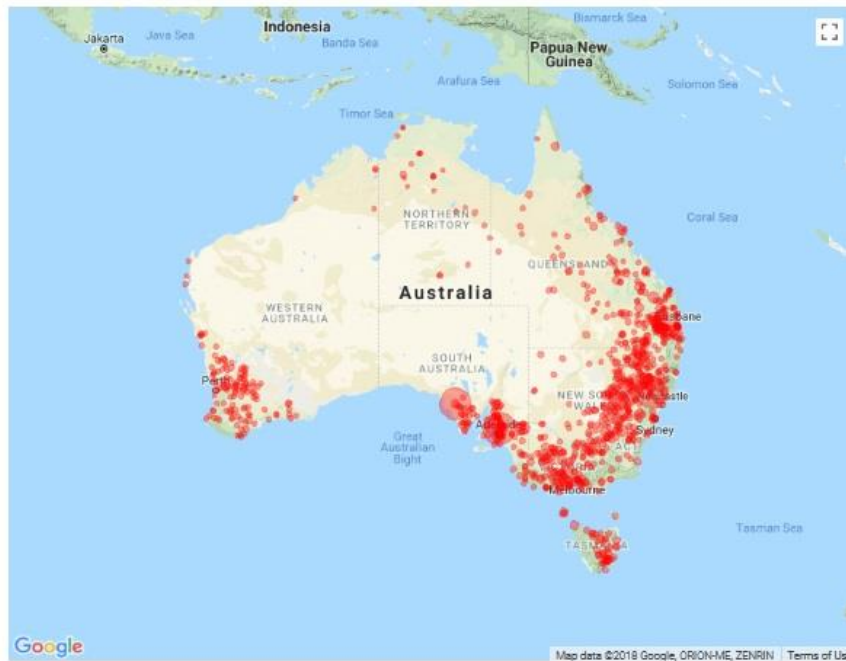


How's the Season Calculations grouped by Platform Type (n=16285)



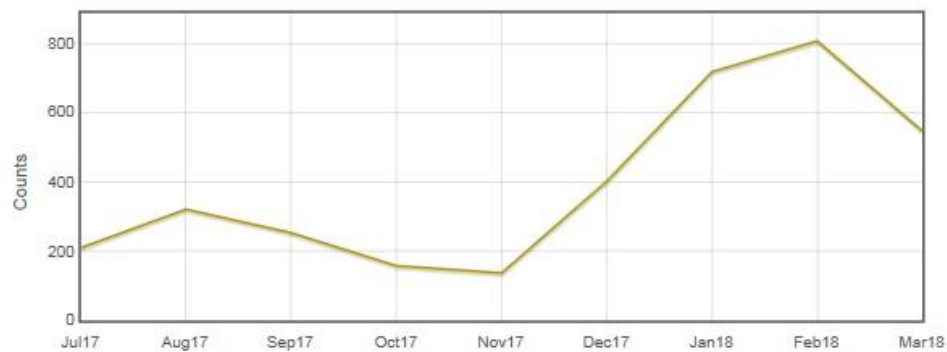
11.7.2 How Often

How Often? Calculations
(n=16068)

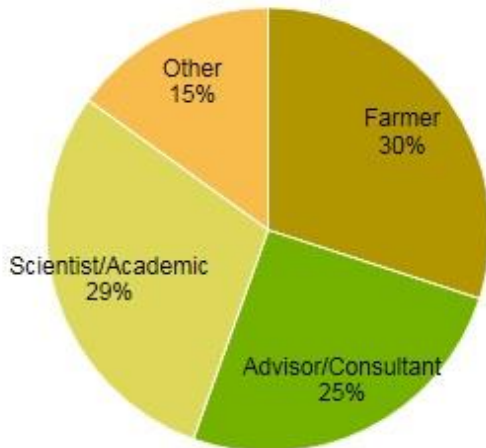


Analytics Reporting Period: July 2017 to March 2018

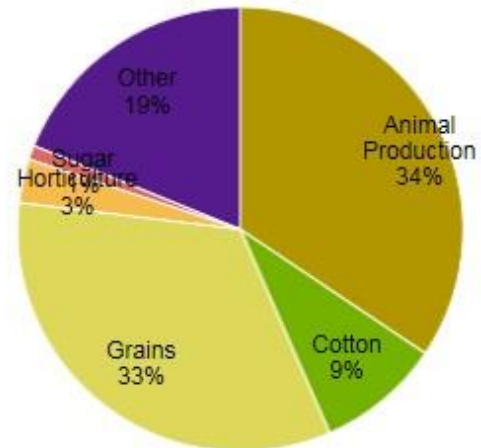
How Likely? Calculations
(n=3553)



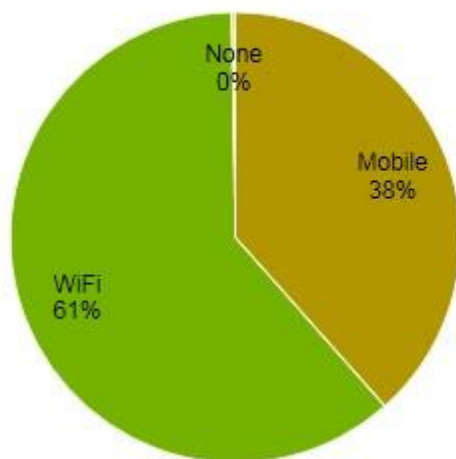
How Often? Calculations grouped by Occupation (n=13419)



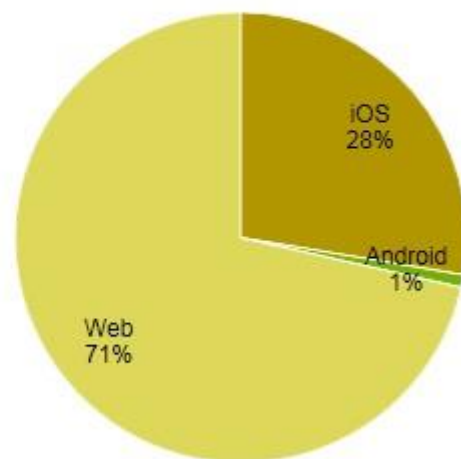
How Often? Calculations grouped by Industry (n=13667)



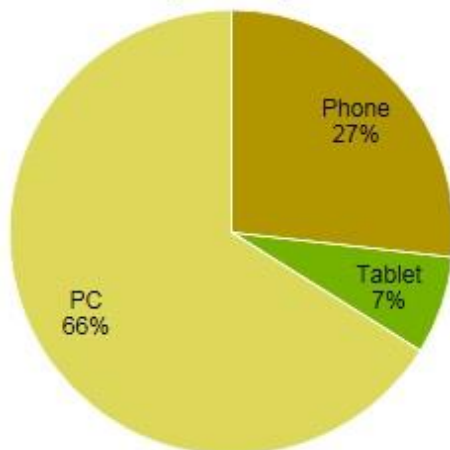
How Often? Calculations grouped by Connection Type (n=4333)



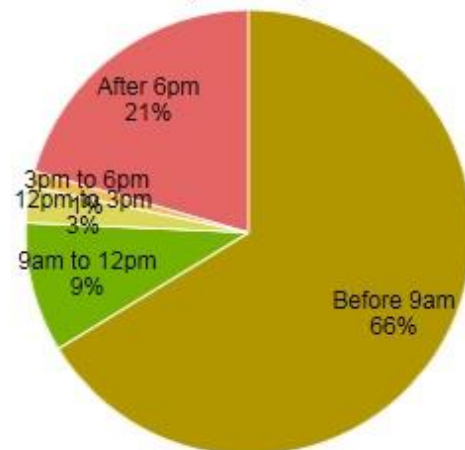
How Often? Calculations grouped by Platform Type (n=15673)



How Often? Calculations grouped by Device Type (n=15927)



How Often? Calculations grouped by Time of Day (n=16068)



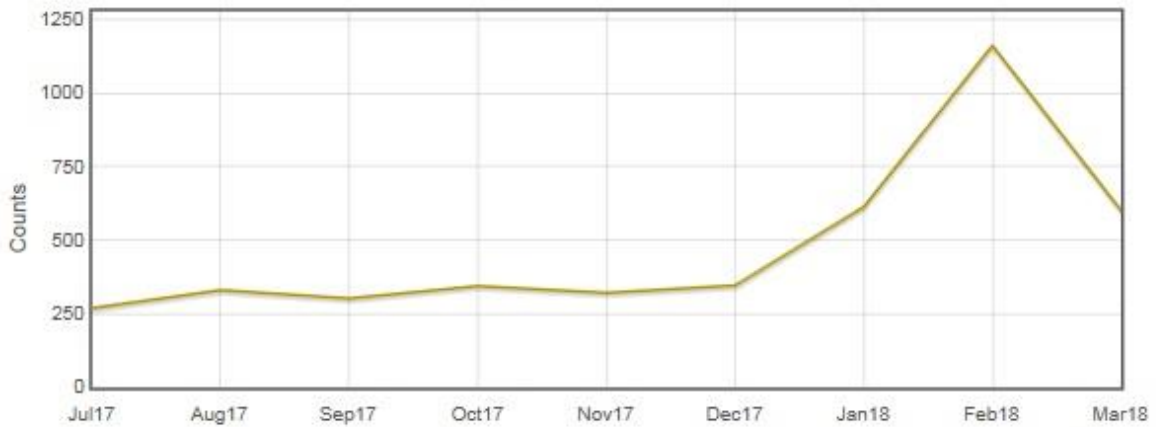
11.7.3 How Wet/Nitrate?

