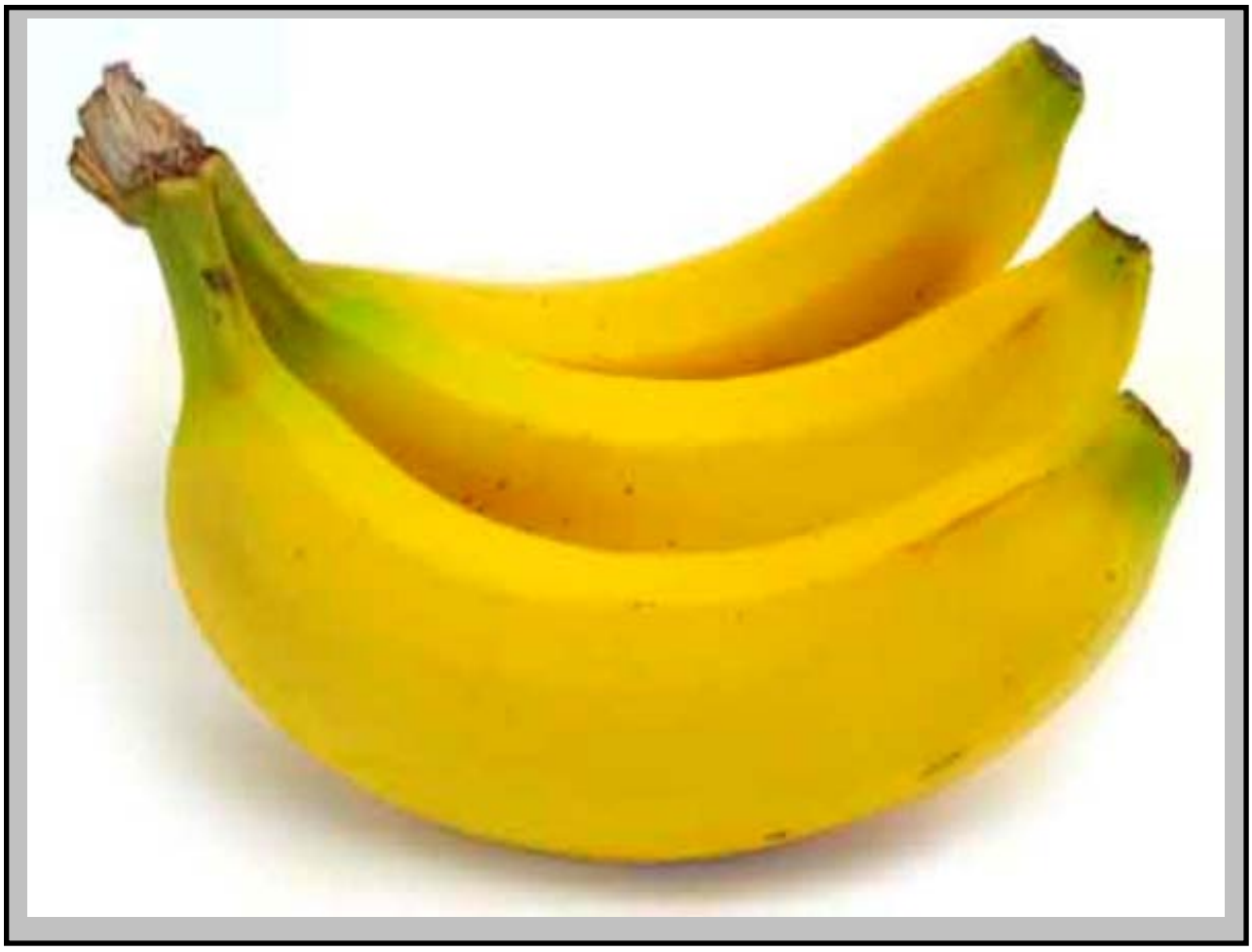
Critical temperature thresholds
Case study

