Drought and climate adaptation program

Extreme heat days impact on Queensland's multi-million dollar sweet corn industry

Can a more accurate long lead time local forecast enhance management decisions, and improve marketable yield of Sweet Corn?

Executive Summary

Several nationally significant sweet corn businesses have sizeable production, grading, packing and marketing bases in the Lockyer Valley, Queensland. Queensland was the largest producer of fresh market sweet corn in Australia and produced over 64% of Australia's sweet corn crop in 2018-19, valued at $175.75 million; Queensland's contribution being $113million (ABS, 2018-19). These businesses supply fresh and semi-processed (dehusked, portion cut, wrapped and tray packed) product to the local, national, and export markets.

These local businesses grow, harvest and process sweet corn in the Lockyer Valley in the spring, summer and autumn seasons and at other Queensland and interstate locations for the remainder of the year and have contracts with the major supermarket chains in Australia to supply fresh product 52 weeks of the year. These field production, processing and packing facilities operate year round and all employ hundreds of staff. Production is carefully planned, planted and scheduled in order to meet weekly contracted supply arrangements throughout the year. Unexpected and extreme weather events can severely impact sweet corn productivity and marketable yield.

Business, farm, factory, and sales managers aim to deliver quality sweet corn orders daily and weekly as contracted. An accurate long lead time forecast (especially temperature) would be an invaluable/essential tool, facilitating and informing improved business management and crop management decisions. This "in-field, real life" case study documents the impact and costs of extreme temperature events on three sweet corn crops harvested in the same week in the Lockyer Valley in November 2019.

Over the last 10 years marketable yield and profitability of midsummer harvested sweet corn has in some years been severely impacted by summer heatwaves of increasing frequency and severity. Local growers report that these heatwaves can reduce seed germination, slow crop growth rates, increase plant water use and most importantly can cause missing kernels (blanking) within the sweet corn cob. The severity of this blanking varies between events but has been reported to cause significant marketable yield loss (up to 50% reduction in yield) in some plantings.

Project staff aware of the issue have in past years performed some ad-hoc investigations into this marketable yield loss. The Use of Bureau of Meteorology multi-week and seasonal forecasts to facilitate improved management decisions in Queensland's vegetable industry project was a chance to investigate and document these serious economic impacts more fully.

This observation trial carried out in three separate commercial plantings maturing at the same time on different farms in the Lockyer Valley set out to identify and document the climate drivers that cause "blanking" and marketable yield loss in commercial sweet corn crops harvested in summer in the Lockyer Valley.

Queensland Government

The experimental forecast project work focussed on developing and testing multi-week and seasonal forecasts for the vegetable industry in the Granite Belt and Lockyer Valley horticultural production regions of Queensland, with an emphasis on Maximum Temperature. It's part of the Queensland Government's Drought and Climate Adaptation Program that helps producers to better manage drought and climate impacts through improved forecasts products, tools and extension activities.

Ideal Growing Conditions

Sweet corn is sensitive to frost and prefers warm weather. Optimum temperature for growth is 24° to 30°C. Soil temperatures above 18°C are necessary for good germination of super sweet varieties. Normal sweet corn will germinate at soil temperatures above 12°C. (Sweet Corn Agrilink).

Plant growth ceases below 10°C while temperatures above 35°C are usually above the optimum for photosynthesis and can be detrimental to development of reproductive parts and reduce cob quality.

Pollination

Pollination will be poor if hot (above 35°C), dry and windy conditions occur at silking. Poor pollination causes missing kernels (blanking), within the body of the mature cob. Missing kernels at the tip of the cob are not a major issue as cobs can have their tips machine-trimmed prior to packing and marketing.

Missing sections of kernels in the body of the mature, harvested cob are a major quality defect often making the cob unsaleable.

Pollination is an extremely critical growth stage and poor tip fill will result if the plant is water or nutrient stressed or if environmental conditions are not favourable.

Cob pollination continues over several days but it is not continuous and stops when the tassel is either too wet or too dry. Hot dry conditions are much more likely to interfere with pollination than wet conditions.

(Ref - Sweet Corn Agrilink).

A silk elongates from each flower and eventually extends out of the husk at the tip of the cob.

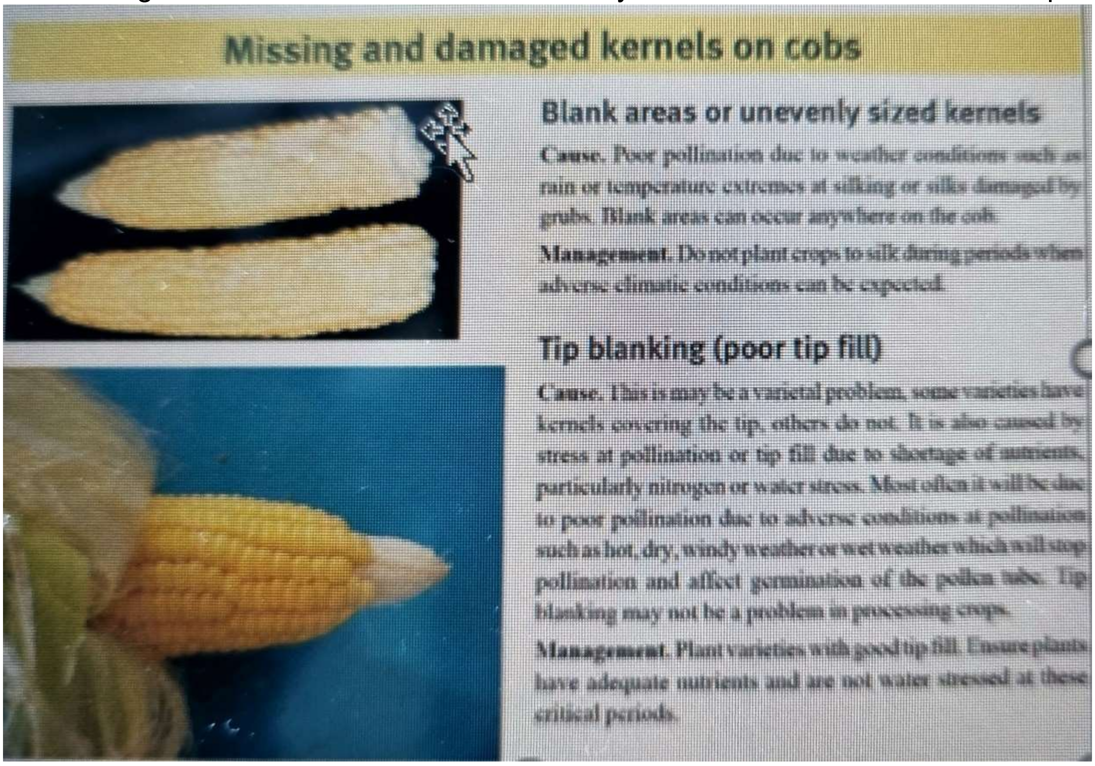


Figure 1 Blanking in sweet corn.

During silking wind-blown pollen, deposited on the silk from the male tassels takes about 24 hours to grow down and reach the ovule, where fertilisation produces a new kernel. ‘Blanks’ appear on the cob from those missing kernels when silks (or pollen granules) are damaged before pollination.

(Web reference, *https://www.publications.qld.gov.au/dataset/high-value-horticulture-value-chains-for-the-queensland-murray-darling-basin-activity-3/resource/905ca0fb-6819-411b-a005-78e1ec7b7a26*)

Setting the Scene

During October and November 2014 very high daily maximum temperatures in the Lockyer Valley growing region had a significant impact on crop yields and profitability in a range of high value horticultural crops.

The graph below compares the 2014 October and November maximum daily temperatures to the long term mean maximum temperature (blue line) for these months.

