Cotton
RESEARCH & DEVELOPMENT

Annual, Progress and Final Reports

Part 1 - Summary Details **REPORTS**

Please use your TAB key to complete part 1 & 2.

CRDC Project Number: **CSP128C**

Annual Report: ☐ Due 30-Sep-03

Progress Report: ☐ Due 29-Jan-03

Final Report: ☒ Due 30-Sep-03
(or within 3 months of completion of project)

Project Title: Enhancing access to weather and climate data

Project Commencement Date: 01/07/2000 **Project Completion Date:** 30/06/2003

Research Program: Technology Transfer and Extension

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Background and Industry Significance

The availability of accurate and continuous weather and climate data is essential for strategic research, operation of decision support systems (eg. CottonLOGIC, OZCOT crop simulation model) and analysis of numerous operational aspects of cotton agronomy and management. Of particular importance is the need for complete data sets of climate for research into irrigation, optimal sowing dates, crop physiology and many other aspects of cotton production/management. In addition historical climate data is being used by researchers to assess the potential of cotton growth in new regions and to analyse the performance of crops in current seasons in the context of the whole climatic record. Increasingly consultants and growers are using this information for making informed management decisions.

At the start of this project the CSIRO Cotton Research Unit supported the maintenance of 14 stations spread throughout the major cotton growing regions. These stations required regular maintenance and annual calibration. The information collected from these stations was made available via the Cotton CRC's web site. After numerous problems installing the network they were operating at an acceptable level. At the start of the project the stations were over 6 years in age and are beginning to show signs of wear. Components were failing more frequently and the stations showed visible signs of degradation from the weather. Maintaining these stations and handling the data for quality and continuity had required much more effort than initially anticipated. At the time only one third of a technician's time was

devoted to supporting and maintaining the stations. In addition to the time spent by the technician, valuable time of Dr Michael Bange's and David Larsen's was also consumed.

Undoubtable one of the reasons for installing the weather network was because it was difficult in the past to obtain data through the Bureau of Meteorology. With the advent of the Internet it has allowed the Bureau and other associated parties through the SILO project to deliver climate and weather information more quickly and effectively. The SILO project's objectives are to:

- Provide a rich source of national meteorological and agricultural data that is readily accessible to decision makers, researchers and educationalists, particularly in the agricultural area.
- Develop a coordinated information service that will facilitate further adoption of climatic risk management.
- Provide a framework to encourage future additions to the agrometeorological data bank.
- To establish collaborations required ensuring the system remains operational beyond the term of this research funding.

Briefly some of the resources that were already available through the SILO project included:
- Patched historical climate files up to yesterday.
- Weather forecasts.
- Seasonal Climate Outlooks.
- Numerical weather data forecasts suitable for modelling purposes.
- Daily estimates of solar radiation.

Working with the members of the SILO project presented the industry with a unique opportunity to harness the information collected by the Bureau to assist research and crop management directly without relying on maintaining it own weather station network.

Research Proposal Summary

The aim of this project was to improve access to quality and continuous weather and climate data by:

- Maintaining the existing cotton industry weather station network.
- Providing researchers with access to historical climate files.
- Collaborating with the SILO project to improve access to weather and climate data collected from other sources.
- Through collaboration with the SILO project develop tools using weather and climate data to assist with cotton management.

In order to achieve these aims the proposal was essentially divided into three parts, which were:

1. Provision of weather information through the existing cotton industry weather station network.

Given at the time that real time weather information was been collected at standard Bureau of Meteorology stations and could be accessed via the SILO website, it is proposed that the cotton industry's automatic stations located near these real time stations would be removed. The benefits in using the Bureau's station are that data is collected from high quality sources and data can be checked and managed by the Bureau. Stations that are located nearby these real time recording stations were:

Emerald
Dalby
St George
Boggabilla
Warren
Bourke
Midkin

The remaining six stations would remain in place as until access to real time weather could be obtained or the stations failed. Parts from the stations removed would be used in the interim to maintain the remaining stations. It was requested that the same amount of technical resources would be made available to maintain and remove these stations.

Importantly part of the ongoing maintenance regime included the station located at ACRI. More effort will be placed on ensuring that this station is as accurate as feasibly possible.

2. Provision of historical climate patched point data sets to the Australian Cotton Research Institute for research purposes.

Access to accurate and continuous (no missing data) historical climate records are crucial to research activities (especially modelling OZCOT, HEAPS, APSIM etc.) at ACRI and as part of Cotton CRC activities. At the start of the project SILO was developing a methodology to provide this service to ACRI for all the existing and potential cotton growing regions. This database would be updated daily via the Internet. This information is presently being used for modelling activities and investigation of seasonal performance in context of the whole climatic record.

3. Collaboration with partners of the SILO project to develop weather and climate tools specific to the cotton industry.

The cotton industry has a strong reputation for using decision support tools to assist with crop management. Underlying these tools is a need for accurate and continuous weather data. Examples include the need of cumulative degree-days for monitoring crop development, for different management decisions, and degree-days for NutriLOGIC contained in CottonLOGIC. The SILO project had already developed a prototype degree-day calculator that was available free to the industry for evaluation during the 1999-2000 growing season.

Access to different types of weather information is becoming available through the SILO project regularly. One recent development has been the release of meteograms, presenting numerical weather prediction 7 days in advance. This information could potentially be used to improve the Helicoverpa population prediction model in CottonLOGIC, predictions of migratory patterns of Helicoverpa using the HEAPS model as well as assisting with irrigation scheduling using the OZCOT crop simulation model. The numeric weather prediction data will be merged into the patched point data to provide a seamless transition from reported to predicted data.

In the case of CottonLOGIC it is hoped that the user would directly be able to access and download the information with the click of the button whilst running the CottonLOGIC software.

Some of the opportunities in using the weather and climate data available through the SILO project are unknown, simply because access to this information in the past had been limited. This project aimed to identify new opportunities to utilise this data and develop tools that will assist with cotton research and management.

Part of the objectives of this project will be to assess the cost of maintaining these services to the industry. At this stage, the Bureau of Meteorology and the Queensland Department of Natural Resources (both SILO partners) have each nominated a small amount of money to allow some commitment in their programs to investigating and developing tools specifically for the cotton industry. The type of contribution, whether it be for development or for subscribing to the services was revised annually in discussion with relevant cotton industry represents.

