Clarity Agriculture Pty Ltd

Hughenden Irrigation Project

Suitability and Viability of Crop Production in the Hughenden Region

14 June 2019

Disclaimer

This report provides a preliminary assessment of the crops that could potentially be grown in the proposed Hughenden irrigation scheme. Although this report addresses the economic viability of specific crops, the conclusions should be considered indicative only. The conclusions are based o the best available data that we have been able to identify. The source of the data is referenced in the report. Additional investigations will need to be undertaken to look at the economic viability of the crops at the specific location.

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1.0 Executive Summary

There are four sources of water that can be considered with regards to crop production in the Hughenden region:

- rainfall
- artesian water
- flood harvesting
- irrigation scheme supply

Rainfall in this region varies from 130-900mm/year, with an average of 442mm/year, which would be considered highly variable. This makes dryland cropping unviable in some years.

Artesian water volumes are unknown and of variable quality, which means more research would be required before this supply could be considered as part of the irrigation-water mix.

Flood harvesting and on-farm storage of water is a logical option for regions where rainfall can be infrequent but high in intensity. This water source is likely to be of value to supplement other sources of water as well as to enable on-farm reticulation of water to minimise off-farm environmental impacts.

Irrigation scheme water may provide 46-90GL/year at a nominal yield of 90% on a monthly basis.

When considering the four water sources collectively, the irrigation scheme water would be central to any development plans but would need to be supported by the other three sources of water – which would need to be maximised.

Rainfall in the Hughenden region ranges from 130-900mm/year with an average of 442mm/year and is considered highly variable. Therefore, dryland cropping will not be viable in some years unless supplementary irrigation applications were possible.

The temperature ranges from an average maximum of 25-35C from April to September and 35-38C from October to March, with actual maximum temperatures reaching as high as 43-44C in the middle of summer. The minimum temperatures range from an average of 9-18C from April to September, and up to 19-24C from October to March, with temperatures reaching as low as minus 2 to 6C during the middle of winter. These wide temperature ranges limit the potential for some crops to be grown either due to the highest temperatures in summer, or the risk of chill damage and frost in winter.

The impact of climate change on the region is not considered to be significant in any given year but the cumulative impact of year-on-year change may be significant in the longer term. It is expected that average rainfall will decrease by 1-2mm/year, temperatures will increase by 0.03-0.04C/year and evapotranspiration will increase by 0.25-0.5mm/year.

A total area of just over 30,000Ha was reviewed from CSIRO soil data, which showed almost 3,500Ha was lighter alluvial soils and the remainder was heavier clay soils.

The four major identified soil types are:

- sand or loam over friable clay subsoils
- red, yellow or grey loam soils (Kandosols)
- friable non-cracking clay or clay loam soils (Dermosols and Ferrosols)
- cracking clay soils (Vertosols)

Thanks to this range of soils, a wider range of both irrigated and non-irrigated crops can be considered as part of the whole-of-region approach.

The opportunity to utilise the lighter soils for high value irrigated crops, while using the heavier soils for dry land crops, during average or above wet seasons, has the potential to provide a balanced and sustainable farming situation.

The crops classes included in this review include:

- cereal and grain crops
- food legume
- industrial
- intensive horticulture
- oilseed
- fruit trees
- nut trees
- vines
- hay

The objective of this review was to identify crops that have the potential to be grown in the region based on the available data around climate, soil and water sources/supply.

The final list of potential crops includes:

- maize/sorghum
- soybeans
- corn
- mungbeans
- wheat/barley
- cotton
- guar
- brassica crops
- onions
- carrots
- pumpkins
- eggplants
- sweet potato
- sweet corn
- table grapes
- citrus
- lychee
- pomegranate
- mango
- avocado
- macadamia

Gross margin analysis was performed on most of these crops.

Additional assessment of this list of crops needs to be considered and would consider the following issues:

- in-region crop trials (where applicable)
- market access
- production windows
- further gross margin analysis (using region-based costs and yields from crop trials)

2.0 Introduction

A component of the project planning work for Engeny (to produce a feasibility report for a water supply scheme for the Hughenden region), was a requirement to validate the potential for viable production.

Clarity Agriculture was contracted to review the region, with a focus on assessing the range of crop groups and crop types suitable to the climate and soils of the Hughenden region.

Central to the focus of this report was the need to define the factors that heavily influence crop potential, such as soil, water and climate, and to quantify the crops that are most likely to perform from both a production and economic viewpoint in this region.

This report is a desktop review of the region and the cropping opportunities.

This report will cover the following key areas:

- potential water supply and security of allocation
- climate review
- major soil type review
- review of crops within major crop classes for suitability
- gross margin analysis of high potential crop within each crop class

The main objectives of this report for the larger Engeny project, is to provide a list of suitable crops by soil type and for the gross margin data to feed into the wider economic assessment and viability of the project.

3.0 Review of Water Supply

3.1 Water source

There are effectively four sources of irrigation water for crop production in the Hughenden region

- rainfall
- artesian water
- flood harvesting
- irrigation scheme water

3.1.1 Rainfall

Insights gained from a review of rainfall patterns include:

- the annual rainfall ranges from 130 – 900mm/year
- most of the rainfall occurs in the months from October to March
- there is little effective rainfall occurring in the months from April to September

- for dryland crops, the opportunity for viable crop production will be linked entirely to the amount of stored moisture that builds up over summer, as effective rainfall "in-crop" cannot be relied upon
- only the heavy clay soils will hold sufficient moisture that could sustain a dryland crop through to a viable harvest. The alluvial soils are not likely to be viable for dryland cropping.
- the ability of a farmer to plan for a viable dryland crop will be moderate to high as the decision can be made based on:
    - effective summer rainfall
    - soil profile stored moisture
- this scenario does mean that in some years, dryland cropping will not be viable due to a lack of moisture. Although this is not inconsistent with other dryland cropping regions elsewhere in Australia, other regions rely on "in-crop" rainfall to finish the crop with seeding decisions mostly made on long range weather forecasts, with seeding into dry soil with the hope of rainfall being common.

3.1.2 Artesian water

Insights gained from a review of artesian water sources include:

- there are two main aquifers in the Hughenden region
    - sub-artesian aquifer
    - alluvial non-artesian aquifer
- the water quality of these two aquifers varies significantly with high levels of sodium being the major challenge with using water from the sub-artesian aquifer for crop production
- the alluvial aquifer has better quality water and can be suitable for use in crop production
- in all cases, when considering utilising water from either aquifer, extensive water quality testing will be essential to ensure that crop or soil damage does not occur after prolonged use
- even a limited aquifer water supply may be of significant benefit in seasons with low river flow, or years of prolonged drought where perennial crops need to be maintained

3.1.3 Flood harvesting

Insights gained from a review of flood harvesting water sources include:

- in semi-arid desert locations such as Hughenden, rain events can be short, with significant river flows or overland flows occurring for short periods of time
- these flows have the potential to be captured via a flood harvesting strategy and stored for future use throughout the year
- it is likely that this water supply will not be consistent but may compliment other water sources to sustain crop production during low rainfall months/years

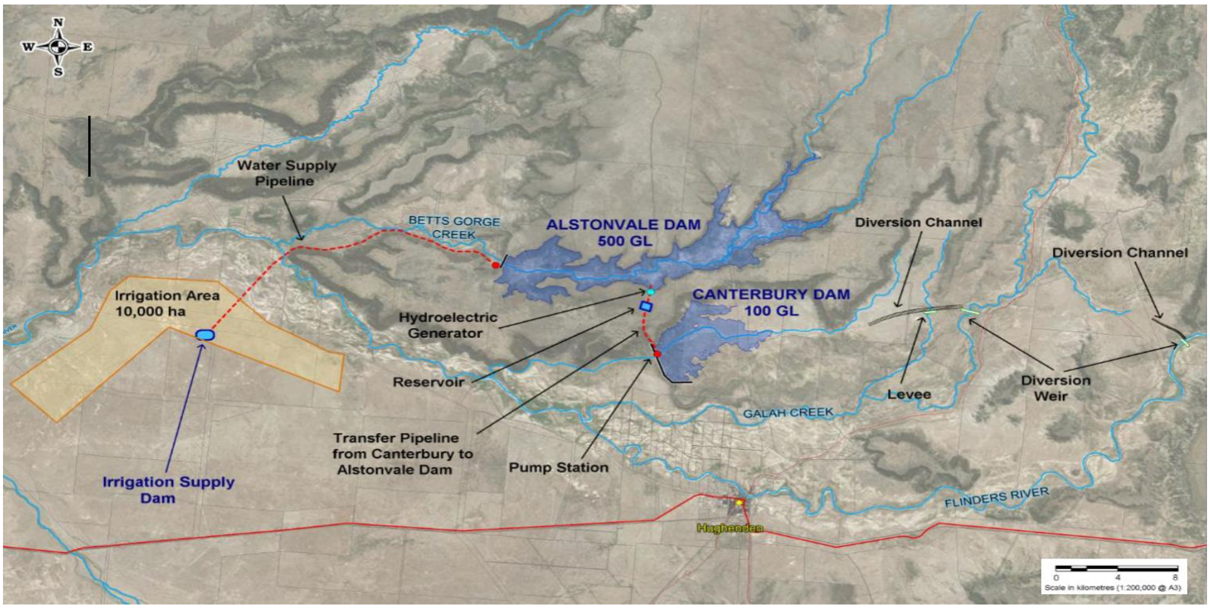
3.1.4 Irrigation scheme water

Insights gained from a review of proposed irrigation scheme water include:

- the Hughenden irrigation scheme is a concept to effectively capture river flow in a network of dams and levees to provide long term water supply to support agricultural production.
- there are currently two dam strategy options being considered for the region:
    - A two-dam option scheme including a 500 GL Alstonvale Dam and a 300 GL Canterbury Creek Dam. This will provide a 90 GL/year nominal yield at 90% monthly reliability

- A one-dam option that includes the 300 GL Canterbury Creek Dam. This will provide a 46 GL/year nominal yield at 90% monthly reliability

Image one: Hughenden irrigation scheme two-dam plan



3.2 Irrigation scheme water volumes

Insights gained from a review of proposed irrigation scheme water include:

- the two-dam scheme providing 90GL/year or 7.5GL/month has the potential to irrigate the following area:
    - annual crops using approximately 6Ml/ha/year: 15,000Ha
      or
    - perennial crops using approximately 15Ml/ha/year: 6,000Ha
- the one-dam scheme providing 46GL/year or 3.8GL/month, has the potential to irrigate the following area:
    - annual crops using approximately 6Ml/ha/year: 7,700Ha
      or
    - perennial crops using approximately 15Ml/ha/year: 3,000Ha
- these volume calculations do not include any water supply from rainfall, flood harvesting or aquifers to fully, partially or supplement the scheme water supply

3.3 Reliability

Insights gained from a review of proposed irrigation scheme water include:

- the concept of nominal yield relates to the reliable volume of water that can be discharged from the storage network over a consistent/defined period
- the concept of 90% monthly reliability relates to the ability of the storage network to supply a given volume of water in 90% of the months
- for the two-dam scheme, in 90% of the months, 7.5GL of water be supplied to growers. In 10% of the months a volume between 7.5–0GL/month will be available
- for the one-dam scheme, in 90% of the months, 3.8GL of water be supplied to growers. In 10% of the months a volume between 3.8–0GL/month will be available

- in the case of perennial crops, additional water supply from aquifers, on-farm storage and the like will be potentially required to cover the 10% of the time when allocations are less than 100%

3.4 Irrigation system options

Insights gained from a review of irrigation systems include:

- there are four main options for irrigating crops
    - Rainfall
    - Flood/furrow
    - Overhead
    - Drip/micro
- to maximise the efficiency and ROI of an irrigation system, while also maximising crop performance, matching the right system to a crop and soil type is essential. To achieve this level of efficiency, the following considerations need to be understood:
    - surface drainage and requirements for precision land levelling
    - soil type changes, both surface and deeper profile
    - soil infiltration rates
    - supplementary or full irrigation requirements
    - opportunistic or consistent cropping requirements

3.4.1 Rainfall

Insights gained from a review of rainfall as an irrigation source include:

- the biggest challenge with rain events, is to ensure that the infiltration of water into the profile is high and the fields are uniformly wet-up. To achieve this, consideration needs to be taken to implement appropriate precision land levelling and tillage practices.
- matching land levelling and tillage practices to soil types will also be necessary
- typical crops suited to dryland farming with 100% reliance on rainfall include:
    - small grains
    - large grains
    - cotton
    - pasture
    - forage crops

[Note: this is not a prescribed list of suitable crops for the Hughenden region]

3.4.2 Flood/furrow irrigation

Insights gained from a review of flood/furrow irrigation include:

- this is the lowest cost irrigation method with regards to upfront cost of infrastructure
- to maximise water-use efficiency, precision land levelling is required
- enables large areas of land to be irrigated effectively with minimum infrastructure
- suits cropping systems where reliability of water supply is moderate to low
- enables large areas of land to be opportunistically cropped with higher value crops when adequate water is available, without expensive infrastructure being unutilised in low to no allocation years
- can be easily used to supplement dryland crops (e.g. cotton)
- typical crops suited to flood/furrow systems include:
    - small grains

    - large grains
    - cotton
    - forage crops
    - sugar
    - peanuts

[Note: this is not a prescribed list of suitable crops for the Hughenden region]

3.4.3 Overhead irrigation

Insights gained from a review of overhead irrigation include:

- the types of irrigation systems in this category include:
    - centre pivot
    - lateral move
    - low pressure boom
- typically results in significant infrastructure and therefor relies on med-high reliability of water supply to maximise the ROI on the investment
- water use efficiency (WUE) is improved if precision land levelling is used to enable uniform application and infiltration across a given area
- allows for various options of cropping systems as the system is not tied to a specific row configuration
- WUE can reduced as a result of:
    - evaporative loss between the nozzle and the soil surface
    - evaporative loss directly from the soil surface
- typical crops suited to overhead irrigation include:
    - small grains
    - large grains
    - cotton
    - pasture
    - forage crops
    - horticulture (heavy produce)
        - potatoes
        - corn
        - carrots

[Note: this is not a prescribed list of suitable crops for the Hughenden region]

3.4.4 Drip and micro irrigation

Insights gained from a review of drip and micro irrigation include:

- the types of irrigation systems in this category include:
    - thin walled drip tape
    - heavy walled drip tube
    - solid set impact sprinklers
    - under-tree sprinklers
- thin walled drip tape and solid set sprinklers are typically used for annual crops
- drip tube and under-tree sprinklers are typically used for perennial crops
- these systems have a moderate to high infrastructure cost and typically are used on high value cropping situations

- WUE is typically high as a result of the precise system design and uniform delivery of water across a field
- typical crops suited to drip and micro irrigation include:
    - cotton
    - sugar
    - horticulture

[Note: this is not a prescribed list of suitable crops for the Hughenden region]

4.0 Review of Climate

With any new expansion or change in land use from one industry to another, one of the most significant considerations of what the opportunities are, is the influence of climate. It is also important to appreciate the difference between a climate review for decision making and a weather review:

- climate: the weather conditions prevailing in an area in general or over a long period
- weather: the state of the atmosphere at a particular place and time as regards to heat, cloudiness, dryness, sunshine, wind, rain, etc.

This section aims to appropriately detail climate trends and weather extremes to evaluate viable crop opportunities.

4.1 Rainfall

Rainfall is highly variable in this region, with a high of slightly more than 900mm and a potential low of just 130mm on an annual basis.

