Department of Primary Industries

primefact

Walnut industry expansion

July, 2016, Primefact 1437, second edition

Jacquelyn Simpson, Research Horticulturist, Horticulture Unit, Yanco Agricultural Institute

Introduction

Global awareness of the health benefits of nuts, including walnuts, is driving an increased demand for nuts and nut products. Presently, walnuts are planted from Tasmania to Moree in northern New South Wales (NSW). There are small production regions scattered throughout northern Victoria and southern NSW, and the Adelaide Hills and Riverland regions of South Australia (SA). Large walnut orchards are located in the Goulburn Valley (Victoria), Riverina (NSW) and Tasmania. There has been strong growth in the Australian walnut industry over the last decade, with projections for continued growth. The Australian Walnut Industry Association (AWIA) is the representative association for small and large walnut orchards, which presently cover approximately 3,000 ha of walnut plantings throughout Australia (ANIC 2015).

The Australian industry is relatively disease and pest free (compared with other global industries), which increases the marketability of Australian grown walnuts. Large walnut industries are located in the Northern Hemisphere, for example California, with only 3% of the world's production coming from the Southern Hemisphere in 2008 (ANIC, 2015). The Australian walnut industry has room to expand and provide the freshest nuts for six months of the year.

Walnuts (*Juglans regia* L.) grow up to 25 to 30 m tall and can live for hundreds of years. Native to Central Asia, they prefer a Mediterranean climate with cold winters and mild summers. A walnut tree is first harvestable after 4 to 6 years and reaches full productivity by 11 or12 years of age. Trees are wind pollinated over 2 or 3 weeks of pollination; they are self-compatible, but pollination and flower receptivity often fail to synchronise and pollinators need to be interspersed throughout the orchard (Adem, 2004). Walnut trees produce male catkins and female pistillate flowers.

Traditionally, the cultivars planted in Australia were terminal bearing; more recently there has been an increase in cultivation of lateral-bearing varieties, many of which are imported from California. Pollination occurs during spring and nuts are harvested in April or May. The edible nut, or walnut kernel, is contained within a hard wrinkled shell that grows inside a leathery green husk. Hull split occurs late in the growing season and trees are shaken for mechanical harvesting.

This information package is supplementary to high resolution maps available online. The information provided should be used as a guide to narrow down potential regions for expansion, however, specific site analysis should precede any expansion. 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 Walnut industry.

Walnut growth requirements

Chill

Walnuts, like other nut trees, require a minimum chill accumulation throughout dormancy (1 May–31 August) for phenological processes, including budbreak and flowering. Chill accumulation is important for pollination and flower receptivity timing and varies from cultivar to cultivar. The accumulation of chill heavily influences the location of walnut plantings and the combination of cultivars that are compatible. The quantity of chill portions required varies between cultivars, but ranges from 48 to 60 (Table 1).

Water

Walnuts require regular water, but do not perform well when water logged. In regions such as Italy there is sufficient rainfall to negate the need for irrigation systems; this is not the case in most of Australia. Scientific and industry-facing literature has been reviewed to find a minimum water requirement of 738 mm throughout the growing season. This is likely an underestimate of water requirements for maximising crop yield and quality. Regions capable of supplying more water are recommended, for example within irrigation schemes.

Table 1. Chill portions (low from cultivar Hartley, high from cultivar Chandler) and water (1 October–30 April mm) requirements of walnut trees

	Requirement
Chill	54-72
Water	738

Soil

Walnuts prefer deep, well-drained, fertile soils. Heavy clays should be avoided with preference given to loam or sandy loam soils. Australian soils are often poorly structured and have low fertility and high salinity. Establishing highly productive, sustainable and long-term walnut plantings requires individual site analysis followed by careful planning and preparation.

The depth, clay content, structure and previous use of the soils at each site has the potential to vary greatly within a small area. With chemical and physical amendments and additions, the scope of potentially suitable and productive soils is broadened. 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 walnut bioclimatology model map (see Figure 2).

Risk factors

Walnut are susceptible to a range of risk factors including late spring frosts, high heat and wind days, 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.
Resources are available to access local information on many risk factors. For example through examining historical frost data on the BoM website (Figure 1) it is possible to identify regions more likely to be impacted by frost.