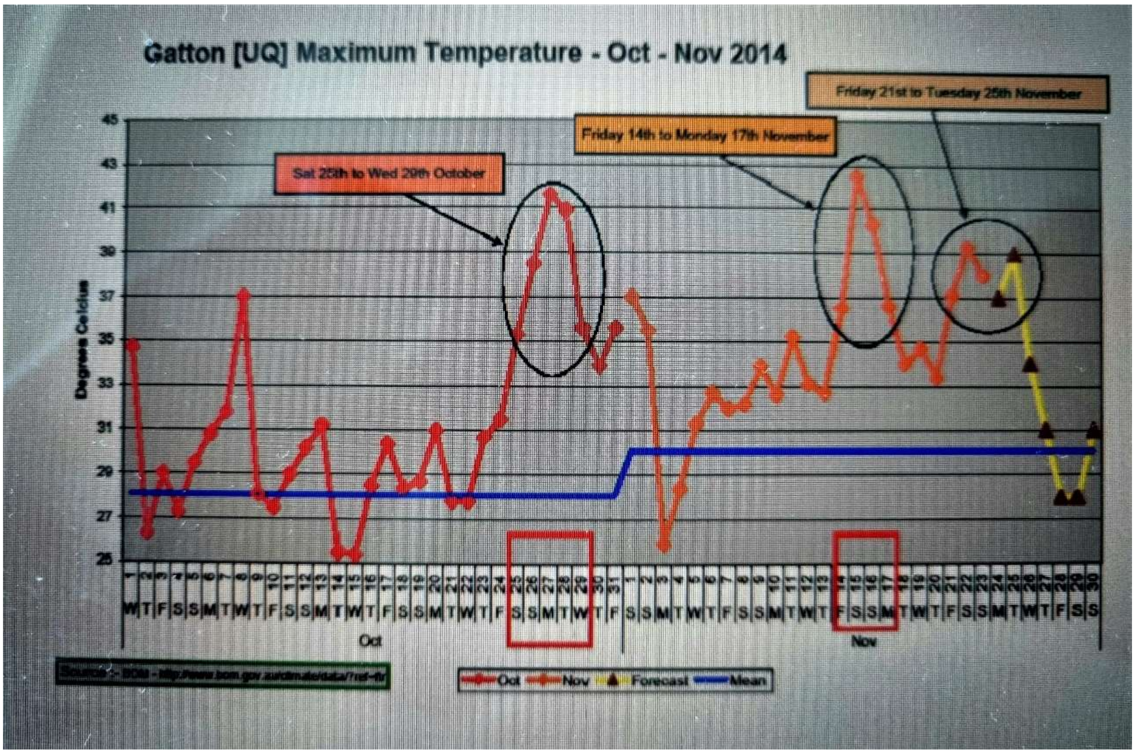


Figure 2. Gatton maximum temperatures October and November in 2014.

These heatwave conditions resulted in significant crop impacts and quality loss in Lockyer Valley sweet corn crops in late 2014 (P. Deuter personal communication 24th November, 2014). Local sweet corn producers have historically reported loss of marketable yield in sweet corn crops that mature during peak summer heat. Examination of the cob quality of one of these fresh market sweet corn crops that was maturing and filling cobs during this high temperature period October and November in 2014 revealed high levels (80% of cobs) in this crop had missing kernels (blanks) in the upper and mid region of the cobs – significantly reducing crop quality and marketable yield.

Figure 3. Sweet corn cobs showing severe “blanking” as a result of extended extreme temperatures experienced in Gatton in the 2014-15 season.

The term “blanking” refers to missing kernels on a mature sweet corn cob. It appeared that the extended heatwave detailed above was the most obvious cause of this “blanking” and yield loss. On reviewing the local temperature data and comparing it to historical summer maximum temperature data and corn yield records we postulated that the extreme maximum daily temperatures (exceeding 35°C) occurring during the critical cob pollination (silking) phase of the crop and lasting three or more consecutive days could well be the cause of cob “blanking”.

These high temperature events prevent complete cob fertilization and subsequent kernel formation and filling on the developing cob (DEPI 2013). Sweet corn cobs with significant levels of “blanking” are unmarketable as whole fresh cobs. However, if the crop is partially de-husked and trimmed for the tray pack market, some of the affected cobs can potentially be marketed in wrapped packs as cobettes. Sorting de-husking, trimming and packing these imperfectly filled cobs requires extra labour, equipment and expertise and the specialist trimmed cob market demand is limited. The market for cobettes is also limited, so not all fresh market sweet corn with obvious blanking can be channelled into this niche market – the remainder is wasted.

The high October and November daily maximum temperatures in Gatton in 2014 resulted in significant crop quality impacts in sweet corn plantings that were in the pollination (silking) phase during this period. When harvested (approximately 20 - 25 days later) these plantings showed varying levels of “blanking”, resulting in lost yield as well as extra labour costs throughout the grading, packing and trimming process in the packing shed. Cob fill uniformity was poor in multiple weekly plantings making it necessary to closely inspect every cob in the packing shed to determine if it was fit for the fresh market. Rejected cobs (up to 50% in some plantings) were then further assessed to determine if any value could be salvaged by using part of those cobs as smaller dehusked, cut and prepacked cobettes.

Documented Commercial Yield Impacts

Observation # 1 – the Summer of 2017-18

In the 2017 – 2018 growing season we took the opportunity to again follow up on the impact of extreme temperatures on sweet corn yield and identified a number of Lockyer Valley sweet corn plantings that had grown through significant heatwave conditions during the crop silking period.

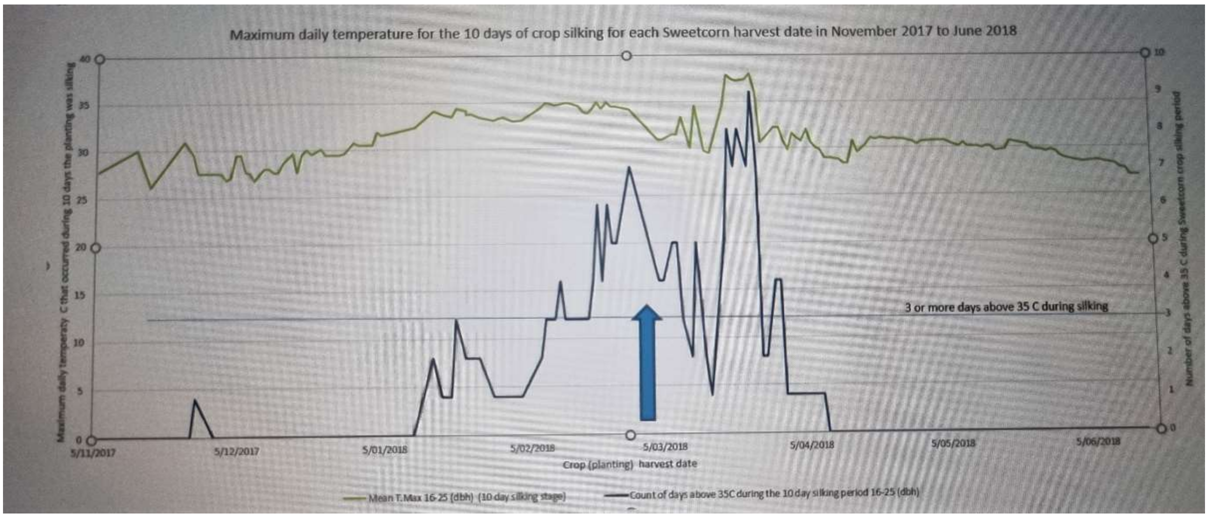


Figure *4*. Daily maximum temperatures and days > 35°C in the Lockyer Valley in 2017-18 during the local sweet corn growing window.

We obtained the commercial harvest data for these crops, grown on different farms using different growing, irrigation and agronomic practices to determine if we could align and document the extreme temperature events (3 days above 35°C) with reduced marketable yield. The data showed the trend we expected - i.e. Reduced marketable yield in the peak of the heat, (Figure 5). However, variation in individual crop management practices as well as irrigation method, frequency, duration and timing resulted in significant variation within the data set, making it difficult to directly identify and quantify the impact of blanking alone on marketable yield.

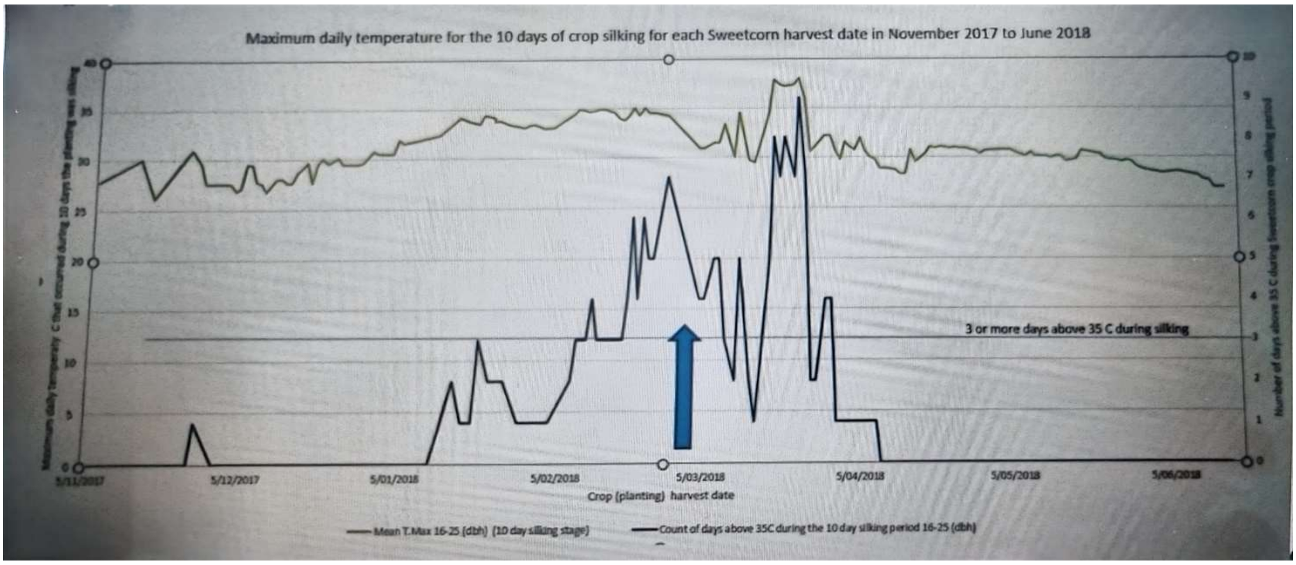


Figure 5. Daily maximum temperatures and averaged marketable yield from sweet corn grown in the Lockyer Valley in 2017-18 during the season.