Graph One: last 18-year annual rainfall graph for the Hughenden region

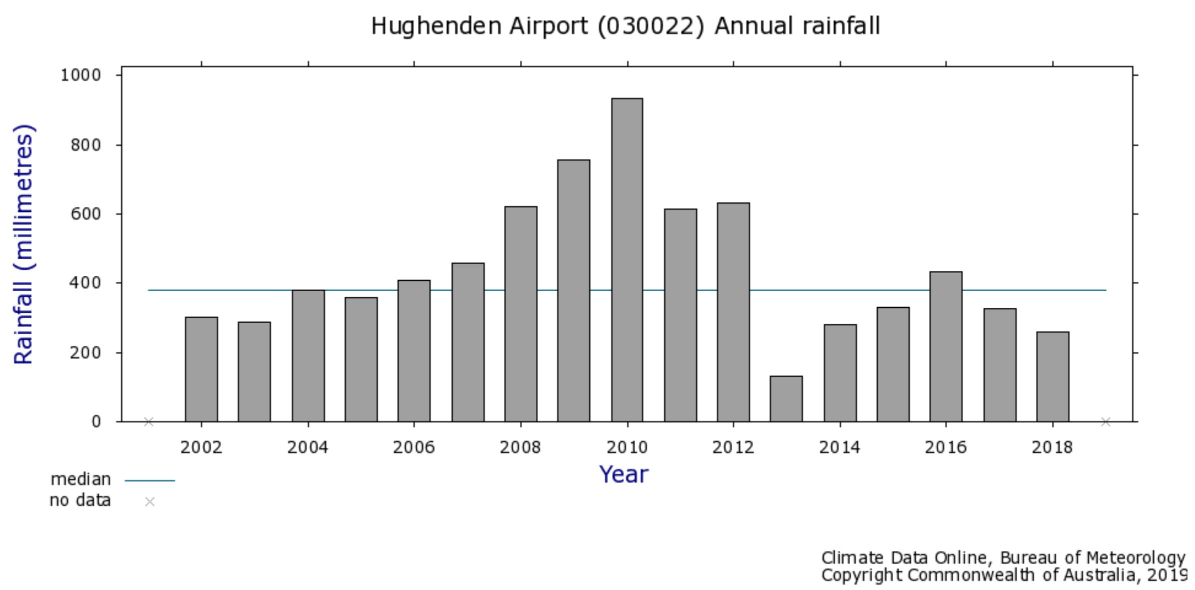


Table One: last 18-year rainfall statistics for the Hughenden region

Statistics	Annual Rainfall (mm)
Mean	441.8
Lowest	129.6
5th percentile	234.6
10th percentile	272.4
Median	378.4
90th percentile	681.3
95th percentile	791.9
Highest	932.4

*Data provided by BOM

When considering rainfall in a new cropping decision, there are several key considerations:

- ability to grow crops only on rainfall (dryland farming) and reliability of a successful cropping result
- annual requirement for irrigation to supplement rainfall
- intensity of rainfall and evaporation loss (effective rainfall)
- seasonality of rainfall

With such a high variability in annual rainfall, the potential for reliance on rainfall to produce viable dry land crops may be considered risky. However, variable rainfall is not uncommon in other regions of Australia where dry land farming is conducted – the correct farming approach and appropriate management of risks would therefore be key.

When calculating the required amount of irrigation water to supplement any rainfall, consideration needs to take into account the majority of years where rainfall is not going to reach the average value of 442mm. Working off the 10th percentile value of 272mm would be considered more realistic to understand normal peak irrigation requirements for a given crop.

In a region like Hughenden, where humidity can be low and surface evaporation can be extremely high, the intensity of rainfall events can be critical with regards to effective rainfall. Effective rainfall is the amount of water following a rain event that is stored in the soil, after any surface evaporation is complete. Rainfall events less than 10-15mm can result in a negligible level of effective rainfall, if they fall at the wrong time of the day.

Seasonality of rainfall is important to consider with regards to:

- timing of cropping operations, seeding, tillage etc.
- demands on irrigation infrastructure

Table Two: average rainfall by calendar month

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
118.1	85.2	34.2	19.2	5.3	18.6	13.7	8.2	8.3	16.2	46.1	66.5

Data provided by BOM

Like most regions in northern Australia, most of the rainfall occurs during the "wet season" (of November through to March), with a relatively dry autumn to spring period.

This rainfall pattern would enable ground-based operations (tillage, seeding, planting etc) to comfortably occur from February to March onwards, depending on temperature requirements for individual crops.

When considering irrigation requirements, peak demand would be from March to October. This is a critical consideration when designing water supply infrastructure, as well as on-farm and individual field irrigation infrastructure.

- irrigation designs would need to consider specific crop factors, peak daily water demand and evapotranspiration impacts on daily crop water use

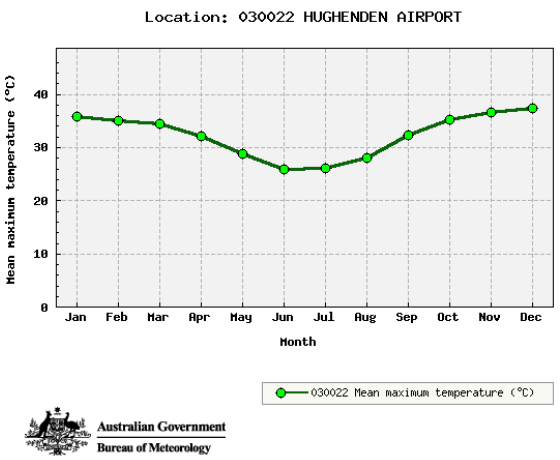
4.2 Temperature

The Hughenden region typically has desert type temperature conditions where the days are hot and the nights are typically cool to cold.

Insights gained from a review of temperature data include:

- maximum temperatures
    - the average maximum temperatures peak in the mid to high 35-38C during the months of October to March. The maximum temperatures can reach as high as 43-44C during this period, which will have a major influence on crop performance in some cropping situations.
    - the temperature during the months of April through to September show an average maximum in the range of 25-35C, which is an ideal temperature for a range of crops. Maximum temperatures can still reach 35-40C during this period.
- minimum temperatures
    - the average minimum temperature during the months of October through to March is in the range of 19-24C. The minimum temperatures can be as low as 6-16C during this period.
    - the average minimum temperatures during the months of April through to September are in the range of 9-18C. The temperatures can be as low as -2–6C which would indicate the risk of frost or chill damage with some crops during the coldest part of the year

Graphs Two and Three: last 18-years average maximum and minimum temperatures for the Hughenden region



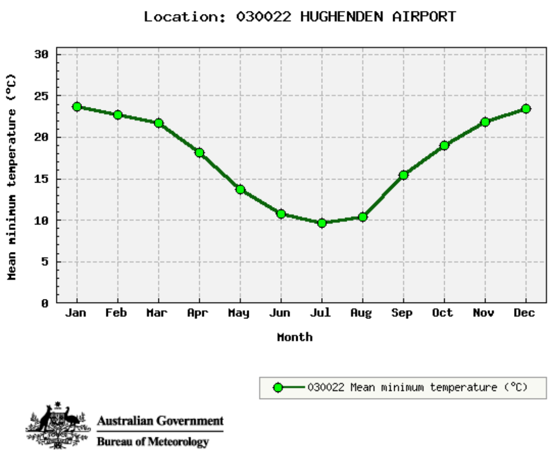


Table Three: monthly temperature statistics for the Hughenden region

Statistics	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean Max Temp	35.8	35.1	34.5	32.2	28.8	26.0	26.1	28.1	32.3	35.3	36.6	37.4
Highest Max Temp	44.2	43.2	42.5	37.8	37.1	34.0	34.6	37.6	39.8	42.6	43.6	43.9
Mean Min Temp	23.7	22.7	21.7	18.2	13.7	10.7	9.6	10.4	15.4	19.0	21.9	23.5
Lowest Min Temp	16.3	12.8	12.0	6.0	1.9	0.2	-2.0	-0.5	4.0	6.1	12.6	13.0

Data provided by BOM

4.3 Humidity

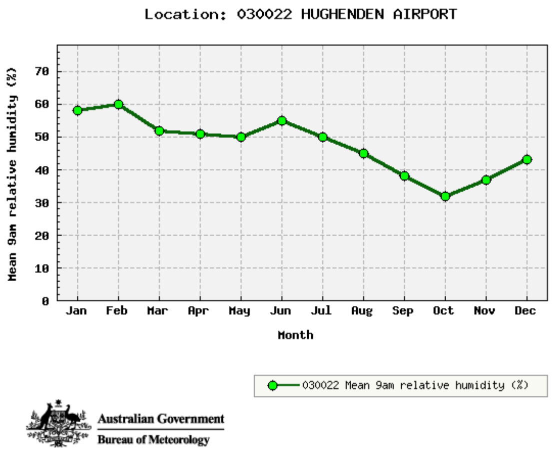
The humidity has a strong influence on plant physiology and the rate of water movement through a plant's leaf. This influence relates to:

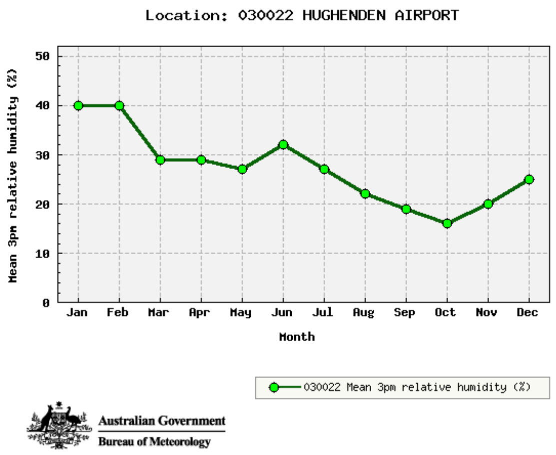
- cooling effect on the plant
- stomatal water loss
- daily water use

As humidity levels drop, the loss of water through a leaf increases, thereby increasing the requirement for stored profile moisture in dry land cropping situations or irrigation applications for irrigated crops.

In general terms across the entire year, the humidity for the Hughenden region is close to or well below 50% during most of the day when plants are using water, which results in moderate to high, daily plant water use requirements, for the entire year.

Graphs Four and Five: relative humidity values at 9am and 3pm by month for the Hughenden region





4.4 Evapotranspiration

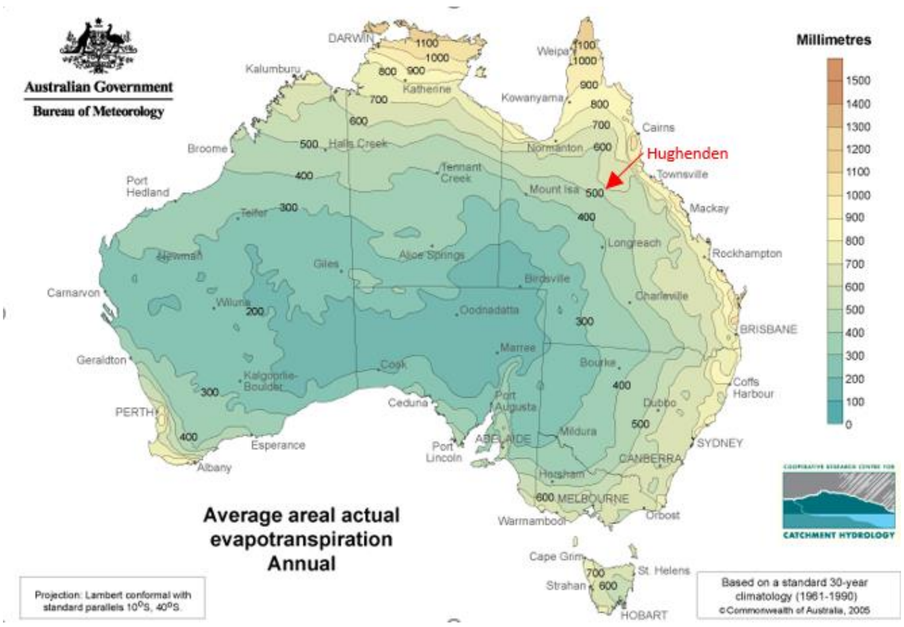
Evapotranspiration (ET) is the process whereby water is lost from a soil system either by transpirational loss through a plant or by evaporative loss from a soil surface.

Knowledge of ET is critical to understand how much water a plant will require at certain crop stages during the season and to be able to accurately design an irrigation system to meet peak demand.

Insights gained from a review of ET include:

- the Hughenden region is in the ET range of 600mm/year. Based on seasonal variability, this number could stretch from 500–700mm/year
- this equates to an actively growing perennial crop, that has an effective ground cover of 100%, using a minimum of 5–7Ml/ha/year of water with an average of 6Ml/ha/year
- some crops have a plant water use value that is higher than a daily background ET value during specific crop stages, and this impact will increase a plants annual water demand to be higher than 7Ml/ha/year
- total rainfall varies from 1.3–9Ml/ha/year with an average of 4.4Ml/ha/year
- effective rainfall or plant usable rainfall is always lower than total rainfall values

Image One: annual ET values



4.5 Climate Change

There are several versions of the definition of climate change. The most appropriate way to explain what climate change means to a region like Hughenden is:

> *"significant long-term changes in the expected patterns of average weather of a region over a significant period of time."*

When considering a new long-term project like the irrigation project in Hughenden, reviewing climate data is critical.

Consideration also needs to be given to any significant changes to historical climate data that may occur in the future and potentially influence the success of the chosen crops in both production and use of natural resources

The Bureau of Meteorology has released several trend maps that can be used to assist in future planning strategies for agriculture

Based on the trend maps following, the expected changes to the climate to take into consideration in crop type decisions are:

- reduction in annual rainfall by 1-2mm/year
- increase in atmospheric temperature by 0.03 - 0.04C/year
- increase in evaporation of 0.25-0.5mm/year (direct influence on ET)

Although these numbers do not appear large or significant over a short period, when planning a long-term irrigated agriculture project, small annual changes in climate figures add up.

The potential impacts to crop production planning would include:

- varietal changes to suit hotter and drier growing conditions
- crop type changes to suit hotter and drier growing conditions
- increase annual water use
- changes in crop performance (positive and negative)

Image Two: rainfall trend resulting from climate change

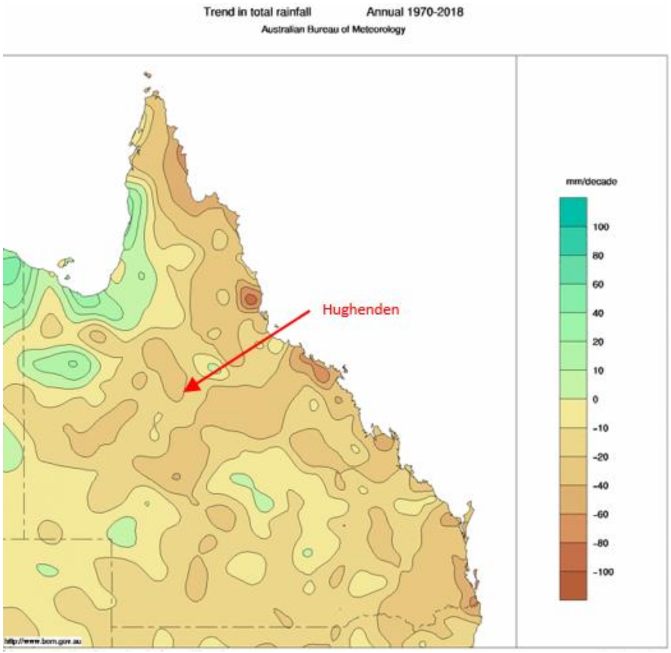


Image Three: temperature trend resulting from climate change

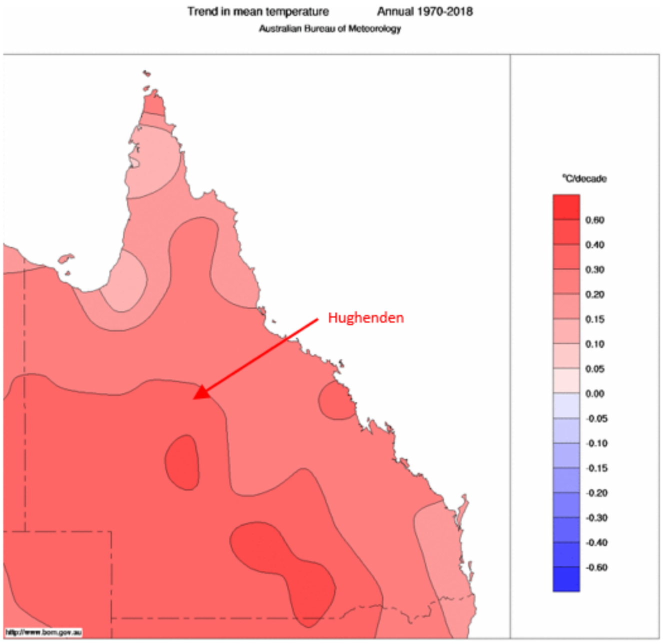
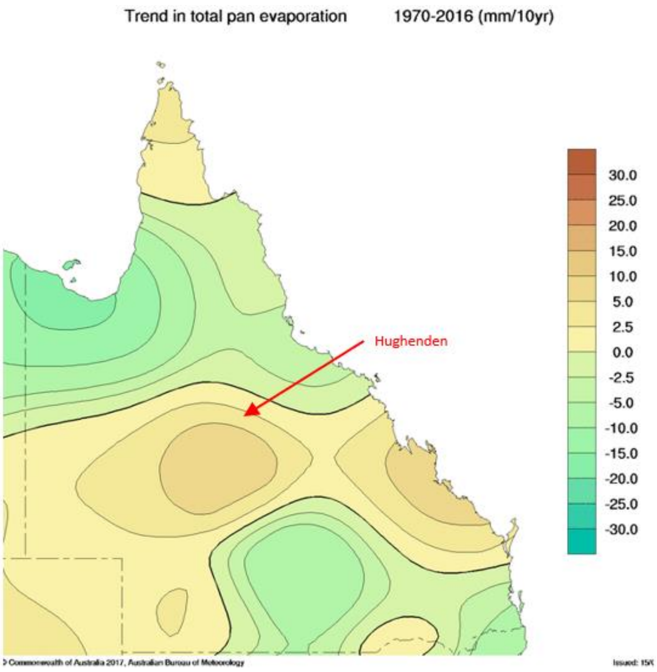


Image Four: evaporation trend resulting from climate change



5.0 Review of Soils

Insights gained from a review of the local soil types include:

- the area of interest is in the upper Flinders Catchment
- most soils in the area of interest are alluvial
- there are four soil types in the area considered suitable for irrigated agriculture

The soils of the Flinders Catchment under consideration for this project are relatively deep with some approximating one meter in depth. This means the plant available water (PAWC) in many cases, in the absence of salinity, should support crops likely to be of interest in this part of the Flinders.