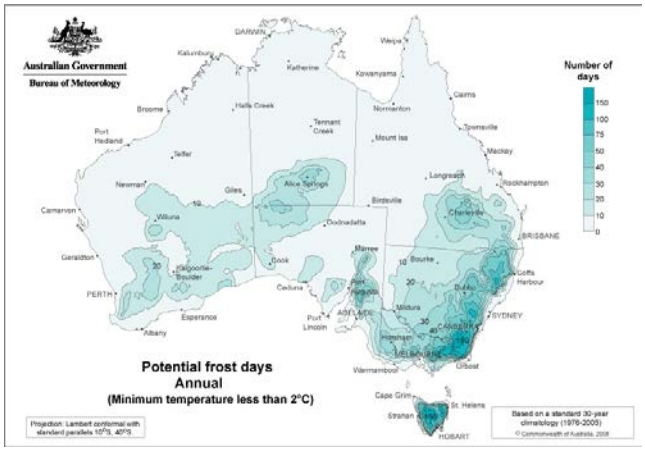

Figure 1. Annual average potential frost days for Australia. Regions with an average number of frost days greater than 100 are likely to have late spring frosts.

Bioclimatology model for walnut industry expansion

Potentially suitable regions for walnut industry expansion throughout Australia have been modelled using bioclimatology – the study of the effects of climate on living organisms (Figure 2). The aim of this work is to provide an objective basis for expansion of the Australian walnut industry.

The bioclimatology model was generated based on walnut tree phenology. 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, 2011; Zhang, 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.