Banana



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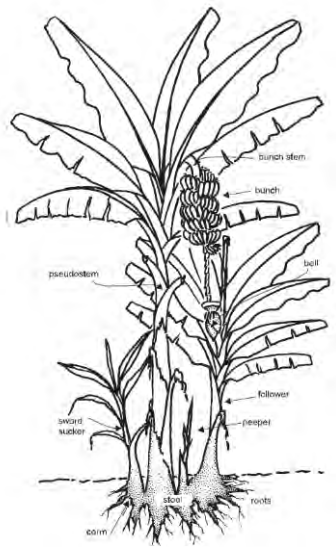
Introduction

The banana is a tropical/subtropical plant best suited to warm, frost-free, coastal climates. Bananas are commercially grown from the equator to latitudes of 30 degrees or more (Turner and Lahav, 1983). While a few significant areas of banana cultivation do exist outside these limits (such as banana production in New South Wales), these areas are marginal during winter months. At a global level, the majority (20%) of world banana production is based in India, followed by Brazil.



In Australia, bananas are believed to have been imported from either Malaysia or the Pacific Islands in the 1870s. In 1891, plantations were established in Coffs Harbour and surrounding areas of New South Wales. Today over 90 percent of banana production is based in Queensland where bananas grow in high rainfall regions such as Innisfail and Tully.

"The banana plant is a large, tree-like herb that finishes as a flower and dies. New plants grow from a corm. The plant consists of a false stem (pseudostem) that is composed of leaf sheaths with a crown of large leaves. The flower stalk grows from the top of the corm near ground level, through the centre of the pseudostem. Fruit are formed from female flowers at the top of the bunch" (Lindsay, et al. 1998).

Commodity production data

The major production areas are Qld (Innisfail/Tully, Sunshine Coast, Bundaberg,) and NSW (mid north coast, far north coast) followed (distantly) by WA and NT (Table 1).

***Table 1** : Australian banana production, year ended 30 June 2007*

	NSW	Qld	WA	NT	Total 2007
Production (t)	19,017	188,635	3,822	1,701	213,193
Area (ha)	1,668	9,793	137	65	11,662

(Source: ABS Catalogue 7121, 2006-07)

Production regions

More than 90 percent of Australia's bananas are grown in Queensland, in the high rainfall region in the far-north. Bananas grow in a coastal strip between Cardwell in the south and Babinda in north. The industry is now centred around Innisfail and Tully in North Queensland.

The remainder are grown in northern New South Wales from around Coffs Harbour to the Tweed River and in southeast Queensland as far north as Bundaberg. Small commercial operations exist in Western Australia around Carnarvon, as well as the Ord River near Kununurra and near Darwin.

Although the majority of bananas are currently grown in the tropics, bananas were originally grown in the sub-tropics by Chinese migrants to Carnarvon in the 1980's. Banana production also continues in Northern New South Wales around the Coffs Harbour region.

“Temperature is an important factor in successful commercial banana production, with the optimum temperature being approximately 27°C and poor fruit production occurring if temperature drops below 15°C” (Espino et al. 1992).

Area	Climatic type[a]	% of Australian production	Number of farms	Average farm size
North Queensland (Babinda to Cardwell)	Tropical rainforest	70%	569	18 ha
South-east Queensland (Bundaberg to Qld border)	Sub-tropical (no dry season)	20%	1,200	3 ha
Northern NSW (Qld border to Coffs Harbour)	Sub-tropical (no dry season)	7%		
Humpty Doo (near Darwin, Northern Territory)	Tropical rainforest	1%	4	50 ha
Kununurra (north-eastern Western Australia)	Grassland (winter drought)	1%	10	14 ha
Carnarvon (mid west coast of Western Australia)	Desert (summer drought)	1%	65	2 ha

Table 2 *: Australian banana production districts - 2005*

Source - Anon. (2008)

Current level of knowledge on temperature thresholds

Table 3 *: Critical Temperature Threshold - Banana*

Crop	Development Phase	Critical Temperature Threshold
Banana	Fruit Maturity	38°C

The banana is a tropical/subtropical plant best suited to warm, frost-free, climates, and is commercially grown from the equator to latitudes of 30 degrees or more.

The optimum temperature for banana growth is between 25°C and 30°C. Growth and development of bananas are impaired by temperatures outside this range. High air temperatures (usually greater than 38°C) and bright sunshine result in sunburn of exposed fruit, especially on the top hands of the bunch.