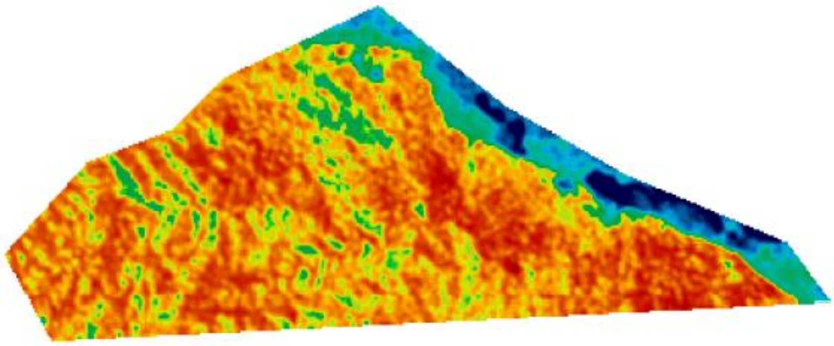
Soils with a higher PAWC for a crop, should be of greater interest for cropping as such soils can store significant soil moisture with fallowing which will reduce irrigation requirements.

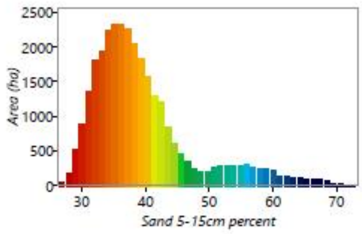
Hard-setting soils are usually difficult to get rainfall and irrigation water to infiltrate to maximise soil water storage for crop production. Tillage typically increases issues associated with water infiltration into the soil as soil structural decline takes place following soil organic matter decline resulting from tillage.

Irrigation could result in salinity issues in some soils in the area of interest especially the cracking clay Rolling Downs soils. Increased access to ground water associated with irrigation could result in raised water tables, which could be or become saline and so limit the long-term benefits of irrigation. These challenges could necessitate specific irrigation management practices to ensure longevity of any irrigation scheme.

Image Five: Boundary of review of CSIRO soil classification

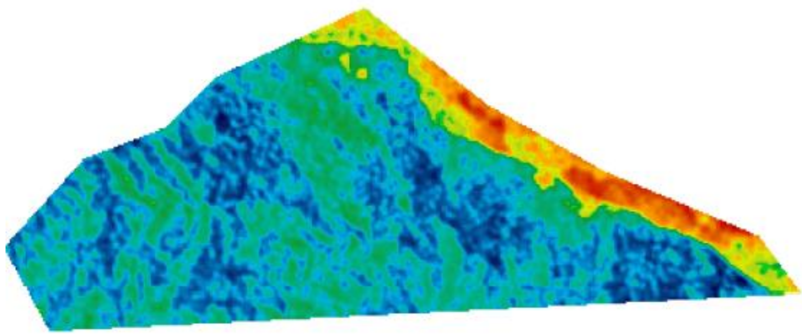
Image Six: CSIRO soil classification for sand at 5-15cm

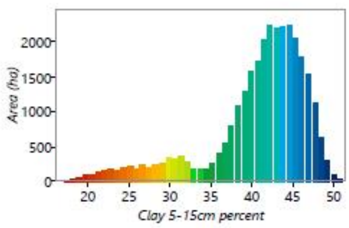




Layer name	Sand 5-15cm percent
Field name	All fields
Season	2019
Min	26.86
Min	26.86
Mean	39.96
Mode	36.23
Max	73.68
SD	8.09
CV	20.24%
Total	1203982.26
Total Area	30129.57 ha

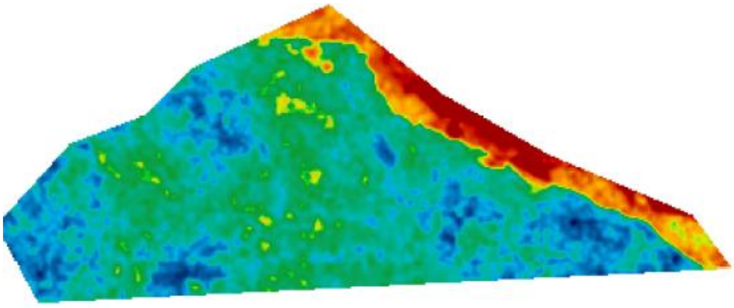
Image Seven: CSIRO soil classification for clay at 5-15cm





Layer name	Clay 5-15cm percent
Field name	All fields
Season	2019
Min	16.62
Min	16.62
Mean	41.33
Mode	42.32
Max	51.67
SD	6.12
CV	14.80%
Total	1245115.66
Total Area	30129.57 ha

Image Eight: CSIRO soil classification for soil pH at 5-15cm



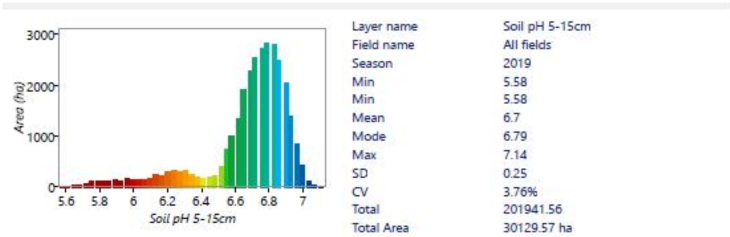
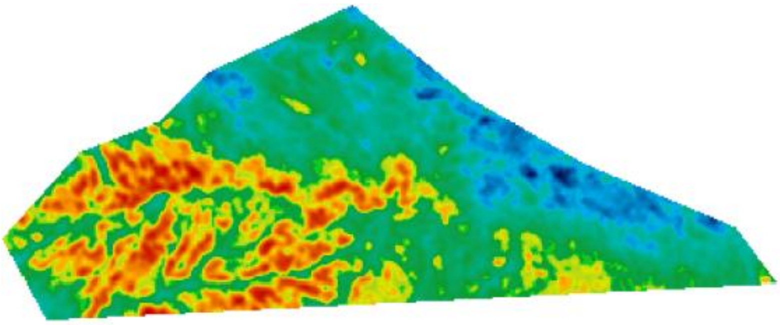
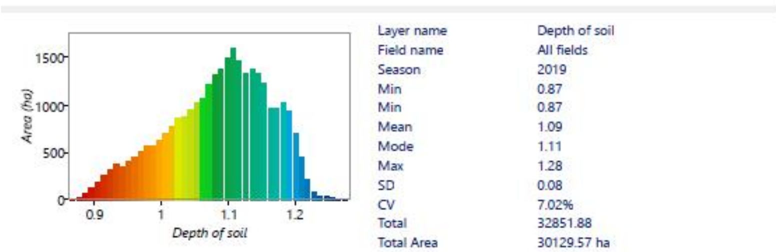


Image Eight: CSIRO soil classification for soil depth





5.0.1 Area breakdown of review boundary

Insights gained from a review of GIS soil maps include:

- total area reviewed: 30,130Ha
- total area of alluvial soils depicted by high sand and low clay levels: 3,450Ha (approx.)

- total area of clay soils depicted by low sand and high clay levels: 26,680Ha (approx.)
- soil pH ranges from 5.6 – over 7pH
- soil depth ranges from 0.8 – over 1.2m

5.1 Soil Types

Insights gained from a review of the four major soil types include:

5.1.1 Sand or loam over relatively friable clay subsoils

- these are undulating plains over the top of a wide variety of parent materials
- the non-acid soils of this group are widely used for agriculture

5.1.2 Red, yellow, or grey loamy soils (Kandosols)

- these are level, to gently undulating plains and plateaus, are well drained, are neutral to acid, with little or only gradual increase in clay content with depth
- they can be shallow to deep in profile
- they have moderate to high agricultural potential, with overhead or drip/micro irrigation due to their good drainage
- they have moderate water holding capacity but are often hard setting
- they are considered to have high agricultural potential because of their good structure and their moderate to high chemical fertility and water holding capacity
- however, those that are ferrosols (red) on young landscapes may be shallow and/or rocky

5.1.3 Friable non-cracking clay or clay loam soils (mostly Dermosols and Ferrosols)

- some occur on plains and plateaus
- they are moderate to strongly structured
- are neutral to strongly acid in reaction
- have only gradual increase in clay content with depth
- these red to grey soils are moderately deep to very deep

5.1.4 Cracking clay soils (Vertosols)

- these clay soils have shrink/swell properties, that induce cracking when dry
- usually alkaline
- are deep to extremely deep in profile
- they occur on floodplains and other alluvial plains
- they have generally high agricultural potential
- may have flooding issues which vary according to location
- salinity may be an issue on some soils, particularly those associated with the Rolling Downs
- Gilgai micro-relief may occur
- coarse structured, surface soil may be present

5.2 Clay Soils

Insights gained from a review of the clay soil types include:

- besides floodplains and other alluvial plains areas, most of these soils occur on undulating to rolling Mitchell Grass Downs country, formed mostly on sedimentary rock. Some are on basalt landscapes
- generally, these soils have a high plant available water-holding capacity (PAWC) for a specific crop e.g. sorghum, as different crops have varying abilities to overcome some soil constraints.

- sub-soil constraints, commonly sodicity and/or salinity, can limit PAWC and as such may limit suitability for some crops, even with irrigation which can moderate some of these limitations.
- whilst information is provided to help define soil type zones, this needs to be "ground truthed" to better define the focus area of this report based on topography and general terrain which are not considered in this desktop assessment

5.3 Alluvial Soils

Insights gained from a review of the alluvial soil types include:

- these areas include flood plains and other alluvial plains.
- light clay soils with shrink/swell properties that induce cracking as they dry (while this is usually positive and indicates high levels of water availability for plants, the cracking can cause issues with physiological plant disease e.g. phytophthora root rot)
- soils are usually alkaline
- are deep to extremely deep
- attributes as listed above as well as general workability, make them worthy of serious consideration for irrigation of a range of crop types
- depending on the clay type and the ratio of sand, silt and clay, these soils are generally relatively easily worked and with proper management need not be subjected to the soil degradation often assigned to these soils because of their ease of working
- in the scheme of things, alluvial soils associated with the river are not a significant proportion of the total area under consideration in this review, although may have significant value in crop selection

6.0 Review of CSIRO Crop Groups

6.1 Cereal and Grain Crops

The grain crops assessed were:

- grain sorghum
- maize corn
- winter cereals (wheat, barley and oats)

6.1.1 Grain sorghum crop management considerations

Summer growing in North Queensland, the northern part of the Northern Territory and the Ord River area of WA, has been plagued by harvest difficulties in many seasons, necessitating the use of grain dryers to enhance the chances of harvesting quality product.

Weeds on the alluvial soils are likely to become troublesome over time and the use of appropriate residual herbicides for the weed spectrum would be essential.

Insects in the way of sorghum midge and Helicoverpa (heliothis) are likely to require management and control. Midge is known to occur on native sorghum plants in the Downs country in the area. The larvae of Helicoverpa are a common pest in crops in the areas to the east. Rutherglen bugs are likely to be problematic in some years, with control measures using known insecticides are unlikely to be successful economically.

Ergot, a fungal pathogen, which results in affected florets being replaced by spores (sclerotia) causing a sticky exudate which effectively replaces the seed, is unlikely to be problematic in the environment of the study area. Grain contaminated with the exudate can negatively impacting harvest operations and causes livestock feeding issues, which can be somewhat managed with appropriate feed additives in most situations.

6.1.2 Grain sorghum climate, soil and water considerations

This summer growing crop grows well on cracking clay soils and with typical pH readings in the range of pH 6.5 – pH 8.0 would be suitable in general terms for grain sorghum. Such pH readings appear to be common on both the alluvial and the cracking clay soils.

Total crop water use approximates 6 Ml per hectare in a typical season. In seasons, some or all this water requirement could be supplied by rainfall. In poorer rainfall seasons, some or all water required would have to come from irrigation.

PAWC of available soils in the area for sorghum is unknown and can only be estimated. The deeper Vertosols in the study area may have a PAWC of up to 200 mm. The most significant constraining factor is likely to be salinity, either natural or induced (in the long term). Vertosols in the Maranoa of Queensland have a typical PAWC for wheat of only 130 mm because of salinity at a shallow depth (30-40 cm).

It is unlikely that the use of fallow moisture will be an option in the Hughenden region due to the strongly seasonal rainfall and high evaporation values

Due to the low chance of frost, grain sorghum could be grown in either summer on stored profile moisture, or winter with irrigation.

Dryland production of sorghum would be financially rewarding in some seasons on deep Vertosols with wide row configurations and singulations.

Crop production modelling using APSIM for another project showed economic yields as far north as Tambo with specific plant spatial arrangements. The rainfall at Blackall did not lend itself to grain sorghum production in the long term.

6.1.3 Grain sorghum harvest and market considerations

Crop grain yields in the order of 7-8 t/Ha would be feasible with good management.

6.1.3 Maize corn crop management considerations

Grit, silage or sweet corn all have similar water and nutrient requirements and corn produces well under surface, sprinkler or drip irrigation management, where seasonal water use (rainfall plus irrigation) is typically >7 Ml/Ha.

Irrigation methods will be largely influenced by topography and soil type. Drip irrigation is the most water efficient method, whilst surface or furrow is typically the least. However, furrow irrigation can often provide large quantities of water in a timely manner, in the case of water deficit, an advantage the other methods don’t usually have. Water deficit at the tasselling stage can be economically very damaging.

Corn is more intolerant of poor water management than either sorghum or cotton but plant diseases in the form of cob rots and/or boiled smut could be issues especially with overhead irrigation

6.1.5 Maize corn climate, soil and water considerations

Most of the alluvial and cracking clay soils of the study area are suitable to produce maize/corn, with irrigation.

The geographic location of the area provides climatic diversity in the case of sweet corn, essential for continuity of supply. However, this opportunity can be driven by climatic adversity in other growing areas.

Like sorghum, corn prefers warm environments with cool nights to allow respiration and daylight hours rather than day degrees are a major determinant of maize yield.

Good irrigation management can assist in providing suitable respiration conditions but is not a substitute for cool night temperatures.