The trend line of reduced marketable yield (actual individual farm marketable cobs/ha) caused by the extreme heat in the Lockyer Valley in 2018 as measured by the number of days when maximum temperatures exceeded 35°C is evident in Figure 5. The individual farm marketable yield data showed yield variation ranging from 35,000 cobs/ha down to as low as 12,000 cobs/ha in some sequential plantings harvested during February and March 2018. This documented variation in marketable yield represents a 65% decline in potential yield in some plantings over the summer season when demand for sweet corn is high.

The above data (Figure 5) indicates that sweet corn production managers would have to plant up to 65% more crop area through these extreme heat (summer) months in order to ensure the same marketable yield per hectare they would expect in cooler months of April and May. This means 65% more land, water, labour and agronomic inputs would need to be applied to obtain the targeted commercial yield during the summer harvest season.

The sweet corn yield data from crops that were silking during the extreme heat of the 2018 summer production season show conclusively how these high temperatures impact on marketable yield. This again highlighted the need to further investigate and identify the underlying Lockyer Valley summer environmental factors that cause this yield loss.

Figure 6. Sweet corn cob showing "blanking" as a result of extended extreme temperatures experienced in Gatton in the 2017-18 season.

Observation # 2—February 2019

In February 2019 we identified 5 consecutive days on which temperatures were above 35° C (9th to 13th Feb 2019), and we concluded that these consistent extreme temperatures were likely to have an adverse effect on sweet corn pollination. Crops silking on these days would be due to harvest around 20 to 25 days later from 5th to 10th of March 2019.

We visited and inspected several sweet corn crops that met these criteria and assessed the level of cob damage (blanking) occurring as a result of this excessive heat on sweet corn.

To do this we arranged to inspect a field of sweet corn which was silking between 9th and 13th Feb, and likely to be close to harvest by early March (4th, 5th,6th,7th & 8th of March).

We spoke with growers who had sequential sweet corn plantings that fitted these criteria and visited the farms to inspect the mature crops on the 8th of March 2019 prior to their scheduled harvest.

A field visit to these crops when the cobs were mature revealed no significant cob blanking even though the crop had grown through more than three days where maximum temperatures exceeded 35°C. These plantings were grown in a typical Lockyer Valley black clay soil and irrigated using drip irrigation. Unlike overhead gantry (boom) irrigators which move slowly across a field, drip irrigation is permanently in the crop – allowing easy irrigation to a whole planting as needed.

On the day we inspected the crops it was noticeable that humidity levels within the crop canopy were significantly higher than the surrounding cultivation area and the temperature within the tall leafy mature crop seemed cooler.

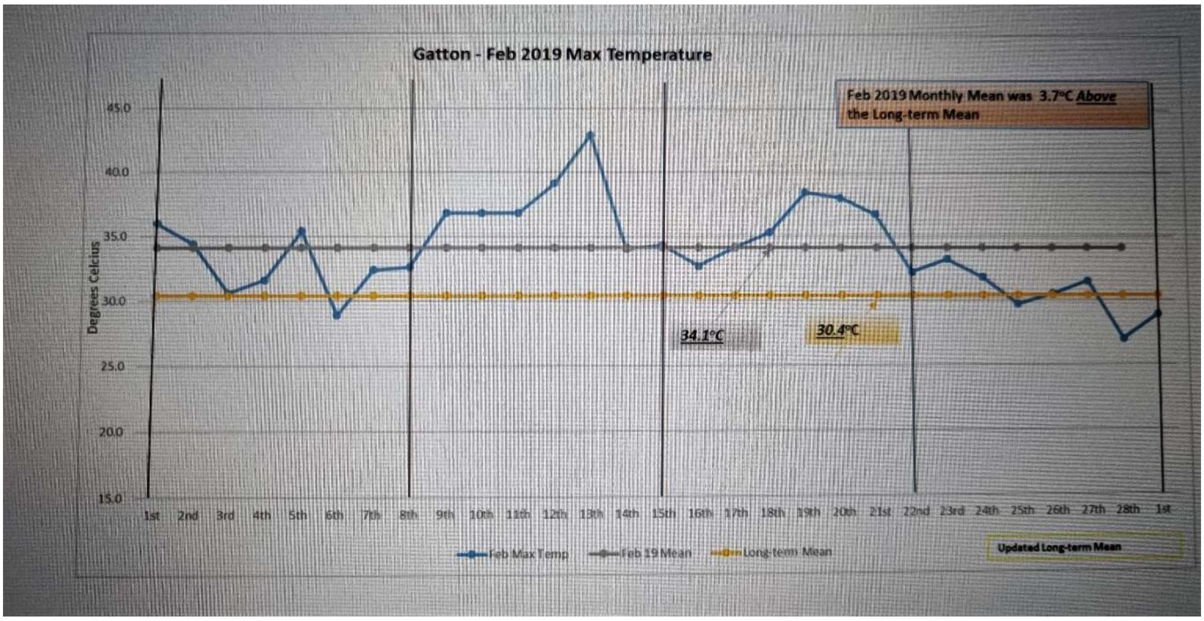


Figure 7. Gatton daily maximum temperature in February 2019 and the monthly historical February mean.

Figure 8. Team member Peter Deuter inspecting cob quality of a drip irrigated sweet corn crop that was silking in extreme February heat and was ready to harvest in March 2019.

After a thorough inspection and sampling of mature cobs from these crops we found no evidence of blanking, all the oldest maturing cobs were marketable. After speaking with and discussing our findings with the farm manager we postulated that the drip irrigation used on this farm had the effect of increasing relative humidity in the crop as well as reducing in-crop temperature. The farm manager stated, “I have been caught in previous years by hot dry weather so now I use drip irrigation and get the soil and crop well-watered through the heat”. When walking into the crop on a hot dry day we noted a definite cooler and more humid micro-climate within the cropping area. The tall leafy crop combined with well irrigated soil acted to create a modified in-crop, microclimate potentially protecting the crop from the full impact of the extreme heat.

Figure 9. High quality mature sweet corn cobs from four sequentially planted drip irrigated crops showing no evidence of blanking even though the crops had grown through the extreme February heat in the Lockyer Valley.

This field inspection led us to revise our thinking, based on observations and we postulated that high temperature alone was not the sole environmental variable responsible for the development of blanking in commercial sweet corn crops in the Lockyer Valley in summer. Our sweet corn crop inspections in February 2019 pointed to the possibility that humidity levels during the crop silking stage may be a key factor that influences marketable yield under high temperature conditions.

Observation # 3—November/December 2019

In the following November and December 2019, we monitored the temperature and humidity in commercial sweet corn crops that were silking in heatwave conditions in the peak of the summer heat. The three sweet corn plantings we monitored all matured in the same week allowing us to compare temperature and humidity readings during his silking stage of these crops and relate this to cob quality at harvest time. All three crops were overhead irrigated using moving gantry (boom) irrigators, however, the extreme heat and prolonged drought resulted in different irrigation regimes (amount and frequency) being adopted by the crop managers. This information was an important consideration when each monitoring site was initially chosen, as it was thought that comparing similar aged crops grown using differing irrigation approaches may well produce differing in-crop microclimates (temperature and humidity) during the silking period in a hot dry summer.

Temperature and humidity loggers were placed in each crop (13th November 2019) on the same day one week prior to the expected silking date of the crops. Loggers were also set up adjacent to the crop (about 20m away) at all sites to allow a comparison of temperature and humidity within and adjacent to the crop. The loggers recorded temperature and humidity hourly and were calibrated for consistency and accuracy and installed at a standardised height of 1.5m above the ground in accordance with temperature measurement protocols.

Figure 10. Humidity and temperature sensor in a sweet corn crop.

Relative humidity and temperature data from all crops confirm that a well-watered crop with full canopy does in fact create its own microclimate. This effect can be seen in the maximum temperature and relative humidity data from the well managed and well irrigated crop below (Figure 11 & Figure 12).

During this observation trial the well irrigated crop showed the most significant and consistent microclimate effect of all three crops. This is to be expected and was in part due to the extreme heat and scarcity of irrigation water available at the other two comparison planting sites.

