Department of Primary Industries

primefact

Pistachio industry expansion

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Introduction

The pistachio (*Pistacia vera* L.) is native to the desert regions of western Asia and Asia Minor and has a high tolerance to salinity and drought stress. Pistachios are wind pollinated dioecious trees (separate male and female trees) that grow best under hot, dry summers and cold winters. It is expected by seven year of age trees are productive, with full bearing by 10–12 years of age (Ferguson, 2005).

Australian production averages at 3000 kg/ha annually (PGAI, 2011) with 950 ha of pistachio plantings in 2014 (ANIC, 2014). The Australian pistachio industry primarily operates along the River Murray from Swan Hill in Victoria and up into South Australia (SA). Production also occurs in Western Australia (WA) and New South Wales (NSW). The local (Australian) demand for pistachios has steadily increased by approximately 9% per annum since 2000 (ANIC, 2014).
While the productivity of the Australian pistachio industry is increasing, local production only supplies approximately 40% of local demand. Industry expansion will require establishing new pistachio plantings. Climatic and agronomic factors that influence pistachio production have been used to model potential regions within Australia suitable for such expansion.

This information package is supplementary to the high resolution maps available online as both PDF documents with theoretical bioclimatology data and an interactive map with a range of different data sources. The information provided should be used as a guide to find potential regions for expansion. However, specific and comprehensive site analysis must precede the final decision regarding site suitability for any orchard establishment. A further use of this work would be to provide information of suitable regions for sentinel plantings to determine the most appropriate regions for expansion of the Australian pistachio industry.

Pistachio growth requirements

Chill and heat

Pistachio trees are best grown in regions with cool winters and hot, dry summers. Chill requirements were identified as a critical determinant of agronomic success. Pistachios, like other nut trees, require a minimum chill accumulation throughout dormancy (1 May to 31 August) to achieve bud burst, identified as 59 chill portions. Local studies have found that chill accumulation from 1 March is necessary for synchronised bud break and flowering (Zhang and Taylor 2011and Darbyshire *et.al.* 2016).

In addition to chill accumulation, pistachios also require heat accumulation throughout spring. During spring, the accumulation of 900 heat units is necessary for flowering and nut maturation (approximately 31 August to 31 October) where heat units is the number of hours above 18 °C.

Water and soil

Pistachios are desert natives and can tolerate drought. They are, however, more productive where water is available at certain times of the year. A review of scientific literature revealed that pistachios require dry summers with excessive summer rain detrimental to maturing nuts. Throughout the year however, as much as 11 to 13 mega litres (ML) of water is required per hectare of pistachio trees annually for an economically desirable crop.

Soil

Pistachios prefer deep, well-drained fertile soils. Australian soils are often poorly structured and have low fertility and high salinity. Soil properties, including depth, clay content, structure and previous use potentially varies greatly within a small area. Establishing highly productive, sustainable and long-term pistachio plantings requires individual site analysis followed by careful planning and preparation. Using the Australian Soils Classification and data obtained from the Australian Soil Resource Information System (ASRIS, 2011) the soil layer was added as a 5th layer to the pistachio bioclimatology model map.

Risk factors

Pistachios are susceptible to certain risk factors including late spring frosts, high heat events, and rainfall during harvest, but there are many other risks that affect different locations. The severity of the impact of risks varies each year, from region to region and even within small areas on an orchard.
Furthermore, these risks are potentially negated or reduced by orchard management strategies, and are influenced by orchard size and local infrastructure. These factors are not incorporated into the model as we are not able to accurately account for the high variability between locations, farm management, infrastructure and the severity of each risk factor from year to year. We strongly recommend local research to assess the potential for negative climatic conditions

Bioclimatology model for pistachio industry expansion

Potentially suitable regions for pistachio industry expansion throughout Australia have been modelled using bioclimatology – the study of the effects of climate on living organisms. The aim of this work is to provide an objective basis for expansion of the Australian pistachio industry.

The bioclimatology model was generated based on pistachio tree phenology requirements. The Dynamic Model of Chill Portions (Dynamic Model) quantifies chill hours (hours between 0 °C and 7.2 °C) accounting for the cancelling effect of heat. This model has been extensively tested on many crops in Australia and California (Luedeling and Briown 2011; Zhang and Taylor, 2011). Chill portions were determined as the most limiting factor to regional suitability so were the primary factor to be modelled. Additional layers were added to the chill portion map to incorporate water availability and soil suitability. Water availability has been added in the form of blue contour lines for rainfall, blue shaded vectors for irrigation schemes, and grey lines show the river catchment areas. The depth of green shading increases with increasing soil suitability.

