Activity # 1- Assessing Horticultural Crop Suitability for the Queensland Murray Darling Basin Study Area

The Matrix Methodology Process utilised to identify horticultural crops suited to production in the QMDB Study Area

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This publication has been compiled by David Carey of Agri-Science, Department of Agriculture and Fisheries.

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Executive Summary

This final report was developed after the review and analysis of detailed information specific to the QMDB Study Area. In developing this report team members, collected information from peer reviewed scientific reports, and grey literature as well as through grower consultation, upon which biophysical and economic crop suitability assessments have been made.

Activity 1 - Assessing Crop Suitability set out to determine; what crops were suited to the QMDB Study Area, where (e.g. soils, water, location) and when (time of year) they would perform best.

Gross margin analysis was then carried out on selected crops to analyse and compare economic performance. The report includes location specific chill hours mapping, a new unique chill hours and heat hours look-up tool, maximum and minimum temperature maps, water availability mapping, soil maps as well as mapping current "known" horticultural crop production sites within the QMDB Study Area.

The information presented includes a detailed Crop Suitability Matrix for vegetables, fruit crops, native flower and foliage crops, as well as native food crops. The Crop Suitability Matrix details critical biophysical crop requirements and indicates the suitability or otherwise of individual crops. This crop suitability information is complimented by production window guidelines for both annual and perennial crops suited to the QMDB Study Area.

The entire Queensland horticultural industry sector will benefit from a newly developed web based dynamic interactive chill hours and heat hours tool. (Hort Science Shiny apps) This tool allows growers and industry to easily obtain current local site specific temperature data (chill hours and hours above a chosen high temperature threshold) from the nearest Bureau of Meteorology weather station located in Queensland.

In consultation with industry the project team have developed crop gross margin data and an interactive web portal for a select range of horticultural and broad acre comparison crops. The AgMargins™ gross margins tool allows the comparison of "potential returns" from a range of horticultural and broad acre crops (available on the web in 2017).

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Nine vegetable and eleven perennial fruit crop summaries are presented in this final report. The Crop Suitability Matrix details the biophysical criteria required for successful production of 55 annual and 42 perennial horticultural crops as well as 41 native flower and foliage crops. The Crop Suitability Matrix summarises the requirements of 18 additional crops investigated following suggestions from people in the QMDB Study Area.

This Crop Suitability Matrix, as well as Crop Production Windows for the annual and perennial fruit crops, and a map of the QMDB Study Area is available on the DAF website: DAF Publications

Extensive work has been carried out to develop the temperature (max and min) and chill hour mapping in Section 3 - **Mapping the QMDB Study Area for temperature, irrigation and soil suitability**. This section gives a unique insight into the climate, soils and topography of the QMDB Study Area.

The report also details the latest best quality scientific information relating to Australia's future climate projections — specifically tailored to the study area. Observations and climate modelling paint a consistent picture of ongoing, long-term climate change interacting with underlying natural variability. This is an important consideration especially when planning a new "future focussed" horticultural business venture.

Planning, developing or diversifying into any new enterprise requires capital expenditure. To assist decision makers, project staff developed a web based gross margin tool and complimentary database for a selection of broad-acre and horticultural crops. The web based AgMargins™ tool will enable access to selected horticultural crop gross margin information that can be used by growers and agribusinesses to compare and assess a crops potential. The live secure internet tool also allows later analysis and comparison of actual crop outcomes with the original "planned crop" input costs and yield.

Three case studies including detailed economic analysis have been completed for the QMDB Study Area. The case studies represent an annual crop (sweet corn), a short lived perennial crop (blueberry) and a long lived perennial crop (pecan). These case studies highlight the different production systems and economic implications associated with initial crop choice. Sweetcorn a short term (3 month) annual, mechanised horticultural crop with minimal hand labour, blueberry a medium term perennial crop (6 years) with high infrastructure (net/ tunnels) and high labour costs and pecan a long term (25 years plus) mechanised perennial crop that will not reach full yield potential until around 8 years after establishment. The case studies allow the reader to compare, contrast and consider these three representative horticultural crop production types.

The High Value Horticulture Value Chains for the Queensland Murray-Darling Basin with a focus on the Balonne and Border Rivers district project sought to facilitate the development of new and expanded high value horticulture value chains. Activity 1 Assessing Crop Suitability was tasked with identifying potential horticultural crops that could be produced in the Balonne and Border Rivers district to maximise the potential return from scarce irrigation water. The Crop Suitability Matrix lists a large number of crops both annual and perennial that are suited (or not suited) to the larger QMDB Study Area from a biophysical perspective. Potential horticultural crop suitability in the Balonne and Border Rivers area is also dependent on many other factors including, crop labour (requirements and availability), water availability and surety, crop perishability, distance to market, production timing,

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market specifications, local infrastructure, technical support potential return and existing cropping options.

