CROP SCIENCE SOCIETY
OF SA INCORPORATED
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NEWSLETTER

Welcome to the October issue of the Crop Science Society of SA newsletter

Dear CSSSA Members,

Welcome to the October issue of the Crop Science Society of SA.

In this month's newsletter we explore:

- Member in focus – Stefan Schmitt
- Temporal and spatial variation in frost in Mid and Upper North SA
- Vale – William Donald Hunt

We hope you are keeping well. Please contact us if you have any requests for content of information.

Kind regards,

Dan Petersen
President, Crop Science Society of South Australia

Member in focus – Stefan Schmitt

My name is Stefan Schmitt and I am a current CSS committee member. I have been working in fee for service agronomy consulting for 8 years, after completing Bachelor degrees in Agriculture and Corporate Finance. I work with farming businesses across the Lower North, Mid North, Yorke Peninsula and Eyre Peninsula.

I grew up on a family farm at Port Broughton, which my brother and father run. Each year I enjoy heading home to help out with the harvest. This is a great time to reflect on the season, ponder improvements to farming systems or consume audio books.

In addition to consulting I conduct contract trial research work on numerous areas of agronomy including nutrition, precision ag, crop protection, phenology and more. A key area of research I have been working on over the past four years is exploring the benefit of precision planting technology on legume and oilseed establishment and yield. This research has been made possible through separate investments by the GRDC and SAGIT.

Consultancy and research work is highly satisfying, as no day is the same working across variable soil types and rainfall zones in southern Australia. I thoroughly enjoy assisting clients to adopt new farming innovations in a rapidly changing technology environment.

I have only recently taken a position on the CSS committee I look forward to ensuring it remains relevant and engaged with the agricultural community moving forward.

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Temporal and spatial variation in frost in Mid and Upper North SA

Part 1. Temporal variation in frost

Peter Hayman, Dane Thomas and Bronya Cooper, SARDI Climate Applications

Some years are frostier than others and there seem to be frostier and less frosty decades. This newsletter article addresses the year to year variability in frost.

Why is historical minimum temperature data important?

In the last decade there has been an explosion of NRM and on-farm weather stations and many of these are now networked. The lower cost and availability of temperature loggers such as Tiny Tags and iButtons provide further local information. This is valuable information, but unfortunately it is all recent. Even 10 years of measurement is a small sample to try and understand year to year variability. In the future there may be clever ways to connect the on-farm weather data with the long term data. At the moment we rely on BoM sites for long term records

These long term records are the only way to 1) rank the frostiness of a season like 2021 to better interpret the demonstration trials 2) make long-term comparisons of the frostiness of regions, 3) check the impact of climate drivers like negative IOD, 4) check on how frost risk is changing over decades and 5) analyse 'optimal' or 'safe' flowering windows.

Measuring and ranking the frostiness of a season or a region is somewhat similar to what we do with deciles for rainfall. Dryland farmers would agree that a statement like *"the growing season was a decile 3 season"* tells us more than *"it was a dry season, not the worst season, but dry"*. Of course, deciles for the growing season don't cover everything. The statement of a decile 3 season might be followed with *"a late break but the rain came just as the crops were flowering"*. Deciles as a way to rank the rainfall of the season are only possible because we have reliable long-term records of rainfall. We have fewer temperature records and even when we do have good records, it is more difficult to provide a frostiness decile. Candidates for ranking years include the number of frosts, date of last frost, coldest night, accumulated nights or 'frost sum' under a threshold of 2 degrees or 0 degrees and simulated damage from frost using a crop model like APSIM (YieldProphet). We will explore different ways to measure and rank frostiness for recent years, including 2021 in the third newsletter. Any suggestions would be gratefully received.

What do you mean by Optimal Flowering Windows?

In addition to ranking a given season, historical information on frost risk is important to identify the optimum flowering window. This is a "window" of days in spring that balances the risks of frost, heat and moisture stress. At recent frost workshops organised by MSF and GRDC we asked farmers and agronomists *"about what date in spring would you drive past a crop in head think it was too early and pushing against frost risk? What date would you think a crop was a bit late to be in head and prone to heat and moisture stress?"* Farmers and agronomists in the room were able to give us a

consensus based on their experience, local trials and because they had paid attention to discussion at recent GRDC updates, for example Stabilising the flowering time of wheat - GRDC . Farmers and agronomists at the workshops were quick to point out that hitting the optimum flowering window with different varieties and sowing times isn't always easy, especially if a season is warmer or cooler than usual. Further discussion covered how the targeted flowering window might shift earlier or later depending on the risk appetite of the farmer and the frostiness of the paddock. It is obviously a mistake to determine the Optimal Flowering Window after a single year, or even a three year project; we need to use long term climate records.