6.1.6 Maize corn harvest and market considerations

Grain yields in Victoria, which has a twilight period, are much higher than those expected in southern Queensland (20 t/Ha versus 14 t/Ha).

6.1.7 Winter cereal crop management considerations

Government and semi-government agencies have of recent years encouraged growers to produce wheat grain at northern locations to expand the area of wheat in Queensland. It is presumed the benefit of such expansion would be to provide feed grain to northern intensive animal producers.

The phenology of wheat is controlled by several factors including photo period, accumulated day degrees and soil temperature

Varietal selection would be important. Some long season varieties have a vernalisation requirement, which means they must have a certain number of day degrees below near zero before reproductive processes begin. Even in southern Queensland environments, such varieties will not set seed properly due to failure to meet vernalisation requirements.

It is known that the application of water to the soil surface has a cooling effect, either from rainfall or irrigation. Such cooling is typically towards 5^0C and lasts for about 5 days. Besides ensuring germination, the soil cooling effect could favourably influence emergence by increasing the coleoptile length. In practical terms, this management approach should not be depended on for crop success with regards to germination and plant population success.

In the relatively warm dry winters of north Queensland, barley may be considered a better option than wheat because of the changed water use pattern in the dry-down phase of the ripening process. Barley is likely to want to terminate water use earlier in the plant life cycle than wheat (finish earlier) and be not so inclined to pinch the grain with the onset of water stress imposed by heat at the end of the season.

Foliar plant disease in the form of rust (leaf and stem) and various leaf blotches (barley) are likely to be common because of warm moist conditions (if irrigating), necessitating fungicide applications which may impact profitability.

6.1.8 Winter cereal climate, soil and water considerations

The soil temperatures at seeding time for these winter cereals are commonly >30^0C even in a southern Queensland situation in May. These temperatures result in shortening of the coleoptile (plant tip). This makes emergence of the seedling difficult due to the resulting premature opening of the coleoptile into a leaf which has limited penetrative power to break through the soil surface.

Due to a high evaporative demand and warm soil conditions, producers typically place seed deeper than normal to ensure the seed remains in moist soil long enough to support the germination and emergence processes.

In warm winter conditions, as occur in the study area, poor winter crop establishment could be common. There are varietal differences in plant establishment, but these are relatively insignificant from a practical perspective.

Most varieties have a day degree requirement which differ due to genetic differences. Day degrees start accumulating from the hour of seeding. Crops seeded in warm months of the year accumulate day degrees rapidly, bringing the crop to premature physiological maturity.

As yield is determined mostly by the leaf area index, a plant that has been forced into early maturity, has limited leaf area, resulting in poor yield prospects, both for biomass and grain yield.

6.1.9 Winter cereal harvest and market considerations

Should winter cereal production be attempted, crop yields for wheat irrigated wheat are likely to be commonly ≤ 5.5 tonnes/ha. Yields comparable to this have been achieved from irrigated wheat in the Belyando area to the south of the study area.

Irrigated barley would be expected to yield approximately 10% greater than wheat, but price is usually about 10% less than for wheat in the feed market. Sometimes prices on offer for barley are greater than for wheat because of barley having a higher fibre content for intensive livestock use.

Oats may be considered as a feed crop to fill a feed gap in a livestock enterprise. Like wheat and barley, issues relating to soil temperature at germination and emergence are relevant, as well as the rapid accumulation of day degrees leading to premature maturity.

6.2 Food Legume

The food legume crops assessed were:

- soybeans
- mungbeans

6.2.1 Soybean crop management considerations

Soy is a summer growing legume which can be used for grain, fodder as a grazing crop, or hay/silage. The seed is large and is audio sonic, meaning it is sensitive to sound which may result in killing of the seed if mishandled at seeding time.

Soy is commonly seeded on wide rows out to 1 meter to facilitate furrow irrigation. With overhead irrigation, row-spacings as narrow as 30 cm are common.

High yields can be achieved from close row spacing, high fertiliser regimes and regular and adequate watering. Conditions that favour soybean growth, also favour diseases, especially Scleractinia, charcoal rot and phytophthora. Management understanding are required to optimise the yield outcome.

Variety selection for particular seeding dates is important, as the plant is sensitive to day length, (photo period), with maturity being largely controlled by hours of daylight.

Insect management is becoming increasingly important, particularly where insects seek refuge in fresh green crops with surrounding dry conditions. Sucking insects, including the green vegetable bug, could potentially be the biggest insect problem in the short term.

6.2.2 Soybean climate, soil and water considerations

While this crop can be grown dryland, moisture management is important in determining the outcome. If irrigating, requirements could be as high as 8 Ml/Ha depending on the yield expectation and other variables including rainfall, soil type and variety.

6.2.3 Soybean harvesting and market considerations

Soy products are sought by many cultures. Hence a diversity of markets exists. A range of products are made from the seed including oil, meal, tofu and soymilk. The Americas produce large quantities of soy seed which is largely exported to Asia.

Irrigated yields can be ≤5 t/Ha with 4.5 t/Ha being commonplace with good management.

6.2.3 Mungbean crop management considerations

This leguminous crop is likely to have a place in the region as a summer grown crop with a short growing season approximating 90 days from seeding to harvest.

Typically, good mungbean crops have been fertilised pre-seeding with 150 kg/Ha of urea and 60kg/Ha of MAP.

Insect management is critical throughout the season, especially pre-flowering to pod fill. Poor management of insects at this time can impact final yield performance.

Mirids can be extremely destructive at budding and through flowering. Though relatively inexpensive, the use of OP insecticides for mirid control can significantly increase the likelihood of Helicoverpa damage. Helicoverpa larvae can also cause significant flower and pod losses if not adequately controlled.

Seed borne diseases such as Tan Spot can be common in somewhat more humid regions and it is essential that seed from sources known to be free from Tan Spot are used.

6.2.5 Mungbean climate, soil and water considerations

This crop has relatively low water requirements compared to maize, sorghum etc. approximating 2 Ml/Ha with irrigation due to a relatively shallow tap root system that doesn't deplete moisture from depth.

Mungbeans grow on a range of soil types with both the alluvial soils and the alkaline cracking clay soils in the proposed irrigation area being suitable, however, mungbeans will perform poorly on saline and/or sodic soils.

6.2.6 Mungbean harvesting and market considerations

Grain yields of 2.5 t/Ha under irrigation should be a target with good agronomy and management, but in dryland situations, realistic average yields ≤ 0.9 tonnes per hectare can be expected in an average season with good insect management.

Harvest losses can be significant on uneven soil surfaces and/or where dryland crops fail to grow tall enough as the plant is naturally short and moisture stress can cause the plant to be too close to the ground for many harvester fronts.

6.3 Industrial

The industrial crops assessed were:

- cotton
- guar

6.3.1 Cotton crop management considerations

Cotton has been produced successfully in northern Australia (Ord River in WA & Douglas Daly in the NT) by growing it over winter, with seeding taking place at the end of the 'wet' season and picking in the spring.

Nutrient requirements are like high yielding grain, or silage crops of sorghum/maize.

Insect damage is a major potential loss pathway, necessitating good management from an early stage and the use of genetically modified cotton (bt) to control the ongoing threat of Helicoverpa caterpillars would be essential from both management and financial perspectives

Silverleaf whitefly, aphids and mites could all be potentially very damaging to cotton yield that will still need to be controlled using conventional spray application methods.

A disadvantage of cotton over some other crops is that there is no back-up position in the event of failure. The option of grazing a failed/failing crop is not available, as it is in the case for grain crops.

6.3.2 Cotton climate, soil and water considerations

Given the available soil information, soils of the proposed irrigation area appear suitable for cotton production, especially the deeper alkaline cracking clay soils, however, ground truthing of soil information would be essential before embarking on a cropping program.

Deep soils, in the absence of salinity, offer the opportunity of reduced irrigation frequency due to the soils ability to store water. Salinity/sodicity can reduce the plant availability of soil water and would need to be quantified.

Water requirements for an average crop can be up to 9 Ml/Ha, which can be provided with furrow, overhead or drip irrigation.

Topography can have an influence on irrigation type. It is believed that there may be only limited areas suitable for surface irrigation in the area, due to slope related issues.

Cropping of some of the alluvial soils area may have the limitation of erosive flooding that can result in severe financial losses.

With different plant row configurations, very profitable cotton crops can be produced on as little as 6 Ml/Ha of total water (stored profile water plus irrigation).

Optimum day temperatures for cotton are in the order of 36^0C. Temperatures greater than 36^0C are not particularly deleterious providing soil water supply is adequate.

Cold temperatures during the northern growing season can result in loss of flowers and/or fruit from the middle of the plant. In these circumstances, cotton is mainly produced at the bottom and the top of the plant.

6.3.3 Cotton harvesting and market considerations

Cotton is a valuable cash crop and of the comparable broadacre crops, delivers the best return on water asset investments in most years, unless the enterprise has a need for a particular crop to fill a gap for livestock feed (E.g. silage in a feedlot, silage in a grazing enterprise, hay making for live export etc.).

Yields are dependent on water and the potential impact of cold temperatures over the winter growing period and in the absence of such losses, yields of <15 bales/Ha of high-quality cotton are achievable.

6.3.4 Guar crop management considerations

Guar has been grown in southern Queensland on a commercial scale for more than 23 years.

Both determinant and indeterminant varieties have been selected for use in Queensland, however, the different types have become contaminated/mixed leading to difficult agronomic and harvest management. For this reason and because of inadequate financial rewards, many growers have moved to alternative crops. For this reason, should pure seed of a determinant variety be available, it should be selected as the variety of choice, *ceteris parabus.*

Guar is susceptible to Helicoverpa. With indeterminant varieties, there could be many waves of insect attacks necessitating multiple insecticide applications, impacting profitability.

Fertiliser requirements are like sorghum in the absence of more detailed information.

6.3.5 Guar climate, soil and water considerations

Guar is described as a drought tolerant summer annual legume and can be grown on a variety of soils including alkaline light clays and clay loams. It prefers reasonably well drained soils as it is susceptible to root diseases, including phytophthora, which is carried by some legumes.

Guar is reasonably salt tolerant and somewhat frost tolerant.

6.3.6 Guar harvesting and market considerations

Guar has many uses with an ever-increasing use in fracking of underground strata for oil/gas production.

Marketing options can be challenging, with nobody in the chain prepared to give up lucrative margins to allow producers to economically grow the crop.

6.4 Intensive Horticulture

The horticultural crops assessed were:

- cauliflower
- cabbage
- broccoli
- onions
- carrots
- pumpkins
- eggplants
- sweet potato
- sweet corn

The key decision points considered are:

- temperature extremes
- suitability of cracking clays
- reliability of high security allocations
- potential impact of wildlife and insect pests

6.4.1 Water requirements relating to priority water supply

All horticultural crops will require a water supply that is high security and on demand to meet the crop management requirements and compensate for the weather extremes in the region.

Actual water requirements of listed horticultural crops are usually in the range of 4-5 Ml/ha, but this may increase in Hughenden if higher temperatures result in more frequent watering being required.

The listed horticultural crops have a low tolerance for water logging, thus irrigation requirements will be a high frequency of low volume applications.

Irrigation techniques will likely comprise a mixture of centre-pivot, sprinkler and trickle, however, will require the development of more intensive mains and other distribution infrastructure due to production units being smaller.

6.4.2 Climate

Temperature extremes may mean that it may not be commercially feasible to grow some horticultural crops from November to February. A "split season," that is, growing a crop in the months either side of the hottest part of the year will be feasible for some crops.

Both temperature extremes and unseasonal rainfall events are likely to affect quality in some years.

Sowing/harvesting windows will be different compared to those for the same horticultural crops in southern latitudes providing potential opportunities for higher returns by being able to supply when a given crop is normally out of season.

Cauliflowers, cabbages, broccoli, onions and other crops are frost tolerant potentially providing lower risk cropping options during winter.

6.4.3 Suitability to soil types

While carrots and sweet corn are not suitable for cracking clays, many horticultural crops will tolerate a wide range of soil types and it is probable that a range of horticultural crops will be able to be grown on all types of soils able to be irrigated in the scheme.

Growing costs are likely to be higher in the first years of production compared to more established horticultural regions due to the need to spend more time to establish a seed bed suitable for horticultural crops.

6.4.4 Yield expectations (irrigated only)

Regional conditions mean that it may be possible to achieve higher than average yields for some crops. Yields that could be reasonably expected for irrigated crops of the listed types are as follows:

- cauliflowers – 173 tonnes/hectare
- cabbage – 162 tonnes/hectare
- broccoli – 11.5 tonnes/hectare
- onions – 40 tonnes/hectare
- carrots – 38 tonnes/hectare
- pumpkins – 30 tonnes/hectare
- eggplant – 21 tonnes/hectare
- sweet potato – 15 tonnes/hectare
- sweet corn – 2.2 tonnes/hectare

6.4.5 Profitability

The profitability of horticultural crops is volatile, fluctuating significantly from year to year due to issues of supply and demand. This means that the mix of crop types grown in a given season may change from year to year.

The possibility of being able to produce crops that are out of season in other growing areas could improve profitability.

Most horticultural crops are highly mechanised, so profitability will be affected by the availability of harvesting and other equipment as well as the capability to service and repair it.

Margins may be able to be improved through investment in additional growing infrastructure such as windbreaks or shade cloth covering for higher value crops.

The development of post-harvest infrastructure such as packing sheds, processing equipment and cold storage will have a significant effect on profitability.

The availability, quality and efficiency of transport infrastructure will be important to maintain viability.

Predation by local and migratory wildlife, insect and weed pests, and the extent to which this can be managed, will impact margins.

6.5 Oilseed Crops

The oil seed crops assessed were:

- sunflower

6.5.1 Crop management considerations

A summer production broadleaf crop is widely grown in Queensland and northern New South Wales and as far north as the Burdekin when market prices and demand allow.

An even plant distribution is essential, and particularly so with most other crops being considered for this region. Clustering of plants in the row leads to excessive competition for moisture and light, resulting in highly variable oil content from seeds from different heads.

Seeding with a precision planter capable of singulation is likely to give best results due to even plant spacing and removal of double plants at each plant site.

Weed control options are limited for this broadleaf crop with incorporated residual herbicide grass control being common. The need for extensive soil disturbance makes this option unattractive to some producers due to the moisture loss incurred by the tillage operation.

In-crop knockdown herbicide options for weed control are likely to prove attractive in this area for this reason.

Disease issues are potentially significant with many being seed borne. Seed treatments can only manage some diseases, with Scleractinia being a serious limitation once a field is infected. This disease is soil borne and can affect many other crops including soybean, some brassica crops, mungbeans. A crop rotation of greater than five years (preferably 10 years) is required between susceptible crops once a field is infected.

The main insect to affect sunflowers is likely to be rutherglen bug. They can be difficult to bird damage from parrots will likely be an issue, with field selection/location being important in limiting damage.

6.5.2 Climate, soil and water considerations

Oil content of high oil varieties can be negatively impacted by hot dry conditions and insect damage (rutherglen bugs) leading up to harvest. Late seeded crops may prove to be better in the north for this reason.

6.5.3 Harvesting and market considerations

Hybrid varieties producing mono-unsaturated oils have gained favour of recent times, though significant volumes of birdseed and grey stripe sunflower varieties that are produced for niche markets.

Consideration to harvest for seed should be determined at planting, as harvesters have specific row spacing requirements. A row spacing that fits the harvester should be chosen. Desired row spacings generally are around 900-1000mm.

6.6 Fruit Tree Crops

The fruit tree crops assessed were:

- mango
- grapefruit
- lemon
- lime
- mandarin
- avocado
- orange
- lychee
- pomegranate

The key decision points are:

  - water reliability
  - frost sensitivity
  - high temperature sensitivity
  - chill requirements
  - soil suitability

6.6.1 Water requirements relating to priority water supply

All fruit tree crops would require permanent irrigation systems and high security water and on-demand water supply would allow better irrigation management than scheduled water supply.

Possible irrigation types include dripline and mini-sprinkler, or a combination of both, for example:

- drip irrigation would require double driplines per row to increase wetted soil volume
- drip irrigation may also require cooling misters
- under-vine mini sprinklers use more water than driplines but may not require cooling misters

Fruit tree crops using driplines in extreme environments, such as Hughenden, would require up to 10-12 Ml/Ha/year.