New leaves are continually emerging from the stem of the banana throughout the growth phase. The rate of appearance of new leaves is largely governed by temperature. In subtropical conditions during the winter, the rate of production is often significantly reduced, sometimes to a rate of one leaf in 20 days. In contrast, summer leaf emergence can be completed in around 4 days in tropical conditions.

In modelling undertaken on 17 banana cultivars at Alstonville, New South Wales, the optimum rate of leaf emergence occurred at 28.5°C.

Research by Turner and Lahav (1983) into the growth of banana cv. Williams (Giant Cavendish), concluded that plants showed heat injury at day/night temperatures of 37/30°C.

This is illustrated by the graphical representation of temperature limitations of Banana (Figure 1).

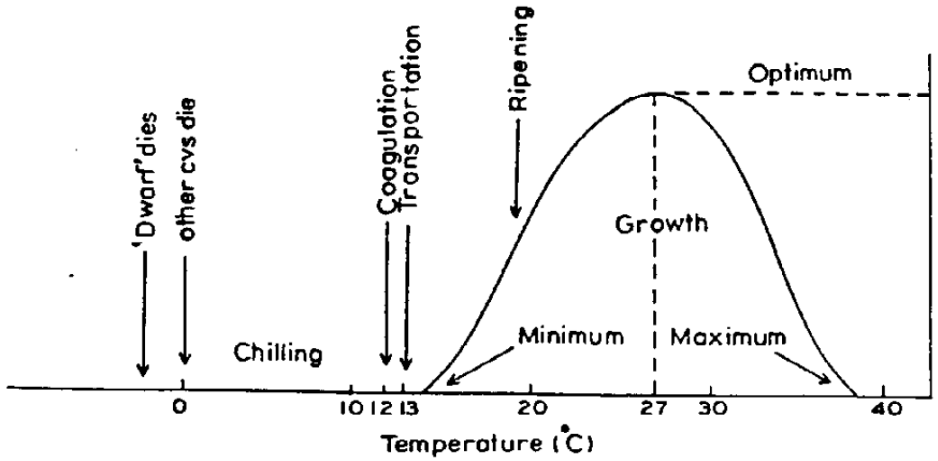


Fig 1 : *Relation between temperature, growth and other processes in banana culture.*

Source: Samson (1980) cited in Sastry (1988)

Projected regional temperature changes

The projections of future maximum temperature change for the major banana production region in Australia, have been produced using the OZCLIM scenario generator developed by CSIRO Atmospheric Research and the International Global Change Institute (http://www.cmar.csiro.au/ozclim).

OZCLIM generates future climate change scenarios based on twelve different Global climate models (GCMs) and eighteen different greenhouse gas emission projections (IPCC, 2001). In this way it represents a comprehensive range of future climate uncertainties for use in climate change impact and adaptation research.

The CSIRO Mk3.5 Climate Model with the SRES Marker Scenario A1FI, chosen to represent a change in temperature, is a scenario based on the world community taking less action on climate change and remaining fossil fuel dependant.

Innisfail, North Queensland

Table 4 *: Innisfail, Queensland – Temperature ^{o}C*

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Current Mean Max ^{o}C	24.1	24.9	26.9	28.3	29.6	30.7	**30.9**	30.7	29.9	28.3	26.4	24.7
Threshold	38	38	38	38	38	**38**	38	38	38	38	38	38
2030 Mean Max – A1F1 Scenario	24.8	25.8	27.7	29.7	31.1	**32.0**	31.8	31.6	30.9	29.0	27.2	25.3

Using CSIRO Mk3.5 Climate Model with the SRES Marker Scenario A1FI, by 2030 the mean maximum temperature at **Innisfail (North Queensland)** does not exceed the threshold.