How Wet/Nitrate? Calculations
(n=4296)

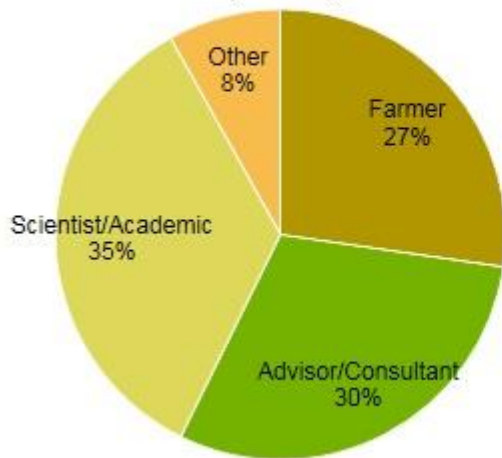


Analytics Reporting Period: July 2017 to March 2018

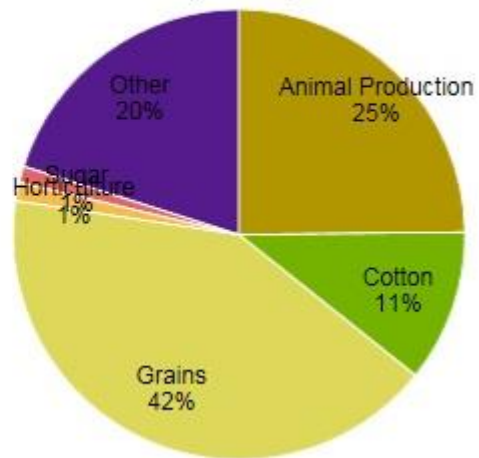
How Wet/Nitrate? Calculations
(n=4296)



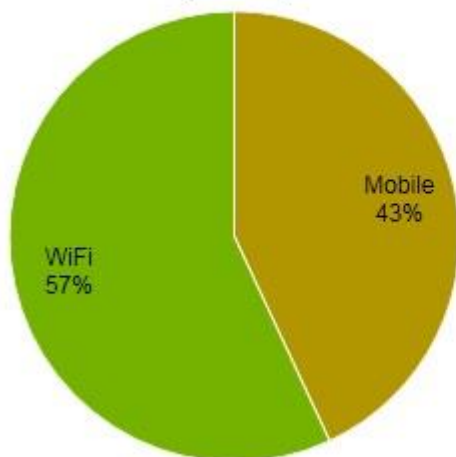
How Wet/Nitrate? Calculations grouped by Occupation (n=3398)



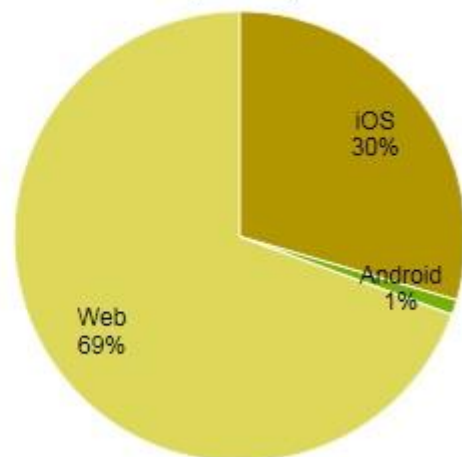
How Wet/Nitrate? Calculations grouped by Industry (n=3433)



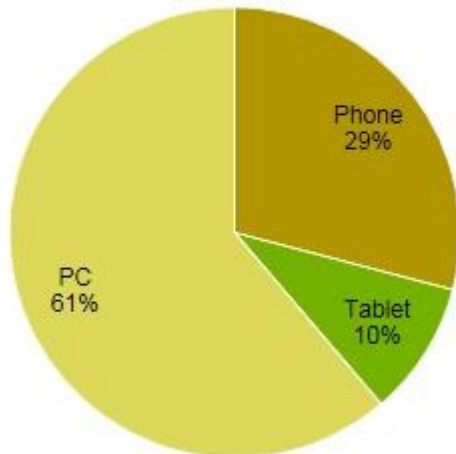
How Wet/Nitrate? Calculations grouped by Connection Type (n=1224)



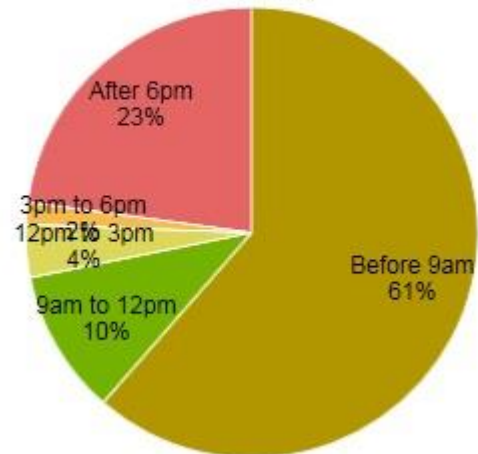
How Wet/Nitrate? Calculations grouped by Platform Type (n=4143)



How Wet/Nitrate? Calculations grouped by Device Type (n=4251)



How Wet/Nitrate? Calculations grouped by Time of Day (n=4296)

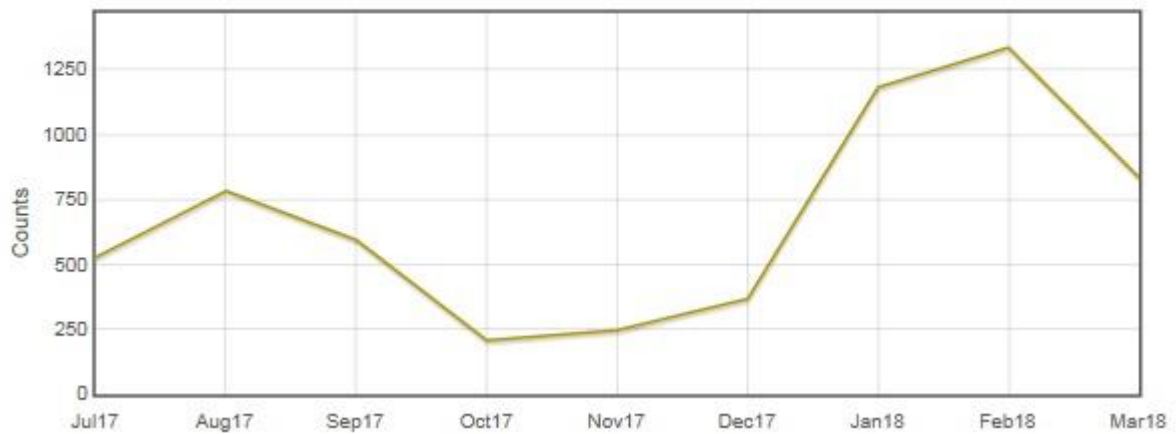


11.7.4 Yield Potential

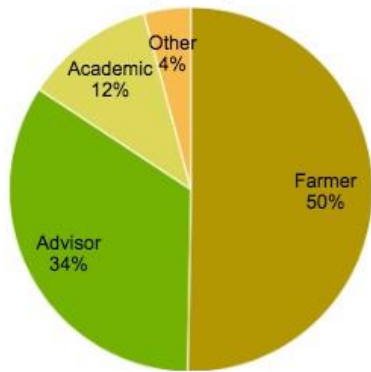


Analytics Reporting Period: July 2017 to March 2018

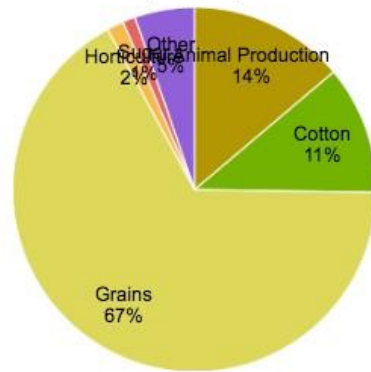
Potential Yield? Calculations
(n=6080)



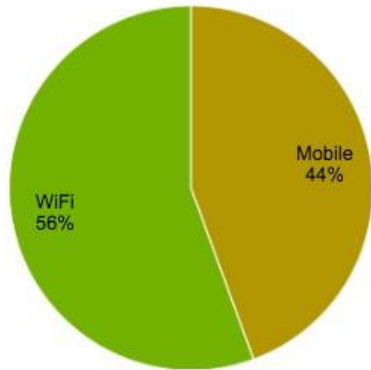
Potential Yield? Calculations by Occupation
(n=5646)



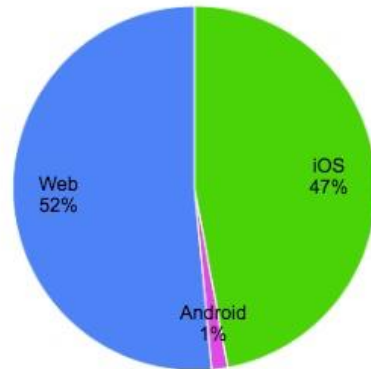
Potential Yield? Calculations by Industry
(n=5717)



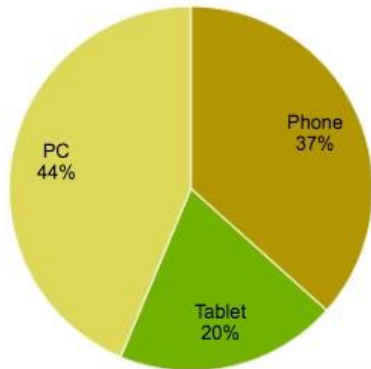
Potential Yield? Calculations by Connection Type
(n=2907)



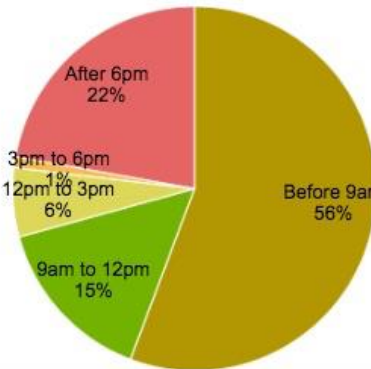
Potential Yield? Calculations by Platform Type
(n=6175)



Potential Yield? Calculations by Device Type
(n=6239)



Potential Yield? Calculations by Time of Day
(n=6326)