Objectives to be achieved in each year of grant

Year 1

- Remove redundant weather stations located near existing real time Bureau of Meteorology stations and monitor remaining weather station network performance, monitoring faults and organising for rapid repairs.
- Supervise daily the weather station located at the Australian Cotton Research Institute.
- Conduct annual calibration and servicing of all stations in the network.
- In collaboration with the SILO project investigate and develop weather and climate tools specific to the cotton industry.
- Maintain ACRI's access to the patched point data set and refine the degree-day calculator.

Year 2

- Supervise daily the weather station located at the Australian Cotton Research Institute.
- Monitor remaining weather station network performance, monitoring faults and organising for rapid repairs.

- Conduct annual calibration and servicing of all stations in the network.
- In collaboration with the SILO project investigate and develop weather and climate tools specific to the cotton industry.
- Identify uses for the weather forecast data available from SILO's meteograms and begin development of tools for CottonLOGIC.
- Investigate opportunities to link weather and climate directly to decision support software via the Internet.

Year 3

- Supervise daily the weather station located at the Australian Cotton Research Institute.
- Monitor remaining weather station network performance, monitoring faults and organising for rapid repairs.
- Conduct annual calibration and servicing of all stations in the network.
- Identify uses for the weather forecast data available from SILO's meteograms and begin development of tools for CottonLOGIC.
- Review the weather station network and arrangements with SILO.

Summary of Outcomes

A brief outline of the major results and outcomes form this project is given below.

1. Provision of weather information through the existing cotton industry weather station network.

In the first year of the project seven weather stations located near official Bureau of meteorology station were removed. Over the course of the last two years the remaining stations with the exception of Merah North and Breeza were also removed. While stations in remained in the field, Graeme Rapp calibrated and serviced at these stations at least once every six months. To maintain these stations especially as there were failing more often due to age and weathering consumed considerable time.

These weather stations are now over nine years old. Of the initial 14 only five remain functioning. The parts from the stations removed from the field are being used to maintain

these functioning stations. Three are being used for experiments while two remain in the field (Merah North and Breeza). More reliable and continuos data is now available through the SILO Internet site http://www.bom.gov.au/silo/.

During this time as part of this project we installed a new weather station at the Australian Cotton Research Institute. Graeme Rapp has had the responsibility of maintaining this station and assisting with the dissemination of information to researchers. This station was the first in Australia to be connected directly to a computer network to enable storage and delivery of data. Data collected from this station is accessed from the Internet via the Cotton CRC's website for purposes of data collection for research, and chemical spray application (Figure 1). With regular maintenance this system has been operating reliably.

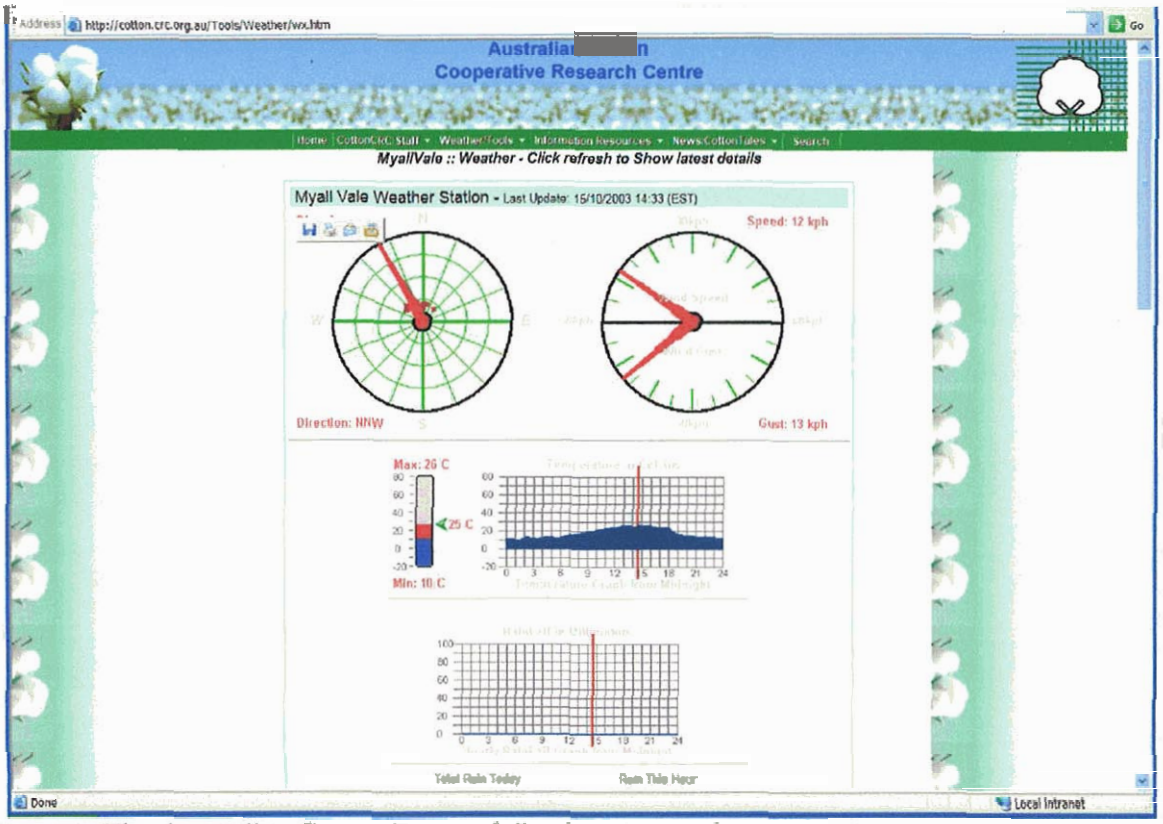

Figure 1: The Australian Cotton Research Institute's weather page.

2. Provision of historical climate patched point data sets to the Australian Cotton Research Institute for research purposes.

ACRI and Cotton CRC researchers now have reliable and easy access to up to date weather information and historical data for research purposes. Researchers access this data through an internal website from a data server located at ACRI (Figure 2). On a daily basis the SILO web services updates the server with the latest numerical weather measurements recoded.