Grower and enterprise "risk profile" is also a key driver in any cropping decision - is the risk worth the potential reward and is the underlying business capable of carrying that risk? Mechanised horticultural crops that can be grown on a broad acre scale offer reduced labour costs compared to other annual vegetable crops. Direct seeded and mechanically harvested crops such as sweetcorn, green beans and carrots fall into this category. In the more westerly region of the QMDB Study Area high summer temperatures will dictate crop choice and production windows.

Broccoli is a robust brassica crop that has proven export potential and can attract larger volume orders. Broccoli is however a high labour content crop (manual harvest) that would require a dedicated export market to be identified and targeted by local producers in the QMDB Study Area in order to ensure long term viability. Once this export market was established this may lead to potential exports of other more fragile brassicas such as cauliflower.

Australian Garlic is undersupplied in the Australian market and is suited to parts of the QMDB Study Area. Accessing good quality planting material has been a continuing issue. Extra domestic garlic supply has the potential to replace current imports and one enterprise in the QMDB Study Area is known to be targeting this market.

Perennial horticultural crops are a long term prospect with many currently oversupplied on the domestic market. Chinese demand for nut products has increased consistently over the last few years. Pecan is a crop that has been identified as suited to parts of the QMDB Study Area, domestic demand exists and the market is co-ordinated by one Australian processor. The Australian pecan season is counter cyclical to northern hemisphere production and world-wide demand for the pecan nut outstrips supply.

Pomegranate is suited to the QMDB Study Area and currently Australia imports pomegranate fruit for a large part of the season. In Australia there is a documented history of large scale pomegranate tree deaths (refer to pomegranate crop summary) and to date no causal agent has been properly identified. This issue needs further investigation before the Australian pomegranate industry can reach full potential.

There may be opportunity to grow and export crops such as pumpkin (jap, butternut) and melon (rockmelon, honeydew and water), these crops are currently grown in the area. The dedicated development of an export market (possibly even of value added product (sliced and wrapped, juiced) may offer a way forward.

Horticultural crop production is a high cost, high labour farming choice. Crops are highly perishable, market options are limited and consumers demand high quality blemish free product.

A guaranteed product sale at a known price is the first step in developing a sustainable new horticultural enterprise. Any new horticultural crop production should be aimed at import replacement (e.g. garlic) or supplying into a known export market (e.g. pecan & broccoli). Additionally, profitable export requires significant market knowledge, good relationships with overseas buyers and a thorough knowledge of preferred varieties and product specifications.

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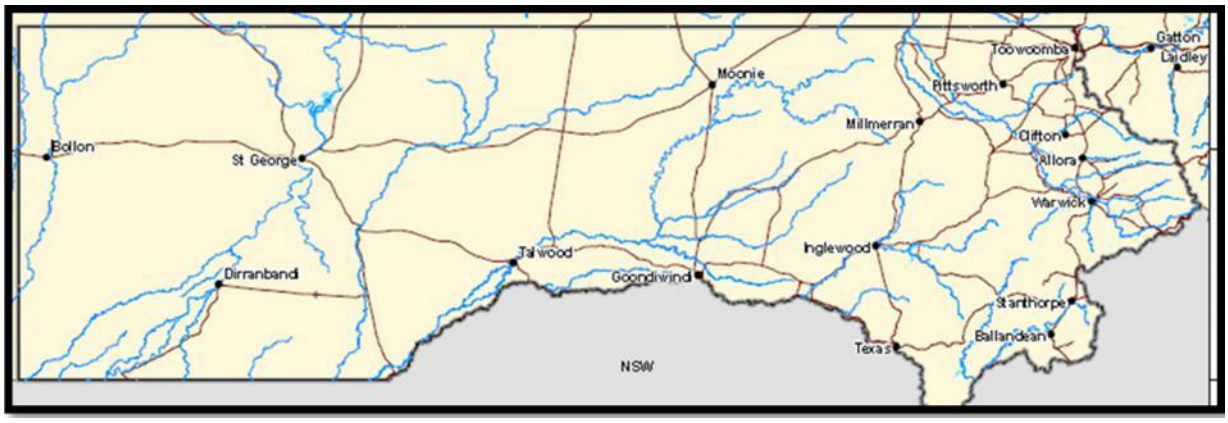
Introduction

This is the final report identifying horticultural crops suited to production in the QMDB study area, based on climatic and soil requirements, seasonal production windows and gross margin analysis.