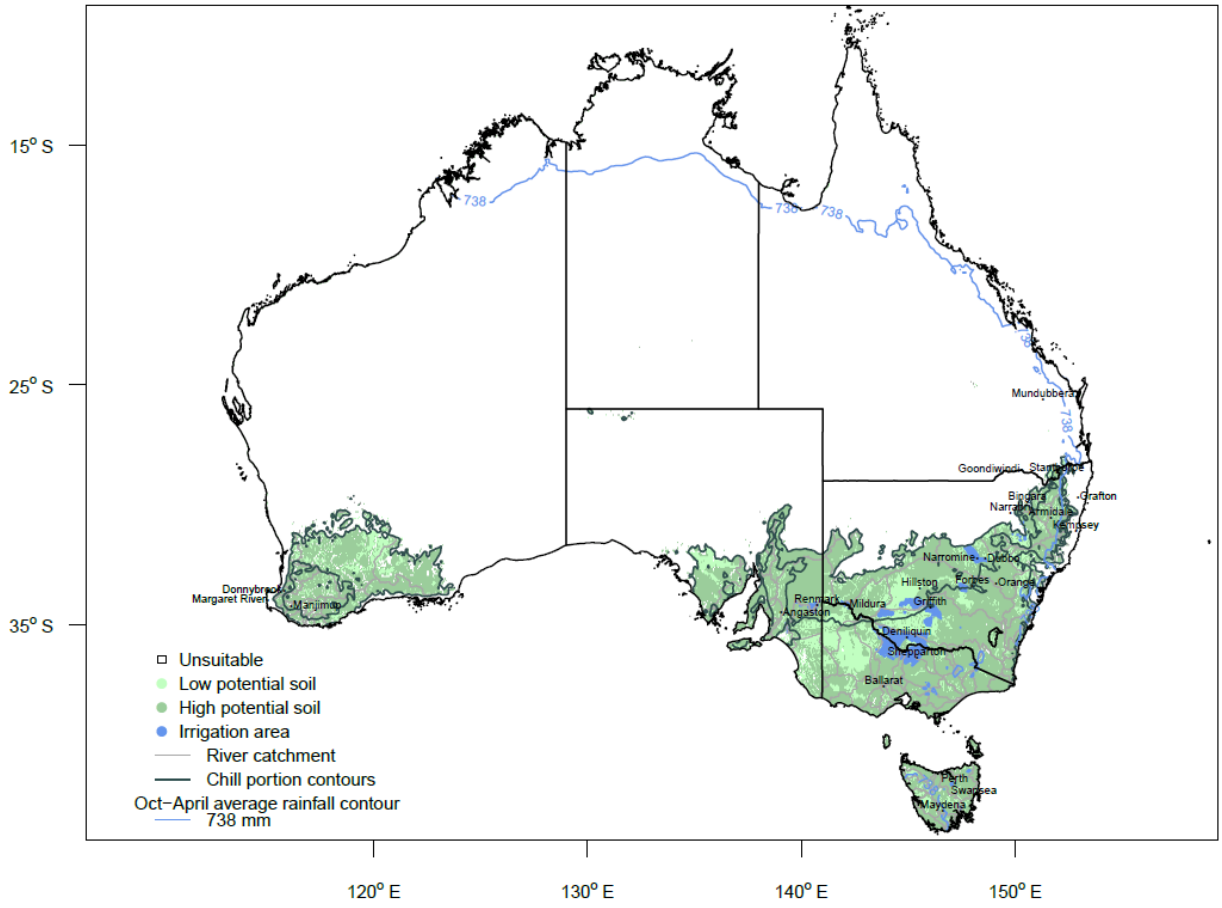

Figure 2. Bioclimatology model for walnut industry expansion.

Using the Dynamic Model to predict chill portions

The Dynamic Model was used to predict chill portions 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 to 31 August. 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 industry model (Figure 3, hazelnut industry model has the same features as walnut industry model) outlines the key features of the bioclimatology models: chill portion contours, river catchment regions, rainfall contour, irrigation scheme areas and soil suitability. The two chill portion contours represent the range in chill portion requirements of the range of commercial cultivars for each nut crop (as described further in the following sections for each specific nut crop).

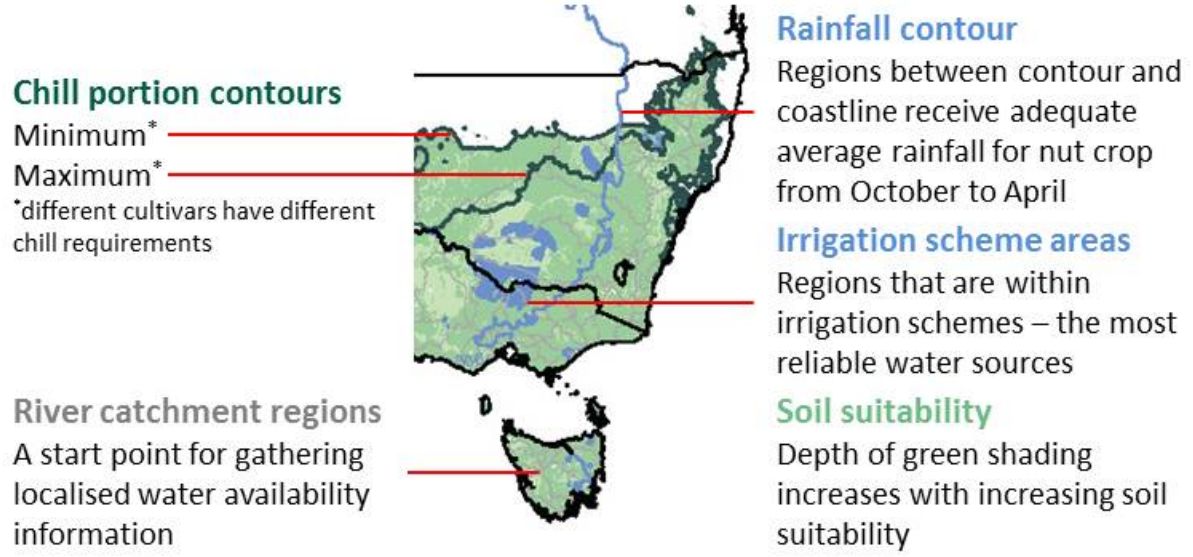

Figure 3. Key to interpretation of bioclimatology model – an example using the hazelnut bioclimatology map.

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 and starting point; further information will be needed to form your final decision. For example, Figure 4 shows the Macquarie–Bogan rivers, Lachlan River and Hawkesbury River catchments on the NSW east coast. The water availability in these catchments is variable and depends on many factors including rainfall and temperature.