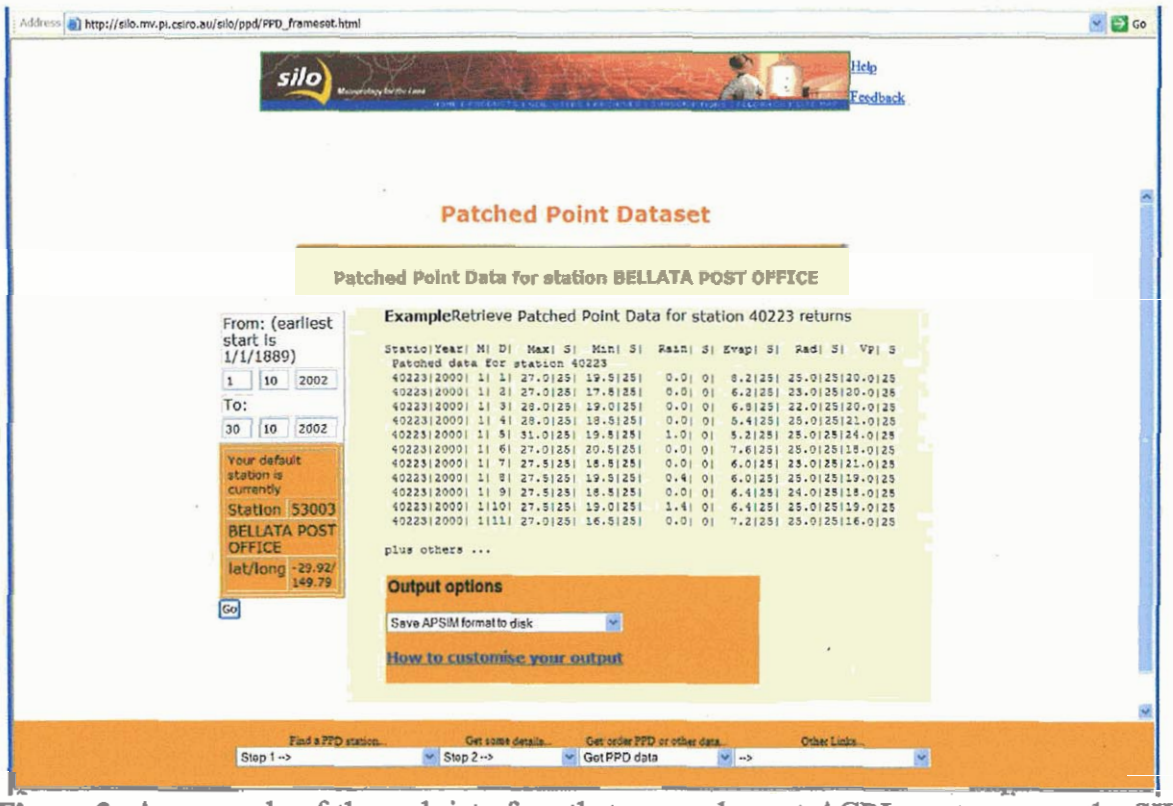

Figure 2: An example of the web interface that researchers at ACRI use to access the SILO patched point climate datasets

This service has enabled any project utilising this data to run more effectively. No longer is there a significant cost in time and dollars to obtain this data. Missing data in these datasets is also patched using interpolation algorithms that utilise knowledge of the location and measurements collected from nearby weather stations. For a researcher, not having to go through the process of patching datasets is again a considerable time saving. An example of this data is shown in Figure 3 while examples of the types of analyses and research conducted are highlighted in the list of publications mentioned later.

```
!station number = 053003
!station name = BELLATA POST OFFICE
!latitude = -29.92  (DECIMAL DEGREES)
!longitude = 149.79  (DECIMAL DEGREES)
!tav = 21.2
!tamp = 15.2
!Data extracted from Silo on 15 , 2003
!As evaporation is read at 9am, it has been shifted to day before
!ie The evaporation measured on 20 April is in row for 19 April
!The 6 digit code indicates the source of the 6 data columns
!0 actual observation, 1 actual observation composite station
!2 daily raster, 7 long term average raster
!more detailed two digit codes are available
!
!For further information see the documentation on the datadrill
!  http://www.nrm.qld.gov.au/silo/datadrill.html
!
Year  Day Radn  MaxT   MinT  Rain  Evap    VP   Code
2002 274   25.0  25.5   4.0   0.0   6.4  10.0 222022
2002 275   25.0  28.0   6.5   0.0   7.0  12.0 222022
2002 276   25.0  29.0  11.5   0.0   8.2  12.0 222022
2002 277   25.0  29.5  14.0   0.0   7.6  13.0 222022
2002 278   23.0  30.0  14.5   0.0   8.4  13.0 222022
2002 279   24.0  31.5  13.5   0.0   9.4  14.0 222022
2002 280   24.0  33.0  16.5   0.0  10.6  15.0 222122
2002 281   25.0  33.5  20.0   5.4  10.6  16.0 222122
2002 282   26.0  28.5  11.0   0.0   9.4  12.0 222022
2002 283   23.0  29.5   7.0   0.0   8.4  13.0 222022
2002 284   20.0  27.0  14.0   0.0   5.6  14.0 222022
2002 285   17.0  24.0  13.0   0.0   4.4  16.0 222022
2002 286   23.0  31.0  16.5   0.0   7.4  18.0 222022
2002 287   25.0  27.0  11.5   0.0   8.6  12.0 222022
2002 288   24.0  28.0   7.0   0.0   8.0  12.0 222022
```

Figure 3: An example of a patched climate dataset available from SILO.

During the course of the SILO project members also trained Darren Linsley and Scott Johnston (software developers form the Cotton Management support systems team) in advanced data mining techniques using the SILO patched point dataset. These skills enable both Darren and Scott to write code that enables them to conduct specific analyses and reports from the dataset. This has helped researchers query the dataset for their research as well as developing means linking this data to new and existing decision support tools.

3. Collaboration with partners of the SILO project to develop weather and climate tools specific to the cotton industry.

In gaining reliable and easy access to continuous climate datasets has enable a number initiatives where tools for research and decision support to be developed in collaboration with the SILO team. Currently all tools developed are available free to members of the Australian

cotton industry. The tools developed and initiatives undertaken during this project are as follows:

SILO/Cotton CRC day degree calculator

One of the major problems that existed in the past in providing day degrees to the industry for decision making was reliable and easy access to **continuous** climate datasets. The use of the patched point datasets (which are continuous and updated daily) from SILO has enabled the development of a web based day degree calculator developed in collaboration with the Cotton Management Support Systems and SILO team members.