Most irrigated cropping in the Balonne and Border Rivers districts of the Queensland Murray—Darling Basin (QMDB) is devoted to cotton and grain crop (maize, cotton, sorghum, wheat, barley, chickpeas and other pulse crops) production. These crops are highly mechanised with low labour requirements and are generally exported from the district as bulk commodities, with little value adding by local communities. However, there are some locations within the region with soils, climate and water supplies suitable for a wide range of high value horticulture crops including annual vegetables and perennial fruits and nuts. Horticultural crops have the potential to generate a higher return per hectare and per ML of irrigation water. These crops have higher labour requirements and also offer the potential of local processing and value adding opportunities.



The Queensland Murray Darling Downs (QMDB) Study Area

Specialist growing systems and labour intensive harvesting methods (predominantly hand harvest) typify Australian horticultural crop production. Highly perishable horticultural products require refrigerated storage and transport due to their short shelf life (days). Planting, growing, harvesting and packaging of horticultural crops is often highly labour intensive. This is problematic as Australian labour rates are some of the highest in the world and therefore a large proportion of total crop production costs (commonly greater than 40% of packed product cost) are directly attributable to labour inputs. Given this cost constraint and the current focus on broad acre cropping in the QMDB Study Area, horticultural crops that are largely mechanised may offer the best option for farm profitability and cost competitiveness in the export market.

The horticultural industry in Australia is a mature and highly specialised industry underpinned by a complex supply chain that services both local and international market demand. The Australian domestic market is adequately supplied (if not oversupplied), with top quality produce achieving the best price and the market offering little opportunity to sell inferior grade product. Extra production if sold on the domestic market will simply result in a further decrease in farm gate pricing. Any additional horticultural production capacity developed in the QMDB Study Area will need to target the replacement of currently imported produce, or be exported to overseas markets.

There are some current examples of successful horticultural production enterprises in the region (e.g. table grapes, onions, pumpkins, and melons).Further expansion is limited by access to profitable markets, high capital requirements, lack of local expertise in production and marketing, and the need to reach a critical mass for efficient transportation, local processing and dedicated marketing. The

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High Value Horticulture Value Chains for the Queensland Murray-Darling Basin project sought to address these barriers to facilitate the development of new and expanded high value horticulture activities (production & processing) in the QMDB, with a focus on the Balonne and Border Rivers district.

The High Value Horticulture Value Chains in the Queensland Murray Darling Basin project included five distinct activities that link to inform and deliver the overall project outputs and outcomes;

Activity 1. Assessing crop suitability
Activity 2. Building capacity in the value chain
Activity 3. Developing new markets
Activity 4. Analysing new value chains
Activity 5. Supporting businesses to establish new value chains

This final report (Activity 1) identifies potential horticultural crops suited to the QMDB Study Area. This was accomplished by reviewing and analysing published horticultural crop growth requirements, investigating regional climate records and mapped soil types, determining chill hours and considering water availability in the QMDB Study Area. To investigate the economic viability of key horticulture crops Activity 1 staff produced gross margins (AgMargins™) across the region and undertook three detailed bioeconomic case studies of: sweet corn, pecans and blueberry enterprises. Planning, developing or diversifying into any new enterprise requires capital expenditure. AgMargins™ can assist Activity 3 to identify potential export markets and enable Activity 5 to analyse potential value chains that link to international markets

This report was underpinned by engaging current and potential stakeholders, through public forums (workshops) and farm visits within the QMDB Study Area. Input costs and yield information was developed after discussion with existing horticultural growers both within and outside the study area. The overall direction of the work was developed through regular consultation with the project steering committee.

Methodology Steps

Step 1 - Creating and populating a Criteria Matrix

The Methodology commenced by using a Matrix approach to document the biophysical constraints against a large list of 'candidate' crops.

This list of candidate crops has excluded those whose performance will be affected by 'obvious' limitations in the Balonne-Border Rivers region of the QMDB — e.g. Bananas (a tropical crop which is extremely cold and frost sensitive); Avocadoes (a sub-tropical crop with very specific soil requirements which are met only in the far east of the Darling Downs region); Apples (a temperate crop with specific winter chilling requirements which are only met in the Granite Belt); etc.

Matrix — a list of crops assessed against the following criteria.