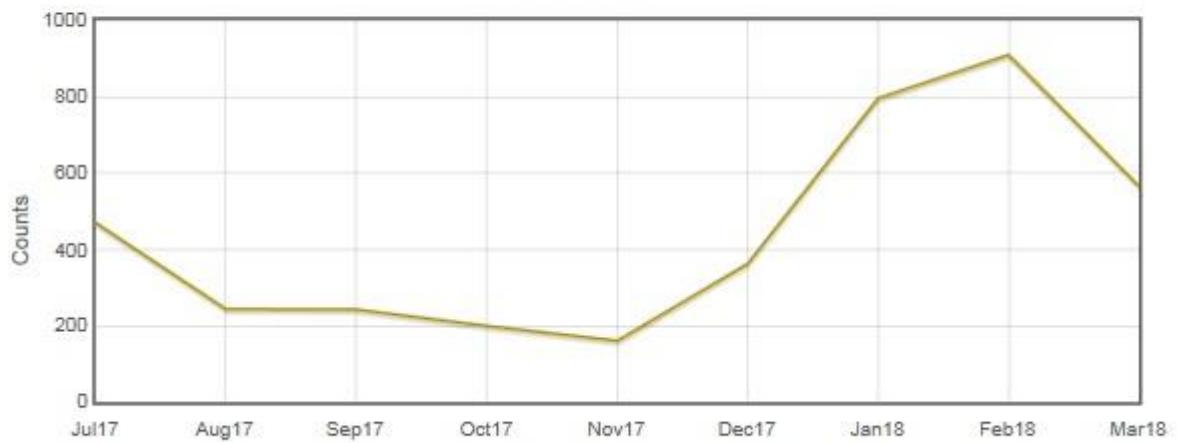


11.7.5 Drought

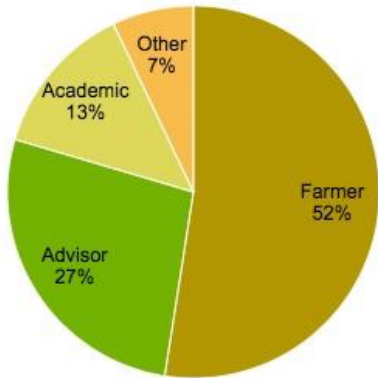


Analytics Reporting Period: July 2017 to March 2018

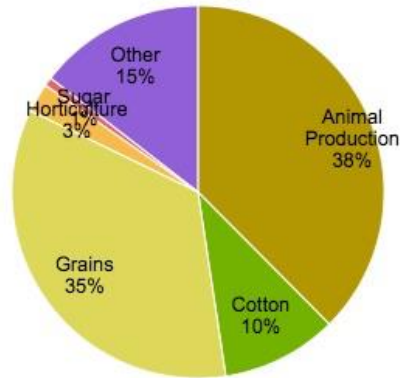
Drought? Calculations
(n=3953)



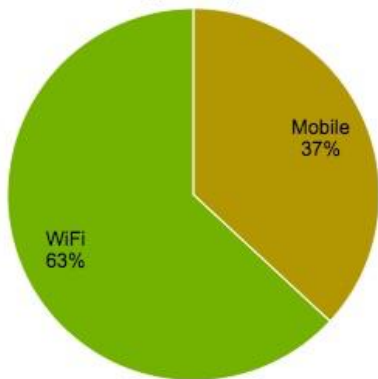
Drought? Calculations by Occupation (n=3444)



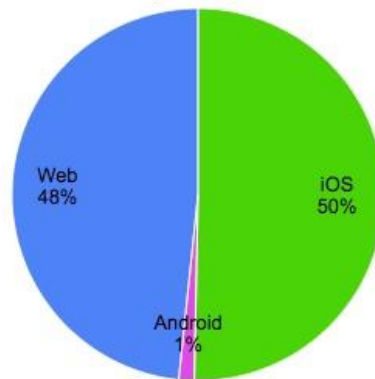
Drought? Calculations by Industry (n=3474)



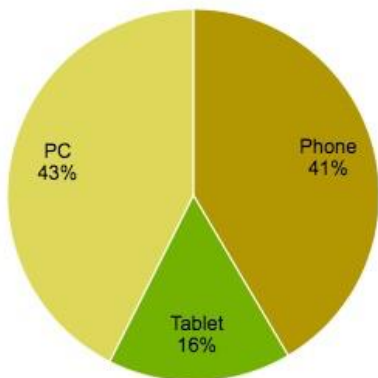
Drought? Calculations by Connection Type (n=1957)



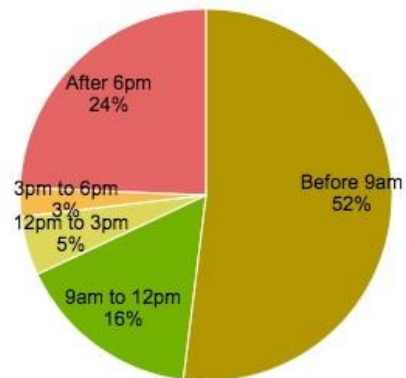
Drought? Calculations by Platform Type (n=3889)



Drought? Calculations by Device Type (n=3892)



Drought? Calculations by Time of Day (n=3944)



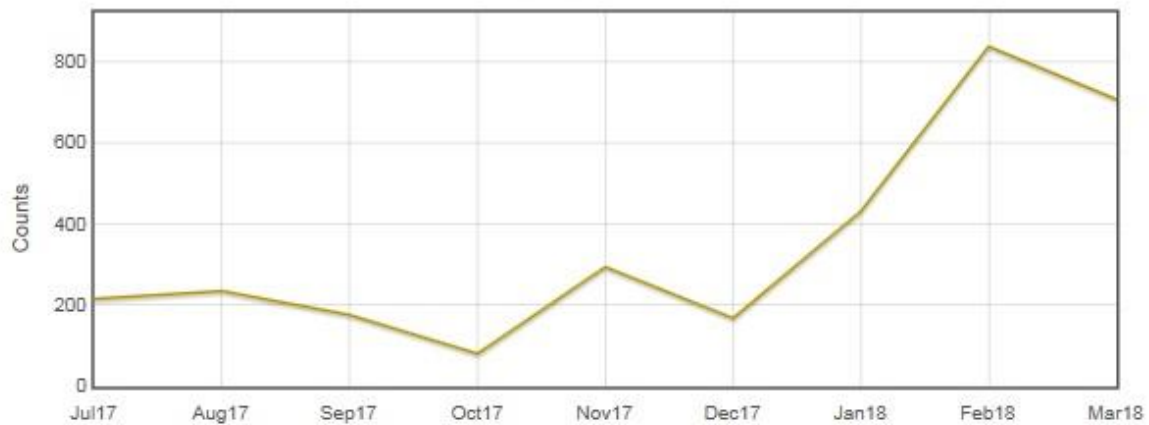
11.7.6 How Hot/Cold?

How Hot/Cold? Calculations
(n=3143)

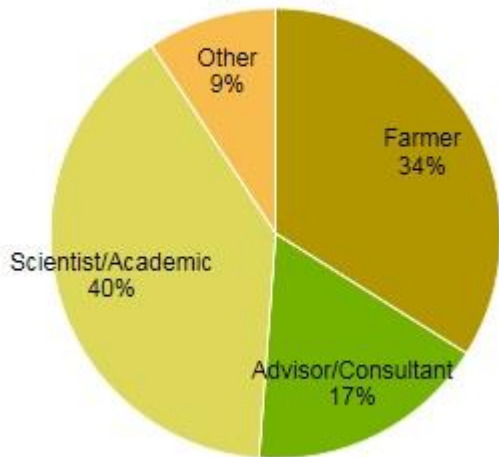


Analytics Reporting Period: July 2017 to March 2018

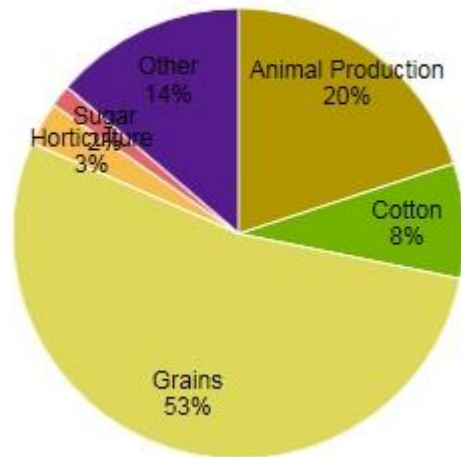
How Hot/Cold? Calculations
(n=3143)



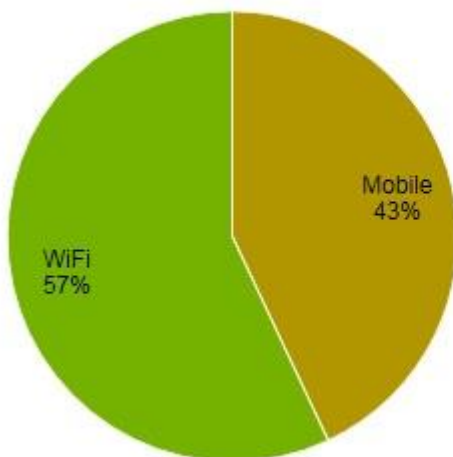
How Hot/Cold? Calculations grouped by Occupation (n=2288)



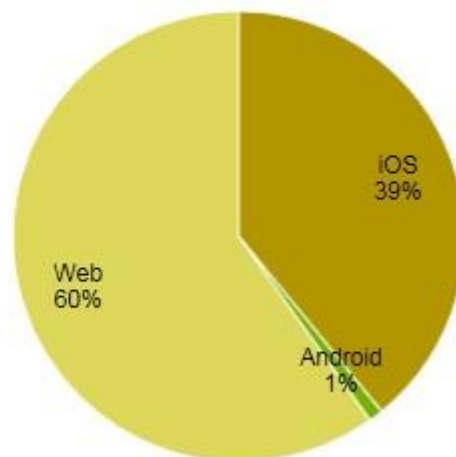
How Hot/Cold? Calculations grouped by Industry (n=2330)



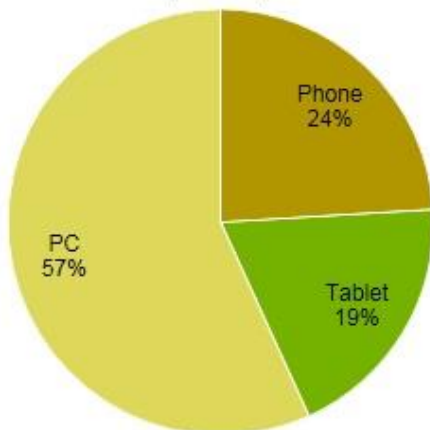
How Hot/Cold? Calculations grouped by Connection Type (n=1179)



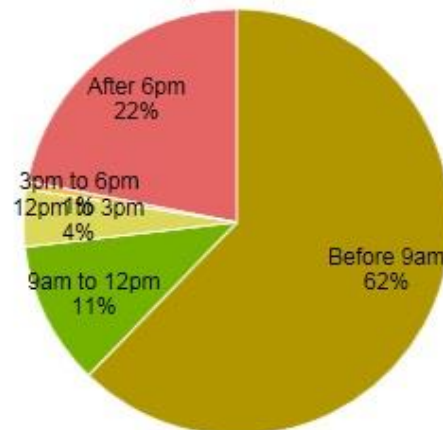
How Hot/Cold? Calculations grouped by Platform Type (n=3013)



How Hot/Cold? Calculations grouped by Device Type (n=3112)