This decision tool is available through the Cotton CRC's website http://cotton.crc.org.au/Tools/Agronomy/SILODayDegCalc.htm (Figure 4) and allows user to enter a starting date and finishing date to calculate the day degrees. In addition to this information the report provides information on the following:

- The number of hot days for the period (Days when maximum temperature exceeds 36°C.
- The number of cold shock days (less than 11°C).
- An analysis of the time when a crop will reach a certain day degree target.
- Probability analysis of day degree estimates, no. of hot days and cold shock.

An example of this report can be found in Appendix 1.

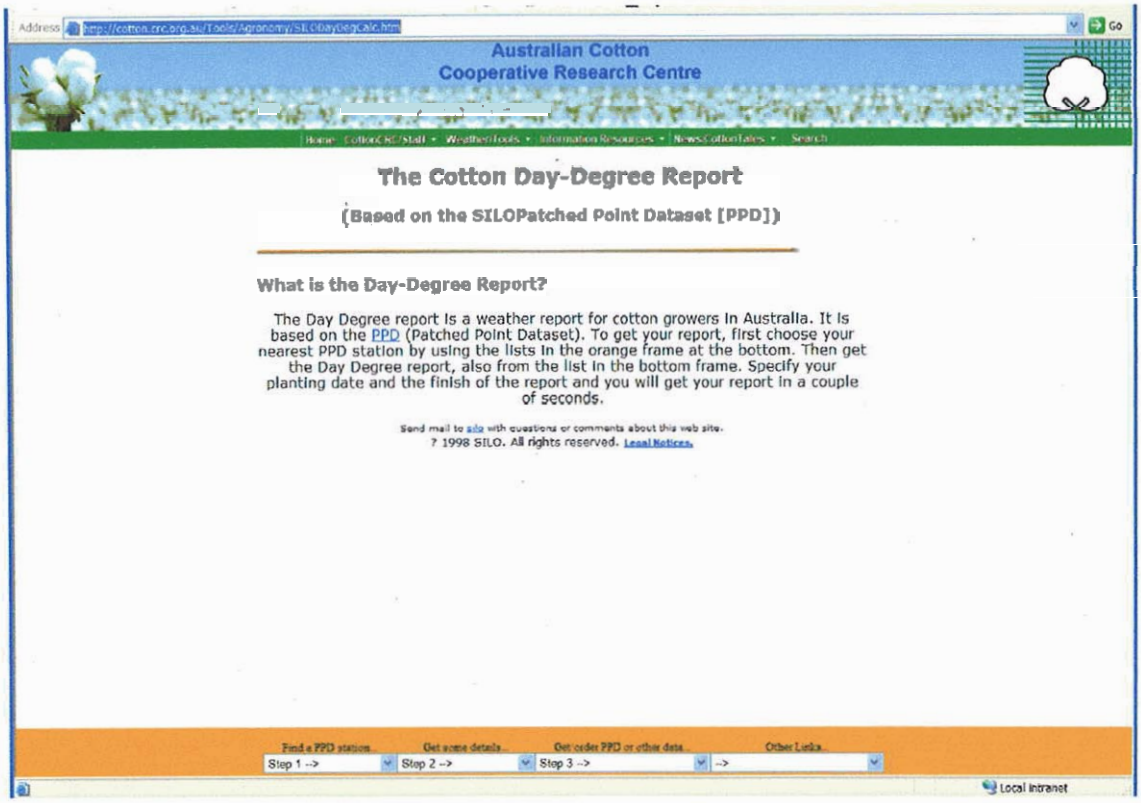

Figure 4: The SILO day degree calculator located on the Cotton CRC's website.

SILO/Cotton CRC day degree target calculator

This decision tool is similar to the day degree calculator described above only that it differs in enabling the users to specify a target day degree (Figure 5). The users enter their day degree value and the calculator returns an estimate (and probability distribution) of the time when this day degree target is reached during the season based on historical climate records. The users also have the option to enter a number of targets (eg. first square, first flower, first open boll) and report on dates when these events may occur. An example of this report can be found in Appendix 2.