- Currently Grown in Qld, QMDB, NSW or Vic? (highlighted in the list below)
- Frost Sensitivity (Seedling, Growth and Reproductive Phases)
- Low Temperature Sensitivity (Seedling, Growth and Reproductive Phases)
- High Temperature Sensitivity (Seedling, Growth and Reproductive Phases)
- Specific Rainfall Sensitivity
- Special Soil Requirements

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- Chilling Requirement
- Water Quality
- Harvest Months
- Length of Harvest
- Suitability for QMDB

Candidate Vegetable Crops

Alliums

- Bunching onion (Allium fistulosum)
- Chives (Allium schoenaprasum)
- Garlic (Allium oleracium)
- Leek (Allium ampeloprasum var. porrum)
- Onion (Allium cepa)
- Shallot (true shallot) (Allium cepa var. aggregatum)
- Spring onion (Allium fistulosum)

Artichoke (Cynara cardunculus, C. scolymus)
Asparagus (Asparagus officinalis)
Beetroot (Beta vulgaris)

Brassicas

- Asian vegetables (Brassicas sp)
- Broccoli (Brassica oleracea var. italica)
- Broccolini (Brassica oleracea)
- Brussels sprouts (Brassica oleracea var. gemmifera)
- Cabbage (Brassica oleracea var. capitata)
- Cauliflower (Brassica oleracea var. botrytis)
- Chinese cabbage (Brassica campestris var. chinensis)
- Kale (Brassica oleracea var. acephala)
- Kohlrabi (Brassica oleracea var. gongylodes)

Broad bean (Vicia faba var. major)
Capsicum (Capsicum annuum)
Carrot (Daucus carota)
Celery (Apium graveolens var. dulce)
Celeriac (Apium graveolens var. rapacium)
Chilli (Capsicum annuum)

Cucurbits

- Butternut and Jap 'pumpkin' (Grammas) (Cucurbita moschata)
- Cucumber (Cucumis sativus)
- Gherkin (Cucumis sativus)
- Marrow/Squash (Cucurbita pepo)
- Pumpkin (Cucurbita maxima)
- Zucchini and button squash (Cucurbita pepo)

Edible soybean (Glycine max)
Eggplant (Solanum melongena)
Endive (Cichorium endivia)
Green bean (Phaseolus vulgaris)
Ginger (Zingiber officinale)
Globe artichoke (Cyanara scolymus)
Jerusalem artichoke (Helianthus tuberosus)
Lettuce (Lactuca sativa)

Melons

- Honeydew (Cucumis melo var. indorus)
- Rockmelon (Cucumis melo var. reticulatis)
- Watermelon (Citrullus lanatus)

Mushroom (Agaricus bisporus)
Okra (Abelmoschus esculentus)
Parsley (Petroselium crispum)
Parsnip (Pastinaca sativa)
Pea (Pisum sativum)
Potato (Solanum tuberosum)
Radicchio (Whitloof or Chicory) (Cichorium intybus)
Radish (Raphanus sativus)
Rhubarb (Rheum rhaponticum)
Silver beet (Beta vulgaris var. sicla)
Snow pea (Pisum sativum var. macrocarpon)
Sugar snap peas (Pisum sativum var. saccharatum)
Spinach (Spinacia oleracea)
Swede turnip (Brassica napis var. napobrassica)
Sweet corn (Zea mays var. saccharata)
Sweet potato (Ipomea batatas)
Tomato (Lycopersicon esculentum)
Turnip (Brassica rapa var. rapa)
Wasabi (Wasabi japonica)
Watercress (Nasturtium officinale)

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Candidate Fruit Crops

Almond (Prunis dulcis)
Blueberry (Vaccinium cotymbosum)
Cashew (Anacardium occidentale)
Chestnut (Castanea sativa)
Chinese jujube (Ziziphus jujuba)
Citrus
- Desert lime (Citrus glauca)
- Lemon (Citrus limon)
- Lime (Citrus aurantifolia)
- Grapefruit (Citrus x paradis►)
- Mandarin (Citrus reticulata)
- Orange (Citrus sinensis)
- Pummelo (syn Pomelo) (Citrus grandis)
- Australian finger lime (Citrus australasica)

Coffee (Coffea arabica)
Custard Apple (Annona atemoya)
Date (Phoenix dactylifera)
Dragon fruit (Pitaya) (Hylocereus undatus)
Fig (Ficus carica)
Gooseberry (European) (Ribes grossularia)
Guava (Psidium guajava)
Grapes (Vitis vinifera)
Kiwifruit (Actinida chinensis)
Lychee (Litchi chinensis)
Longan (Dimocarpus longan)
Loquat (Eriobotrya japonica)
Macadamia (Macadamia integrifolia)
Nashi (Pyrus pyrifolia, P. bretschneideri and P. ussuriensis)
Mango (Mangifera indica)
Olive (Olea europaea)
Passionfruit (Passiflora edulis)
Pecan (Catya illinoinensis)
Persimmon (Diospyros kak►)
Pomegranate (Punica granatum)
Quandong (Santalum acuminatum)
Raspberry (Rubus idaeus)
Stonefruit
- Apricot (Prunus armeniaca)
- Cherry (Prunus avium)
- Nectarine (Prunus persica var. nectarina)
- Peach (Prunus persica)
- Plum (Prunus domestica)