Fruit tree crops susceptible to heat stress using dripline in extreme environments may require cooling misters using up to an additional 6 Ml/Ha/Yr.

Fruit tree crops using mini sprinklers in extreme environments would require up to 16 Ml/Ha/year, while pomegranates require less water than other fruit crops

6.6.2 Climate

High temperatures and low humidity during fruit development can reduce fruit size and fruit quality.

Frost risk is low but will still require management protocols to ensure crop damage during conditions below 0C is kept to a minimum.

Extreme climatic events may need to be moderated with cooling misters and/or the environment to be moderated with netting infrastructure for optimum fruit quality.

Lychees, citrus and avocados are particularly susceptible to wind damage, so windbreaks will be vital. Optimum quality may require a netting enclosure over and around the crop, which will also assist with managing fruit damage from birds.

Young mango trees can be killed at temperatures below 0.5 degrees Celsius so timing of planting will be critical.

Insights gained from a review of the climatic suitability of crops include:

- suitable for mango with frost protection infrastructure
- suitable for avocado with cooling mister and netting infrastructure
- suitable for citrus with cooling mister infrastructure
- suitable for lychees with wind protection infrastructure
- suitable for pomegranates

6.6.2 Suitability to soil types

All the fruit crops investigated prefer deep well drained soils to manage root diseases and would be better suited to the alluvial soils and where soil pH is slightly acidic.

6.6.4 Yield expectations (irrigated only)

Insights gained from a review of the yield potential of fruit tree crops include:

- mango yield 12.9 T/Ha
- avocado yield 11.3 T/Ha
- grapefruit yield 48.3 T/Ha
- lemon yield 46.2 T/Ha
- lime yield 20.1 T/Ha
- orange yield 49.2 T/Ha
- mandarin yield 49.1 T/Ha
- lychee yield 3.5 T/Ha
- pomegranate yield 15T/Ha

6.6.5 Profitability

Most fruit tree crops have good gross margins once in full production but do not reach full production for at least 10 years and this greatly increases the time until return on investment (ROI) is reached.

Infrastructure costs not included in gross margin analysis would include permanent irrigation systems (pumps, mainlines etc) and packing shed and cool-room facilities.

Hughenden-specific infrastructure costs may include crop cooling systems and overhead netting to ameliorate the hot temperatures and low humidity.

High temperatures and low humidity in the Hughenden region would require additional infrastructure investment to achieve high quality fruit compared to other regions.

Harvest timing for some fruit tree crops may fall within market windows with higher prices but additional investigation would be required to confirm this.

Most fruit tree crops are susceptible to Phytophthora root disease in poor draining soils and thus would be better suited to the well-drained alluvial soils rather than the cracking clay soils

Higher infrastructure and production costs in Hughenden may make some fruit tree crops uncompetitive compared to other growing regions

6.7 Nut Tree Crops

The nut tree crops assessed were:

- macadamia
- cashew
- almond
- pistachio
- walnut

The key decision points are:

- water reliability
- chill requirements
- high temperature sensitivity
- soil suitability

6.7.1 Water requirements relating to priority water supply

Macadamia trees have shallow roots but significant water requirements, so frequent irrigation would be necessary in Hughenden

6.7.2 Climate

Nut trees originating from subtropical and tropical climates that are frost sensitive include:

- cashew
- macadamia

Nut trees originating from temperate climates that require a certain level of winter chill for adequate yields include:

- almond
- pistachio
- walnut

Critical climatic conditions for reviewed nut trees include:

- Cashew trees are frost sensitive and may be damaged below 7 degrees Celsius
- almond trees require at least 250 hours below 7 degrees Celsius
- pistachio trees require at least 900 hours below 7 degrees Celsius
- walnut trees require from 450 to 1500 hours below 7 degrees Celsius
- walnuts are very sensitive to frost, high summer temperatures and wind

Insights gained from a review of the climatic suitability of crops include:

- marginally suitable for macadamias with frost protection infrastructure
- unsuitable for cashews due to frost risk
- unsuitable for almond due to insufficient chill units
- unsuitable for pistachio due to insufficient chill units
- unsuitable for walnuts due to insufficient chill units

6.7.3 Suitability to soil types

Nut crops need to be grown on soils without small stones and pebbles that could be swept up from the ground with the nuts during harvest.

Macadamias are sensitive to root diseases in poorly drained soils and require high soil organic matter for optimum tree health.

6.7.4 Yield expectations (irrigated only)

Insights gained from a review of the yield potential of nut tree crops include:

- macadamia yield 4.5 T/Ha

6.7.4 Profitability

Access to nut harvesting equipment processing factories from the isolated location would add cost to the operation.

Macadamia trees are frost sensitive until reaching maturity and management protocols along with frost prevention infrastructure would need to be considered.

Windbreaks may be necessary around macadamia fields at exposed sites to protect the young trees

6.8 Vines

The vine crops assessed were:

- table grape
- dried fruit
- wine grape

The key decision points are:

- water reliability
- frost sensitivity
- high temperature sensitivity
- chill requirements
- soil suitability
- marketability of product

6.8.1 Water requirements relating to priority water supply

Grapevines are a perennial crop that require high priority water and water supply must be on demand rather than scheduled.

Peak water demand between flowering and veraision is critical for fruit quality and cannot be compromised.

Possible irrigation types include dripline and mini-sprinkler, or a combination of both, for example:

- drip irrigation would require double driplines per row to increase wetted soil volume
- drip irrigation would also require cooling misters
- under-vine mini sprinklers use more water than driplines but do not require cooling misters

Table grapes using dripline in extreme environments, such as Hughenden, require up to 8 Ml/Ha/year and when using dripline in extreme environments require cooling misters using up to an additional 6 Ml/Ha/year.

Table grapes using mini sprinklers in extreme environments require up to 14 Ml/Ha/Yr.

6.8.2 Climate

Low winter chill units may lead to reduced yield capacity of grapevines.

Low yields for dried fruit may make the enterprise unviable as no price premium is paid for early production.

Frost risk is low but will still require management protocols to reduce risk to very low.

High temperatures and low humidity during fruit sizing can result in reduced fruit quality at harvest.

Extreme climatic conditions will need to be moderated, with cooling misters and may also require to be moderated with netting infrastructure.

Insights gained from a review of the climatic suitability of crops include:

- suitable for table grapes with cooling misters
- suitable for dried fruit if enough yield can be achieved
- unsuitable for wine grape production due to adverse effects of high temperatures on wine quality and yields

6.8.2 Suitability to soil types

Grapevines can grow successfully on soil ranging from heavy clay to light sand as management practices, such as spraying for disease control after rainfall events, require soil that allows access to the vineyard without bogging.

The alluvial soils along the Flinders River provide good access after rainfall and good fertility.

Cracking clay soils have good fertility but are not suitable for access after rainfall or irrigation.

6.8.3 Yield expectations (irrigated only)

Grapevine yields decline as they are grown further north towards a tropical climate due to difficulties with carbohydrate partitioning. Grapevine lifespan is also decreased as they are grown further north towards a tropical climate.

In southern growing regions grapevine yields range from 20-30 kg per vine (22-34 T/Ha), in northern regions yields range from 5-20 kg per vine (5-22 T/Ha)

6.8.5 Profitability

Estimates based on a minimum area of 40 Ha due to high infrastructure costs for cold-room infrastructure and result in the following figures:

- estimated average price per carton (10kg) of $45 or $4,500 per Tonne
- estimated grapevine yield at 10 kg/vine or 11.2 T/Ha
- calculated a gross margin of $21,500 per hectare
- calculated plant and equipment costs at $112,500 per hectare

6.9 Hay Crops

The hay crops assessed were:

  - oaten hay

6.9.1 Crop management considerations

Early seeding (April) of winter cereals can lead to emergence issues and premature maturation of the plant with resulting low biomass yield. Growth rates are driven by day degrees starting from seeding.

In the environment of Hughenden, mid-May seeding may provide the best compromise seeding date to avoid the heat at both ends of the season and take advantage of seeding in the last of the summer rains.

Even with favourable growing conditions, early seeded crops can grow so well that lodging will occur, with resulting loss of biomass yield due to difficulty in cutting. In such circumstances of early lodging (often exacerbated by high soil nitrogen), regrowth from the crown of the plant can prevent consistent drying off, of the plant material for hay making.

Oats could be grown over the winter period, either dryland or irrigated.

While the optimum growth stage for cutting oats for hay is just after flowering (watery ripe), modern varieties with good water and nutrition management are often too high in moisture to dry down the plant material in a reasonable time to optimise hay quality and storability.

The crop is commonly past the optimum stage for the carbohydrate/protein trade-off when cut. The protein level falls as the oat plant matures past flowering. This is different for wheaten hay.

With all trade-offs in harvest timing in place, grain is usually starting to form. This can result in the hay becoming appealing to rodents when in storage. Depending on the extent of grain maturity at cutting, there may be an inability of cattle to digest the (maturing) seed. Sheep and maybe horses are better able to cope with this type of hay.

Rust susceptibility is common in most Queensland varieties. Fungicides are relatively cheap and effective and would be a good option in warmer northern environments.

Due to the total removal of biomass, there is significant nutrient removal from the field. It is imperative that a nutrient replacement strategy by followed. Major losses occur in nitrogen and potash as well as phosphorus, sulphur and zinc. Fertiliser rates of 200 kg urea, 100 kg MAP, 100 kg potassium sulphate and 10 kg zinc sulphate monohydrate would need to be considered on an annual basis.

Economically, dryland production is likely to be the most financially rewarding. From a practical point of view, seeding into good fallow moisture on the heavy clay downs country (high PAWC) with supplementary irrigation to cover for 'dry spells' is probably the best option.

Water requirements are perceived as being approximately 2 Ml per tonne of hay produced.
In southern Queensland, it takes about 1.5 Ml of water per cut of approximately 1 tonne of lucerne hay. Water has been trading around $400 per Ml, so water costs about $600 per cut to grow hay worth $800 at the height of the current drought. All other costs: pumping, seed, fertiliser, cutting and raking, baling, cartage are unaccounted in the $600

6.9.2 Climate, soil and water considerations

The Hughenden area, assuming winter is the driest period of the year usually, should be ideal for producing winter hay with seeding in late May/June and cutting in September.

Oats will consistently produce more biomass than lucerne per Ml of water.

6.9.3 Harvesting and market considerations

Hay as a source of roughage is sought after for the live cattle export business.

The quality of hay demanded by different markets is varied according to purpose, with high protein hay can being too good for some animal types e.g. horses, although the market sees high protein as an indicator of caring.

High protein hay can be useful for young growing bovines. Sheep like the small leaves as they have a small mouth and a cleft palate.

Demand in the north appears to be for non-legume hay as a filler and a carbohydrate source

Grass hay e.g. Rhodes grass and winter cereal hay, generally would be most in demand in providing bulk (biomass). The market typically won't pay for protein in grass hay, however, if grown for own use, the thoughts and considerations may be different.

Forage sorghum typically provides high biomass yield relative to other crop types being considered but typically has a lower protein content related to in-crop nitrogen supply, the stage of growth at cutting and weather impact on hay quality post-cutting/pre-baling.

Oaten hay provides a compromise between the high biomass yield of forage sorghum and Rhodes Grass at the lower end.

Palatability/acceptability for different classes of animal should be considered in hay type selection. For example, the large stems of forage sorghum can be difficult for young cattle to eat, while the finer stemmed product provided by Rhodes Grass would have better animal acceptance.

Accepting the compromise (trade-off between biomass, the carbohydrate/protein balance and palatability) with oats, there will be better market acceptance of quality oaten hay for a wide range of animal classes and types.

After cutting, rapid drying of the plant material to facilitate baling is essential. Rain on freshly cut oats (even 12 mm) can result in a significant decline in quality, worse than leaving it in the field for another two weeks. Rain can leach nutrients from the cut product and cause bleaching, while sunlight negatively impacts the vitamin A level of the hay.

Timing of hay cutting relative to weather events can have significant impacts on the quality of the final baled product.

Variety selection will be important, as the rate of dry-down of the cut product varies between varieties. Typically, varieties grown for grazing in Queensland have too thick a stem to ensure optimal dry-down for hay.

The selection of hay varieties from South Australia (e.g. Tungoo) would be worth considering if hay making is the purpose. This variety has finer stems and are similar in biomass yield to common varieties used in Queensland grain growing areas.

Haymakers use mower/conditioners which crimp (squeeze) the stems to facilitate more rapid drying.

An annual crop of oats can yield around 4 tonnes per hectare of hay, on average. Lucerne, a perennial, can produce much more with an average of 12 cuts per year being common.

Storage is another serious consideration with hay. Deterioration of hay stored in the open, even if appropriately covered, can be rapid. If planning for long term storage, placement in a shed is the best option.

Hughenden Irrigation Project
Crop Gross Margin Analysis
Summary of All Crops

			Clay Soils		Alluvial Soils		Water Priority Requirements			Water Use	Yield Expectations		Cost of Production		Farm Gate Returns		Gross Margins		
Crop Group	**Crop**	**Climate**	**Dryland**	**Irrigated**	**Dryland**	**Irrigated**	**High**	**Med**	**Low**	**Ml/Ha**	**Dryland (t/ha)**	**Irrigated (t/ha)**	**Cost of Production Dryland - ($/ha)**	**Cost of Production - Irrigated ($/ha)**	**Farm Gate Returns Dryland - ($/ha)**	**Farm Gate Returns - Irrigated - ($/ha)**	**Gross Margin - Dryland ($/ha)**	**Gross Margin - Irrigated ($/ha)**	**Notes**
Cereal/Grain Crops	Maize/Sorghum	Yes	Suitable	Suitable	Not suitable	Suitable	No	No	Yes	7	3.5	8	$605.00	$1,824.00	$875.00	$1,925.00	$270.00	$101.00	1
	Soybeans	Yes	Not Suitable	Suitable	Not suitable	Suitable	No	No	Yes	8		4.5		$1,418.00		$2,160.00		$742.00	
	Corn	Yes	Potential	Suitable	Not Suitable	Suitable	No	No	Yes	5		12		$2,282.00		$4,200.00		$1,918.00	
	Mungbeans	Yes	Potential	Suitable	Not suitable	Suitable	No	No	Yes	2		2.5		$841.00		$1,750.00		$909.00	
	Wheat/Barley	Yes	Suitable	Suitable	Not suitable	Suitable	No	No	Yes	6		5.5		$1,322.00		$1,513.00		$191.00	
	Sunflower	Yes	Suitable	Suitable	Not suitable	Suitable	No	No	Yes	5		3		$1,214.00		$1,500.00		$286.00	
Industrial	Cotton	Yes	Not Suitable	Suitable	Not Suitable	Suitable	No	No	Yes	9		12 bales/ha		$3,599.00		$7,566.00		$3,967.00	
Vegetables	Cauliflower	April-Sept	Not suitable	Potential	Not suitable	Suitable	Yes	No	No	4	na	173	na	$40,821.00	na	$32,400.00	na	-$8,421.00	8
	Cabbage	April-Sept	Not suitable	Potential	Not suitable	Suitable	Yes	No	No	4	na	162	na	$25,242.00	na	$24,225.00	na	-$1,017.00	7
	Broccoli	April-Sept	Not suitable	Potential	Not suitable	Suitable	Yes	No	No	4	na	11.5	na	$26,562.00	na	$23,120.00	na	-$3,442.00	4
	Onions	April-Sept	Not siutable	Potential	Not suitable	Suitable	Yes	Yes	No	4	na	40	na	$27,806.00	na	$31,000.00	na	$3,194.00	2
	Carrots	April-Sept	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	4	na	38	na	$13,337.00	na	$14,250.00	na	$911.00	3
	Pumpkins	April-Sept	Not suitable	Potential	Not suitable	Suitable	Yes	No	No	5	na	30	na	$10,601.00	na	$12,000.00	na	$1,399.00	5
	Eggplants	April-Sept	Not suitable	Potential	Not suitable	Suitable	Yes	No	No	5	na	20.6	na	$21,604.38	na	$30,782.11		$9,177.73	10
	Sweet potato	April-Sept	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	5	na	15	na	$8,625.46	na	$11,341.95	na	$2,716.49	9
	Sweet corn	Potential	Not suitable	Potential	Not suitable	Suitable	Yes	Yes	No	5	na	2.2	na	$3,683.00	na	$6,600.00	na	$2,917.00	6
Vine crops	Table grape	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	14	na	9	na	$29,532.00	na	$36,000.00		$6,468.00	
	Dried fruit	Marginal	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	14	na								
	Wine grapes	Not suitable	Not suitable	Not suitable	Not suitable	Suitable	Yes	Yes	No										
Tree crops (fruit)	Grapefruit	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	48.3	na	$40,578.00	na	$44,890.00	na	$4,312.00	
	Lemon	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	46.2	na	$39,499.00	na	$44,928.00	na	$5,429.00	
	Lime	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	20.1	na	$57,733.00	na	$62,052.00	na	$4,319.00	
	Mandarin	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	49.1	na	$42,012.00	na	$49,086.00	na	$7,074.00	
	Lychee	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	12	na	3.5	na	$15,034.00	na	$24,255.00	na	$9,221.00	
	Pomegranate	Potential	Not suitable	Not suitable	Not suitable	Suitable	Yes	Yes	No	12	na	15	na		na		na		
	Mango	Marginal	Not suitable	Suitable	Not suitable	Suitable	Yes	No	No	10	na	12.9	na	$30,603.00	na	$35,520.00	na	$4,917.00	
	Avocado	Marginal	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	11.3	na	$23,898.00	na	$28,018.00	na	$4,120.00	
	Orange	Marginal	Not suitable	Not suitable	Not suitable	Suitable	Yes	No	No	16	na	49.2	na	$38,105.00	na	$44,928.00	na	$6,823.00	
Tree crops (nuts)	Macadamia	Potential	Not suitable	Not suitable	Not suitable	Potential	Yes	Yes	No	16	na	8	na	$4,546.00	na	$11,925.00	na	$7,379.00	
Hay Crops	Oaten Hay	Suitable	Suitable	Suitable	Not Suitable	Suitable	No	No	Yes	8		4		$1,671.00		$1,600.00		-$71.00	