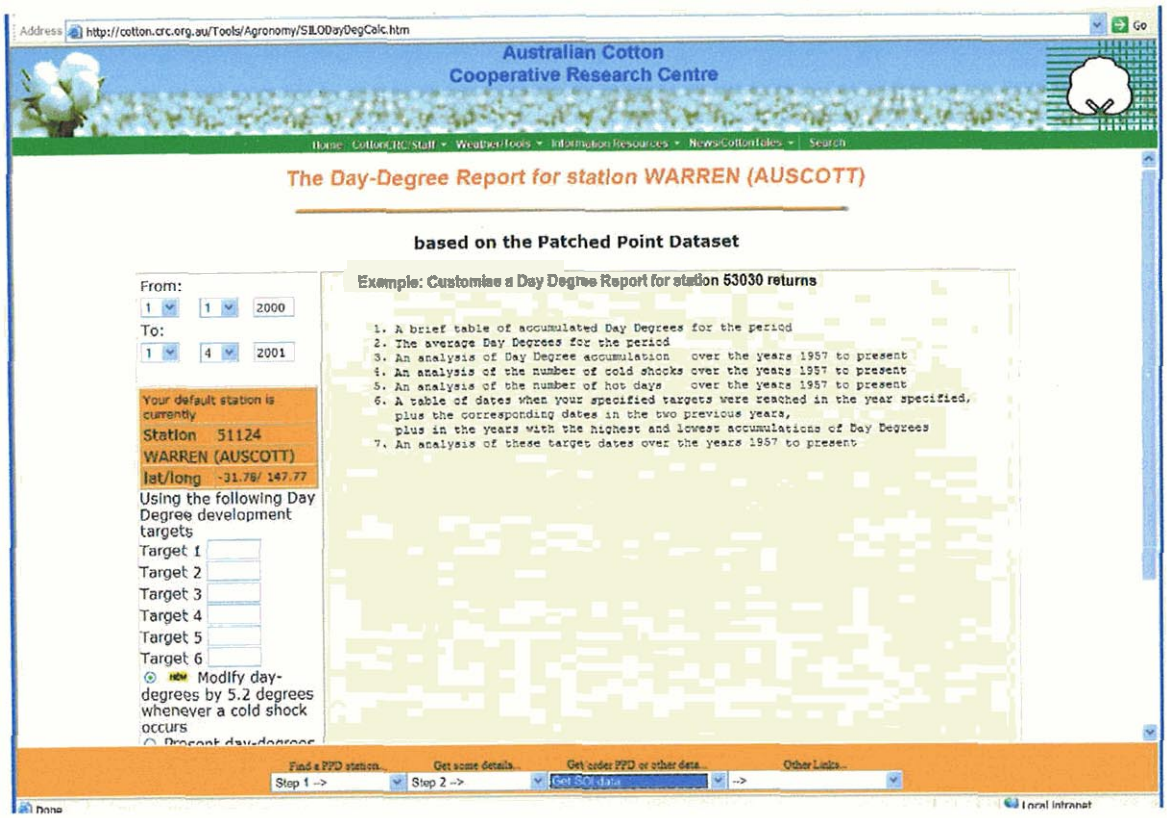

Figure 5: The SILO day degree target calculator located on the Cotton CRC's website.

Early season diagnosis tool

The early season diagnosis (ESD) tool was developed for the Cotton CRC's website to assist with the agronomic management of cotton crops http://cotton.crc.org.au/tools/esd.cgi?. It involves a crop manger monitoring their cotton crop's development and using the ESD tool to help assess whether the crop is suffering from any stress. Early in the season the rate of fruiting node development is monitored, while later in the season the rate of nodes above white flower are monitored. Both rates are assessed against a potential rate that requires estimates of day degrees. The ESD has been linked to the SILO day degree calculator, and allows the users to enter the sowing date and the dates on which the measurements were taken. The ESD then queries the patched point dataset using the SILO day degree calculator and returns the day degrees for each measurement date and then plots the results (Figure 6).

HydroLOGIC

Fundamental to the effective use of the HydroLOGIC software released to the cotton industry in September 2003 is gaining access to daily weather data. HydroLOGIC uses the OZCOT crop simulation model that requires historical and up to date daily values of maximum and

minimum temperatures, radiation and rainfall. The SILO initiative was able to contribute to the development of HydroLOGIC in a number of ways:

- Historical patched point datasets for major cotton growing regions were provided with the release of HydroLOGIC. Users who have their own weather stations or access SILO data can merge more current data with these historical files.
- Computing routines were developed to enable HydroLOGIC to directly access SILO's patched point datasets from the Internet. This was especially useful for HydroLOGIC users that do not have access to their own weather stations. Users can purchase weather data from SILO on an annual basis which has been patched and check for mistakes.

To enable users to gain the full benefits of accessing the SILO data and meet intellectual property agreements data transfer and storage undertaken by HydroLOGIC users had to be encrypted to prevent the data being used for other purposes. This required significant effort by both the SILO the Cotton Management Support Systems teams.

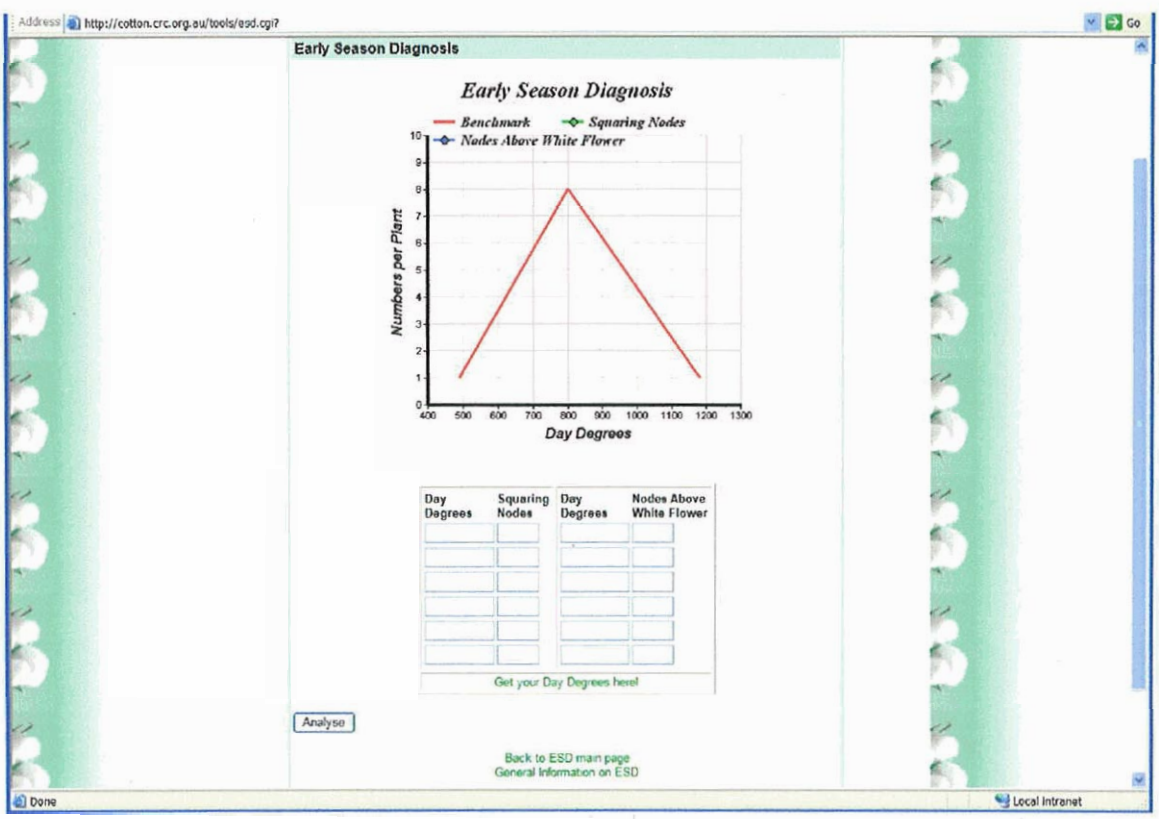

Figure 6: The Early season diagnosis tool utilising the SILO day degree calculator located on the Cotton CRC's website.

