University of New England

Controlled Environment Horticulture Industry Potential in NSW

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EXECUTIVE SUMMARY

The report focuses on the potential for controlled environment horticulture (CEH) development in NSW. This focus is driven by what appears to be a growing trend in the industry towards construction of large-scale, technologically complex, high-yielding and resource-efficient greenhouses which offer possibilities for meeting future demand for vegetables and other products (both domestically and internationally) in a relatively sustainable way and which could also increase employment opportunities in regional Australia.

THE AUSTRALIAN GREENHOUSE INDUSTRY

Horticulture is Australia's third largest agricultural sector (after the livestock and broadacre sectors) with an estimated gross value of production of $8.9bn in 2013/14. It is the largest agricultural sector employer (employing about 61,000 people). However, glasshouse horticultural production contributes a relatively small proportion to these totals for the sector, although establishing exactly how much it contributes is difficult. Smith (2013) states that the Australian protected cropping industry produces $1.3bn farm-gate value per annum and employs over 10,000 people. Ibisworld quotes revenue figures for the Australian under cover vegetable growing sector for 2016-17 at $576mn (but note that this figure also includes the value of mushroom production). This report also notes that market share in this sector is dominated by four key players: the Costa Group (42.3%), Perfection Fresh Australia (10.7%), Flavorite Hydroponic Tomatoes (8.5%) and Sundrop (4.9%). These companies dominate the production of mushrooms and tomatoes.

ABS statistics for undercover production of fresh market tomatoes show a major change between 2008-09 and 2014-15 with an increase in area, a decline in number of growers, a 205% increase in production and an increase in average yield from 158 tonnes per ha to 258 tonnes per ha. This remarkable increase can be explained by the construction of a number of large glasshouses operating CEH systems over recent years.

MAIN CEH PRODUCTS

A variety of different crops can be grown under our broad definition of greenhouse production. However, CEH is viable only for high-value crops and globally, production in these environments has been focused upon the following: tomato, capsicum, lettuce and other leafy greens, cucumbers, eggplant, herbs, and some types of cut flowers. Note that, so far, development of large-scale CEH facilities in Australia has been predominantly confined to growing tomatoes.

POTENTIAL FOR EXPANSION OF THE GREENHOUSE SECTOR IN NSW LOCATION

Most areas of the state (apart from the far west) share favourable climatic conditions for CEH production. The Northern Tablelands has the advantage of altitude which means that it rarely experiences summer days with temperatures in excess of 30°C – which can inhibit productivity – and relatively high levels of solar radiation. Regional areas of NSW also have cheaper land than areas closer to the metropolitan centres. However, siting of large-scale CEH operations in regional areas is dependent upon those areas having good transport linkages (North and South) and a reliable supply of water, fuel and labour. The availability of labour is likely to be a major constraint on expansion. Whilst rural unemployment levels are in general higher than in metropolitan areas there is evidence that it is difficult to retain local residents in employment in these facilities and that they are reliant on a supply of overseas labour.

MARKET POTENTIAL

So far expansion has occurred in fresh market tomato production for the domestic market. This market continues to grow both in terms of market size and production, but given the volume of production from the existing large facilities there appears to be limited further scope for expansion in the domestic market. Exports of fresh tomatoes are obstructed by strict phytosanitary requirements in some Asian countries although there is the potential for these obstructions to be overcome by irradiation technologies and other measures. Future expansion will be in other products, for example cucumbers and capsicums and more specialised products such as leafy green vegetables for export to Asian markets. The potential for expansion into exportable products means that areas that have good transport linkages north to Toowoomba and to the new Western Sydney airport are likely to be attractive for potential investors in this industry.

POLICY ISSUES

Policy issues that may influence locational decisions centre on planning, environmental management, access to water and labour, and access to good transport infrastructure.

Development of new large-scale CEH facilities is unlikely to be situated close to areas of high population density and with state of the art control systems it can have a relatively small environmental impact (since there is minimal, or no, run-off of nutrients or pesticides and they can be self-sufficient in water) apart from an aesthetic impact upon the landscape. For these reasons planning and environmental management policy are unlikely to be important factors which influence location. However, there are documented issues with the efficiency of the current planning process in NSW although these may be addressed by amendments which have been proposed to the Environmental Planning and Assessment Act 1979. Access to markets via a well-maintained road transport network is likely to be an important consideration, as is access to air transport for growers who are considering producing for export.

If it is generally true that the kinds of jobs available in large CEH greenhouses are unattractive to existing residents in regional areas, then any change to policy which inhibits foreign workers coming to Australia will influence location.

If this were the case such large operations would be more likely to locate closer to more urbanised areas in order to guarantee labour supply.