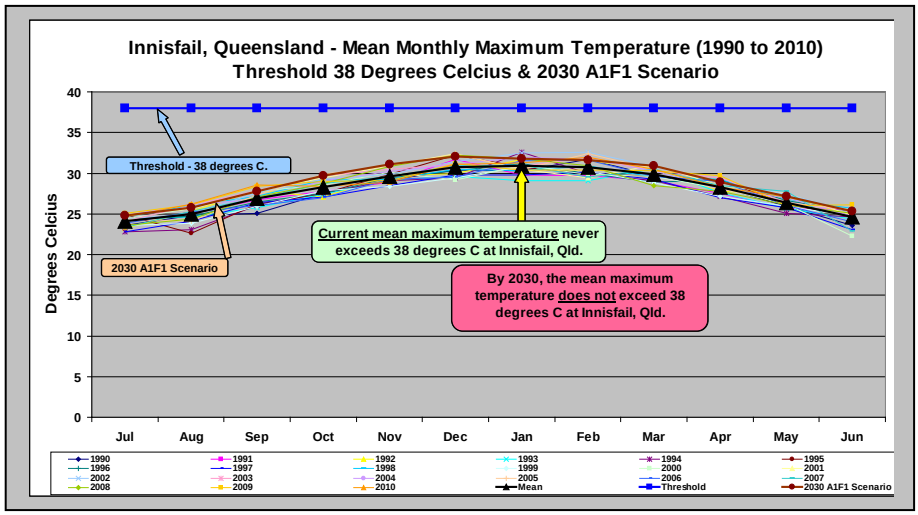


Fig. 2 : *Innisfail, Qld - Mean Monthly Maximum Temperatures & Projected Increases*

Carnarvon, WA

Table 5 *: Carnarvon, WA – Temperature °C*

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Current Mean Max °C	22.7	23.4	24.4	26.2	28.1	29.8	31.1	**32.3**	31.8	29.4	26.8	23.6
Threshold	38	38	38	38	38	38	38	**38**	38	38	38	38
2030 Mean Max – A1F1 Scenario	23.9	24.6	26.2	28.0	29.7	32.1	33.9	**35.4**	34.4	31.3	28.4	25.0

Using CSIRO Mk3.5 Climate Model with the SRES Marker Scenario A1FI, by 2030 the mean maximum temperature at **Carnarvon (Western Australia)** does not exceed the threshold.

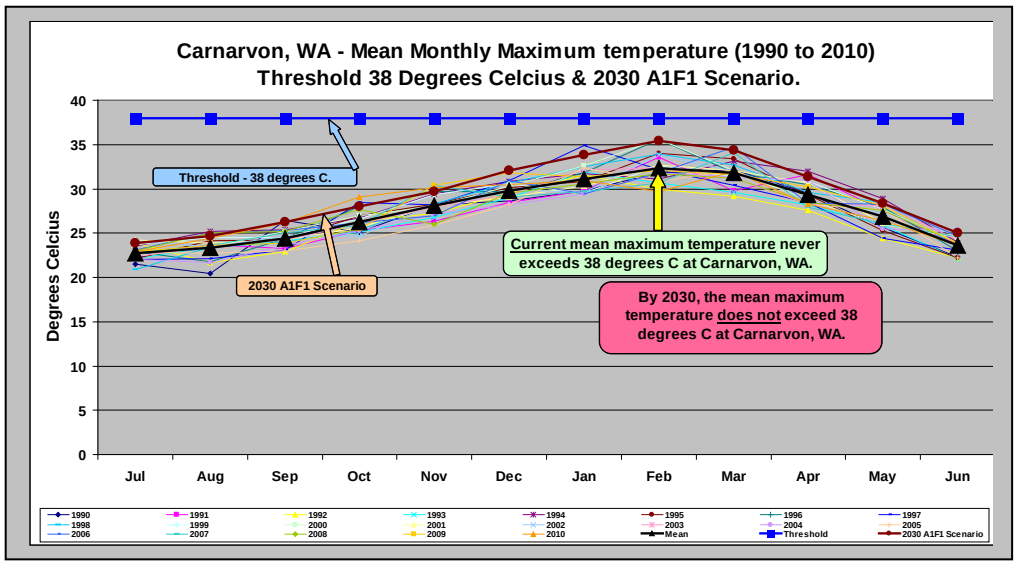


Fig. 3 : *Carnarvon, WA - Mean Monthly Maximum Temperatures & Projected Increases*

Kununurra, WA

Table 6 *: Kununurra, WA – Temperature ^{o}C*

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Current Mean Max ^{o}C	30.5	33.0	36.4	38.5	**38.9**	37.7	36.1	35.2	35.5	35.4	32.8	30.4
Threshold	38	38	38	38	**38**	38	38	38	38	38	38	38
2030 Mean Max – A1F1 Scenario	30.8	33.3	36.3	38.9	**39.4**	38.1	36.7	35.9	36.0	35.8	33.5	30.9

Using CSIRO Mk3.5 Climate Model with the SRES Marker Scenario A1FI, by 2030 the mean maximum temperature at **Kununurra (Western Australia)** exceeds the threshold from October to December.