How can farmers access local information on frost and heat?

The APSIM model behind Yield Prophet captures the dynamics of crop development and how critical stages interact with the risks of heat and frost but also rainfall, crop water use, nitrogen supply and the other driver of modelling biomass, radiation.

A great tool for farmers and agronomists to freely access climate data is the CliMate App CliMate: Home Page (climateapp.net.au). A recent GroundCover article gives a good example of using CliMate as one input into managing frost risk Dodging frost a numbers game | Groundcover (grdc.com.au). A user of CliMate app can set the percent chance of reaching a cold or hot threshold. For example the 10% chance of being warmer than zero degrees and the 30% chance of being cooler than 30 degrees. Because this is only based on frost and heat it is better understood as a user defined 'safe flowering window'. Unless farming in a highly frost prone area, the Optimal Flowering Window is usually earlier than the Safe Flowering Window. This is because earlier flowering minimises the risk of moisture stress as well as heat stress. What this means is that an over-emphasis on flowering after the last frost or a very low chance of the last frost can be costly insurance because yields are reduced by moisture and heat stress.

What is the risk of frost and heat at Booleroo?

The upper north cropping region has limited temperature recording stations, especially stations that are appropriate for frost. Temperature data is not recorded at Booleroo, but the data is calculated from the nearest recording stations with correction for altitude etc. This is the same data that is used in CliMate and YieldProphet for Booleroo.

Figures 1 and 2 show the risk of being colder than zero degrees and warmer than 30 degrees for Booleroo. The x axis of both graphs is the day of year and the Y axis is frost risk presented as a percentage. The difference is that Figure 1 is the risk for a single day whereas Figure 2 is the risk at least one day in seven. The very sensitive stage of wheat to frost is at least 7 days. The chance of one frosty night over 7 days or one hot day over the week is much higher than the chance of a frost or heat on a single day.

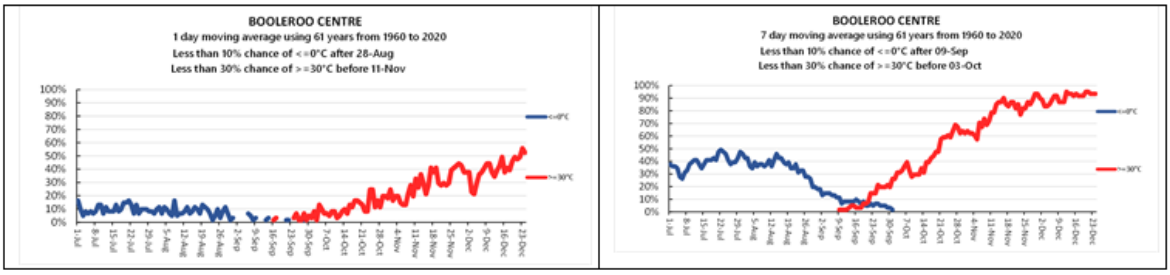


Figure 1 – Left side panel - chance of a single day measured at Booleroo Centre being zero degrees or colder (blue line) and 30 degrees or warmer (red line). Figure 2, (right side panel) the same thresholds as Fig 1 but chance of at least one day in seven meeting the threshold.

One way to think about this is that you are crossing a six lane highway with no safety island in the middle and you want to know the best hour of the day to do this. One analyst tells me the risk of being hit by a vehicle in one lane, another tells me the risk of being hit on at least one lane. They will both tell me how the risk changes by hour over the day, but the risk of being hit in at least one lane is a better measure of the risk for my problem. The chance of one event over the period gives a more realistic measure of risk. This should not be interpreted as a criticism of CliMate, it is a great tool and the how cold/ how hot component was not designed specifically for wheat, it can be applied to many agricultural applications.

The analysis in YieldProphet assumes that frost has impacts depending on the severity of the minimum temperature and the stage of the crop. Taking the analogy of crossing the six lane highway even further, YieldPropher is taking into account how quickly you cross the road. Late in spring in a warm location wheat will move through the sensitive stages much more quickly than earlier in spring.

Is the risk of frost and heat changing?