Strawberry (Fragaria x ananassa)
Tamarind (Tamarindus indica)
Walnut (Juglans regia)
White Sapote (Casimiroa edulis)

Step 2 - Include and exclude crops

The second step in the Methodology was to further rationalise the candidate crops list by "excluding" those which have one or more biophysical limitations. Hence crops are excluded where chill hour requirements are not met, or physical conditions such as excessive maximum temperatures or season length preclude crop production.

Because of the large number of potential candidate horticultural crops (150+), it was necessary to significantly reduce this to a manageable number to facilitate a meaningful targeted work program and relevant specific outputs.to be achieved by Activity #1 project team members.

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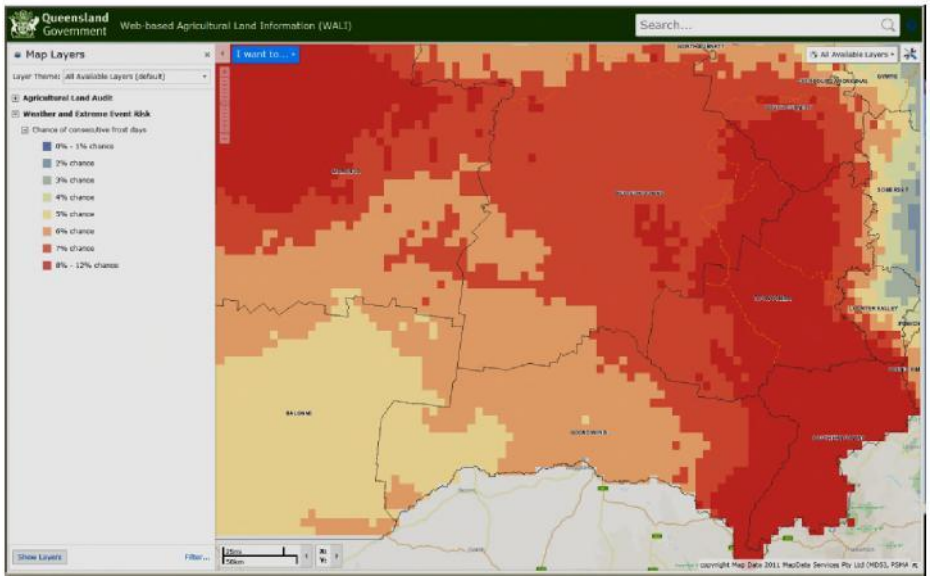
Step 3 - Mapping of biophysical conditions in the study area

The third step was to map, where possible, the biophysical criteria for the rationalised list of candidate crops. This process will firstly identify those areas (locations) within the region where these crops are capable of being grown (from a biophysical point of view); and secondly, contribute to an understanding of the seasonality of production, especially for the annual candidate crops. The seasonality of production for perennial crops may also identify additional limitations imposed by climate and/or soils.

Some mapping is available (on the Web - Agricultural Land Audit) from the Agricultural Land Audit (ALA) — see Consecutive Frosts example below (Figure 1).

Figure 1- Chance of Consecutive Frosts — from ALA- Agricultural Land Audit



Mapping activities completed for this project contribute to the Crop Suitability Matrix approach, as well as assisting in determining Seasonal Production Windows, using updated and patched Bureau of Meteorology (BoM) Gridded Data. The maps included in this Final Report are based on best current knowledge and provide a unique focussed insight into the biophysical characteristics of the QMDB Study Area. The BoM climate data used in this report has been updated and patched with Dept. of Science, Information Technology, and Innovation (DSITI) gridded data. (See Appendix III for an analysis of these data sets and the reasons for this change).

Step 4 - Economic analysis

The fourth step in the process of assessing the potential of high value horticultural crops in the QMDB Study Area was to compare the economic return from selected horticultural crops (both perennial and annual) to each other and to current broad acre irrigated crops grown in the QMDB Study Area. Gross margins are a commonly used method of comparing the potential return of horticultural crops. The project team developed crop specific gross margins based on known production costs, labour, machine cost, crop input costs and expected current returns. An iterative process of consulting growers in existing Queensland growing locations and defining labour, transport costs and yields has allowed the development of selected generic crop gross margins across the QMDB Study Area. This allows the comparison of potential gross margins (per hectare and megalitre) by both crop and production location.

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