Notes:

1. Source: agmargins.net.au, assumes $300/tonne for irrigated and $250/tonne for dryland
2. Source: agmargins.net.au, assumes price of $15.50 for a 20 kg bag or $775/tonne. Actual GM budget based on growing at Goondiwindi
3. Source: agmargins.net.au, assumes 1st Grade 75%, 2nd Grade 25%, growing on Darling Downs, hand shift irrigation
4. Source: agmargins.net.au, assumes a price of $16.00 for an 8 kg styro, GM is for growing in the Maranoa, needs a yield of 13.8 t/ha to break even at $16/styro
5. Source: agmargins.net.au, assumes a price of $400.00/tonne, Jap pumpkins grown on the Darling Downs, drip irrigation.
6. Source: agmargins.net.au, assumes a price of $300/tonne, grown in the Lockyer Valley
7. Source: agmargins.net.au, assumes a price of $75/bin for Drumhead cabbage for processing. Yield of 323 bins/ha, at $75/bin yield need to be 355 bins/ha to make a +ve GM
8. Source: agmargins.net.au, assumes a price of $13.50 for a 72 L carton, grown in the Maranoa. Price has to be $14.85/carton and yield 2,880 cartons/ha to break even. The GM shown here assumes 2,400 cartons/ha
9.Source: QLD DPI Spreadsheet, assumes an average price of $756.13/tonne with % of Grades being 70%, 15%, 10%, 5% for 1st to 4th.
10.Source: QLD DPI spreadsheet, assumes 2956 cartons/ha, I used 7 kgs/carton, % Grades being 10%, 30%, 20%, 40% from 1st to 4th
11. Source: QLD DPI Agbiz spreadsheet, CHECK this as not sure how old, yield used is only 11.7 t/ha and prices used were an average of $2.49/kg which was equivalent to $16.00 for a Class 1 tray and $11.25 for a Class 2 tray

Overhead Irrigated Sorghum
Gross Margin Budget
Income:

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
7	275	1925
	Total Income $/ha	**1925**

Variable Costs:

	Tillage	100
	Seeding	90
	Fertiliser	701
	Herbicide	48
	Insecticide	55
	Irrigation*	700
	Contract harvesting	80
	Levies & Insurance	50
	Total Variable Costs $/ha	**1824**
	Gross Margin $/ha	**101**

*Irrigation cost: 7Ml @$100Ml to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha

Yield tonnes/h	$225	$250	$275	$300	$325	$350
3	-$1,149	-$1,074	-$999	-$924	-$849	-$774
4	-$924	-$824	-$724	-$624	-$524	-$424
5	-$699	-$574	-$449	176	-$199	-$74
6	-$474	-$324	-$174	576	$126	$276
7	-$249	-$74	$101	976	$451	$626
8	-$24	$176	$376	$576	$776	$976
9	$201	$426	$651	$876	$1,101	$1,326
10	$426	$676	$926	$1,176	$1,426	$1,676

Effect of Yield & Price on GM per mL

Yield tonnes/h	$225	$250	$275	$300	$325	$350
3	-$164.14	-$153.43	-$143	-$132.00	-$121.29	-$110.57
4	-$132.00	-$117.71	-$103	-$89.14	-$74.86	-$60.57
5	-$99.86	-$82.00	-$64	$25.14	-$28.43	-$10.57
6	-$67.71	-$46.29	-$25	$82.29	$18.00	$39.43
7	-$35.57	-$10.57	$14	$139.43	$64.43	$89.43
8	-$3.43	$25.14	$54	$82.29	$110.86	$139.43
9	$28.71	$60.86	$93	$125.14	$157.29	$189.43
10	$60.86	$96.57	$132	$168.00	$203.71	$239.43

Soybeans with overhead irrigation

Gross Margin Budget

Income

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
4.5	480	2160
	Total Income $/ha	**2160**

Variable Costs:

Tillage		100
Seeding		180
Fertiliser	(N,P,K,S,Zn)	258
Herbicide		60
Insecticide		60
Irrigation*	6 Ml	600
Contract harvesting		90
Levies & Insurance		70
Total Variable Costs $/ha		**1418**
Gross Margin $/ha		**742**

*Irrigation cost: 6 mL @$300 + $100 /mL to pump and apply

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha soybean

Yield tonnes/h	$425	$450	$475	$500	$525
2	-$568	-$518	-$468	-$418	-$368
2.5	-$356	-$293	-$231	-$168	-$106
3	-$143	-$68	$7	$82	$157
3.5	$70	$157	$245	$332	$420
4	$282	$382	$482	$582	$682
4.5	$495	$607	$720	$832	$945

Effect of Yield & Price on GM per mL

Yield tonnes/h	$425	$450	$475	$500	$525
2	-$95	-$86	-$78	-$70	-$61
2.5	-$59	-$49	-$38	-$28	-$18
3	-$24	-$11	$1	$14	$26
3.5	$12	$26	$41	$55	$70
4	$47	$64	$80	$97	$114
4.5	$82	$101	$120	$139	$157

Fertiliser: 50 kg urea per ha pre seeding at $540 per tonne
80 kg MAP per ha at seeding at $850 per tonne
100 kg K_2SO_4 per ha pre-seeding at $1300 per tonne
10 kg $ZnSO_4$ per ha pre-seeding at $3300 per tonne

Seeding: 18 kgs per ha @ $1800 per tonne

Insect control: Mirids
Helicoverpa

Irrigation: 6Ml @ $100 per mL to pump and apply through centre pivots or lateral move irrigators

Maize Gross Margin Budget - overhead irrigation

Income:

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
12	350	4200
	Total Income $/ha	**4200**

Variable Costs:

	Tillage	100
	Seeding	430
	Fertiliser	701
	Herbicide	48
	Insecticide	28
	Irrigation*	700
	Harvest	75
	Levies & Insurance	200
	Total Variable Costs $/ha	**2282**
	Gross Margin $/ha	**1918**

*Irrigation cost: 7Ml @ $100/Ml to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha

Yield tonnes/h	$250	$300	$350	$400	$450	$500
8	-$282	$118	$518	$918	$1,318	$1,718
9	-$32	$418	$868	$1,318	$1,768	$2,218
10	$218	$718	$1,218	1718	$2,218	$2,718
11	$468	$1,018	$1,568	2118	$2,668	$3,218
12	$718	$1,318	$1,918	2518	$3,118	$3,718
13	$968	$1,618	$2,268	$2,918	$3,568	$4,218
14	$1,218	$1,918	$2,618	$3,318	$4,018	$4,718
15	$1,468	$2,218	$2,968	$3,718	$4,468	$5,218

Effect of Yield & Price on GM per mL

Yield tonnes/h	$250	$300	$350	$400	$450	$500
8	-$40.29	$16.86	$74	$131.14	$188.29	$245.43
9	-$4.57	$59.71	$124	$188.29	$252.57	$316.86
10	$31.14	$102.57	$174	$245.43	$316.86	$388.29
11	$66.86	$145.43	$224	$302.57	$381.14	$459.71
12	$102.57	$188.29	$274	$359.71	$445.43	$531.14
13	$138.29	$231.14	$324	$416.86	$509.71	$602.57
14	$174.00	$274.00	$374	$474.00	$574.00	$674.00
15	$209.71	$316.86	$424	$531.14	$638.29	$745.43

Mungbeans with overhead irrigation
Gross Margin Budget
Income

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
2.5	700	1750
	Total Income $/ha	**1750**

Variable Costs:

Tillage		100
Seeding		161
Fertiliser		132
Herbicide		48
Insecticide		60
Irrigation*	2Ml	200
Contract harvesting		90
Levies & Insurance		50
Total Variable Costs $/ha		**841**
Gross Margin $/ha		**909**

*Irrigation cost: 2Ml @ $100/Ml to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha

Yield tonnes/h	$450	$500	$600	$700	$800	$900
0.5	-$616	-$591	-$541	-$491	-$441	-$391
1	-$391	-$341	-$241	-$141	-$41	$59
1.5	-$166	-$91	$59	$209	$359	$509
2	$59	$159	$359	$559	$759	$959
2.5	$284	$409	$659	$909	$1,159	$1,409
3	$509	$659	$959	$1,259	$1,559	$1,859

Effect of Yield & Price on GM per mL

Yield tonnes/h	$225	$250	$275	$300	$325	$350
0.5	-$308.00	-$295.50	-$271	-$245.50	-$220.50	-$195.50
1	-$195.50	-$170.50	-$121	-$70.50	-$20.50	$29.50
1.5	-$83.00	-$45.50	$30	$104.50	$179.50	$254.50
2	$29.50	$79.50	$180	$279.50	$379.50	$479.50
2.5	$142.00	$204.50	$330	$454.50	$579.50	$704.50
3	$254.50	$329.50	$480	$629.50	$779.50	$929.50

Fertiliser: 150 kg urea per ha pre seeding
60 kg MAP per ha at seeding
Seeding: 18 kgs per ha @ $1800 per tonne
Insect control: Mirids
Helicoverpa
Irrigation: $300 per mL for water + $100 per mL to pump and apply through centre pivots or lateral move irrigators

Overhead Irrigated winter cereal (wheat/barley)
Gross Margin Budget
Income:

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
5.5	275	1512.5
	Total Income $/ha	**1512.5**

Variable Costs:

	Tillage	100
	Seeding	70
	Fertiliser	464
	Herbicide	48
	Insecticide	0
	Irrigation* 5mL	500
	Contract harvesting	90
	Levies & Insurance	50
	Total Variable Costs $/ha	**1322**
	Gross Margin $/ha	**190.5**

*Irrigation cost: 5Ml @ $100/Ml to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha

Yield tonnes/h	$225	$250	$275	$300	$325	$350
3	-$647	-$572	-$497	-$422	-$347	-$272
4	-$422	-$322	-$222	-$122	-$22	$78
5	-$197	-$72	$53	$178	$303	$428
6	$28	$178	$328	$478	$628	$778
7	$253	$428	$603	$778	$953	$1,128

Effect of Yield & Price on GM per mL

Yield tonnes/h	$225	$250	$275	$300	$325	$350
3	-$129.40	-$114.40	-$99	-$84.40	-$69.40	-$54.40
4	-$84.40	-$64.40	-$44	-$24.40	-$4.40	$15.60
5	-$39.40	-$14.40	$11	$35.60	$60.60	$85.60
6	$5.60	$35.60	$66	$95.60	$125.60	$155.60
7	$50.60	$85.60	$121	$155.60	$190.60	$225.60

Sunflower with overhead irrigation
Gross Margin Budget
Income

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**
3	500	1500
	Total Income $/ha	**1500**

Variable Costs:

Tillage		100
Seeding		160
Fertiliser	(N,P,K,S,Zn)	224
Herbicide		110
Insecticide		60
Irrigation* 4 mL		400
Contract harvesting		90
Levies & Insurance		70
Total Variable Costs $/ha		**1214**
Gross Margin $/ha		**286**

*Irrigation cost: 4Ml @ $100/Ml to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha soybean

Yield tonnes/h	$450	$500	$550	$600
2	-$314	-$214	-$114	-$14
2.5	-$89	$36	$161	$286
3	$136	$286	$436	$586
3.5	$361	$536	$711	$886
4	$586	$786	$986	$1,186

Effect of Yield & Price on GM per mL

Yield tonnes/h	$450	$500	$550	$600
2	-$78.50	-$53.50	-$29	-$4
2.5	-$22.25	$9.00	$40	$72
3	$34.00	$71.50	$109	$147
3.5	$90.25	$134.00	$178	$222
4	$146.50	$196.50	$247	$297

Fertiliser: 250 kg urea per ha pre seeding at $540 per tonne
60 kg MAP per ha at seeding at $850 per tonne
10 kg $ZnSO_4$ per ha pre-seeding at $3300 per tonne

Seeding: 50000 seeds per ha @ $430 per 200000 kernals ($110 per ha for seed alone)

Insect control: Mirids
Helicoverpa

Irrigation: $300 per mL for water + $100 per mL to pump and apply through centre pivots or lateral move irrigators

Overhead Irrigated Cotton
Gross Margin Budget
Income:

Lint	12 bales/ha	$500 /bale	$6,000
Seed	3.8 tonnes/ha	$230 / tonne	$874
Refuge (10%)			$692
		Total Income $/ha	**$7,566**

Variable Costs

Cultivation		120
Seeding	seed, seeding	120
Crop Insurance		75
Fertiliser and applic'n		624
Herbicide and applic'n		80
Insecticide and applic'n		150
Irrigation*	8 mL	800
Contract picking		100
Cartage to gin		150
Ginning charges		600
Levies		60
Licence fees		400
Other incl consultant		70
Cotton refuge crop, 10% of Bt cotton area		250
	Total variable costs $/ha	**3599**
	Gross margin	**$3,967**

*8Ml irrigation water @ $100/Ml pump and apply only

Sensitivity Tables
Effect of Yield and Price on GM /ha

Lint bales per ha	Seed t/ha	$400/bale $150/t	$450/bale $180/t	$500/bale $200/t	$550/bale $240/t	$600/bale $300/t
8	2.88	33	519.4	1092.2	1492.2	2065
9	3.24	487	1034.2	1678.6	2128.6	2773
10	3.6	941	1549	2265	-3599	3481
11	3.96	1395	2063.8	2851.4	3401.4	4189
12	4.32	1849	2578.6	3437.8	4037.8	4897
13	4.68	2303	3093.4	4024.2	4674.2	5605
14	5.04	2757	3608.2	4610.6	5310.6	6313
15	5.4	3211	4123	5197	5947	7021
16	5.76	3665	4637.8	5783.4	6583.4	7729

Effect of Yield and Price on GM/mL

Lint bales per ha	Seed t/ha	$400/bale $150/t	$450/bale $180/t	$500/bale $200/t	$550/bale $240/t	$600/bale $300/t
8	2.88	595.05	674.06	765.41	832.08	923.43
9	3.24	669.43	758.31	861.09	936.09	1038.86
10	3.6	743.81	842.57	956.76	1040.10	1154.29
11	3.96	818.19	926.83	1052.44	1144.10	1269.71
12	4.32	892.57	1011.09	1148.11	1248.11	1385.14
13	4.68	966.95	1095.34	1243.79	1352.12	1500.57
14	5.04	1041.33	1179.60	1339.47	1456.13	1616.00
15	5.4	1115.71	1263.86	1435.14	1560.14	1731.43
16	5.76	1190.10	1348.11	1530.82	1664.15	1846.86