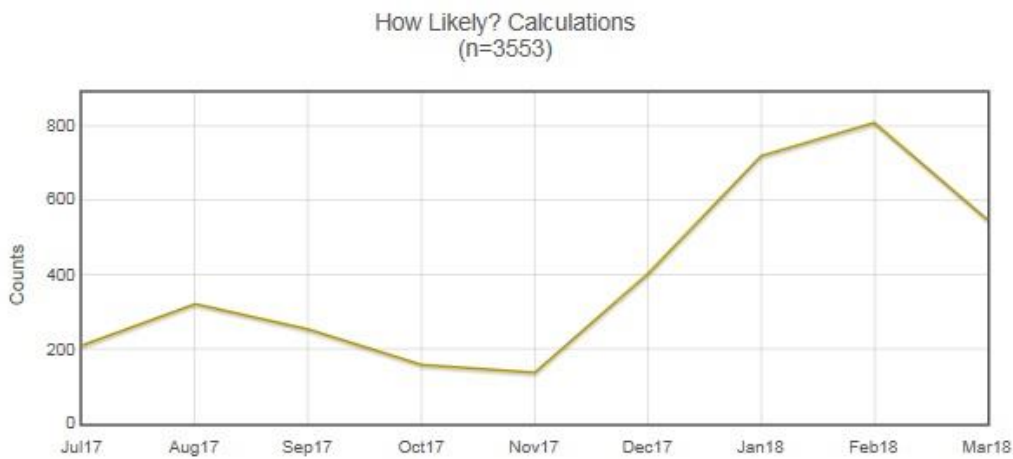
How Hot/Cold? Calculations grouped by Time of Day (n=3143)



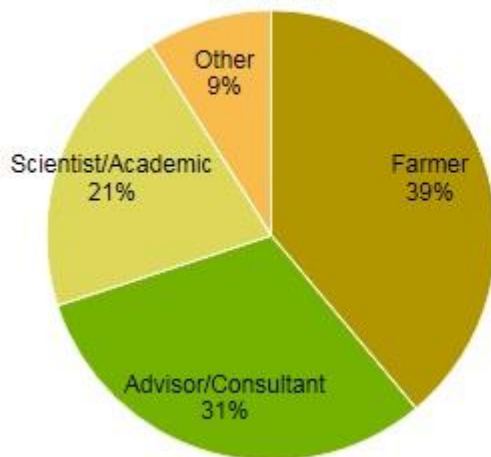
11.7.7 How Likely?



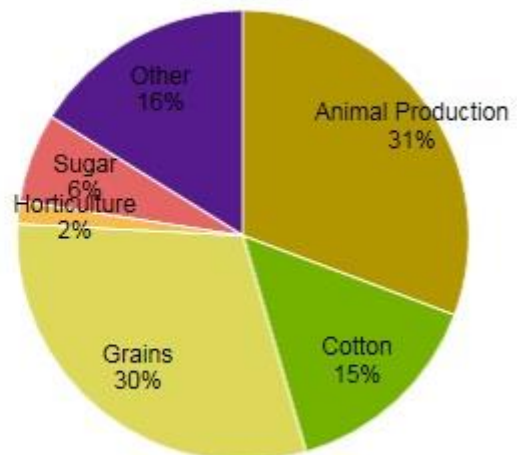
Analytics Reporting Period: July 2017 to March 2018



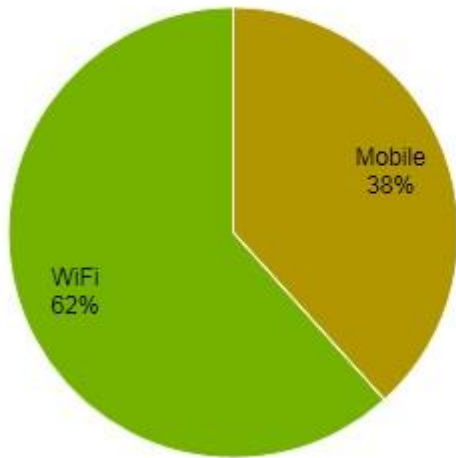
How Likely? Calculations grouped by Occupation
(n=2740)



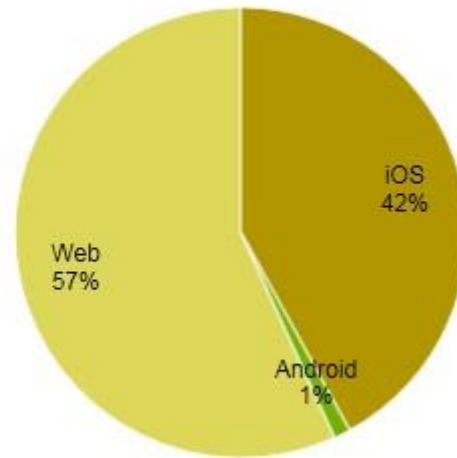
How Likely? Calculations grouped by Industry
(n=2750)



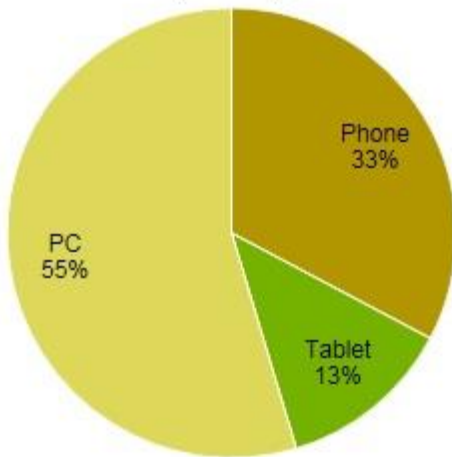
How Likely? Calculations grouped by Connection Type (n=1441)



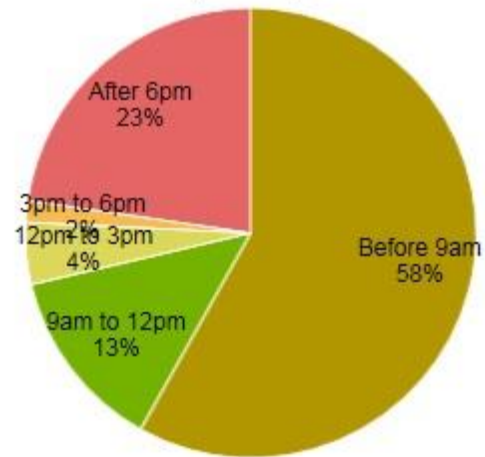
How Likely? Calculations grouped by Platform Type (n=3430)



How Likely? Calculations grouped by Device Type (n=3512)



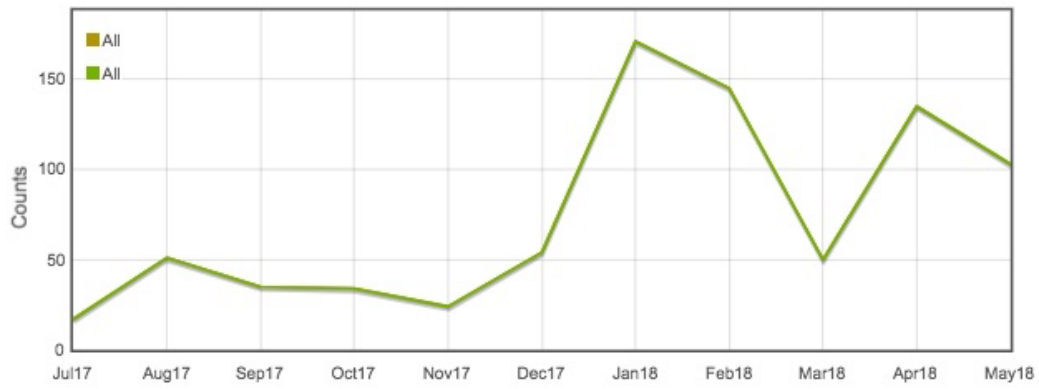
How Likely? Calculations grouped by Time of Day (n=3553)



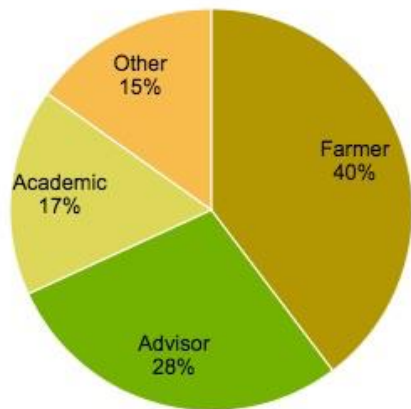
11.7.8 How's El Nino

Analytics Reporting Period: July 2017 to May 2018

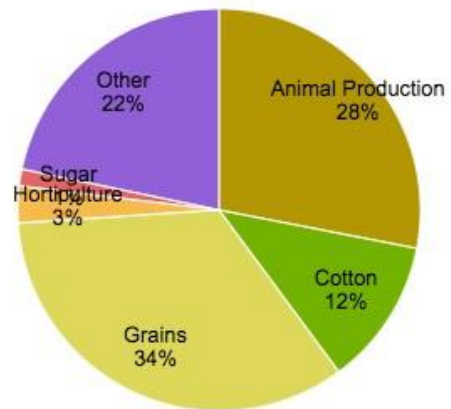
How's ENSO? Calculations
(n=819)



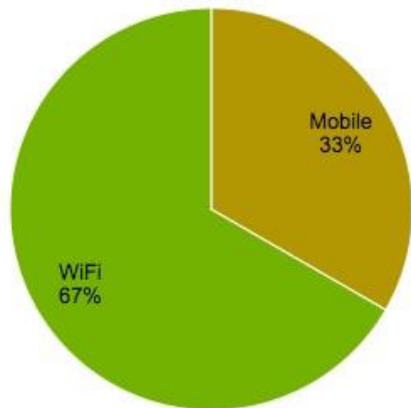
How's ENSO? Calculations by Occupation
(n=738)



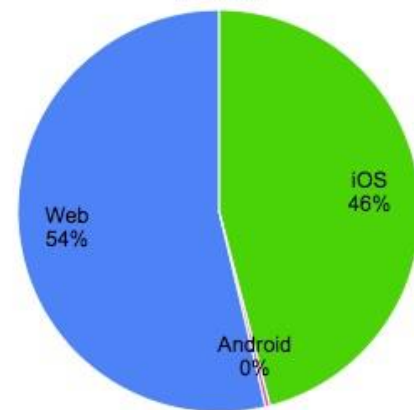
How's ENSO? Calculations by Industry
(n=745)