Farmers and agronomists with long experience have observed more frost damage and in many cases, earlier heat events. There is a paradox whereby in a warming world, we seem to be getting more frost, or at least noticing more frost damage. Figure 3 presents the heat and frost risk in the same way as Figure 2 (at least one event in seven days). The data for Figure 2 comes from 61 years (1960 to 2020). Figure 3 compares the risk for the last 20 years (2001 to 2020) with the risk in the previous 20 years (1981-2000). It is clear that days over 30 degrees C are coming earlier; the red line showing risk in recent decades is shifted above and to the left of the brown line. The risk of frost is also much greater in the last 20 years. It is hard to say whether this is a permanent shift, but it supports local experience that recent decades have had damaging frosts at a critical period. This timing may contribute to stem frosts.

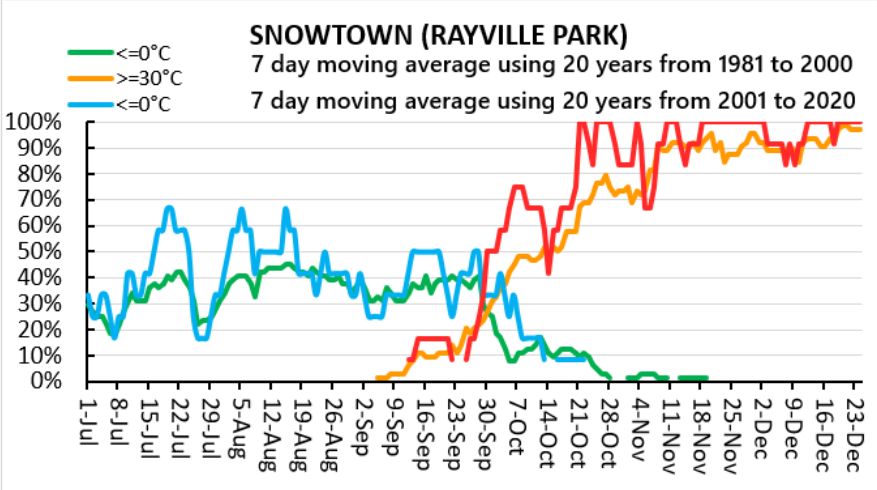


Figure 3 – The chance of at least one day in seven measured at Snowtown being zero degrees or colder and 30 degrees or warmer in the last 20 years from 2001 to 2020 (blue line and red line) or the previous 20 years from 1981 to 2000 (green line and orange line).

Part 2. Understanding the spatial variability of frost

Part 1 addressed variation in time; some years are frostier than others and some decades seem to be frostier than other decades. This section addresses the spatial variability; some regions are frostier than others and some paddocks and parts of the paddock are frostier than others.

It matters a lot where you put a thermometer to measure minimum temperature on a cold clear still night. During spring, grain growers are keenly watching the three interacting risks of frost, heat and rainfall. Rainfall along with maximum and minimum temperature are the most standard measurements. Measuring maximum temperature is relatively straightforward providing the data logger is shielded from the sun. Spring heat spikes in the grains belt come with a hot dry northerly wind as there isn't enough local solar radiation to generate the heat. Because of the wind and mixing of the air, it doesn't matter much where in the landscape you place a thermometer or data logger. Rainfall varies from region to region and farm to farm, but frontal rain in spring is less variable than a summer thunderstorm and rainfall is much less spatially variable across a farm and a paddock than minimum temperature. Minimum temperature is recognised as the most spatially sensitive parameter and this is especially the case with radiation frosts.