SILO Meteograms

Meteograms are numerical predictions of weather variables seven days in advance. As part of the project a number of opportunities were immediately identified in being able to use these numerical predictions they were:

- Automatically uploading predictions of maximum and minimum temperatures for EntomoLOGIC's Helicoverpa prediction model.
- Coupling the meteograms with the patched point datasets and use this to predict short-term impacts of climate on cotton growth using HydroLOGIC for irrigation management.
- Development of a day degree predictions for use at sowing time to help reduce the risk of poor crop establishment.

On advice from the SILO team these projects were put on hold until this technology had been more thoroughly evaluated.

How has your research addressed the Corporations three outputs: Sustainability, profitability and international competitiveness, and/or people and community?

This project has assisted researchers and extension personnel of the Australian Cotton CRC to conduct research, which ultimately contributes to all outputs nominated by the CDRC. More efficient and timelier access to day degrees during the season allows growers and consultants another important source of information to assist with production management decisions. This project has been integral in enabling the redevelopment of the decision support system HydroLOGIC which has been released to assist with increasing yields and improve water use efficiency of irrigated cotton crops.

Dissemination of the Project Outcomes

The primary delivery mechanism for weather and climate information is via the Cotton CRC's website. The SILO day degree calculator has been promoted at the CottonLOGIC training workshops, in various industry publications, and through mechanisms of the Technology Resource Centre at ACRI. In addition researchers at ACRI have access to a complete

historical and up to date climate database that covers the existing and potential cotton growing areas for their research purposes. The researchers are able to request climate data using their web browser.

Historical data collected from the weather station network is available on request from the Cotton CRC's technology resource centre.

Work conducted in this project has also contributed to the release of the CottonLOGIC software HydroLOGIC.

Publications arising from this research project

Milroy S, Bange M, and Richards D (2000). Cool Starts: What is Normal? The Australian Cottongrower 21(2). pp.70-73.

Richards, D.Q., Bange, M.P., and Milroy, S.P. (2000). Where did all the sunshine go? – The 1999/2000 season weather in review. 21(3) The Australian Cottongrower pp.24-27.

Richards DQ, Bange M.P, and Milroy SP (2001). The 2000-01 season in review. The Australian Cottongrower 22(3) pp.40-46.

Richards, DQ, Bange MP, and Milroy SP (2002). A season of two halves: 2001-02 weather in review. 23(3) The Australian Cottongrower pp.28-34.

Richards DQ, Bange MP, and Milroy SP (2003). A season without rain: Where's Noah when you need him! The Australian Cottongrower 24(3) pp.52-56.

Examples of publications using data obtained through this project

Effective and timely access to weather and climate data through this project has enabled some significant studies to be completed. Some examples of the publications that utilised the climate data are:

Richards D, Bange MP and Roberts GN (2001). Assessing the risk of cotton 'earliness' management strategies with crop simulation. Proceedings of the 10th Australian Agronomy Conference, Hobart, TAS. 2001. www.regional.org.au/au/asa/2001/

Yeates SJ (2001) Cotton research and development in Northern Australia: a review and scoping study. (The Australian Cotton Cooperative Research Centre, Narrabri, NSW).

Yeates SJ, and Bange MP (2003). Assessing the feasibility for cotton production in tropical Australia: Progress with the development and testing of model for climatic assessment and resource planning. In Proc. 3nd World Cotton Conf. Capetown, South Africa.

Yeates SJ and Bange MP (2003). Preliminary simulation analysis of potential cotton lint yields and irrigation water requirements for different planting dates at Laverton WA. Australian Cotton CRC, Narrabri, NSW.

Future Research Needs

Many of the initiative undertaken in this project will require maintenance and upgrading to meet the future needs of users. Most of this will form part of the overall duties of the Cotton Management Support Systems team based at Narrabri. Some future financial assistance may be requested in the future to help facilitate the links between the *SILO* and the Narrabri team. Discussions on maintaining access to these services are continuing with the Queensland Department of Natural Resources and the Bureau of Meteorology. Cost of access to these services may have to be included in budgets of other projects that utilise the data and services provided by SILO. The overall intention is to maintain these services with minimal cost to industry. Currently these are being provided at no cost while these issues are being resolved.

Other opportunities include further developing tools mentioned above using meteogram predictions when the confidence in these predictions is suitable.

Final Report Summary Enhancing Access to Weather and Climate Data

Principal Researchers: Dr Michael Bange, Mr Graeme Rapp, Mr Dirk Richards, Mr Scott Johnston, Mr Darren Linsley (CSIRO Plant Industry Cotton Research Unit) and Mr Alan Beswick (Queensland Centre for Climate Applications Qld. Department of Natural Resources).

Project Aims: The aim of this project was to improve access to quality and continuous weather and climate data by:

- Maintaining the existing cotton industry weather station network.
- Providing researchers with access to historical climate files.
- Collaborating with the SILO project improve access to weather and climate data collected from other sources.
- Through collaboration with the SILO project develop tools using weather and climate data to assist with cotton management.

Summary

The availability of accurate and continuous weather and climate data is essential for strategic research, operation of decision support systems (eg. CottonLOGIC, OZCOT crop simulation model) and numerous operational aspects of cotton agronomy and management. In addition historical climate data is being used by researchers to assess the potential of cotton growth in new regions and to analyse the performance of crops in current seasons in the context of the whole climatic record. Increasingly consultants and growers are using this information for making informed management decisions.

At the start of this project the industry supports the maintenance of 14 stations spread throughout the cotton growing regions. These stations require regular maintenance and annual calibration. The information collected from these stations is made available via the Cotton CRC's web site. After numerous problems installing the network they were operating at an acceptable level. However, the stations are now over 9 years and components are failing more frequently and the stations show visible signs of degradation from the weather.

A brief outline of the major results and outcomes form this project is given below.

1. Provision of weather information through the existing cotton industry weather station network.

These weather stations are now over nine years old. Of the initial 14 only five remain functioning. The parts from the stations removed from the field are being used to maintain these functioning stations. Three are being used for experiments while two remain in the field (Merah North and Breeza). More reliable and continuos data is now available through the SILO Internet site.

During this time as part of this project we also installed a new weather station at ACRI.

2. Provision of historical climate patched point data sets to the Australian Cotton Research Institute for research purposes.

ACRI and Cotton CRC researchers now have reliable and easy access to up to date weather information and historical data for research purposes. Researchers access this data through an internal website from a data server located at ACRI. On a daily basis the SILO web services updates the server with the latest numerical weather measurements recoded. This service has enabled any project utilising this data to run more effectively. No longer is there a significant cost in time and dollars to obtain this data.