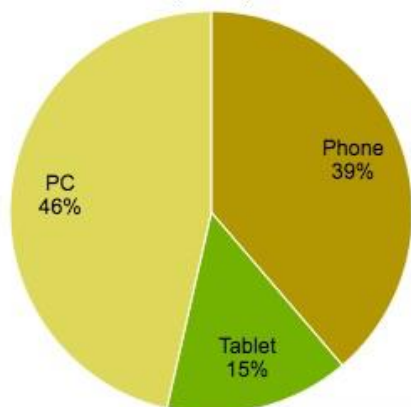
How's ENSO? Calculations by Connection Type
(n=372)



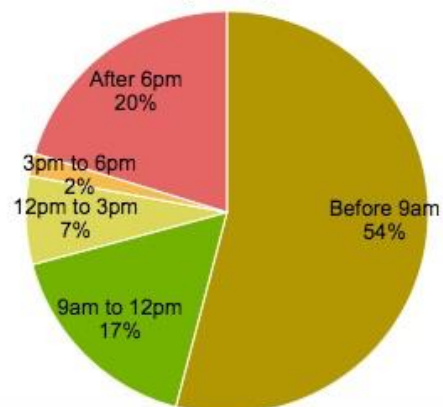
How's ENSO? Calculations by Platform Type
(n=810)



How's ENSO? Calculations by Device Type
(n=816)

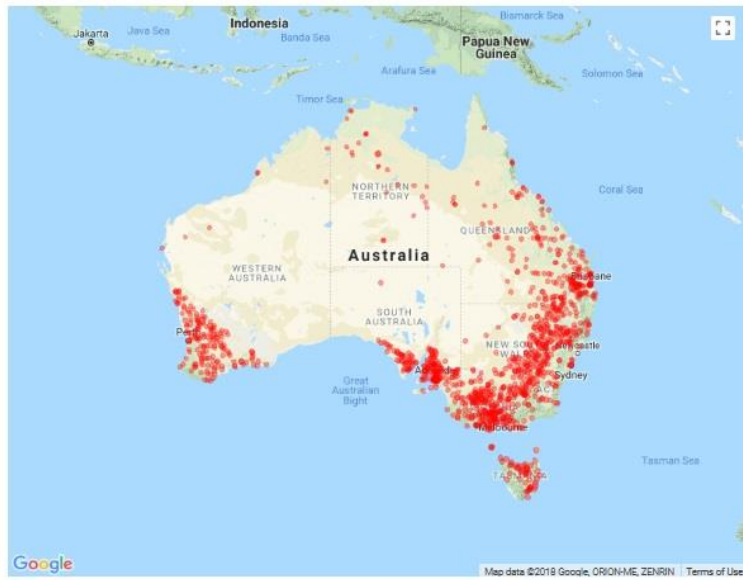


How's ENSO? Calculations by Time of Day
(n=819)



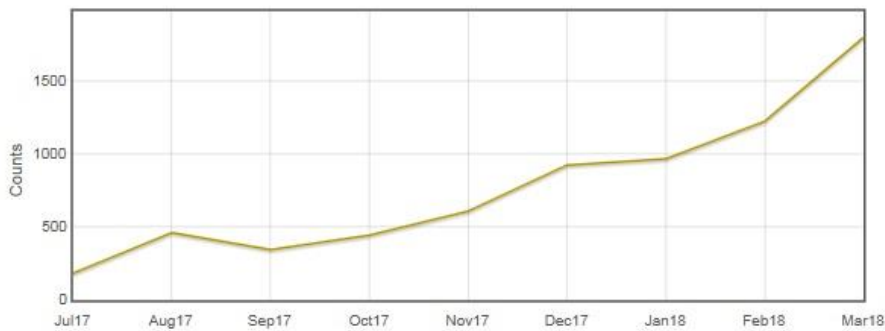
11.7.9 How's the Past?

How's the Past? Calculations
(n=6965)

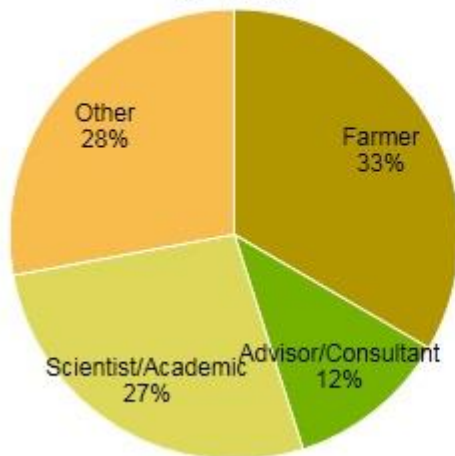


Analytics Reporting Period: July 2017 to March 2018

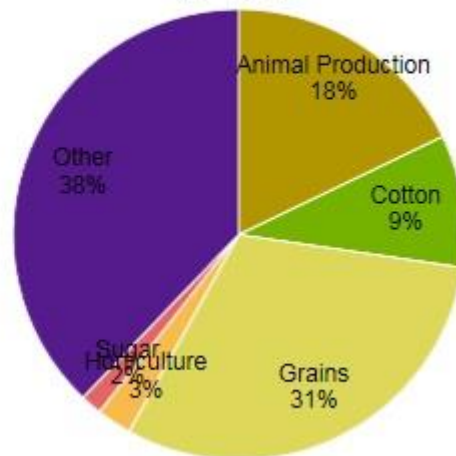
How's the Past? Calculations
(n=6965)



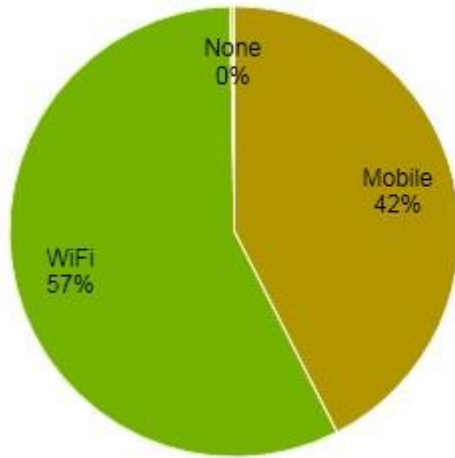
How's the Past? Calculations grouped by Occupation
(n=5749)



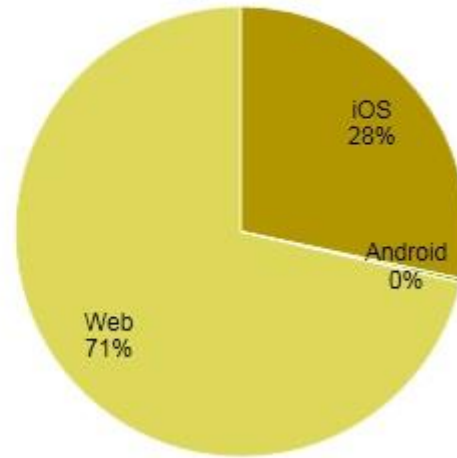
How's the Past? Calculations grouped by Industry
(n=6023)



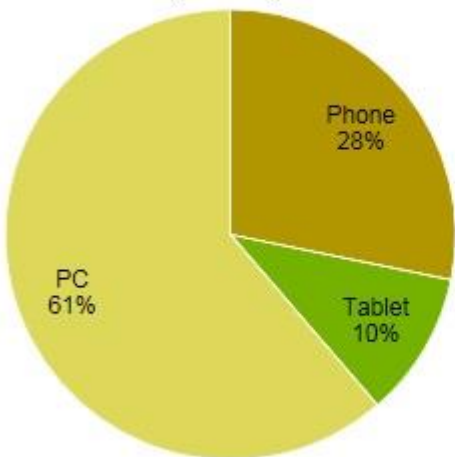
How's the Past? Calculations grouped by Connection Type (n=1947)



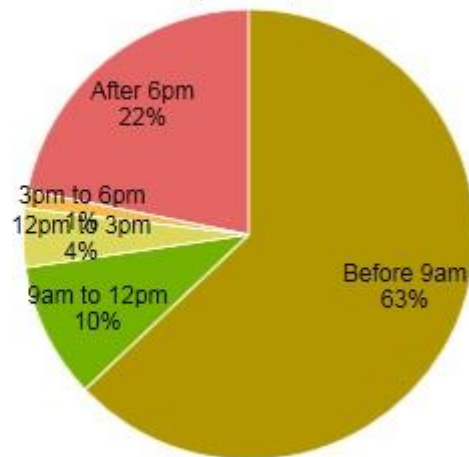
How's the Past? Calculations grouped by Platform Type (n=6868)



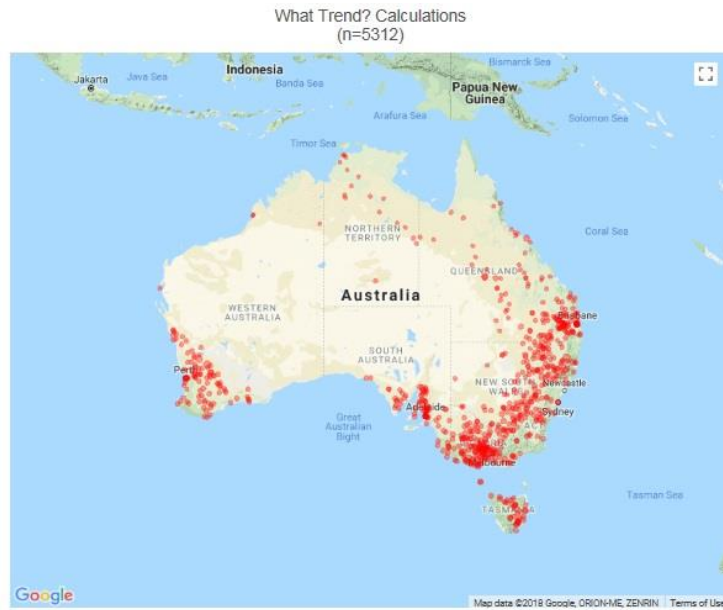
How's the Past? Calculations grouped by Device Type (n=6946)



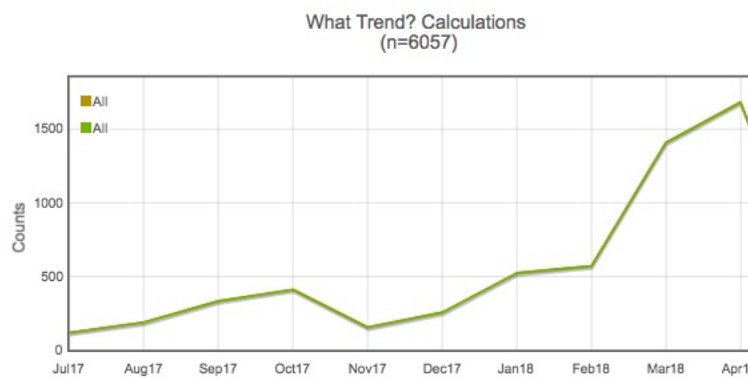
How's the Past? Calculations grouped by Time of Day (n=6965)



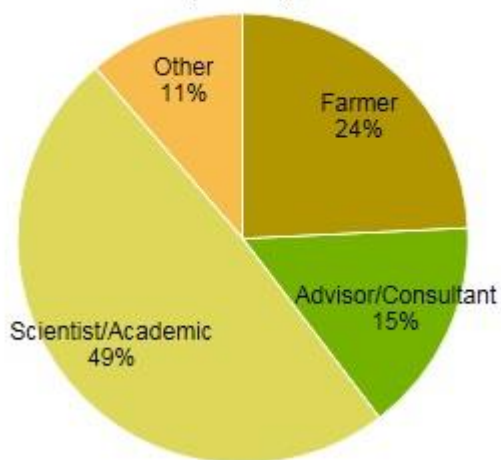
11.7.10 What Trend?