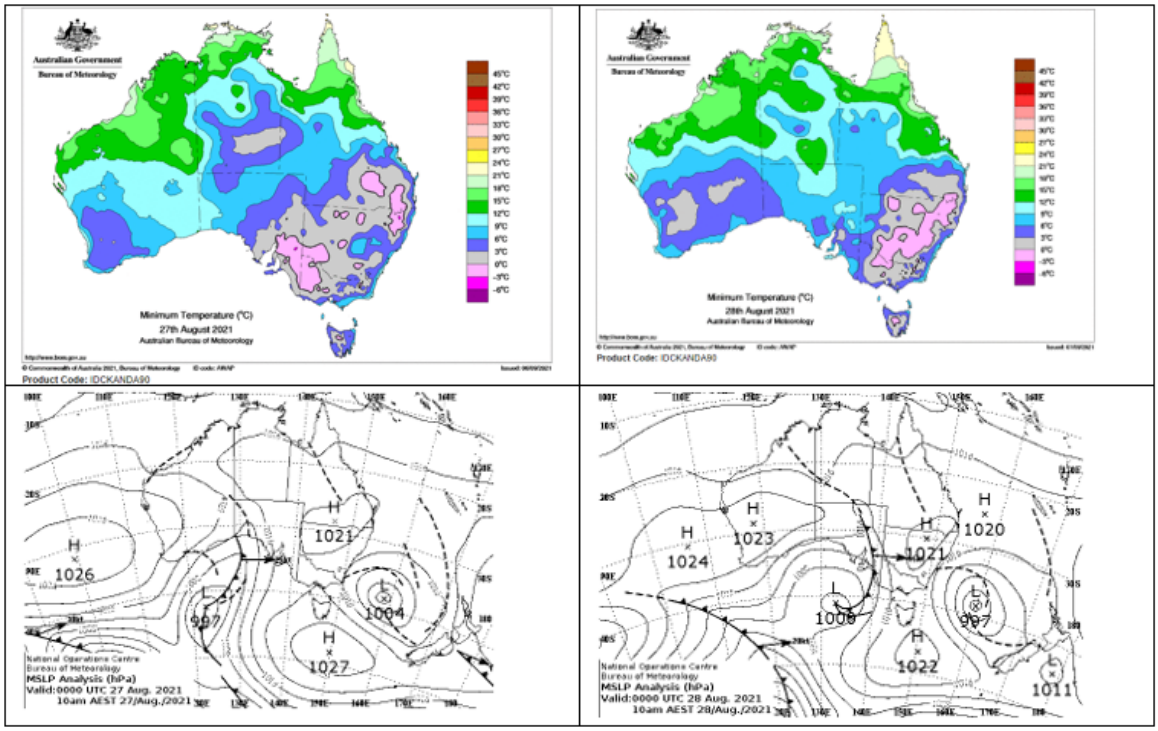
Grain growers in the northern hemisphere experience freezing temperature and strong winds in what is called a freeze or in extreme cases, an ice storm. The wind causes mixing and it doesn't matter where you place the thermometer. A radiation frost on a clear, calm night where heat is being lost from the wheat paddock to outer space is a special case where temperature can vary over very small distances.

Climate MesoClimate and Microclimate The terms macro, meso and micro refer to decreasing levels of scale but there is no single definition of the dimension. It is obvious that climate varies at a finer

scale than we measure it. On a frosty night, the 'microclimate' in a Stevenson screen 1.2 metres above the ground http://www.bom.gov.au/climate/cdo/about/definitionstemp.shtml is different to the microclimate within the paddock. When selecting sites for viticulture it is common to refer to climate or macroclimate (the region), mesoclimate (the vineyard) and the microclimate (the vine). The table below refers to these different levels and includes a fourth level of phyllo-climate or the plant level. Researchers and farmers dealing with frost will sometimes say that the BoM site is irrelevant to what happens in the paddock. The BoM site is different to a measure at head height. If a BoM site was in the coldest frostiest hollow, we are measuring both climate (minimum temperature due to high pressure system and dry cold air) and landscape (cold air drainage). A measure at head height is a measure of the climate, the landscape and the vigour of the wheat crop.

Classification and resolution	Key determining factors	Measurement
Macroclimate Up to ~50 km in hilly regions and ~100 km in flatter expansive regions. *Level of Region or district*	Determined by *geographic location* including altitude, latitude and distance from the coast. Largely independent of landscape or vegetation.	Measured by Bureau of Meteorology Weather stations in Stevenson screens 1.2 m above ground surface, commonly at a regional airport, post office or high school. The aim is to find a location away from vegetation and preferably not in a frosty hollow.
Mesoclimate Up to ~5 km – sometimes referred to as topoclimate. *Level of paddock or zone of paddock*	Determined by *topography* including slope, aspect and relative position in the landscape. Largely independent of vegetation.	Usually measured by an on-farm automatic weather station positioned near a cropping paddock. Networking of on-farm weather stations is increasing. Examples of networks of weather stations are Data Farmer in Victorian Mallee, the SA Mid-North and SA Malle Mesonet
Microclimate Up to ~10 cm above crop height. *Level of crop or a plot in experiment*	The climate within the boundary layer of a crop or plant. Determined by *vegetation.*	Measured by data loggers, usually adjusted to be at the height of the reproductive organs of the crop.
Phylloclimate ~1-5 mm *Level of the plant or organ*	The physical environment perceived by aerial components of the plant. Determined by *relative position of organ* and local energy exchange.	Measured by thermal imaging that can show temperature of individual plant parts.