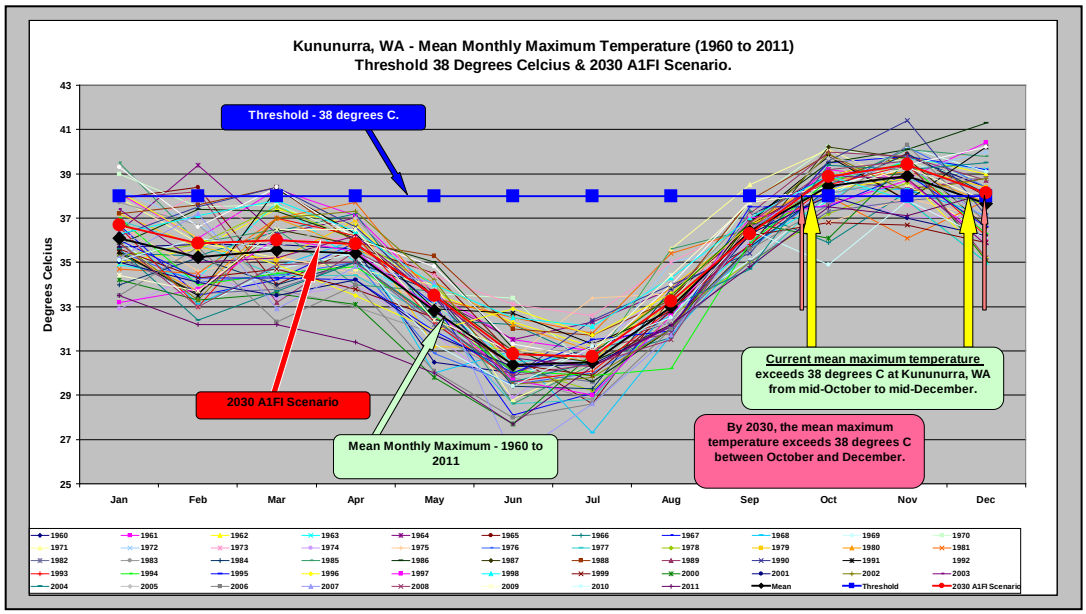


Fig. 4 : *Kununurra, WA - Mean Monthly Maximum Temperatures & Projected Increases*

Impact of projected temperature increases, and adaptation through management practices

If a temperature threshold for banana growth is 38°C, then this is significantly higher than temperatures experienced in the majority of existing tropical growing regions such as Innisfail, North Queensland and Carnarvon, WA. Thus **in the medium term it would seen unlikely that temperature increases associated with climate change will significantly impact production in these regions.** In contrast, the threshold is exceeded from October to December at Kununurra, WA.

However, under a warming climate scenario, the growing conditions in more marginal sub-tropical regions such as in central coastal New South Wales, are likely to improve.

In **Innisfail** the **"Buffer Level"** between the current mean temperature and the threshold temperature in the hottest month is **7.3^{o}C (January)**. **By 2030, this will be reduced to 6^{o}C in December, significantly below the threshold for bananas** (Table 4).

In **Carnarvon** the **"Buffer Level"** between the current mean temperature and the threshold temperature in the hottest month is **5.7^{o}C (February)**. **By 2030, this will be reduced to 2.6^{o}C, significantly below the threshold for bananas** (Table 5).

At **Kununurra** the **"Buffer Level"** between the current mean maximum temperature and the threshold temperature in September and December is **1.6^{o}C (October)** and 0.3^{o}C (December) – Table 6. **This will increase to 1.7^{o}C (September) and be exceeded by 0.1^{o}C (December) by 2030**.

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