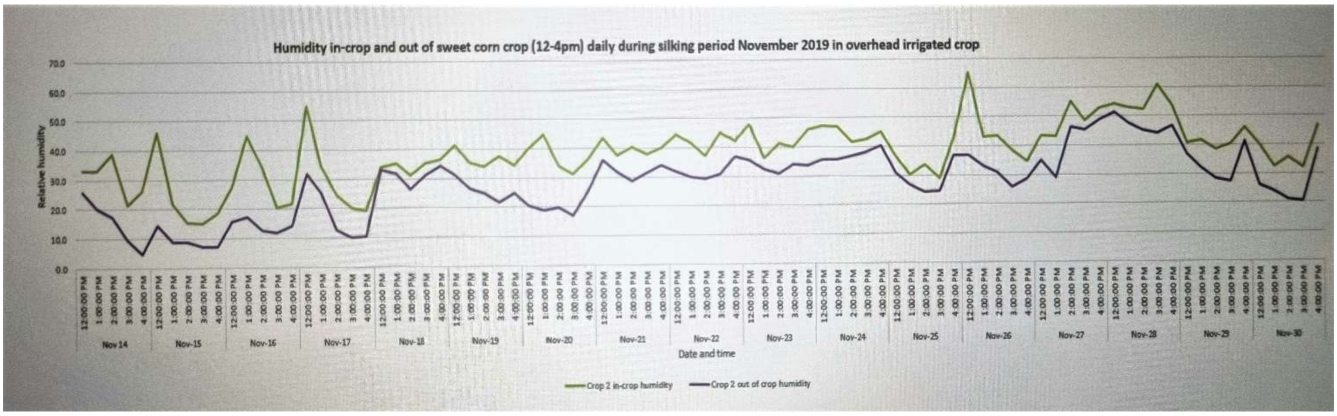


Figure 11. Humidity differences in and adjacent to irrigated sweet corn crop

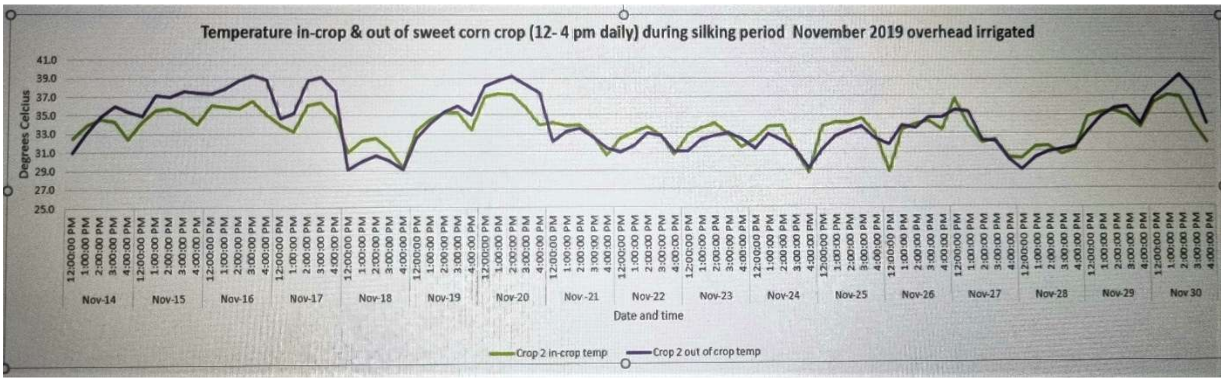


Figure *12*. Temperature differences in and adjacent to irrigated sweet corn crop

Pre-harvest Assessment

A field assessment of cob quality in all 3 crops was carried out on the 6th of December 2019 just prior to commercial harvest. A general assessment of cob quality within the cropped area was carried out by peeling back cobs to examine kernel development and fill. Ten mature cobs were harvested from 10 randomly selected sweet corn plants within 5m of the logger in each crop. These cobs were then assessed on site by removing all covering leaf to allow visually grading and comparison of cob quality and marketability.

Figure 13. Temperature and humidity sensor housing visible in mature sweet corn crop being harvested

Sweet corn crop marketable yield field assessment comparison

Table 1. Field cob quality assessment 6th December 2019.

	Blanking	Unsaleable estimate	Comment
Crop 1	70% of cobs severe	80-90%	Variable quality - 20% of cobs good quality remainder severe blanking
Crop 2	0% of all cobs excellent fill	0%	Excellent quality and cob fill
Crop 3	60% of cobs moderate to severe blanking	30-40%	Variable quality - 40% of cobs good quality remainder severe to moderate blanking

Figure 14. Crop cob quality and blanking assessment image from 3 commercial sweet corn crops.

Climate impact (extreme heat and low humidity) on crop quality and value

Data from the in-crop temperature and relative humidity loggers is presented below. The in-crop climate data for each sweet corn crop was downloaded and the hourly maximum temperature and relative humidity between 12 noon and 4pm each day graphed during the crop silking (kernel pollination) period of crop development. Crop growth records indicated that the crop silking period began on or about the 16th of November and would have been completed by the 20th or 21st of November 2019.

Temperature and relative humidity data

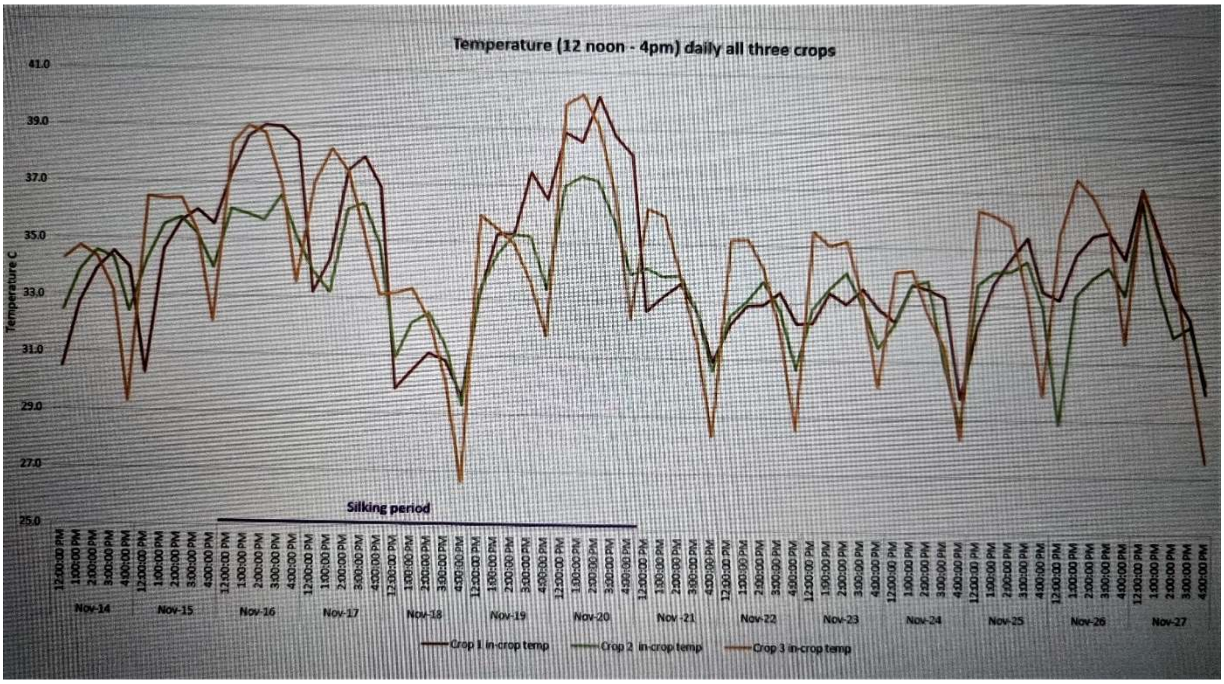


Figure 15. Hourly temperature readings (12 – 4pm) at each crop site from the 14th to the 27th of November

Maximum temperatures on the 15th, 16th and 17th of November as well as the 19th and 20th of November exceeded 35°C for a number of hours each day during the crop silking period in all three crops.

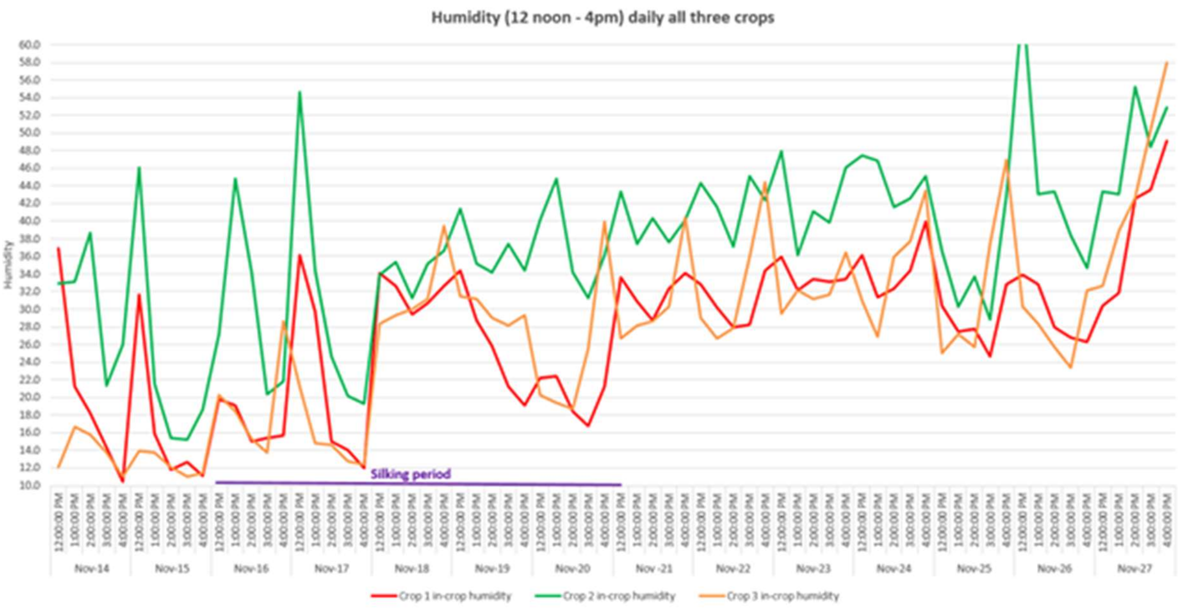


Figure 16. Hourly humidity readings (12 – 4pm) at each crop site from the 14th to the 27th of November 2019.