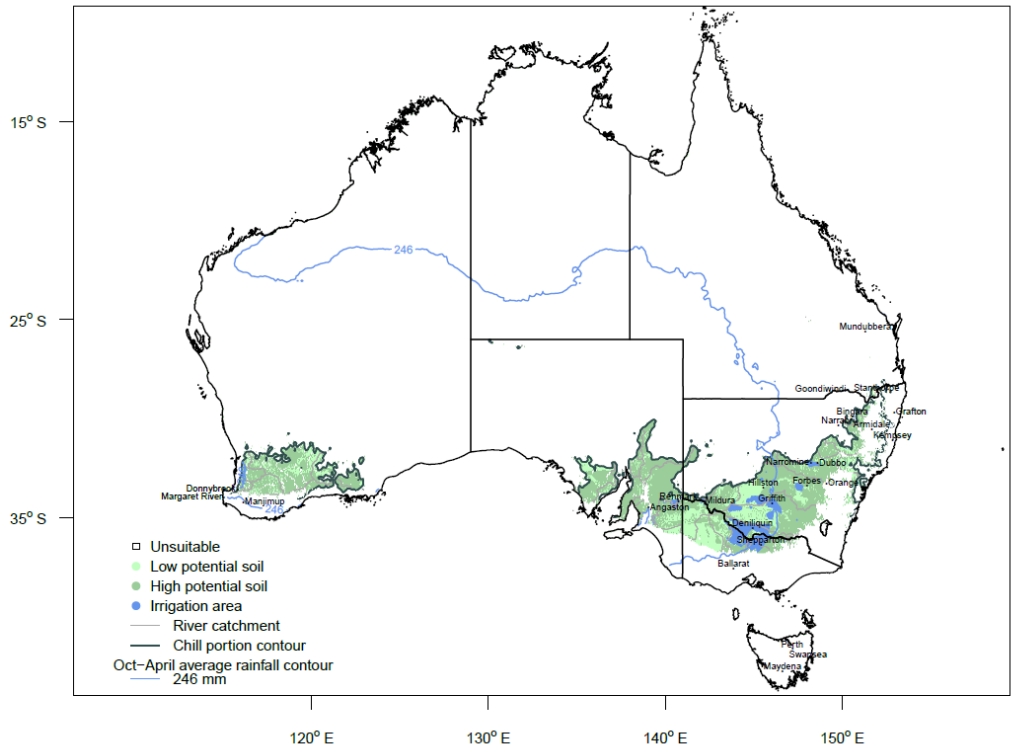

Figure 1. Bioclimatology model for pistachio industry expansion.

Using the Dynamic Model to predict chill portions and heat unit requirements

The Dynamic Model was used to predict chill portions and heat units for 5 km × 5 km grid points covering the entirety of Australia. The Dynamic Model uses daily temperature maxima and minima to generate hourly temperatures for the midpoint of each grid. Chill portions were calculated for 1 May–31 August and heat units for 1 October–30 April. The 'R' statistical package was used to plot dark green chill portion contour lines on a digital map of Australia for each of six temperate nut industries (Figure 2). The upper dark green contour represents the minimum chill requirement and the lower dark green contour represents the maximum chill requirements for a range of commercial cultivars for each nut type.

The Bureau of Meteorology (BoM) historical temperature records date back to 1911. However, this data is often subject to spatial and temporal discontinuities. For this reason, temperature data gathered since 1996 was used to interpolate the chill portion data used to map regions suitable for nut expansion The Moree site in NSW was selected to compare chill portion estimates derived from the interpolated data with those calculated using actual recorded daily temperatures. There was good agreement between the two methods.

Interpreting the model

A sample section of the hazelnut (as an example) industry map (Figure 2) outlines the key features of the bioclimatology models: chill portion contours, river catchment regions, rainfall contour, irrigation scheme areas and soil suitability. These are features common to each nut industry model. The two chill portion contours represent the range in chill portion requirements of the range of commercial cultivars for each nut crop (as describe further in the following sections for each specific nut crop).