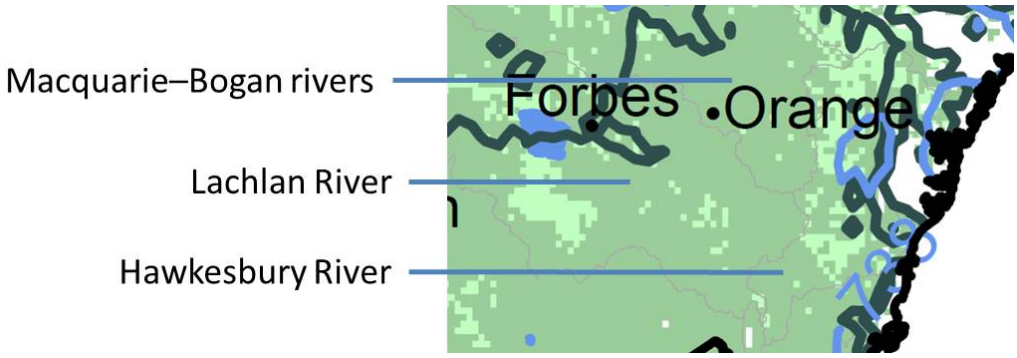

Figure 4. Example of river catchments on the bioclimatology map.

There are some river catchment areas that are highly suitable for the establishment of walnut plantings. Rivers that constantly flow are termed perennial rivers and are relatively reliable sources of stable water, compared with non-perennial or seasonally flowing rivers (Figure 5).

The main perennial river systems with the capability to supply water for irrigation are the Murrumbidgee and Murray rivers, which run through NSW, Victoria and SA. There are also coastal perennial river systems on the east coast of Australia and small perennial rivers in south-western WA.

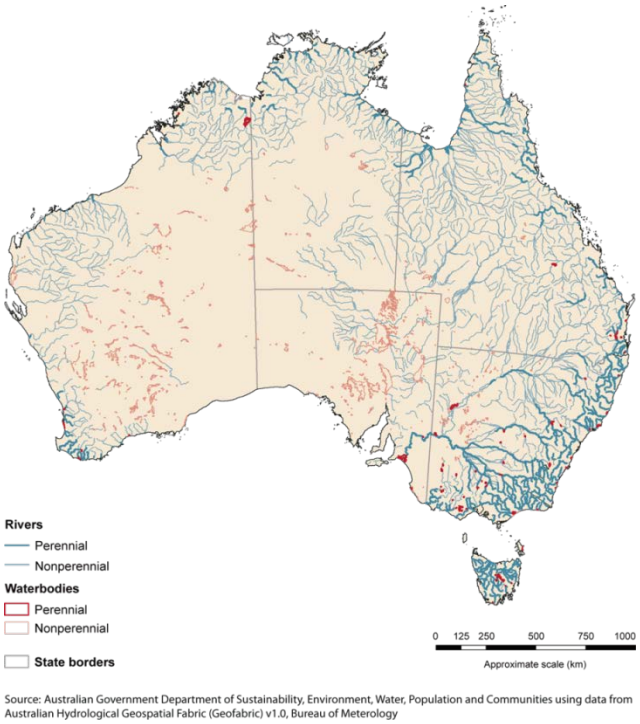

Figure 5. Australian perennial (permanently flowing) and non-perennial (seasonally flowing) river systems and water bodies (source SoE, 2011).

Recommendations

There are suitable regions for Australian walnut production throughout southern NSW and northern Victoria. Areas within the irrigation schemes of the Murrumbidgee Irrigation Area (MIA), or Murray Darling River are particularly suitable due to the availability of water (Figure 6a). Some parts of Tasmania are also potentially productive according to the bioclimatology model, however access may not always be convenient, for example along parts of the west coast (Figure 6b). The regions near Angaston (Adelaide Hills) and Renmark (Riverlands) in SA fall within the chill contours, with suitable soils and good water availability (Figure 6c).