Macro Climate for the different regions The maps of minimum temperature from the Bureau of Meteorology show the broad scale of frost. The synoptic chart indicates the slow moving high pressure system covering the extensive region.



Using a selection of Mid/Upper North sites with recent temperature observations, Figure 4 shows the daily minimum temperatures in 2020

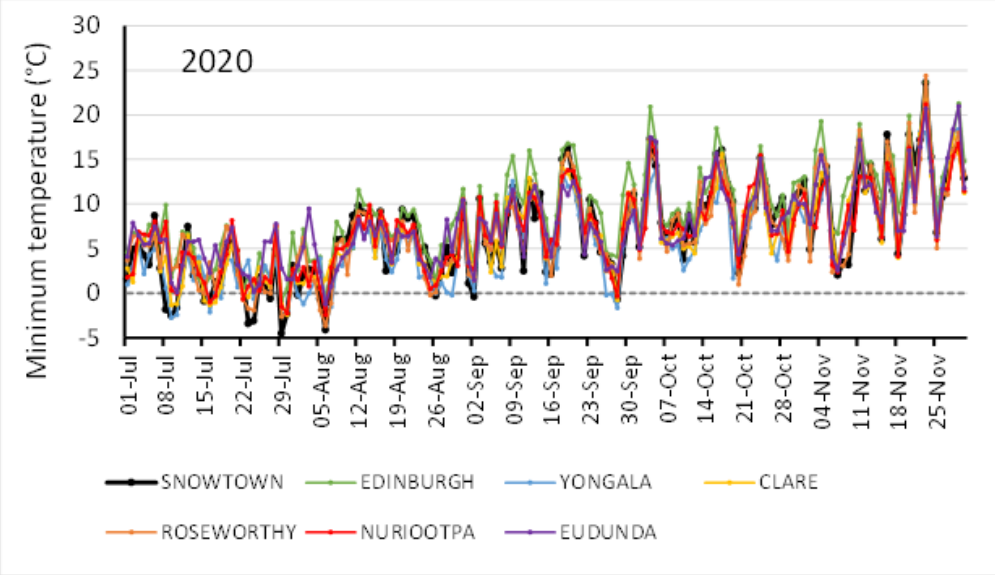
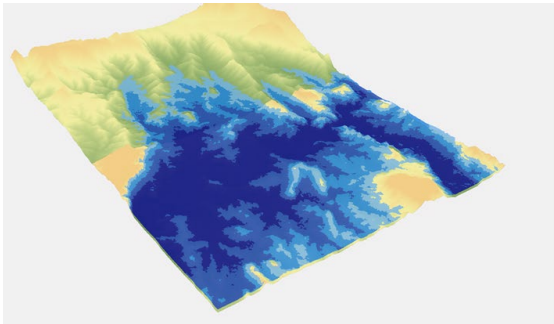


Figure 4: Daily minimum temperatures during 2020 recorded at Snowtown, Edinburgh, Yongala, Clare, Roseworthy, Nuriootpa and Eudunda in the Mid/Upper North, SA.

MesoClimate The term meso climate is familiar to many growers in the mid north and mallee meso-net. The Mid North Mesonet is a great resource of very high quality local data. The system has been co-designed by meteorologists and agriculturalists to measure inversions for spray weather. There are other networks of weather stations such as Data Farmer in the Victorian Mallee and weather stations linked to the soil probe networks.



30m x 30m meso-scale A project led by Dr Uday Nidumolu from CSIRO Waite and funded by GRDC as part of their frost initiative developed a model to combine local terrain data with a single logger to generate 30m x 30m resolution maps of minimum temperature across any paddock in the cereal belt. When tested on additional paddocks they found between 83% and 96% of the pixels correctly identified above or below the 2 degree threshold. https://authors.elsevier.com/sd/article/S0168-1923(21)00105-2 This is not perfect, but it is better than guessing. CSIRO and GRDC are currently in discussion about pathways to market.

GRDC has funded Dr Nidumolu and his team for a project called FrostSense than builds on the minimum temperature monitoring. The goal is to develop an integrated modelling framework to rapidly map the extent of stem and reproductive frost damage in wheat and barley.

MicroClimate and Phylloclimate Researchers who study freezing in plants report surprising results such as the plant can freeze from the lower leaves first and that the process of freezing seems almost random.