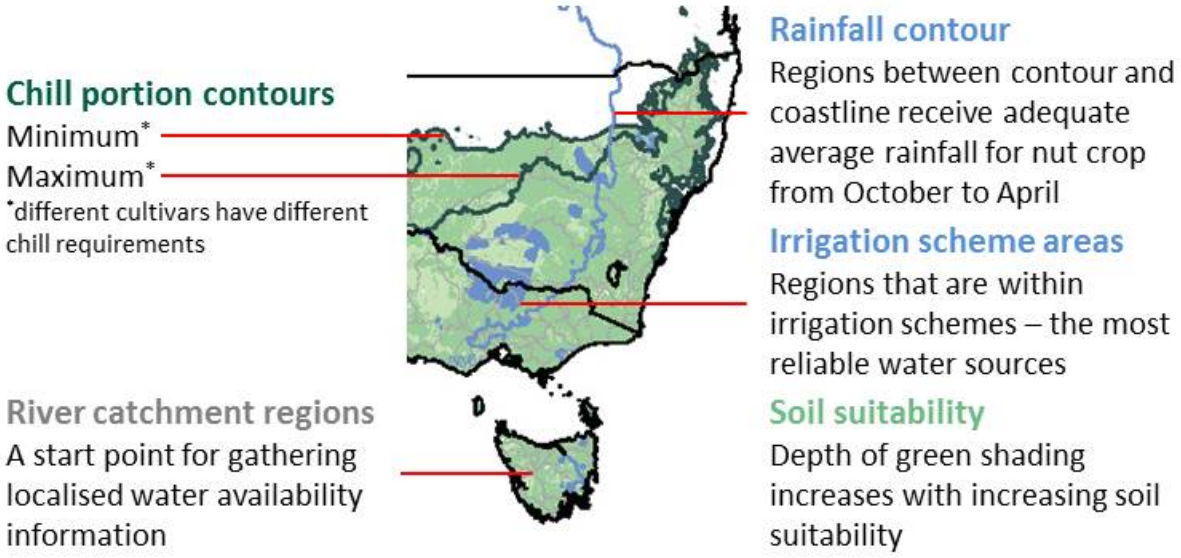

Figure 2. Key to interpretation of bioclimatology model. An example using hazelnut bioclimatology map. NOTE: there is only 1 chill portion contour for Pistachios owing to the research on 'Siora' chill requirements (Zhang, 2011)

Water availability

Catchment areas are outlined on the bioclimatology map (grey). Due to the dynamic nature of water availability in some catchment areas these are provided as a guide from which to seek further information. For example, Figure 3 shows the Wimmera–Mallee, Avoca and Loddon catchment regions south of Mildura, however, the water availability in these catchments is variable and depends on many factors including rainfall and temperature. Growers should also seek information pertaining to perennial and non-perennial river systems to understand local water availability – as is available from the interactive online map.

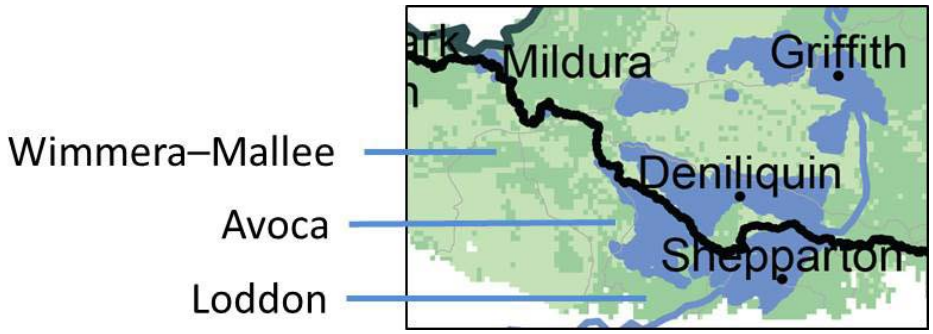

Figure 3. Example of river catchments shown on bioclimatology map. The inclusion of river catchments is as a guide only and specific information pertaining to the water availability in each catchment is recommended.

Recommendations

Suitable regions for pistachio production are within the irrigation schemes of the Murrumbidgee Irrigation Area (MIA), or Murray–Darling river catchment (Figure 4). New growers should proceed with caution when identifying exact locations or farms within these regions as they may experience higher than desirable summer rainfall (e.g. Griffith).