Relative humidity on the 15th, 16th and 17th as well as the 19th and 20th of November fell well below 30% for a number of hours each day during the crop silking period in the Crop 1 and

Crop 3 crops, while relative humidity readings in the Crop 2 crop were significantly higher and for longer during the crop silking period.

Relative humidity is a measure of the percentage of water vapour in the air compared to the maximum possible amount of water vapour the air can hold at a given temperature. Warmer air has the potential to hold more water vapour than cooler air, this is why dew forms on humid days as the temperature drops.

Temperature, relative humidity and vapour pressure deficit

A more meaningful way to compare the effect of temperature and atmospheric moisture levels (humidity) within the crop canopy is to calculate vapour pressure deficit values from the measured temperature and relative humidity readings from the in-crop sensors.

Vapour pressure deficit (VPD) is the difference between the amount of water vapour in the air and how much it can hold when fully saturated. Unlike relative humidity, vapour pressure deficit has a simple straight line relationship to the rate of plant evapotranspiration (water lost from the plant by natural plant cooling processes). A high VPD figure indicates a dry atmosphere surrounding the crop or plant. The higher the VPD the greater the atmospheric force on the plant to lose water as it transpires in an effort to keep the plant cool and the plant tissue hydrated.

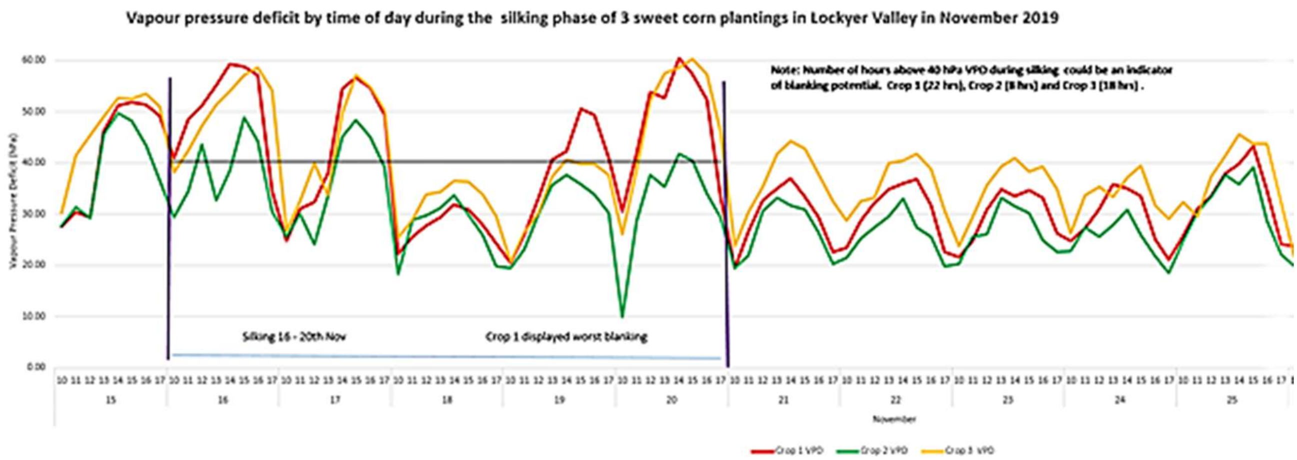


Figure 17. Hourly vapour pressure deficit (10am – 5pm) at each crop site from the 15th to 25th November 2019.

Vapour pressure deficit is a more appropriate measure of how dry the atmosphere and growing environment is than relative humidity.

Relative humidity is a familiar term describing the amount of water vapour in the air compared to how much it can hold. Warmer air has a greater water holding capacity than colder air. Low humidity air dries out our skin and our plants.

Though humidity is a useful and familiar measure, there is a more accurate and meaningful way to express the driving force of water loss from plants as temperature varies, that measure is vapour pressure deficit. Vapour pressure deficit (VPD) is a measure of the evaporative forces at the plant and leaf surface, expressed as pressure units of kilopascals (kPa) or hectopascals (hPa). Ten kilopascals is equal to one hectopascal. VPD is the difference between the amount of moisture in the air and how much moisture the air could potentially hold when it is saturated. Vapour pressure deficit (VPD) is the most accurate way to express and compare the potential for water loss from plants and leaves as its value is independent of temperature. VPD is the difference between the amount of moisture in the air and how much moisture the air could potentially hold when it is saturated. (Wollaeger, 2015).

Temperature (^{0}C)	Relative humidity (%)	Vapour pressure deficit (hPa)
15.5	70	5.5
23.8	70	9.0
32.2	70	14.5

Figure 18. When temperature is increased in 9.4^{0}C increments and relative humidity stays the same vapour pressure varies from 5.5 to 14.5 hPa (Wollaeger, 2015).

A low VPD indicates the air is near saturation so the loss of water from the plant is negligible. A high VPD means the air is drier, and the moisture gradient between the leaf and the drier atmosphere drives a higher rate of plant water loss from the above ground parts of the plant. Plants respond to changes in VPD by increasing or decreasing their stomatal opening (stomata are pores on the surfaces of leaves that function as bio-mechanical valves which control gas exchange and water loss in plants (Source: https://www.britannica.com/science/stomate)).

Sweet corn blanking – determining the environmental cause.

During silking wind-blown pollen, deposited on the silk from the male tassels takes about 24 hours to grow down and reach the ovule, where fertilisation produces each new kernel on the corn cob. ‘Blanks’ appear on the cob (missing kernels) when silks or pollen granules are damaged preventing pollination and subsequent kernel development.

Our investigations and observations over the last few seasons has revealed that more than 3 days of high maximum temperatures (above 35^{0}C) combined with a high vapour pressure deficit (indicated by low humidity) results in significant cob blanking. Based on all our field observations and investigations to-date we postulate that sweet corn cob blanking is due to dessication (drying) of the sweet corn pollen tubes or dessication of the pollen as it is shed, most likely it is a combination of both, preventing pollination and subsequent kernel development.

We postulate that sweet corn ‘blanking’ is caused by three or more days of high temperatures combined with high vapour pressure deficit (drying air) conditions during crop silking. These conditions result in severe cob blanking and a significant loss of marketable yield.

Observation # 4—November/December 2020

In the 2020 summer sweet corn production season the project team set out to document more evidence and observations of blanking in commercial crops to confirm our sweet corn blanking theory.

In November 2020, the Lockyer Valley again experienced a month of extreme maximum temperatures. The first four day period where daily maximum temperatures exceeded 35^{0}C, occurred from the 14th to the 17th inclusive. The project team identified two sweet corn crops growing at different locations in the Lockyer Valley that were in the crop silking (pollination) phase during this four day period where maximum daily temperature consistently exceeded 35^{0}C. With the assistance of several of our production business managers we made arrangements to assess the marketable yield and cob quality of these crops on the 4th of December 2020 just prior to their commercial harvest.