3. Collaboration with partners of the SILO project to develop weather and climate tools specific to the cotton industry.

In gaining reliable and easy access to continuous climate datasets has enable a number initiatives where tools for research and decision support to be developed in collaboration with the SILO team. Currently all tools developed are available free to members of the Australian cotton industry. The tools developed and initiatives undertaken during this project are as follows:

SILO/Cotton CRC day degree calculator - allows user to enter a starting date and finishing date to calculate the day degrees.

SILO/Cotton CRC day degree target calculator - This decision tool is similar to the day degree calculator described above only that it differs in enabling the users to specify a target day degree.

Early season diagnosis tool - The early season diagnosis (ESD) tool was developed for the Cotton CRC's website to assist with the agronomic management of cotton crops. The ESD has been linked to the SILO day degree calculator, and allows the users to enter the sowing date and the dates on which the measurements were taken.

HydroLOGIC - Fundamental to the effective use of the HydroLOGIC software released to the cotton industry in September 2003 is gaining access to daily weather data. The SILO initiative was able to contribute to the development of HydroLOGIC by providing access to Historical patched point datasets for major cotton growing regions and developing computing routines were developed to enable HydroLOGIC to directly access SILO's patched point datasets from the Internet.

APPENDIX 1

Cotton Day-Degree Report

based on the SILO Patched Point Dataset

Table of accumulated day degrees for NARRABRI WEST POST OFFICE for the period 1 October 2003 to 15 October 2003

```
Day Degree accumulation for the period =    0
Number of hot days                     =    0
Number of cold days                    =   12
```

Average day degrees in the period 1957 to 2003 (for the period 1 October to 15 October) = **76**

Every year	has had at least	12 day degrees	
42 years out of 46	have had at least	35 day degrees	(approximately 10th percentile)
37 years out of 46	have had at least	44 day degrees	(approximately 20th percentile)
33 years out of 46	have had at least	56 day degrees	(approximately 30th percentile)
28 years out of 46	have had at least	67 day degrees	(approximately 40th percentile)
24 years out of 46	have had at least	74 day degrees	(approximately 50th percentile)
19 years out of 46	have had at least	78 day degrees	(approximately 60th percentile)
15 years out of 46	have had at least	92 day degrees	(approximately 70th percentile)
10 years out of 46	have had at least	99 day degrees	(approximately 80th percentile)
6 years out of 46	have had at least	116 day degrees	(approximately 90th percentile)
No year	has had more than	158 day degrees	

Average number of hot days in the period 1957 to 2003 (for the period 1 October to 15 October) = **0**

Every year	has had at least	0 hot days	
42 years out of 47	have had at least	0 hot days	(approximately 10th percentile)
38 years out of 47	have had at least	0 hot days	(approximately 20th percentile)
33 years out of 47	have had at least	0 hot days	(approximately 30th percentile)
29 years out of 47	have had at least	0 hot days	(approximately 40th percentile)
24 years out of 47	have had at least	0 hot days	(approximately 50th percentile)
19 years out of 47	have had at least	0 hot days	(approximately 60th percentile)
15 years out of 47	have had at least	0 hot days	(approximately 70th percentile)
10 years out of 47	have had at least	0 hot days	(approximately 80th percentile)
6 years out of 47	have had at least	1 hot days	(approximately 90th percentile)

No year has had more than 3 hot days
Note that some of the percentiles both have the same number of hot days, percentile calculations do this sometimes

Average number of cold shocks in the period 1957 to 2003 (for the period 1 October to 15 October) = 7

Every year has had at least 0 cold days
42 years out of 47 have had at least 4 cold days (approximately 10th percentile)
38 years out of 47 have had at least 5 cold days (approximately 20th percentile)
33 years out of 47 have had at least 7 cold days (approximately 30th percentile)
29 years out of 47 have had at least 8 cold days (approximately 40th percentile)
24 years out of 47 have had at least 8 cold days (approximately 50th percentile)
19 years out of 47 have had at least 9 cold days (approximately 60th percentile)
15 years out of 47 have had at least 10 cold days (approximately 70th percentile)
10 years out of 47 have had at least 10 cold days (approximately 80th percentile)
6 years out of 47 have had at least 11 cold days (approximately 90th percentile)
No year has had more than 14 cold days
Note that some of the percentiles both have the same number of cold days, percentile calculations do this sometimes

Day Degree Targets

This table presents the dates on which specific day degree targets were achieved.
If the target was not achieved, then -no- is printed instead of the date

DD target	2003	2002	2001	Latest 1999	Earliest 1957
1000	-no-	-no-	-no-	-no-	-no-
1200	-no-	-no-	-no-	-no-	-no-
1400	-no-	-no-	-no-	-no-	-no-
1600	-no-	-no-	-no-	-no-	-no-
1800	-no-	-no-	-no-	-no-	-no-
2000	-no-	-no-	-no-	-no-	-no-

Every year reached 1000 Day Degrees before 2/10
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 10th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 20th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 30th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 40th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 50th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 60th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 70th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 80th percentile)
0 out of 0 years reached 1000 Day Degrees before 1/10 (approximately 89th percentile)

APPENDIX 2

Cotton Day-Degree Target Report

based on the SILO Patched Point Dataset

Table of accumulated day degrees for NARRABRI WEST POST OFFICE for the period 1 October 2002 to 15 October 2003

Day Degree accumulation for the period = 0
Number of hot days = 66
Number of cold days = 178

Average day degrees in the period 1957 to 2002 (for the period 1 October to 15 October) = 2252

Every year	has had at least	1861 day degrees	
41 years out of 45	have had at least	1978 day degrees	(approximately 10th percentile)
36 years out of 45	have had at least	2090 day degrees	(approximately 20th percentile)
32 years out of 45	have had at least	2178 day degrees	(approximately 30th percentile)
27 years out of 45	have had at least	2275 day degrees	(approximately 40th percentile)
23 years out of 45	have had at least	2322 day degrees	(approximately 50th percentile)
19 years out of 45	have had at least	2373 day degrees	(approximately 60th percentile)
14 years out of 45	have had at least	2450 day degrees	(approximately 70th percentile)
10 years out of 45	have had at least	2461 day degrees	(approximately 80th percentile)
5 years out of 45	have had at least	2621 day degrees	(approximately 90th percentile)
No year	has had more than	2862 day degrees	