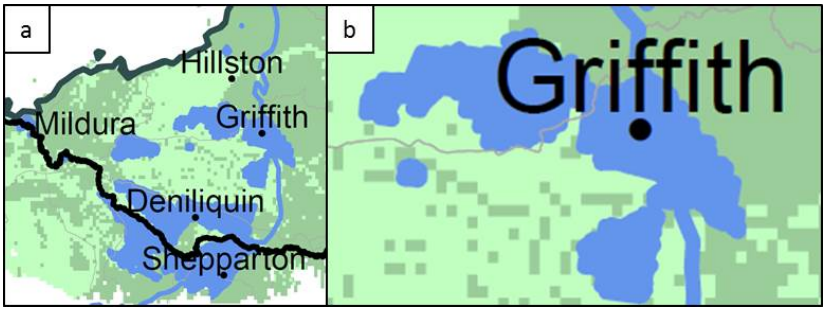

Figure 4. Example of potentially productive regions (a: Sunraysia, b: MIA)

There are potentially suitable regions near the SA/Vic/NSW border, and Western Australia, particularly near Margaret River (Figure 5).

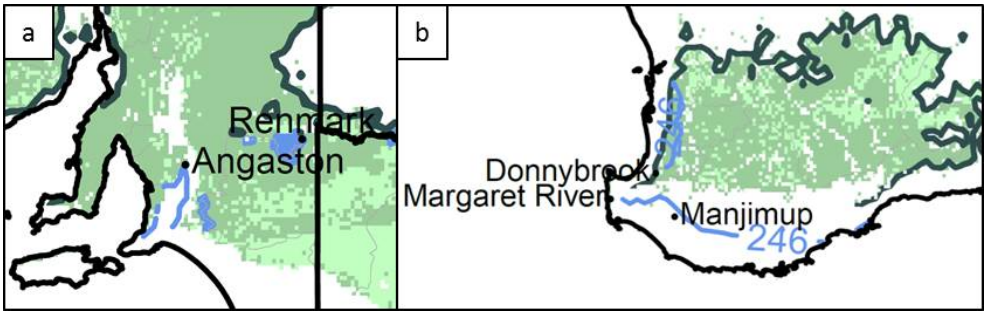

Figure 5. Example of potentially productive regions (a: South Australia, b: Western Australia).

Online resources

Model available for download as PDF

The model generated is available online as an extremely high-resolution map. This map is able to be interrogated, by zooming, to a resolution of 5 km × 5 km (Figure 7). The model is based on bioclimatology and pistachio phenological requirements. Models for other temperate nut industries (almonds, chestnuts, hazelnuts, pecans and walnuts) have also been developed and are available online from the NSW DPI nuts page.

Initially, this information package could be used to guide establishing sentinel plantings in some locations that have been listed/ highlighted as potentially suitable regions for nut crop production. Full site

evaluation and analysis should be undertaken before any site is established, regardless of the bioclimatology modelling.

Multi-industry information package and map

This Primefact is one of six industry specific Primefacts available online (NSW DPI nuts page). In addition, we have a multi-industry information package, which includes more information than these industry specific documents and a more user friendly map. This user friendly map does not include all the information (rainfall, soil or irrigation schemes) that the PDF maps do and we suggest using the two map types to get the maximum possible use out of the resources available.

Reference list

ANIC (2015) *Australian Nut Industry Council* ANIC 2015

ANIC (2014). *Australian nuts naturally*, Australian Nut Industry Council. Available from: ANIC Sept 2015.

ASRIS (2011). ASRIS – *Australian Soil Resource Information System*. CSIRO Land and Water Available from: ASRIS Accessed Sept 2015.

Darbyshire, R, Pope, K. Goodwin, I. 2016. *An evaluation of the chill overlap model to predict flowering time in apple tree*. Scientia Horticulturae 198:142–149

Ferguson, L. (2005). *Pistachio manual 2005*: Chapter 3 The pistachio tree; botany and physiology and factors that affect yield. 4th ed. UC Davis Fruit and Nut Research & Information.

Luedeling, E. & Brown, P. (2011). A global analysis on the comparability of winter chill models for fruit and nut trees. *International Journal of Biometeorology* 55: 411–421.

PGAI (2011). Pistachio Growers' Association Incorporated: Strategic Plan 2011 to 2014 Pistachio Growers Association Incorporated. Available from: PGAI Accessed Sept 2015.

SoE (2011) *Australia's state of the environment report 2011*: Chapter 4– Inland water. Australian Government Department of Environment. SoE2011

Zhang, J. & Taylor, C. (2011). The Dynamic Model provides the best description of the chill process on 'Sirora' pistachio trees in Australia. *HortScience* 46:420–425.

More information

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Acknowledgments

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For updates go to www.dpi.nsw.gov.au/factsheets

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