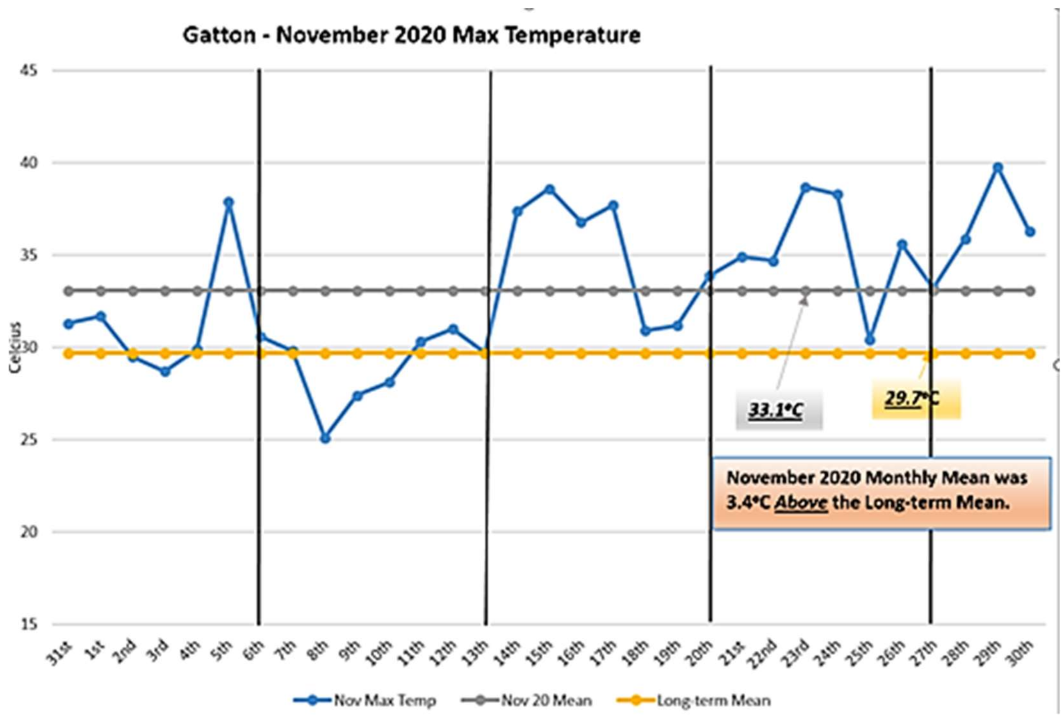


Figure 19. Lockyer Valley November daily maximum temperature, mean monthly maximum (and long term mean maximum 1990-2010)

Heatwave conditions in the Lockyer Valley from the 14th to the 17th of November 2020 resulted in maximum daily temperatures conducive to poor sweet corn cob pollination (later evident as cob blanking). The extreme daily maximum temperature conditions which occurred during the silking period of both the crops we later examined, should have resulted in significant blanking if extreme temperature alone was the prime causal factor.

Our collaborating business managers examined their crop records and confirmed that the two sweet corn crops in two separate Lockyer Valley locations were in fact silking during this heatwave event. Project team members along with our collaborating business managers, sampled and visually assessed the cob quality and marketable yield of both crops on the 4th of December when both crops were fully mature and just prior to their scheduled harvest date.

After completing a thorough visual assessment and physical sampling of the crops we could find no evidence of cob blanking. When these two crops were harvested, graded and packed for sale in the days after we assessed the crops, the business managers confirmed the crops were of high quality and the heatwave did not impact the marketable yield of either crop.

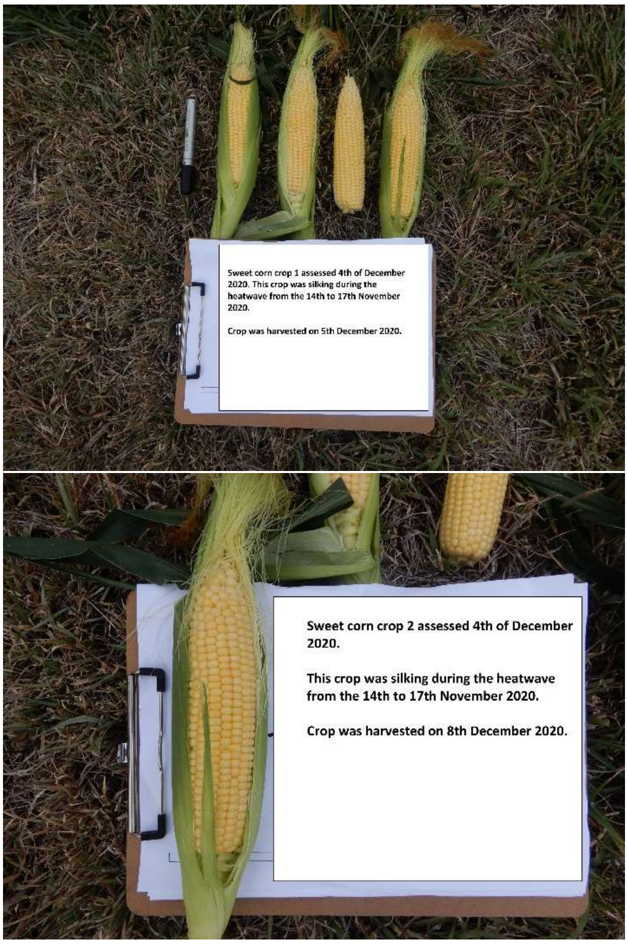


Figure 20. High quality sweet corn cobs harvested and assessed from two crops that were silking during the November 2020 heatwave in the Lockyer Valley.

Why did no cob blanking occur in November 2020?

Despite the extreme daily maximum temperatures and the 4 day long heatwave conditions that occurred in early November 2020, sweet corn cob quality and marketable yield were not impacted. This outcome makes sense, thanks to our earlier field observations and analysis. Although both these silking crops experienced at least 3 days of maximum daily temperatures above 35^0C, cob blanking did not occur as both the pollen granules and pollen tubes were not affected. Although very hot, the air was not dry enough to desiccate (dry out) these reproductive structures, so full pollination was achieved.

A review and analysis of the maximum temperature and vapour pressure deficit conditions during the silking period of these crops (below) confirms that although both these silking crops experienced at least 3 days of maximum daily temperatures above 35^0C, cob blanking did not occur as the air was still relatively moist (low VPD).

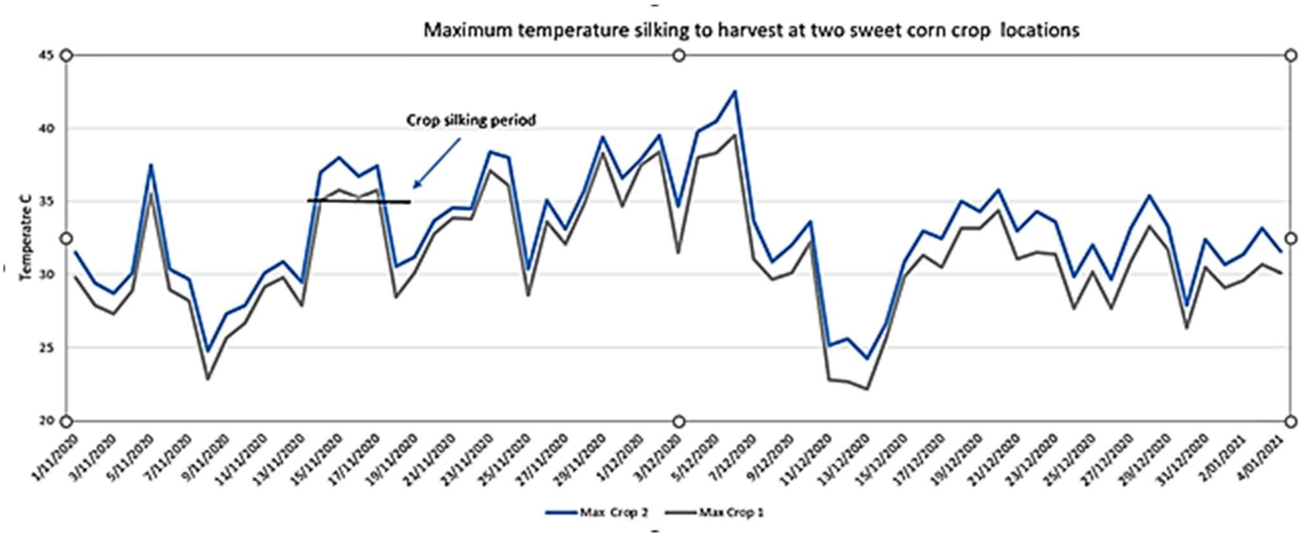


Figure 21. Daily maximum temperature for two Lockyer Valley sweet corn crops during the silking period in 2020.