HORTICULTURAL CROPS - DETAILED GROSS MARGINS

All Revenues and Costs in $/ha Unless Otherwise Indicated

	Carrots	Onions - Brown	Pumpkins	Egg Plant	Sweet Potato	Sweet Corn	Cauliflower	Cabbage - Drumheads for Processing	Brocolli	Maize - Irrigated	Maize - Dryland	Avocado
Income												
1st Grade - $/ha	$11,400.00	$31,000.00	$12,000.00	$38,132.40	$12,040.50	$6,600.00	$32,400.00	$24,225.00	$23,120.00	$2,400.00	$875.00	$28,018.20
2nd Grade - $/ha	$2,850.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
3rd Grade - $/ha	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Income	**$14,250.00**	**$31,000.00**	**$12,000.00**	**$38,132.40**	**$12,040.50**	**$6,600.00**	**$32,400.00**	**$24,225.00**	**$23,120.00**	**$2,400.00**	**$875.00**	**$28,018.20**
Variable Costs												
Preparation												
Operation - Ripping	$34.00	$35.00	$26.00	$45.37	$28.47	$0.00	$35.00	$35.00	$35.00	$14.00	$56.00	$0.00
Operation - Mulching or Spraying/Chemical for fallow mgmt.	$0.00	$0.00	$34.00	$649.12	$0.00	$0.00	$0.00	$0.00	$0.00	$49.00	$0.00	$33.15
Operation - Discing	$126.00	$0.00	$14.00	$32.38	$112.02	$49.00	$14.00	$126.00	$0.00	$0.00	$0.00	$0.00
Operation - Cultivation	$30.00	$0.00	$0.00	$20.47	$20.47	$0.00	$30.00	$30.00	$0.00	$0.00	$0.00	$0.00
Operation - Rotary Hoeing & Bed Forming	$251.00	$250.00	$40.00	$20.47	$151.04	$54.00	$248.00	$251.00	$0.00	$0.00	$0.00	$0.00
Operation - Spreader	$7.00	$0.00	$8.00	$16.72	$30.60	$16.00	$8.00	$8.00	$32.00	$0.00	$0.00	$0.00
Operating - Transplanter	$0.00	$0.00	$0.00	$54.90	$54.90	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Contract Labour	$0.00	$0.00	$0.00	$0.00	$0.00	$107.00	$0.00	$0.00	$120.00	$0.00	$0.00	$1,995.00
Sub Total	*$448.00*	*$285.00*	*$122.00*	*$839.43*	*$397.50*	*$226.00*	*$335.00*	*$450.00*	*$187.00*	*$63.00*	*$56.00*	*$2,028.15*
Planting												
Seed/Seedlings	$2,700.00	$2,014.00	$400.00	$1,885.00	$448.00	$550.00	$5,200.00	$2,800.00	$4,000.00	$335.00	$161.00	$0.00
Operation - Precision Planting	$129.00	$129.00	$66.00	$400.80	$0.00	$65.00	$482.00	$485.00	$482.00	$13.00	$13.00	$0.00
Labour	$0.00	$85.00	$0.00	$0.00	$534.40	$0.00	$1,349.00	$1,215.00	$1,798.00	$0.00	$0.00	$0.00
Sub Total	*$2,829.00*	*$2,228.00*	*$466.00*	*$2,285.80*	*$982.40*	*$615.00*	*$7,031.00*	*$4,500.00*	*$6,280.00*	*$348.00*	*$174.00*	*$0.00*
Nutrition												
Application 1	$404.00	$647.00	$324.00	$385.00	$184.00	$164.00	$404.00	$404.00	$230.00	$238.00	$83.00	$356.16
Application 2	$170.00	$840.00	$202.00	$93.60	$343.75	$157.00	$112.00	$112.00	$550.00	$54.00	$83.00	$24.60
Application 3	$50.00	$62.00	$56.00	$66.00	$51.82	$169.00	$145.00	$136.00	$330.00	$10.00	$10.00	$70.00
Application 4			$34.00	$303.75	$0.00	$19.00	$0.00	$0.00	$0.00	$0.00	$0.00	$175.09
Application 5			$12.00	$210.00	$0.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00	$39.20
Application 6			$7.00	$81.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Application 7			$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Labour	$0.00	$0.00	$270.00	$0.00	$30.60	$97.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Soil Analysis	$0.00	$0.00	$0.00	$0.00	$0.00	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sub Total	*$624.00*	*$1,549.00*	*$905.00*	*$1,139.35*	*$610.17*	*$621.00*	*$661.00*	*$652.00*	*$1,110.00*	*$302.00*	*$176.00*	*$665.05*
Irrigation												
Irrigation - Cost	$280.00	$350.00	$280.00	$767.95	$260.09	$350.00	$280.00	$280.00	$140.00	$333.00	$0.00	$241.50
Water	$80.00	$100.00	$80.00	$226.60	$0.00	$100.00	$80.00	$80.00	$40.00	$100.00	$0.00	$0.00
Labour	$108.00	$227.00	$108.00	$367.40	$80.50	$54.00	$120.00	$54.00	$60.00	$0.00	$0.00	
Sub Total	*$468.00*	*$677.00*	*$468.00*	*$1,361.95*	*$340.59*	*$504.00*	*$480.00*	*$414.00*	*$240.00*	*$433.00*	*$0.00*	*$241.50*
Crop Protection												
Herbicide/s	$215.00	$277.00	$13.00	$237.92	$64.40	$31.00	$30.00	$28.00	$19.00	$55.00	$66.00	$54.60
Insecticide/s	$21.00	$101.00	$16.00	$286.11	$49.04	$519.00	$575.00	$283.00	$618.00	$0.00	$0.00	$232.92
Fungicide/s	$335.00	$407.00	$103.00	$15.97	$87.12	$0.00	$5.00	$47.00	$63.00	$0.00	$0.00	$250.14
Application Cost - All Apps	$34.00	$103.00	$42.00	$149.96	$0.00	$121.00	$62.00	$62.00	$62.00	$0.00	$0.00	$0.00
Labour - Weed Chipping/Pollination	$0.00	$454.00	$324.00	$0.00	$0.00	$81.00	$0.00	$0.00	$90.00	$0.00	$0.00	$0.00
Horticulture Consultant	$0.00	$27.00	$26.00	$0.00	$0.00	$26.00	$0.00	$0.00	$28.00	$62.00	$17.00	$0.00
Sub Total	*$605.00*	*$1,369.00*	*$524.00*	*$689.96*	*$200.56*	*$778.00*	*$672.00*	*$420.00*	*$880.00*	*$117.00*	*$83.00*	*$537.66*
Harvesting												
Paddock & Pack Shed Operations (Inc. cooling)	$1,914.00	$841.00	$600.00	$1,782.19	$344.24	$383.00	$622.00	$1,777.00	$1,533.00	$99.00	$110.00	$137.20
Labour - Picking/Grading/Packing	$360.00	$10,489.00	$945.00	$7,374.64	$3,995.00	$0.00	$4,796.00	$4,360.00	$5,774.00	$0.00	$0.00	$7,889.00
Packaging	$2,393.00	$1,500.00	$1,286.00	$6,120.91	$1,755.00	$0.00	$12,384.00	$808.00	$3,613.00	$0.00	$0.00	$2,924.71
Sub Total	*$4,667.00*	*$12,830.00*	*$2,831.00*	*$15,277.74*	*$6,094.24*	*$383.00*	*$17,802.00*	*$6,945.00*	*$10,920.00*	*$99.00*	*$110.00*	*$10,950.91*
Freight												
Transportation:Refo Pallet	$1,988.00	$4,217.00	$3,485.00	$2,601.28	$397.50	$226.00	$8,980.00	$11,256.00	$3,478.00	$4.00	$0.00	$1,909.02
Levies												
Commission & Levies	$1,710.00	$4,650.00	$1,800.00	$4,759.16	$301.05	$330.00	$4,860.00	$605.00	$3,467.00	$41.00	$6.00	$4,058.23
Total Variable Costs	***$13,339.00***	***$27,805.00***	***$10,601.00***	***$28,954.67***	***$9,324.01***	***$3,683.00***	***$40,821.00***	***$25,242.00***	***$26,562.00***	***$1,407.00***	***$605.00***	***$20,390.52***
GROSS MARGIN - $/Ha	**$911.00**	**$3,195.00**	**$1,399.00**	**$9,177.73**	**$2,716.49**	**$2,917.00**	**-$8,421.00**	**-$1,017.00**	**-$3,442.00**	**$993.00**	**$270.00**	**$7,627.68**

GROSS MARGIN FOR TABLE GRAPES (Inland under trickle irrigation) - North Queensland

Developed by Bill Johnston (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

(1) GROSS INCOME		Yield (Cases/Ha)		$/10kg Case		$/Ha
		900		$40.00		$36,000

(2) PRE HARVEST COSTS

		Operations	$/Operation		$/Case	$/Ha
Machinery Costs (F.O.R.M.)	Tractor/Implements (30hrs @ $25/hr)	1	$750.00		$0.83	$750.00
Crop Management Cost	Prune/Thin/Girdle ($6/vine @ 1667 vines/ha)	1	$10,002.00		$11.11	$10,002.00
		Applications	**Kgs/Ha**	**$/Kg**		
Fertiliser	Urea	2	100	$0.52	$0.22	$200.00
	DAP	1	198	$0.52	$0.22	$198.00
	Potash	2	250	$0.47	$0.56	$500.00
		Applications	**L or Kgs/Ha**	**$/Kg or L**		
Herbicide	Roundup	3	3.5	$9.98	$0.12	$104.79
	Sprayseed	10	1.9	$38.17	$0.81	$725.23
Insecticide	Bugmaster 800	2	1.25	$9.83	$0.03	$24.58
	Rogor	1	0.6	$8.29	$0.01	$4.97
	Lorsban 250W	1	0.8	$17.24	$0.02	$13.79
	Sulphur*	3	40	$1.00	$0.13	$120.00
		Applications	**L or Kgs/Ha**	**$/Kg or L**		
Spray Control	Progrib (G-acid)	1	0.15	$250.00	$0.04	$37.50
	Dormex (bud burst)	1	8	$7.73	$0.07	$61.84
	Penncozeb	8	2.5	$7.02	$0.16	$140.40
	Ridomil plus (downy)	1	1.5	$72.00	$0.12	$108.00
	Tilt (powdery mildew)	5	0.075	$76.56	$0.03	$28.71
		ML/Ha	**$/ML**			
Water Charges		10	$100.00		$1.11	$1,000.00
TOTAL PRE HARVEST COSTS					**$15.58**	**$14,020**

(3) POST HARVEST COSTS

		$/Case	$/Ha
Harvest & Pack	Casual Labour (picking/packing)	$6.00	$5,400.00
	Cartons (styro)	$3.00	$2,700.00
	Strapping of Cartons	$0.05	$45.00
	Corner Pieces	$0.05	$45.00
TOTAL POST HARVEST COSTS		**$9.10**	**$8,190**

(4) MARKETING COSTS

	$/Case		$/Case	$/Ha
Freight	$3.00		$3.00	$2,700.00
Commission	11.00%		$4.40	$3,960.00
Levies	$0.700	cents per case	$0.70	$630.00
TOTAL MARKETING COSTS			**$8.10**	**$7,290**

SUMMARY TABLE

	$/Case	$/Ha
TOTAL PRE HARVEST COSTS	$15.58	$14,020
TOTAL POST HARVEST COSTS	$9.10	$8,190
TOTAL MARKETING COSTS	$8.10	$7,290
TOTAL VARIABLE COSTS	$32.78	$29,500
GROSS MARGIN	**$7.22**	**$6,500**

SENSITIVITY ANALYSIS - $ PER CASE (Expressed per Ha)

$/Case	Gross Income	Variable Costs	Gross Margin
$20.00	$18,000	$27,520	($9,520)
$30.00	$27,000	$28,510	($1,510)
$40.00	$36,000	$29,500	$6,500
$50.00	$45,000	$30,490	$14,510
$60.00	$54,000	$31,480	$22,520

Grapefruit Gross Margin (Mature @ 10 years)

Based on Central Queensland figures (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

Number of Trees/Ha	384
Cases per tree	7.0

Income

	$/18kg Case	Yield (Cases/Ha)	$/Ha
	$16.70	2,688	$44,890

Variable Costs

Machinery Operations (F.O.R.M)

	Operations	$/Operation	$/Case	$/Ha
Fertiliser Applications	2	$8.18	$0.01	$16.36
Slashing	5	$4.09	$0.01	$20.45
Spraying	15	$7.78	$0.04	$116.70

Pruning Costs (Mature Crop)

	Operations	$/Tree	$/Case	$/Ha
Trimming (Contract - Yr.10 onwards)	1	$0.20	$0.00	$0.20
Topping (Contract - Yr.10 onwards)	1	$1.10	$0.00	$1.10
Thinning (Chemical from year 5 on)	1	$0.15	$0.00	$0.15

Fertilisers (Year 10 onward)

	Applications	Kgs/Ha	$/Kg	$/Case	$/Ha
Urea	1	768	$0.42	$0.12	$322.56
Super Phosphate	1	384	$0.35	$0.05	$134.40
Potassium Sulphate	1	768	$0.60	$0.17	$460.80
Dolomite	1	500	$0.11	$0.02	$55.00

Herbicide

	Applications	L/Ha	$/L	$/Case	$/Ha
Roundup	2	3	$15.50	$0.03	$93.00
Sprayseed	2	3.2	$9.98	$0.02	$63.87

Insecticide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Pirimor (0.003/100L)	2	0.33	$47.90	$0.01	$31.61
Endosulfan (0.057/100L)	1	6.27	$8.40	$0.02	$52.67
White Oil (0.6/100L)	8	66	$2.50	$0.49	$1,320.00
Supracide (0.125/100L)	2	13.75	$24.60	$0.25	$676.50

Fungicide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Copper Oxy (0.4/100L)	4	44	$2.93	$0.19	$515.68
Mancozeb (0.2/100L)	2	22	$7.05	$0.12	$310.20
Caustic Soda (0.14/100L)	3	15.4	$0.28	$0.00	$12.94

Irrigation (Year 10 onward)

	ML/Ha	$/ML	$/Case	$/Ha
	9	$100.00	$0.33	$900.00

Harvest and Marketing

					$/Case	$/Ha
Bin Costs					$0.06	$161.28
Contract Picking					$2.50	$6,720.00
Degreening					$0.04	$107.52
Grading, packing, cooling etc.					$6.00	$16,128.00
Freight (80 cases/pallet)	Number of Pallets	33.6	$200.00	/Pallet	$2.50	$6,720.00
Grower Service Levy					$0.10	$268.80
Sales Promotion Levy					$0.10	$268.80
Agents Commission		11.00%	of gross		$1.84	$4,937.86
DPI Levy					$0.06	$161.28

	$/Case	$/Ha	$/Tree
Total Variable Costs	$15.10	$40,578	$105.67
Gross Margin	$1.60	$4,312	$11.23

Lemon Gross Margin (Mature @ 11 years)

Based on Central Queensland figures (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

Number of Trees/Ha	384
Cases per tree	6.5

Income

	$/18.5kg Case	Yield (Cases/Ha)	$/Ha
	$18.00	2,496	$44,928

Variable Costs

Machinery Operations (F.O.R.M)

	Operations	$/Operation	$/Case	$/Ha
Fertiliser Applications	2	$8.18	$0.01	$16.36
Slashing	5	$4.09	$0.01	$20.45
Spraying	15	$7.78	$0.05	$116.70

Pruning Costs (Mature Crop)

	Operations	$/Tree	$/Case	$/Ha
Trimming (Contract - Yr.11 onwards)	1	$0.20	$0.00	$0.20
Topping (Contract - Yr.11 onwards)	1	$1.10	$0.00	$1.10
Thinning (Chemical from years 5 on)	1	$0.15	$0.00	$0.15