Average number of hot days in the period 1957 to 2002 (for the period 1 October to 15 October) = 41

Every year	has had at least	0 hot days	
42 years out of 47	**have had at least**	14 hot days	(approximately 10th percentile)
38 years out of 47	have had at least	28 hot days	(approximately 20th percentile)
33 years out of 47	have had at least	33 hot days	(approximately 30th percentile)
29 years out of 47	have had at least	35 hot days	(approximately 40th percentile)
24 years out of 47	**have had at least**	41 hot days	(approximately 50th percentile)
19 years out of 47	have had at least	45 hot days	(approximately 60th percentile)
15 years out of 47	have had at least	50 hot days	(approximately 70th percentile)
10 years out of 47	have had at least	56 hot days	(approximately 80th percentile)
6 years out of 47	have had at least	66 hot days	(approximately 90th percentile)
No year	has had more than	94 hot days	

Average number of cold shocks in the period 1957 to 2002 (for the period 1 October to 15 October) = 171

Every year	has had at least	12	cold days	
42 years out of 47	have had at least	157	cold days	(approximately 10th percentile)
38 years out of 47	have had at least	161	cold days	(approximately 20th percentile)
33 years out of 47	have had at least	169	cold days	(approximately 30th percentile)
29 years out of 47	have had at least	171	cold days	(approximately 40th percentile)
24 years out of 47	have had at least	174	cold days	(approximately 50th percentile)
19 years out of 47	have had at least	178	cold days	(approximately 60th percentile)
15 years out of 47	have had at least	182	cold days	(approximately 70th percentile)
10 years out of 47	have had at least	186	cold days	(approximately 80th percentile)
6 years out of 47	have had at least	192	cold days	(approximately 90th percentile)
No year	has had more than	201	cold days	

Day Degree Targets

This table presents the dates on which specific day degree targets were achieved
If the target was not achieved, then -no- is printed instead of the date

DD target	2002	2001	2000	Latest 1999	Earliest 1957
80	10/10	18/10	12/10	10/10	20/10
505	19/11	7/12	30/11	2/12	29/11
777	8/12	28/12	20/12	25/12	18/12
1527	27/01	18/02	4/02	19/02	4/02

Every year	reached	80	Day Degrees	before	31/10	
4 out of 46 years	reached	80	Day Degrees	before	10/10	(approximately 10th percentile)
9 out of 46 years	reached	80	Day Degrees	before	12/10	(approximately 20th percentile)
13 out of 46 years	reached	80	Day Degrees	before	14/10	(approximately 30th percentile)
18 out of 46 years	reached	80	Day Degrees	before	16/10	(approximately 40th percentile)
22 out of 46 years	reached	80	Day Degrees	before	16/10	(approximately 50th percentile)
27 out of 46 years	reached	80	Day Degrees	before	17/10	(approximately 60th percentile)
31 out of 46 years	reached	80	Day Degrees	before	20/10	(approximately 70th percentile)
36 out of 46 years	reached	80	Day Degrees	before	23/10	(approximately 80th percentile)
40 out of 46 years	reached	80	Day Degrees	before	26/10	(approximately 89th percentile)
No year	reached	80	day degrees	before	30/10	

Every year	reached	505	Day Degrees	before	21/12	
4 out of 46 years	reached	505	Day Degrees	before	22/11	(approximately 10th percentile)
9 out of 46 years	reached	505	Day Degrees	before	25/11	(approximately 20th percentile)
13 out of 46 years	reached	505	Day Degrees	before	29/11	(approximately 30th percentile)
18 out of 46 years	reached	505	Day Degrees	before	1/12	(approximately 40th percentile)
22 out of 46 years	reached	505	Day Degrees	before	2/12	(approximately 50th percentile)

27	out of	46	years	reached	505	Day Degrees	before	3/12 (approximately 60th percentile)
31	out of	46	years	reached	505	Day Degrees	before	7/12 (approximately 70th percentile)
36	out of	46	years	reached	505	Day Degrees	before	11/12 (approximately 80th percentile)
40	out of	46	years	reached	505	Day Degrees	before	12/12 (approximately 89th percentile)
		No	year	reached	505	day degrees	before	20/12

		Every	year	reached	777	Day Degrees	before	8/01
4	out of	46	years	reached	777	Day Degrees	before	13/12 (approximately 10th percentile)
9	out of	46	years	reached	777	Day Degrees	before	16/12 (approximately 20th percentile)
13	out of	46	years	reached	777	Day Degrees	before	18/12 (approximately 30th percentile)
18	out of	46	years	reached	777	Day Degrees	before	21/12 (approximately 40th percentile)
22	out of	46	years	reached	777	Day Degrees	before	23/12 (approximately 50th percentile)
27	out of	46	years	reached	777	Day Degrees	before	25/12 (approximately 60th percentile)
31	out of	46	years	reached	777	Day Degrees	before	28/12 (approximately 70th percentile)
36	out of	46	years	reached	777	Day Degrees	before	31/12 (approximately 80th percentile)
40	out of	46	years	reached	777	Day Degrees	before	1/01 (approximately 89th percentile)
		No	year	reached	777	day degrees	before	7/01

		Every	year	reached	1527	Day Degrees	before	9/03
4	out of	46	years	reached	1527	Day Degrees	before	3/02 (approximately 10th percentile)
9	out of	46	years	reached	1527	Day Degrees	before	4/02 (approximately 20th percentile)
13	out of	46	years	reached	1527	Day Degrees	before	7/02 (approximately 30th percentile)
18	out of	46	years	reached	1527	Day Degrees	before	12/02 (approximately 40th percentile)
22	out of	46	years	reached	1527	Day Degrees	before	13/02 (approximately 50th percentile)
27	out of	46	years	reached	1527	Day Degrees	before	18/02 (approximately 60th percentile)
31	out of	46	years	reached	1527	Day Degrees	before	19/02 (approximately 70th percentile)
36	out of	46	years	reached	1527	Day Degrees	before	23/02 (approximately 80th percentile)
40	out of	46	years	reached	1527	Day Degrees	before	26/02 (approximately 89th percentile)
		No	year	reached	1527	day degrees	before	8/03