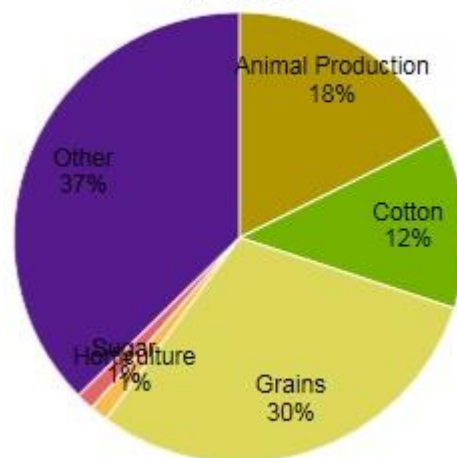
Analytics Reporting Period: July 2017 to May 2018



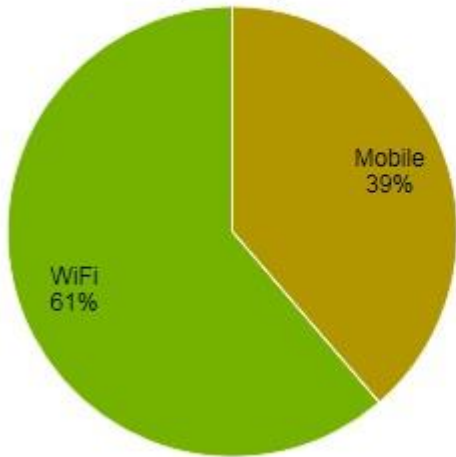
What Trend? Calculations grouped by Occupation (n=4087)



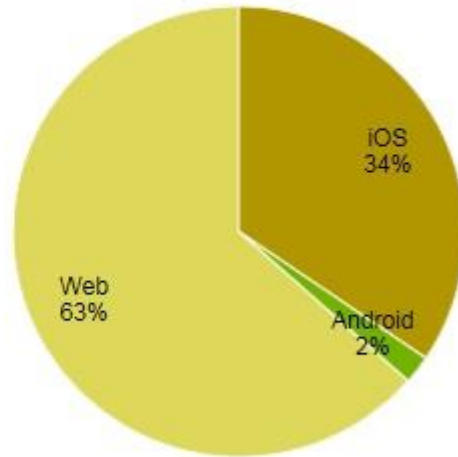
What Trend? Calculations grouped by Industry (n=4283)



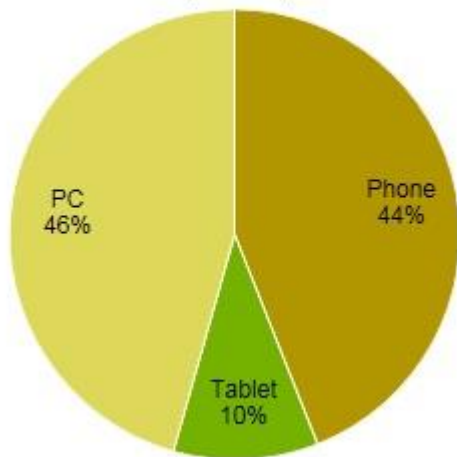
What Trend? Calculations grouped by Connection Type (n=1737)



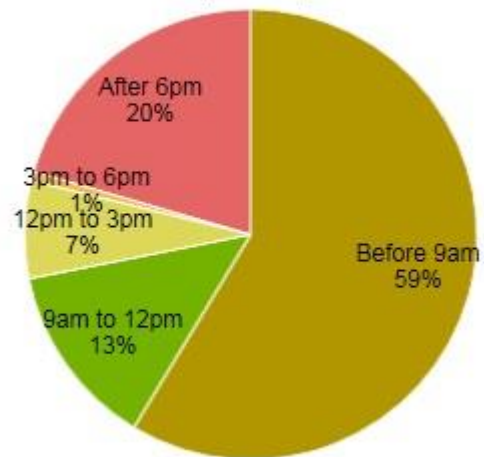
What Trend? Calculations grouped by Platform Type (n=5037)



What Trend? Calculations grouped by Device Type (n=5209)



What Trend? Calculations grouped by Time of Day (n=5312)




11.8 CliMate reviews from App store

(Includes Version 1 and 2)

14th May 2018 from App store

Ratings & Reviews

4.3 out of 5 7 Ratings



Best of Class
★★★★★
18 Jan Rangyloc
Very detailed, easy to use. Easy to compare over the years and by location.

Doesn't work no support
★☆☆☆☆
17 Feb Rubbrish
The new upgrade has made this app useless. It will not download climate forecasts at all (no it's not my network) and if you contact support, your messages bounce back as their server has decided they're spam. Tone deaf and can't do what it's designed for- keep up the great work guys...

Mr
★★★★★
3y ago Toobeah T
Excellent tool for the farmer/agronomist to use for planning or during the cropping cycle.

Fascinating
★★★★☆
5y ago LMT0874
This is a very detailed, but easy to use resource for climate related information, both up to date and historical data. I'm curious as to whether this information can be downloaded as a report.

Great stuff!!
★★★★★
Pru
A great tool for anyone interested in weather and climate. Highly recommend

The Best iFarmer's Friend
★★★★★
5y ago Dfarmer 01
Just get it, very clever, and Free ?.... What the !!!!

Best Aussie climate analysis tool on iOS
★★★★☆
Answers most questions.

climate app is great
★★★★★
5y ago 650BMW
This app is excellent. Really nice that it uses current daily figures as well, not just long term data. Really easy to use, we'll done

Australian Climate
★☆☆☆☆
4y ago P de G
This app appears to be broken more then not. Several times I have attempted to get info. Each time server connection has failed. Please fix this problem.

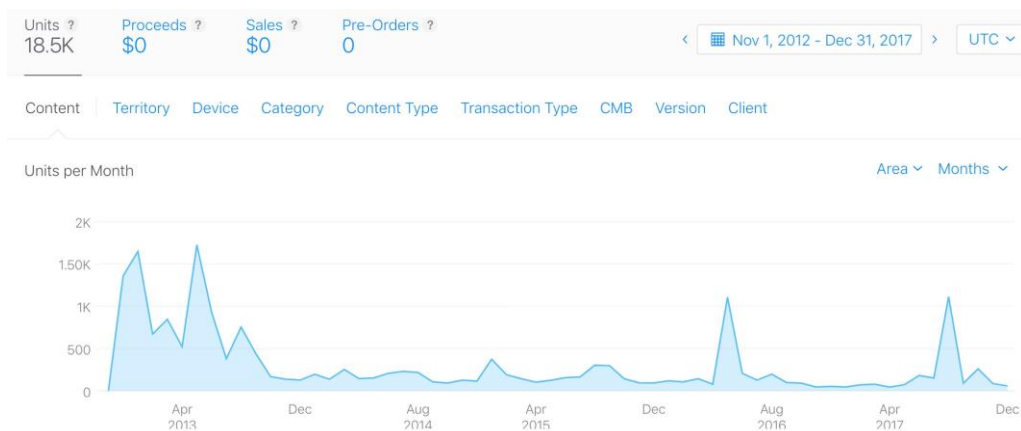
Great app
★★★★★
3y ago jasper2789
So much data to drill down to. Monthly rainfall tables are excellent.

11.9 Additional registration and sessional data

Since the release of the www version of CliMate Version 1 in 2013, the web registrations have totalled 3220. (It is considered that peaks in registrations around September annually may be coinciding with grains industry updates where the app has been included in presentations). The large peak in registrations in September 2017 coincides with release of Version 2.

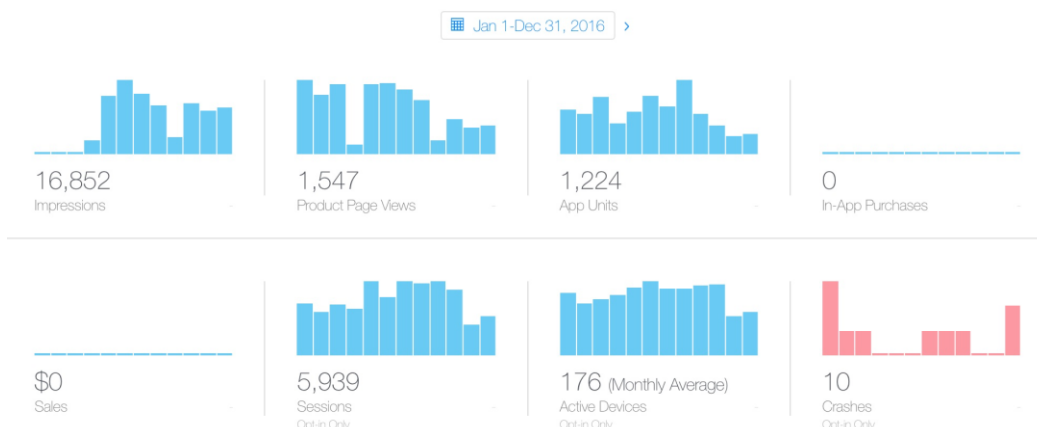
11.9.1 iOS Version 1 registrations and sessions (from iTunes Connect)