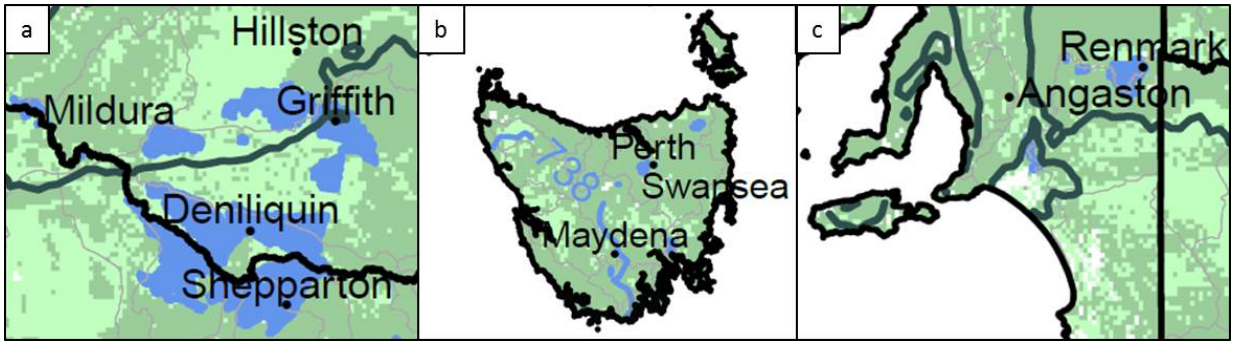

Figure 6. Example of potentially productive regions throughout the regions encompassed by the a: MIA and Murray rivers and throughout b: Tasmania and c: SA.

Perennial river systems within the chill portion areas mean that it is possible to produce walnuts in:

- the Central Tablelands (region around Orange) and central NSW (Narromine–Dubbo) regions (Figure 7a).
- WA, south-western coast (Figure 7b).
- Victoria – near Shepparton and towards the east coast (Figure 7c).

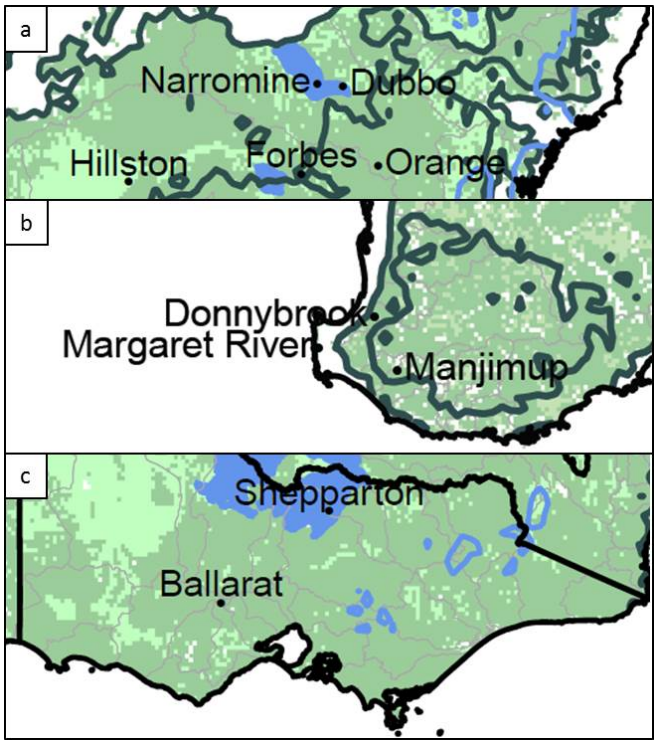

Figure 7. Example of potentially productive regions (a: NSW, b: WA, c: Victoria)

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. The model is based on bioclimatology and the phenological requirements of walnuts. Models for other temperate nut industries (almonds, chestnuts, hazelnuts, pecans and pistachios) have also been developed and are available online from the NSW DPI nuts page.

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.

References

Adem, H. (2004) Walnut industry research and best practice implementation RIRDC available : Best practice PDF accessed July 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.

BoM (2015) Climate and past weather *Australian Government Bureau of Meteorology* Available from: BoM Climate Accessed: September 2015.

Luedeling, E. and 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

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

Zhang, J. and 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

Jacquelyn Simpson 02 6951 2611 email: jacquelyn.simpson@dpi.nsw.gov.au

Acknowledgments

This project is a collaborative work by Shane Hetherington (Director Horticulture), Jacquelyn Simpson (Research Horticulturist), Lorraine Spohr (Biometrician), Damian Collins (Biometrician) and Jianhua Mo (Entomologist) of NSW DPI and Michael Treeby (Senior Research Scientist, Department of Economic Development, Jobs, Transport and Resources), formerly NSW DPI.

This project has been funded by Horticulture Innovation Australia Limited using the almond and chestnut industry research and development (R&D) levies, co-investment from the Australian Nut Industry Council and funds from the Australian Government.

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

Published by the NSW Department of Primary Industries. JT 13810; INT15/130647