Fertilisers (Year 11 onward)

	Applications	Kgs/Ha	$/Kg	$/Case	$/Ha
Urea	1	768	$0.42	$0.13	$322.56
Super Phosphate	1	384	$0.35	$0.05	$134.40
Potassium Sulphate	1	768	$0.60	$0.18	$460.80
Dolomite	1	500	$0.11	$0.02	$55.00

Herbicide

	Applications	L/Ha	$/L	$/Case	$/Ha
Roundup	2	3	$15.50	$0.04	$93.00
Sprayseed	2	3.2	$9.98	$0.03	$63.87

Insecticide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Pirimor (0.003/100L)	2	0.33	$47.90	$0.01	$31.61
Endosulfan (0.057/100L)	1	6.27	$8.40	$0.02	$52.67
White Oil (0.6/100L)	8	66	$2.50	$0.53	$1,320.00
Supracide (0.125/100L)	2	13.75	$24.60	$0.27	$676.50

Fungicide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Copper Oxy (0.4/100L)	4	44	$2.93	$0.21	$515.68
Mancozeb (0.2/100L)	2	22	$7.05	$0.12	$310.20
Caustic Soda (0.14/100L)	3	15.4	$0.28	$0.01	$12.94

Irrigation (Year 11 onward)

ML/Ha	$/ML	$/Case	$/Ha
9	$100.00	$0.36	$900.00

Harvest and Marketing

					$/Case	$/Ha
Bin Costs					$0.06	$149.76
Contract Picking					$2.50	$6,240.00
Degreening					$0.04	$99.84
Grading, packing, cooling etc.					$6.00	$14,976.00
Freight (80 cases/pallet)	**Number of Pallets**	31.2	$200.00	**/Pallet**	$2.50	$6,240.00
Grower Service Levy					$0.10	$249.60
Sales Promotion Levy					$0.10	$249.60
Agents Commission		11.00%	**of gross**		$1.98	$4,942.08
DPI Levy					$0.06	$149.76

	$/Case	$/Ha	$/Tree
Total Variable Costs	$15.38	$38,401	$100.00
Gross Margin	$2.62	$6,527	$17.00

Limes Gross Margin (Mature @ 7 years)

Based on Central Queensland figures (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

Number of Trees/Ha	384
Cases per tree	10.5

Income

$/5kg Case	Yield (Cases/Ha)	$/Ha
$15.39	4,032	$62,052

Variable Costs

Machinery Operations (F.O.R.M)

	Operations	$/Operation	$/Case	$/Ha
Fertiliser Applications	2	$8.18	$0.00	$16.36
Slashing	5	$4.09	$0.01	$20.45
Spraying	15	$7.78	$0.03	$116.70

Pruning Costs (Mature Crop)

	Operations	$/Tree	$/Case	$/Ha
Trimming (Contract - Yr.7 onwards)	1	$0.20	$0.00	$0.20
Topping (Contract - Yr.7 onwards)	1	$1.10	$0.00	$1.10
Thinning (Chemical from years 5 on)	1	$0.15	$0.00	$0.15

Fertilisers (Year 7 onward)

	Applications	Kgs/Ha	$/Kg	$/Case	$/Ha
Urea	1	768	$0.42	$0.08	$322.56
Super Phosphate	1	384	$0.35	$0.03	$134.40
Potassium Sulphate	1	768	$0.60	$0.11	$460.80
Dolomite	1	500	$0.11	$0.01	$55.00

Herbicide

	Applications	L/Ha	$/L	$/Case	$/Ha
Roundup	2	3	$15.50	$0.02	$93.00
Sprayseed	2	3.2	$9.98	$0.02	$63.87

Insecticide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Pirimor (0.003/100L)	2	0.33	$47.90	$0.01	$31.61
Endosulfan (0.057/100L)	1	6.27	$8.40	$0.01	$52.67
White Oil (0.6/100L)	8	66	$2.50	$0.33	$1,320.00
Supracide (0.125/100L)	2	13.75	$24.60	$0.17	$676.50

Fungicide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Copper Oxy (0.4/100L)	4	44	$2.93	$0.13	$515.68
Mancozeb (0.2/100L)	2	22	$7.05	$0.08	$310.20
Caustic Soda (0.14/100L)	3	15.4	$0.28	$0.00	$12.94

Irrigation (Year 7 onward)

ML/Ha	$/ML	$/Case	$/Ha
9	$100.00	$0.22	$900.00

Harvest and Marketing

				$/Case	$/Ha
Bin Costs				$0.06	$241.92
Contract Picking				$2.50	$10,080.00
Degreening				$0.04	$161.28
Grading, packing, cooling etc.				$6.00	$24,192.00
Freight (80 cases/pallet)	**Number of Pallets**	50.4	$200.00 **/Pallet**	$2.50	$10,080.00
Grower Service Levy				$0.10	$403.20
Sales Promotion Levy				$0.10	$403.20
Agents Commission		11.00%	**of gross**	$1.69	$6,825.77
DPI Levy				$0.06	$241.92

	$/Case	$/Ha	$/Tree
Total Variable Costs	$14.32	$57,733	$150.35
Gross Margin	$1.07	$4,319	$11.25

Mandarin Gross Margin (Mature @ 11 years)

Based on Central Queensland figures (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

Number of Trees/Ha	606
Cases per tree	4.5

Income

$/18kg Case	Yield (Cases/Ha)	$/Ha
$18.00	2,727	$49,086
	49	
	Yield (T/Ha)	

Variable Costs

Machinery Operations (F.O.R.M)

	Operations	$/Operation	$/Case	$/Ha
Fertiliser Applications	2	$9.20	$0.01	$18.40
Slashing	5	$4.60	$0.01	$23.00
Spraying	15	$8.70	$0.05	$130.50

Pruning Costs (Mature Crop)

	Operations	$/Tree	$/Case	$/Ha
Trimming (Contract - Yr.11 onwards)	1	$0.20	$0.00	$0.20
Topping (Contract - Yr.11 onwards)	1	$1.00	$0.00	$1.00
Thinning (Chemical from year 5 on)	1	$0.20	$0.00	$0.20

Fertilisers (Year 11 onward)

	Applications	Kgs/Ha	$/Kg	$/Case	$/Ha
Urea	1	768	$0.47	$0.13	$360.96
Super Phosphate	1	384	$0.40	$0.06	$153.60
Potassium Sulphate	1	768	$0.68	$0.19	$522.24
Dolomite	1	500	$0.15	$0.03	$75.00

Herbicide

	Applications	L/Ha	$/L	$/Case	$/Ha
Roundup	2	3	$17.50	$0.04	$105.00
Sprayseed	2	3.2	$11.20	$0.03	$71.68

Insecticide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Pirimor	2	0.33	$53.65	$0.01	$35.41
Endosulfan	1	6.27	$9.40	$0.02	$58.94
White Oil	8	66	$2.80	$0.54	$1,478.40
Supracide	2	13.75	$27.50	$0.28	$756.25

Fungicide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Copper Oxy	4	44	$3.30	$0.21	$580.80
Mancozeb	2	22	$7.90	$0.13	$347.60
Caustic Soda	3	15.4	$0.31	$0.01	$14.32

Irrigation (Year 11 onward)

ML/Ha	$/ML	$/Case	$/Ha
9	$100.00	$0.33	$900.00

Harvest and Marketing

					$/Case	$/Ha
Bin Costs					$0.06	$163.62
Contract Picking					$2.50	$6,817.50
Degreening					$0.04	$109.08
Grading, packing, cooling etc.					$6.00	$16,362.00
Freight (80 cases/pallet)	Number of Pallets	34.1	$200.00	/Pallet	$2.50	$6,817.50
Grower Service Levy					$0.10	$272.70
Sales Promotion Levy					$0.10	$272.70
Agents Commission		11.00%	of gross		$1.98	$5,399.46
DPI Levy					$0.06	$163.62

	$/Case	$/Ha	$/Tree
Total Variable Costs	$15.41	$42,012	$69.33
Gross Margin	$2.59	$7,074	$11.67

GROSS MARGIN FOR MANGO (Kensington Pride - Full Production) - Irrigated Dry Tropics
(185 trees per hectare)

Author - Bill Johnston (developed 1998)
Updated Tom Mullins (2007)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

(1) GROSS INCOME		No. Trays/Tree		$/SL Tray		$/Ha
	Fresh Fruit Only	12		$16.00		$35,520

(2) PRE HARVEST COSTS

		Operations	$/Operation		$/Tree	$/Ha
Machinery Costs (F.O.R.M.)	Slash/Spray/Prune	1	$400.00		$2.16	$400.00
		0	$0.00		$0.00	$0.00
		0	$0.00		$0.00	$0.00
		Kgs/Tree	**$/Kg**			
Fertiliser	CK88	2	$1.07		$2.14	$395.90
	Solubor	0.016	$3.20		$0.05	$9.47
	Potassium Nitrate	0.5	$1.94		$0.97	$179.45
		0	$0.00		$0.00	$0.00
		0	$0.00		$0.00	$0.00
		Trees/hr	**Cost/hr**			
Pruning (Hand)		0	$0.00		$0.00	$0.00
		Applications	**L or Kgs/Tr**	**$/Kg or L**		
Herbicide	H1	3	0.030	$9.75	$0.88	$162.34
		0	0.000	$0.00	$0.00	$0.00
		0	0.000	$0.00	$0.00	$0.00
Insecticide	I1	1	0.020	$24.60	$0.49	$91.02
	I2	3	1.000	$4.69	$14.07	$2,602.95
	I3	2	0.010	$9.18	$0.18	$33.97
	I4	2	0.020	$13.53	$0.54	$100.12
	I5	1	0.020	$13.53	$0.27	$50.06
Fungicide	F1	4	0.027	$8.67	$0.94	$173.23
	F2	2	0.003	$180.40	$0.93	$172.88
	F3	6	0.027	$6.89	$1.12	$206.49
		ML/Ha	**$/ML**			
Water Charges		10	$100.00		$5.41	$1,000.00
		Hours	**$/Hour**			
Labour Cost		73	$20.00		$7.89	$1,460.00
TOTAL PRE HARVEST COSTS					**$38.04**	**$7,038**

(3) POST HARVEST COSTS

		Trays/Hr	$/Hr	$/Tray	$/Ha
Harvest & Pack	Picking	8	$25.00	$3.13	$6,937.50
	Packing	10	$25.00	$2.50	$5,550.00
	Dipping			$0.13	$277.50
	Gas			$0.06	$138.75
	Pallet Hire			$0.05	$111.00
	SL Trays			$1.47	$3,263.40
	Machinery			$0.25	$555.00
TOTAL POST HARVEST COSTS				**$7.58**	**$16,833**

(4) MARKETING COSTS

		$/Pallet	Pallets	$/Tray	$/Ha
Freight	(Pallet = 128 Trys)	$115.00	18.00	$0.93	$2,070.00
Commission		12.50%		$2.00	$4,440.00
Levies		$0.100	cents per $ of gross	$0.10	$222.00
TOTAL MARKETING COSTS				**$3.03**	**$6,732**

SUMMARY TABLE

	$/Tray	$/Ha
TOTAL PRE HARVEST COSTS	$3.17	$7,038
TOTAL POST HARVEST COSTS	$7.58	$16,833
TOTAL MARKETING COSTS	$3.03	$6,732
TOTAL VARIABLE COSTS	$13.79	$30,603
GROSS MARGIN	**$2.21**	**$4,917**

SENSITIVITY ANALYSIS - Expressed per Ha for Fresh Fruit Only

$/Tray	Gross Income	Variable Costs	Gross Margin
$9.00	$19,980	$28,661	($8,681)
$10.00	$22,200	$28,938	($6,738)
$16.00	$35,520	$30,603	$4,917
$12.00	$26,640	$29,493	($2,853)
$13.00	$28,860	$29,771	($911)

Navel Orange Gross Margin (Mature @ 11 years)

Based on Central Queensland figures (last updated 1998)

The data provided here is an example only and should be revised to reflect your particular situation.

Queensland Government

Number of Trees/Ha	384
Cases per tree	6.5

Income

	$/20kg Case	Yield (Cases/Ha)	$/Ha
	$15.00	2,496	$37,440

Variable Costs

Machinery Operations (F.O.R.M)

	Operations	$/Operation	$/Case	$/Ha
Fertiliser Applications	2	$8.18	$0.01	$16.36
Slashing	5	$4.09	$0.01	$20.45
Spraying	14	$7.78	$0.04	$108.92

Pruning Costs (Mature Crop)

	Operations	$/Tree	$/Case	$/Ha
Trimming (Contract - Yr.11 onwards)	1	$0.20	$0.00	$0.20
Topping (Contract - Yr.11 onwards)	1	$1.10	$0.00	$1.10

Fertilisers (Year 11 onward)

	Applications	Kgs/Ha	$/Kg	$/Case	$/Ha
Urea	1	768	$0.42	$0.13	$322.56
Super Phosphate	1	384	$0.35	$0.05	$134.40
Potassium Sulphate	1	768	$0.60	$0.18	$460.80
Dolomite	1	500	$0.11	$0.02	$55.00

Herbicide

	Applications	L/Ha	$/L	$/Case	$/Ha
Roundup	2	3	$15.50	$0.04	$93.00
Sprayseed	2	3.2	$9.98	$0.03	$63.87

Insecticide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Pirimor (0.003/100L)	2	0.33	$47.90	$0.01	$31.61
Endosulfan (0.057/100L)	1	6.27	$8.40	$0.02	$52.67
Kelthane (0.2/100L)	2	22	$13.78	$0.24	$606.32
White Oil (0.6/100L)	5	66	$2.50	$0.33	$825.00
Supracide (0.125/100L)	2	13.75	$24.60	$0.27	$676.50

Fungicide

	Applications	L or Kg/Ha	$/L or Kg	$/Case	$/Ha
Copper Oxy (0.4/100L)	1	44	$2.93	$0.05	$128.92
Mancozeb (0.2/100L)	2	22	$7.05	$0.12	$310.20

Irrigation (Year 10 onward)

	ML/Ha	$/ML	$/Case	$/Ha
	9	$100.00	$0.36	$900.00

Harvest and Marketing

					$/Case	$/Ha
Bin Costs					$0.06	$149.76
Contract Picking					$1.50	$3,744.00
Degreening					$0.04	$99.84
Grading, packing, cooling etc.					$4.10	$10,233.60
Freight (80 cases/pallet)	Number of Pallets	31.2	$200.00	/Pallet	$2.50	$6,240.00
Grower Service Levy					$0.10	$249.60
Sales Promotion Levy					$0.10	$249.60
Agents Commission		11.00%	of gross		$1.65	$4,118.40
DPI Levy					$0.06	$149.76

	$/Case	$/Ha	$/Tree
Total Variable Costs	$12.04	$30,042	$78.24
Gross Margin	$2.96	$7,398	$19.26

Overhead Irrigated oats for hay

Gross Margin Budget

Income:

Yield (tonnes/ha)	**Price ($/tonne)**	**Gross Income $**	
4	400	1600	
	Total Income $/ha	**1600**	
Variable Costs:			
	Tillage	100	
	Seeding	90	40
	Fertiliser	433	383
	Herbicide	48	
	Insecticide	0	
	Irrigation* 6Ml	600	
	Contract hay making (inc fuel)	400	
	Levies & Insurance	0	
	Total Variable Costs $/ha	**1671**	
	Gross Margin $/ha	**-71**	

*Irrigation cost: 6Ml @ $100 /mL to pump and apply only

Sensitivity Tables

Effect of Yield & Price on Gross Margin per ha

Yield tonnes/h	$250	$300	$350	$400	$450
3	-$921	-$771	-$621	-$471	-$321
4	-$671	-$471	-$271	-$71	$129
5	-$421	-$171	$79	$329	$579

Effect of Yield & Price on GM per mL

Yield tonnes/h	$250	$300	$350	$400	$450
3	-$184.20	-$154.20	-$124	-$94.20	-$64.20
4	-$134.20	-$94.20	-$54	-$14.20	$25.80
5	-$84.20	-$34.20	$16	$65.80	$115.80