Version 1 n =18,500, 2013-Dec 2017

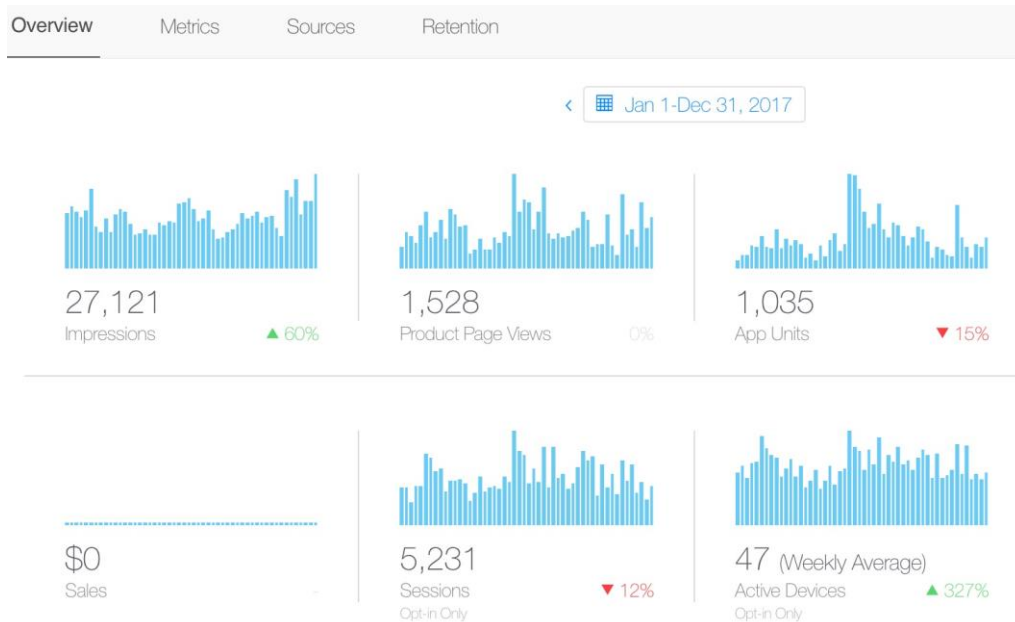


Statistics for sessions for the iOS Version 1 (iTunes Connect) for 2016 and 2017 are shown below.

2016

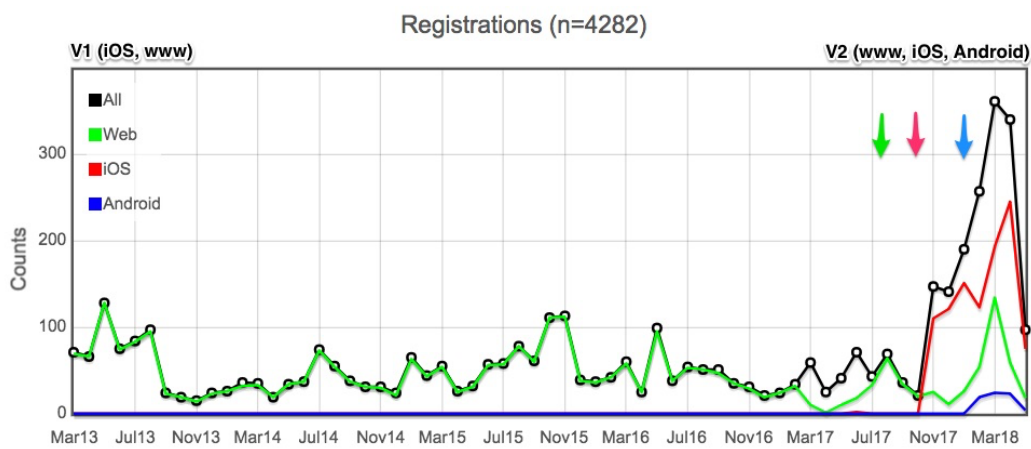


2017

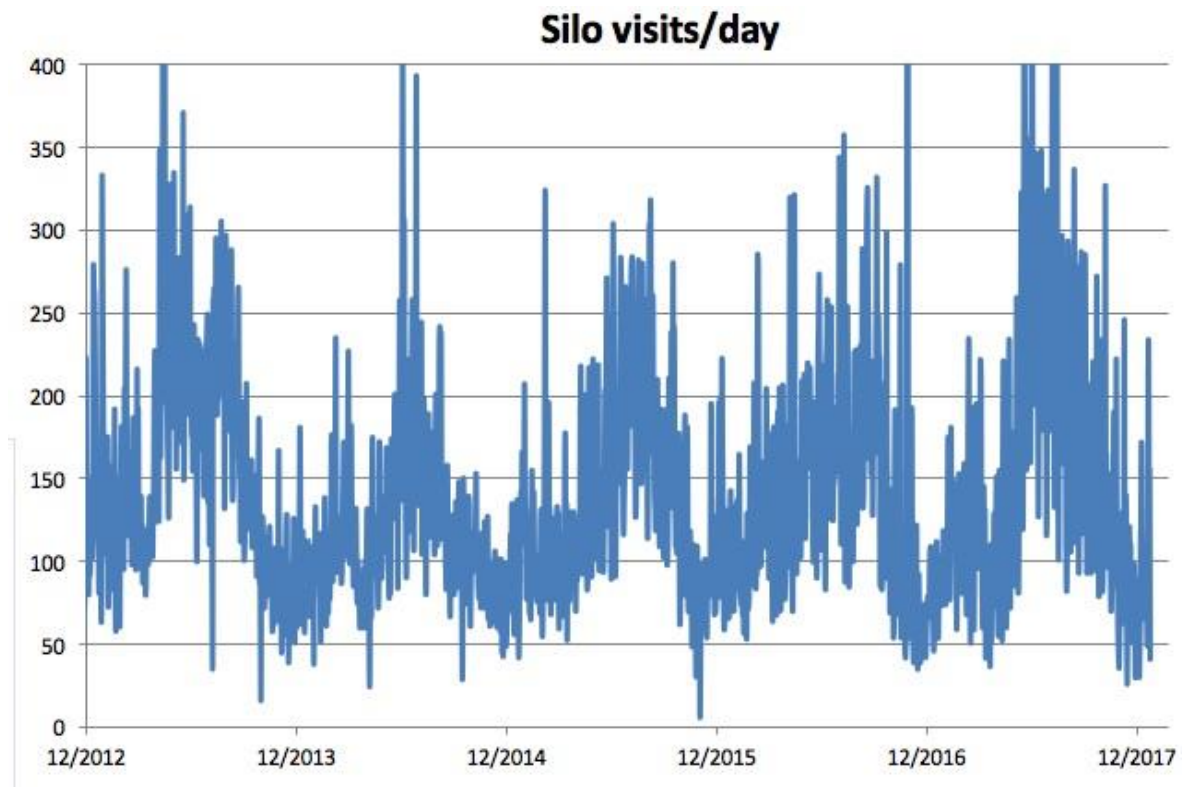


11.9.2 Registrations for Version 1 (2013) and Version 2 (2017-18)

Note: 18,500 iOS registrants (Version 1) 2013-17 not included



11.9.3 Silo data summary

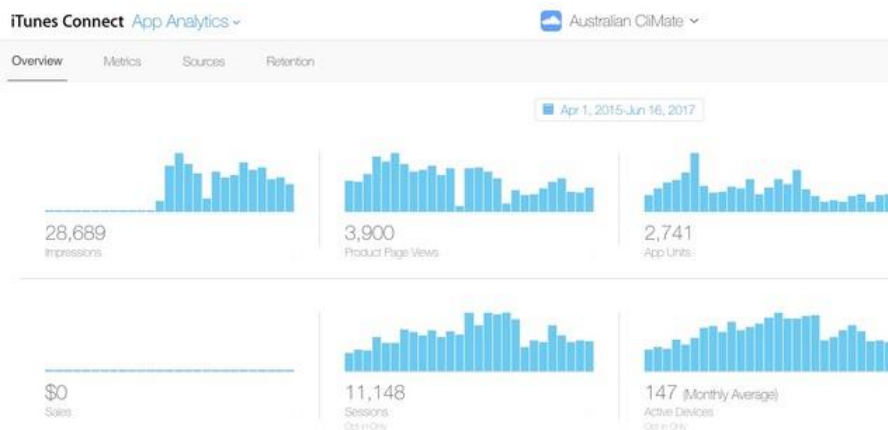


As of 18/1/2018 the CliMate app had registered equivalent to 6.6 million years of data downloaded from Silo.

11.9.4 CliMate Version 1 iTunes summary

April 2015 – June 2017 (27 months) (iTunes data)

Data shows 3900 views of the CliMate page in the App store during this period and 2741 new downloads of the app. It indicates 11 148 sessions in total and the number of devices with at least one session on average each month was 148 devices.



11.10 First User notes

(Record of notes taken by first time users in user testing)

How's the Season

No explanation of Base temperature? – Is this a problem for users? Which crop requires which base? Is there a need for a link in the app to explanatory information? – Otherwise users will just gloss over this and there is no possibility of educating users. People may want to use this but just don't know how or why.

Information about heat sum is needed.

For Fire Hazard style wheel presentation of data – indicates e.g. 30 percentile, yet it shows a deviation away from centre (WHAT IS CENTRE? – the MEDIAN?) Why is it set up to move arrow either side from centre – 50%. Why not V low, low, average, medium, high, v high? Why not progressive scale from left to right in line with the percentile approach? Or indicate 50%ile on the scale. Have a progression of percentiles around the graph.

Query regarding the value of Temperature – Average 30 day rather than daily Temps or average over say 5 days to pick up extremes. (Although 30 day may capture this) (SOME farmers mentioned this)

What is the blue line? What is the red line? Perhaps put words under the heading.

What does it mean 'departure on 22 June at such a large amount (-147mm) from average'?

I do like how the years spread out like that. Our data is presented as decile rankings so ours is a different approach. It's good to know especially how the season is progressing.

...you can actually select your years. A lot of people now don't like to use 100 years of data anymore because we've such a dry climate we only want to use since 1975 because we don't get those wet times we had in the past, there's no point including that in the average.

Showing you the different – 3 months ahead which is sort of analogue years... I suppose it gives you a bit of a spread.

How Often?

Why does it say 3.9 times / year when you've asked how often in relation to a set period of 1 April to 31 May? Should it just say '3.9 times'?

Solar radiation – the app provides no indication of what is a normal range for this. Users are required to select a threshold from a very very large range. In the absence of information on a typical reading, why is the range to select from so wide. When BOM indicates 'typical values for daily global solar exposure range from 1 to 35 MJ/m²'. Why is the minimum number we can pick from 100MJ/m²?

Understandably if the user chooses to calculate solar radiation over a 362 day period, then the total would be very large and this is the reason for the wide range of available MJ to choose from. Large range of options here for time and for readings. May require some additional information to help users choose time frame and threshold.