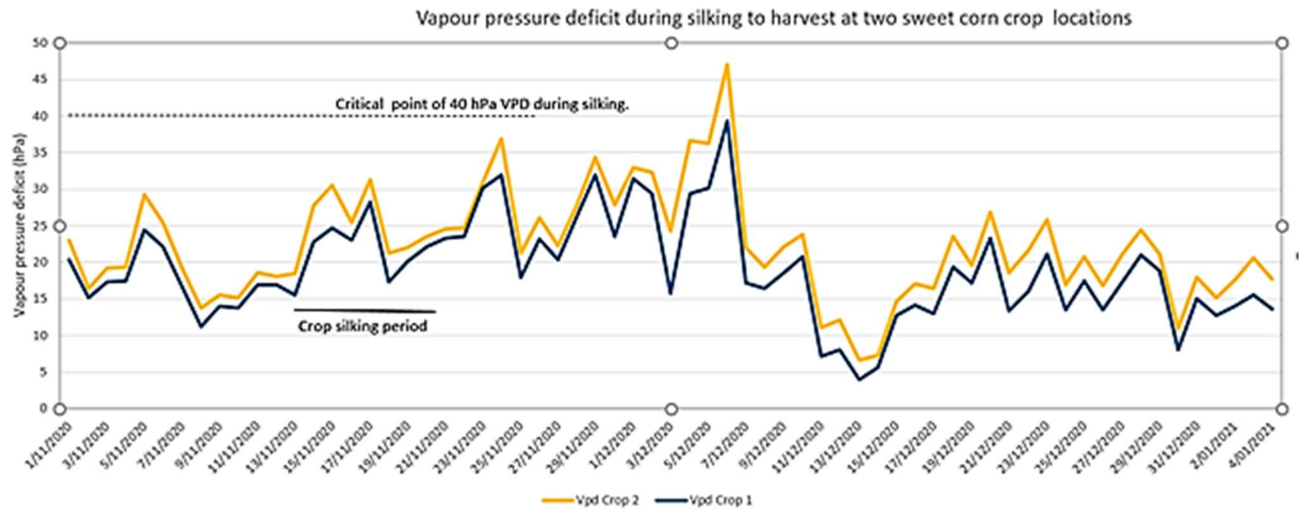


Figure 22. Daily vapour pressure data for two Lockyer Valley sweet corn crops during the silking period in 2020.

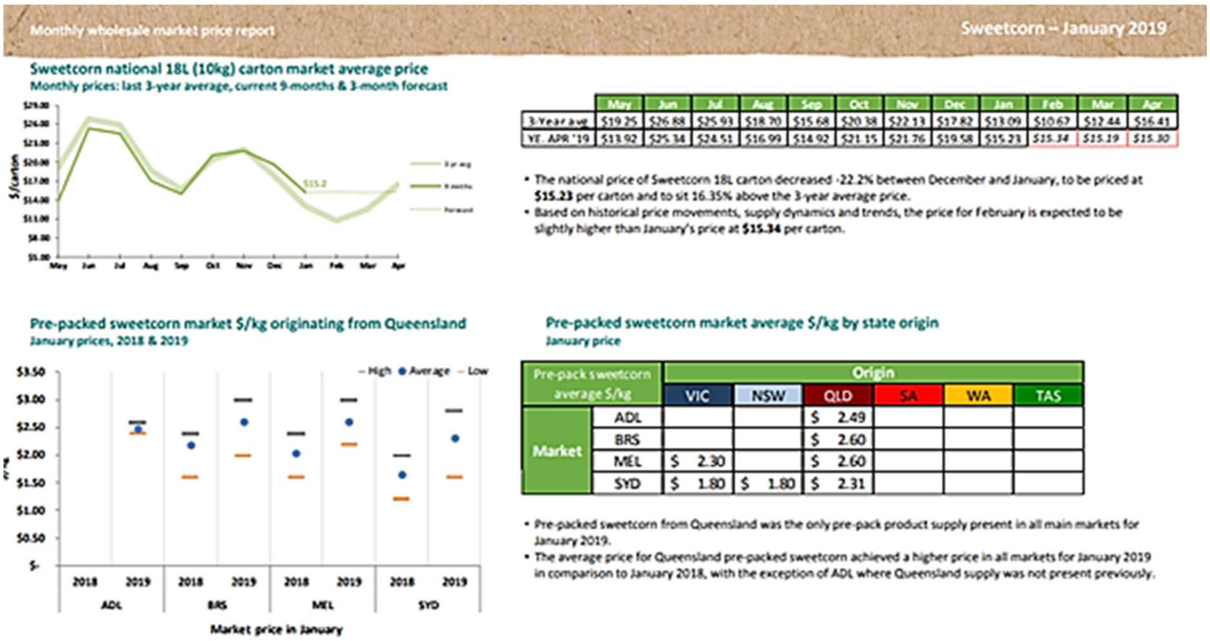
Our crop observations in November/December 2019 provided conclusive evidence that blanking occurred in sweet corn crops when in combination with 3 or more days with a maximum daily temperature at or above 35°C, and a vapour pressure deficit of 40 hPa was attained or exceeded for a number of hours (Figure 17).

In the November/December 2020 crops VPD during the silking stage of the crops ranged from 15 to 32 hPa during the crop silking period. The critical vapour pressure deficit threshold (40hPa) for pollination damage to occur during silking was not reached, so no cob blanking would be expected in these two crops.

Marketable yield and cob quality was not impacted by the extreme daily maximum temperatures in November/December 2020. Both crops yielded well despite the extreme temperatures they experienced during the silking stage. This is to be expected as the weather data shows that pollen tubes and pollen were not affected by the additional trigger of extremely dry air (VPD at or above 40hPa) which impacts pollen tube growth and pollen viability, preventing kernel development which results in blanking.

Sweet Corn Market Value

The market price of sweet corn varies from day to day in response to national supply. The price data used here to calculate the marketable yield value in December 2019 is the three-year average of the December sweet corn national market average price as published by Hort Innovations.


Monthly wholesale market price report

Sweetcorn – January 2019

Sweetcorn national 18L (10kg) carton market average price

Monthly prices: last 3-year average, current 9-months & 3-month forecast

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
3-Year avg	$19.25	$26.88	$25.93	$18.70	$15.68	$20.38	$22.13	$17.82	$13.09	$10.67	$12.44	$16.41
YE. APR '19	$13.92	$25.34	$24.51	$16.99	$14.92	$21.15	$21.76	$19.58	$15.23	$15.34	$15.19	$15.30

- The national price of Sweetcorn 18L carton decreased -22.2% between December and January, to be priced at **$15.23** per carton and to sit 16.35% above the 3-year average price.
- Based on historical price movements, supply dynamics and trends, the price for February is expected to be slightly higher than January's price at **$15.34** per carton.

Pre-packed sweetcorn market $/kg originating from Queensland

January prices, 2018 & 2019

Market price in January

Pre-packed sweetcorn market average $/kg by state origin

January price

Pre-pack sweetcorn average $/kg		Origin					
		VIC	NSW	QLD	SA	WA	TAS
Market	ADL			$ 2.49			
	BRS			$ 2.60			
	MEL	$ 2.30		$ 2.60			
	SYD	$ 1.80	$ 1.80	$ 2.31			

- Pre-packed sweetcorn from Queensland was the only pre-pack product supply present in all main markets for January 2019.
- The average price for Queensland pre-packed sweetcorn achieved a higher price in all markets for January 2019 in comparison to January 2018, with the exception of ADL where Queensland supply was not present previously.

Figure 23. Monthly wholesale market price report (Sweet corn) January 2019.

Web link: https://www.horticulture.com.au/globalassets/hort-innovation/levy-fund-pages/vegetable-fund/vegetable-market-price-reports/monthly-pdfs/january-2019/monthly-wmr-sweet corn -january.pdf

Using this generic national sweet corn price data, the marketable yield from each crop can be valued and compared. This will allow a realistic assessment of the economic impact of cob blanking on marketable yield for each crop. The December national 3-year average price for a 10 kg carton is $17.82 in December, Figure 23. A 10 kg carton contains 28 cobs on average.

Table 2. Crop quality assessment and marketable yield at harvest

Crop	Blanking	Unsaleable estimate	Expected cobs/ha	Actual Cartons/ha	$/ha Gross Return
Crop 1	70% of cobs severe blanking	80-90%	36,000 cobs	129	$2,298
Crop 2	0% of all cobs excellent fill	0%	36,000 cobs	1285	$22,898
Crop 3	60% of cobs moderate to severe blanking	30-40%	36,000 cobs	771	$13,739

In this summer production period, high temperatures combined with low humidity can decimate marketable yield. In the above scenario blanking damage reduced Gross Returns from around $22,898 per hectare down to $13,739 and in the worst case $2,298 per hectare.

A 30 – 40 % decrease in marketable yield makes growing the crop unviable once planting, growing, harvesting, grading, transport and sales costs are factored.

Based on the most recent publicly available gross margin cost for sweet corn (Carey et.al), it costs around $11,000 per hectare to grow, harvest, cool, pack, transport and market packed product from a sweet corn crop grown in the Lockyer Valley.

The full impact and cost of the extreme climatic conditions observed in the 2019-20 summer growing season must take into account these growing and marketing costs, as all these costs are expended before the true impact of extreme heat is realised.

Table 3. The economic impact of extreme heat events and sweet corn blanking on farm income in 3 monitored crops marketed in December 2019

Crop	Harvested value per hectare	Growing and marketing costs per hectare	Net return per hectare	$ loss due to extreme heat impacting quality for each hectare
Crop 1	$2,298	$11,057	-$8,759	$8,759
Crop 2	$22,898	$11,057	$11,841	$0 (good management decisions and planning under extreme conditions)
Crop 3	$13,739	$11,057	$2,682	$0 accrued loss but potential to have made a further $9,159 from each hectare of this planting.

This commercially focussed work identifies and quantifies the real cost of periods of extreme heat (temperatures of 35ºC or above for 3 consecutive days) combined with in-crop low humidity experienced by Lockyer Valley sweet corn growers in the summer of 2019-20.