They also identify that the relationship between temperature and frost damage can be quite weak. This is in part due to super cooling of water. Dr Troy Fredrickson from QDPI poses the question at meetings “What is the freezing point of water” and most of us give the wrong answer of zero degrees. Zero degrees is the melting point of ice, but water can supercool and stay in liquid form well below zero. Dr Ben Biddulph from DPIRD (WA) is investigating the role of ice nucleating bacteria that might explain why some plants freeze at different temperatures – a case of “watch this space”.

Concluding remarks Simply going for a walk on a still evening reveals that minimum temperature varies across the landscape because the human body is sensitive to small changes in external temperature. While we can’t solve the problem of missing measurements from the past, we have access to more weather stations and relatively low-cost data loggers. Information from CSIRO on temperature across the landscape is a way of using the data loggers. This information combined with yield maps has the potential to help with frost zoning. Commercial and research developments in remote sensing of frost damage add information that is immediately beneficial for decisions on cutting for hay and adds to the overall picture of where frost occurs for long term planning.

Acknowledgements

The material in this newsletter has been adapted from the GRDC Southern Frost Extension Project, managed by Mallee Sustainable Farming Systems.

Information on content Peter.Hayman@sa.gov.au.

Information on GRDC Southern Frost Extension Project Tanja.Morgan@msfp.org.au

Vale – William Donald Hunt

Born: Bordertown South Aust :8 April 1951

Died: Bordertown South Aust : 27 July 2021

As all the luxuriant growth unfolds, that typifies Springtime in the Tatiara, it makes me sad that Bill didn't get to enjoy this time of year just once more.

Bill finally lost his 3-year battle with cancer this July and the Tatiara lost a fierce advocate of all things relating to "The Good Country."

Always interested in and passionate about all things agricultural, he was keen to discuss with others their methods and approach to farming and how he could adapt or implement these ideas in our area and also to impart knowledge he had gained to others with the aim of mutual benefit and improving / developing farming techniques.

Bill was born in Bordertown the second of 6 children of Don and Sadie Hunt and grew up at West Nalang.

After schooling at Bordertown Primary and High and Prince Alfred College 1965-1968, he returned to the Tatiara to become manager at the Homestead property of Nalang, south of Bordertown by about 1972 .

He was the fourth generation of his family to manage this property and a sixth-generation farmer in South Australia.

His thirst for knowledge and information about agriculture began early in life and developed with learning from family, friends at home and boys from all over the state and beyond at boarding school.

He was involved with many groups including Rural Youth, ICI farm management advisory group (in 1980s), stockowners and SAFF committees especially Natural Resources Committee and SE water management.

Wolseley Ag Bureau, Crop Science Society featured highly and in more recent times the national group of Climate Champions where he was a GRDC representative.

Crop trial plots run by Roseworthy and Waite Institute were always a highlight for both knowledge gained, and friendships made.

Some people farm to live and some live to farm.

There was no mistaking Bill' s standpoint.

He felt that any topic or view was never completely right or completely wrong but always open to discussion...usually as long as you came round to his way of thinking in the long run!!

An enthusiastic speaker, Letter to the Editor writer and citizen of the Twitterverse, he did love the thrust and parry of a good debate.

He was very pleased to finally finish his book " Houses of Straw "which he began back in 2000 and originally was a chronicle of farming activities and viewpoints over a 12-month cycle, and to try to express how and why farmers do what they do and how passionately they are involved with the land.

Over past 3 years he updated and interleaved the farming chapters with more personal and family history chapters.

He was quite pleased with result that he was able to see in print in May this year.

He was also (pleasantly) surprised that others also enjoyed the read and found it very relatable, even those from non-farming backgrounds.

Quite a legacy for all.

He is survived by his wife Jenny and 3 children (his best crops ever!)

Ben (now 5th generation Hunt of Nalang) and wife Joylene and children Austin and Charlotte. Matthew and wife Jessica (Adelaide) and children Bert and Flora. Johanna and husband Joseph Matthews (Melbourne)

Due to COVID-19 restrictions the funeral was held in Bordertown on Aug 20 with only 50 attending. He was laid to rest at Mundulla Lawn Cemetery and pall bearers were his 3 children and 3 brothers John (Bordertown) Greg (Mundulla) and Frank (Cannawigra)

Two sisters Christine (Mundulla) and Sandie (Meckering WA)

Due to restricted numbers able to attend, Ben organised a guard of Honour as part of "Bill's Last Crop Walk " before the funeral service.

Many people and vehicles lined the driveway up to the homestead and out past the Woolshed here at Nalang, one last time to check things over and say goodbye.