How useful is yearly? - Yearly averaged consecutive days (lowest (min)) - Don't we want to know actual temperatures?

When changed from 1 in 50 year to 1 in 10 year – same chance (??) Why is this?

'How do we know this' – stops mid-sentence?

Probability of cold and heat stress graphic – what is shading on large graph? What are the shaded bars? There is no information on what the bars are or how or if they relate to acceptable risk.

Could acceptable risk be stated in a box as a % - so that it clearly relates to the chance presented with the ½ pie graph?

Acceptable risk?

How Wet / Nitrate

On graph red and brown bar graphs for rainfall and runoff are very thin.

'Avg SW' – purple line – should it say 'Avg SW (all years)'

'Average Nitrat' (spelling) – should this be 'Average Nitrate (all years)'

'Current Nitrate' – should this be 'Current Nitrate (relative to average) – because it indicates in the notes that it is a qualitative estimate. 'Current Nitrate' sounds more an absolute estimate.

What if a user doesn't understand fallow efficiency?

Is the scale in large line graph for rainfall and runoff the same?

What are the yellow background bars?

Very busy graph. Not sure I understand all the different lines on the large line graph

Yield potential

Presume that the choice of years will include 2019 onwards from end 2018.

When choose a crop sown any date after the current date (e.g. April 2018), the program cuts out. Had to use 2017 or sowing date in March 2018. Isn't the tool for predictions for a future crop?

(If it says 'potential' wouldn't it be able to cope with future dated scenarios)

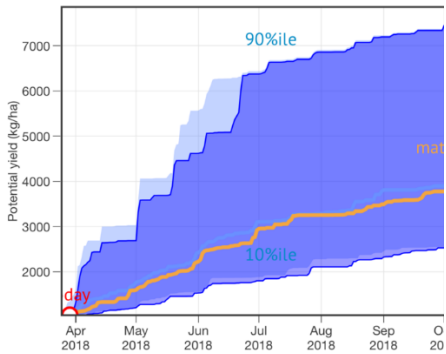
WUE – large range of choices – require some information or link to guide us here.
(People need to talk to an agronomist who knows this stuff if they don't already)

What is 'threshold' water????????? (The information says Threshold water is unproductive evaporation, runoff and 'crop infrastructure' (never heard this term!) water. Wouldn't this be estimated by the tool (based on rainfall and soil type) rather than expecting the user to estimate this – The potential yield resulting is largely determined by what the user chooses – so how does the user know what to input?

I assume starting SW is available (not including wilting point SW).

What is the red line on graph? Information says 'red and orange lines are 'related' to soil water at planting'. In the image below, orange line is clearly the potential yield estimation. Assuming red line is the est. yield since sowing in March? What are the 2 different purple shaded plume areas? One starts from 'today' the other started presumably from sowing date (?)

Potential yield (sown 25/03/2018, mature 21/10/2018)
WUE 8kg/ha/mm



How do we know this?
Yield potential (red and orange lines) is related to soil water at planting (SW) plus in-crop rainfall at SAMFORD CSIRO. The heavy blue line shows the median (50%ile) for all years. The plumes envelope the 10%ile (lower) and 90%ile (upper) range of expected yields based on long term records. Yield estimates are based on the Water Use Efficiency (WUE) model of French and Shultz (1990).
 $Yield = (starting\ soil\ water + in\ crop\ rainfall -$

Drought

What is a '5 year residence period' – is that suggesting that there has been no droughts at our chosen location over the past 5 years? Really needs better explanation.

Suggest the orange/brown band across the graph has the words 'Warning' on it.

Suggest the red/brown band across the bottom of the graph has the words 'Drought' on it. (Assuming this is correct – had to think this through and then see the correlation of the colours with the fire hazard chart) Colours are not the same as in the fire chart.

Is this the cumulative rainfall (in %ile) for the period from 5 years ago up to the marked date? What does the percentile relate to? Is the percentile related to all 5-year periods since 1900 to present?

(Assume from reading that this is the %ile of the rainfall from past 6 months compared with same calendar 6 months 1900 to present.)

Is this the average Drought depth (%ile) over the period of the drought (months) in table?

How is 'Drought Integral (%ile mths) calculated?

How Hot Cold

Very useful tool.

The 'using risk of' box is a little confusing as this is not needed to do the analysis, just to show a line and shading.

Only suggestion is that the risk box be moved to below the selection of years – so that users can see that this is not critical for the analysis (because it is a little off putting when you don't expect to be asked this question and don't know to what context it is referring). Once the user understands to what it refers, there is no problem.

Question – is the temperature data used in these calculations based on monthly averages or actual daily maximums or minimums? Some feedback received from users regarding that CliMate temperatures are based on monthly averages not daily actuals.

?Graph not user friendly

?Chance of cold stress is LOW but the arrow points to V LOW on the half pie chart.

Hot Hot / cold - Extreme weather events tool – 2016 had frosts we've never had before – so I don't use How Hot How Cold – I didn't know it was there. I suppose it's a bit similar to Flowering Calculator. Green bit – is that the sowing window?

Green is acceptable risk area is it – when not reached will be showed green (reading)

Acceptable risk is saying 1 in 2 years we can have a heat stress. (Saying we accept that risk) Looked at 1 in 5 graph. I don't understand (but I have only just looked at it)

How Likely

Don't know what a Tercile is. Googled this and it said the points in a data set to split it into 3 (so assumed something to do with the pie graph). On my example Tercile 1 is 22°C, Median is 22°C and Tercile 2 is 23°C so a little confusing. On my next example it said Tercile 1 (for minimum temperatures) was 675 degrees?????

What is 'forecast skill?'

It does not give a figure for 'near-consistent' – it cuts it short on the screen.

Why is BOM forecast map showing 2014?

Under 'Current BOM forecast' is a URL link in blue – doesn't go anywhere

Also under Australia map – www.longpaddock. – doesn't go anywhere.

Initial thoughts are – not sure what the second semicircle graph is for.

Suggest the 'Probability is 76% This occurred 8 out of 10 years during similar Pacific and Indian Ocean Conditions' words in image below should be moved to above the top semicircle graph.

The words below the second semicircle graph 'Past skill is medium etc' should be moved above the second semi-circle graph. This information on past skill may be 'overkill' because the graph information may be sufficient for most users in Australia.

Assume the pie graph is related to the Period rainfall outlook and the words above it. To clarify this, suggest you put the word 'Outlook' in each pie section i.e. Normal Outlook 34%, Above Normal Outlook 43% etc.

Heading above bar graph – Forecast skill for 5 Minimum temperature (initial comment is what is the 5? – now assume it is the months of the assessment period, yet only one month (the start is highlighted in red).

Suggest 'Forecast skill for Minimum temperature' a better heading.

Note – the BOM graph on this screen in my example is 'the **chance of above median** minimum temperature for April to June' – Initially I thought I was seeing a map in relation to my initial query at the top of the page which was the chance of average minimum temperatures **less than** Tercile 1.

(In my examples the Tercile choices say 'data units'; in my previous example they said 1859°C and 2001°C)

'Anyway – I don't know about that one – How Likely'.

How's El Nino

Does not work during the testing period.

El Nino – in WA it is so far from the Pacific Ocean. It is an indicator and Bureau and Govt might look at it but it doesn't have much influence.

SOI phase and how it relates to rainfall. We don't have that over here. A lot of farmers follow the SOI and I say why would you do that.

How's the Past

Whilst the graph showing monthly average rain, evaporation, min and max temperature appears easy to follow and a very useful summary for any location, the large table lower on the screen (purple shading) is very off putting.

What are the different shades of purple? There is no key to this table anywhere in the app. The different shades are not acknowledged at all.

It is expected that most users do not want this level of information – is it possible to access this via a link. The sight of the table puts users off this very useful app.

The lower graphic showing the coloured years (El Nino, La Nina etc) and annual totals appears a simplified useful snapshot from where a user can then delve deeper to explore monthly totals if required.

Why is rainfall April to March for the Annual totals in lower graphic? Is this timeframe likely to be an issue for users whose rainfall annual experience and data is based around January to December?

If monthly totals are required, then this is more likely to be for particular years and the large extensive table may not be required. A more visual way to see the monthly totals for particular years may be useful.

Unsure why the header for this section says *'..showing coinciding relationship with ENSO'* (even when La Nina years were originally chosen). This is confusing and many users would not know what this is referring to.

Regarding Maximum or Minimum Temperatures – only monthly average maximums and minimums are presented – not daily actuals. Noting that it only takes one daily event (severe cold or severe hot) to impact agriculturally. However the monthly averages provide a good initial guide when viewing climates across the past.

What Trend

Think this trend graph is very useful, as is the Difference from average graph.

Is the Cumulative difference graph – cumulative for each year since 1900 or cumulative for January to December for each year? Bit confused.

The 'moving average period' – is this the period over which the average is calculated? Or is it to do with the cumulative differences.

Cumulative difference smoothed (10 years) – is 'smooth' a statistical term?? What does this mean for the user and graph?

The information section indicates 'interpolation' and 'infilling' (?) – I don't think this is a problem for the large scale review of past years. However when people are exploring

(recent) previous years and comparing to the current season (e.g. How's the Season) for particular locations – there is a strong objection to using data from nearby sites or estimating to infill.

Incidences of rainfall - useful.

Other

Farmers don't mind all this logging in? – sometimes they don't like doing registrations.

When re-registering for Version 2, updating my industry again. I probably fell out of the system when we went to the new CliMate.

Even though I've just put in my location – it's got me as something else.

It's giving us last year's data because we're not in the season yet. Not April yet.

Once I go into the Locations – how do I go back to the CliMate app itself?

Stuck in Locations page (list of locations and grid on right) – can't get out of this screen no back arrow, only edit or a plus sign to add a location.

Doesn't say which task we are in – when we are in one.

iphone - Difficulty because the iphone goes into standby (powersaving) mode and screen goes black, then have to re-enter passwords etc and click on the app icon to get back to the calculation. Very disruptive. Perhaps can change this in settings.

Overview information – requires edit and update (android version coming end 2017)

Analysis information – requires small amount of editing (spelling, sentences)

Contact and admin – and maintenance, - one person seems to manage this

New version

Did we get an email to tell us what to do?

'Current version requires iOS 9.3 or later, but you can download the last compatible version'. (My iPad bought in 2013)

Hope information was sent to users to tell them to delete old version and reload.

Can you load the old version CliMate on a new iPhone or iPad?