The work also highlights the ability of a good crop manager with appropriate local forecast data to minimise this impact by timely irrigations during these high climate stress periods to artificially raise the humidity level and reduce the maximum temperature in the crop during the critical silking period.

Highly perishable product in times of scarcity

In the vegetable marketing system (driven by daily changes in supply and demand) having quality product available when supply is short can reap great returns and high profits during times of scarcity. In late 2019 during the high temperature growing period it is likely that actual returns per carton were much higher than the 3-year average December price used in the gross margin calculations above – further rewarding good management decisions.

Conclusion

The Bottom Line

The above financial analysis demonstrates how a well-informed business manager can take appropriate action to minimise the yield impact of extreme heat events, given an accurate forecast.

Well informed management decisions resulted in an extra $9,159 return per hectare in crop 2 in December 2019.

DCAP Experimental Forecasts - were they of use to local vegetable business collaborators during the cropping period analysed above?

November 2019 DAF #7 experimental forecasts.

The Use of Bureau of Meteorology Multi-Week and Seasonal Forecasts to Facilitate Improved Management Decisions in Queensland's Vegetable Industry

DCAP bi-monthly experimental forecast (November 2019)

A review of the DCAP bi-monthly experimental forecast issued to Lockyer Valley collaborators including the sweet corn crop managers on the 11th of November 2019 reveals that business managers were advised that the experimental forecast indicated that maximum temperatures during November and December 2019 as well as January 2020 would be above the long-term mean.

Looking forward - the ***ACCESS S experimental forecast model for the Lockyer Valley Vegetable industry.***

On the **7th of November** 2019, the DCAP experimental forecast indicates.

Maximum Temperature experimental forecast for:

November Above the Mean maximum temperature
December Above the Mean maximum temperature
January 2020 Above the Mean maximum temperature

Figure 24. Part of the Lockyer Valley November 2019 experimental forecast.

The bi-monthly experimental forecast forewarned business managers that their crops were likely to experience above average maximum temperatures in each of the coming 3 months. This allows managers to review planting plans for the coming 12 weeks, allowing them to adjust planting volume & location, review water availability, irrigation infrastructure, irrigation method, consider labour needs (more people to get product harvested before the hottest part of the day) work start times and discuss the potential impact on volume and quality with their customers (e.g., supermarket chains and food service processors).

DCAP heatwave advisory (Warning of BoM forecast heatwave)

The project team also issued our Lockyer Valley collaborating business managers with a DCAP Heatwave Advisory on the 12^{th} of November – 3 days prior to the extreme high temperature event that caused the sweet corn blanking and subsequent yield and income loss detailed above.

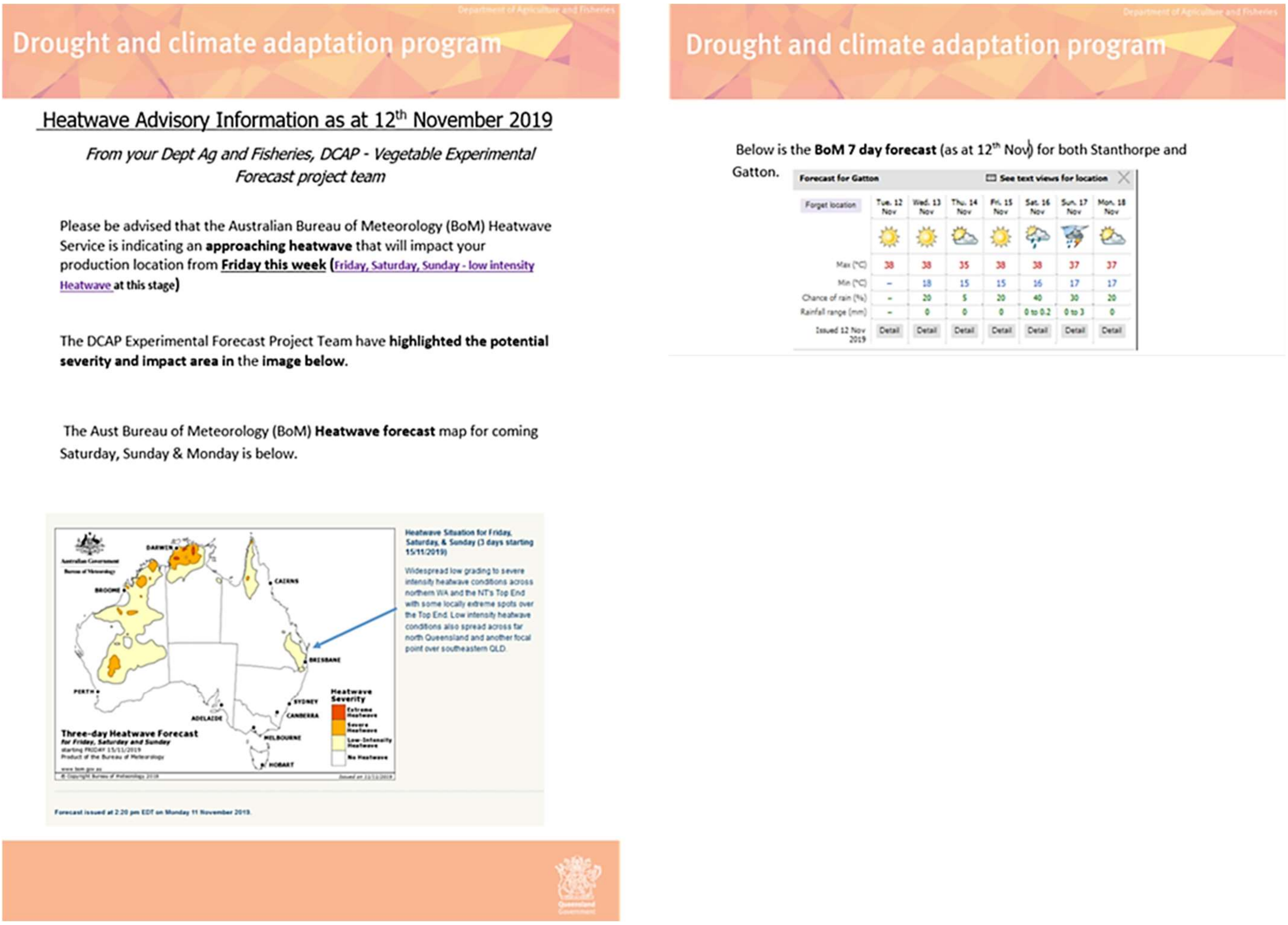


Figure 25. DCAP Heatwave advisory issued November 2019.

This location specific DCAP Heatwave Advisory (highlighting extreme temperature events), based on BoM's Heatwave Service, provided business managers with 3 days advanced warning of the forecast extreme heat. This advice alerting growers and marketing businesses of a period of at least 3 days of extreme maximum temperatures, empowers managers to make specific decisions based on crop type, growth stage and available resources to minimise potential yield and quality impacts and limit disruption to their supply chain.

These management decisions could include such things as;

Re-assessing irrigation plans (volume, frequency, method and time of day).

Delay planting of transplants until after the heatwave.

Splitting new plantings over several locations so they are more effectively irrigated.

Putting sprinkler or overhead irrigation into crops that are flowering or at a crucial growth stage so they can be cooled in the heat of the day to minimise flower loss (e.g. Green Beans).

Apply "sunscreen" products to susceptible crop stages.

Install drip irrigation so larger crop areas can be irrigated in one irrigation move.

Ensure all planted area is deep irrigated prior to the heat – maximising available soil moisture.

Potentially harvest a portion of each mature crop early before the extreme heat.

Temporarily adjust work hours to harvest earlier each day.

Delay direct seeding so reducing water use – freeing up pumping capacity and manpower.

Minimise time from harvest to cooling.

Increase drive speed on overhead gantries so they can cover a larger area more quickly – so cooling more crop.

Review staff numbers and availability so work can be completed more quickly.

In the specific "real world" example of crop 2 above where we were able to document and quantify the extreme temperature event the farm manager was able to get the sweet corn crop well irrigated prior to the heatwave, so that ample soil moisture was available to full depth in the crop root zone and then applied a quick daily "cool down" irrigation (altering the irrigator gears so it moved across the field quickly) on the 14th, 15th, 16th and 17th of November as can be seen by the comparison of relative humidity within and adjacent to the crop in Figure 11 above.

This well considered and pre-planned set of management decisions deployed, thanks to the managers awareness of the forecast heatwave secured marketable yield and maintained high quality product. The business manager was able to continue to supply the market with high quality product at a time when other businesses had quality and supply issues. This enhanced the business's reputation, increased profitability, enhanced market share and brought new customers on-line.

Project team members: David Carey, Senior Horticulturist, Dr Neil White, Principal Scientist, Horticulture and Forestry Science, the Department of Agriculture and Fisheries (DAF); Peter Deuter, Horticultural Consultant, PLD Horticulture, and Dr Debra Hudson, Principal Research Scientist, Bureau of Meteorology (BoM).

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