Re-zoning of land to urban uses in the vicinity of metropolitan areas in response to urban encroachment has had an impact in some areas (the Sydney basin, for example) in terms of reducing the numbers of small greenhouse producers in the peri-urban fringe. Re-zoning inevitably leads to an increase in land prices with the consequence that greenhouse horticulture is not viable in these areas for all but the most highly productive enterprises growing high-value produce.

CEH AS AN ELEMENT OF REGIONAL DEVELOPMENT?

Large-scale CEH is very capital intensive and the level of investment required means that it is dominated by big corporate entities. Smaller CEH facilities, growing high-value crops for local or export markets are viable, but are unlikely to be located in regional areas in any great density because they would not produce the volume of output required to offset high transport costs to distant markets. Clusters of small CEH growers could be viable in regional areas, either; by acting as third-party suppliers to existing large firms and utilising the latter's packing and distributional facilities, or; by working within a cooperative organisation and utilising shared packing and distribution infrastructure. This type of organisation amongst growers is common in Spain, for example, and allows small producers to compete effectively with large companies.

The primary constraint on expansion of the industry appears to be labour availability. Large-scale CEH facilities could provide significant new employment possibilities in regional areas. However, experience suggests that CEH companies have difficulty retaining local labour and are heavily reliant upon overseas labour.

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1 INTRODUCTION

1.1 PROJECT SCOPE

This report has been commissioned by the NSW Government Department of Industry and prepared by the Centre for Agribusiness at the University of New England.

This report is concerned with evaluating the prospects for the controlled environment horticulture (CEH) industry in New South Wales. We specifically focus on future CEH development (see Section 1.2 for how we define this within the report) since there appears to be a growing trend in the industry towards construction of large-scale, technologically complex, high-yielding and resource-use efficient greenhouses which offer possibilities for meeting future demand for vegetables and other products (both domestically and internationally) in a relatively sustainable way and which could also increase employment opportunities in regional Australia.

The capital and operating costs of large-scale CEH are largely unavailable (because of commercial sensitivity) and highly site-specific so we do not deal with them here, rather, the report concentrates on enabling factors for competitive operation and apparent constraints and opportunities in NSW.

1.2 DEFINITIONS

Various terms can be used to describe the structures and methods involved in growing crops within protected environments. Albright and Langhans (1996) presents a hierarchy of terms which progress from low to high levels in terms of the technical sophistication of the plant growing systems they involve:

1. Low tunnels – long, low strips of transparent plastic either supported by hoops to form tunnels or placed directly on top of plants. Used to extend the growing season by warming the soil and by protecting early planted crops from frost ;
2. High tunnels – larger versions of low tunnels, high enough to enable people to work within them. Capable of being heated, but other environmental control is limited;
3. Protected cultivation (also known as protected cropping or protected agriculture) – a catch-all term used to describe a range of different technologies; from high tunnels through to permanent glasshouse constructions with very sophisticated environmental control ;
4. Greenhouse (or glasshouse) horticulture – used to describe the growing of crops under a relatively permanent structure, which could be covered with glass or plastic, and which employs systems which modify the environment, but which are usually limited to temperature and ventilation control ;
5. Controlled Environment Agriculture (CEA) or Controlled Environment Horticulture (CEH) - we borrow from the NSW Department of Primary Industries to define CEH as:

   "*the most modern and sophisticated form of greenhouse horticulture… CEH combines high technology greenhouses with hydroponic (soilless) growing systems. CEH makes it possible to consistently and reliably control or manipulate the growing environment and effectively manage nutrition, pests and diseases in crops*" (NSW Department of Primary Industries 2007);

   CEH and the term *hydroponics* are often used interchangeably. Whilst CEH facilities very often use hydroponic techniques those techniques can often be used in greenhouses with relatively low levels of other technology, e.g. in high tunnels, so the terms are not synonymous.

   CEH is characterised by a high degree of environmental control and system integration and the classification incorporates a variety of different production sub-systems. Aquaponics is one such sub-system which, as the terms implies, is an integrated system of hydroponic plant growing and aquaculture where nutrient rich water from fish tanks is used to fertilise the growing plants. Vertical farming represents the most recent development in CEH. Within this system plants are grown in almost totally closed systems with practically all aspects of the growing environment controlled. In an urban setting these facilities have been constructed on a large-scale in old industrial buildings and at a smaller-scale, several companies produce vertical farms contained in shipping containers.

As stated above, CEH forms the focus of this report, however, it should be noted that it is very difficult to provide an accurate picture of the extent of CEH globally, and in Australia in particular, since there are few published statistics from which it can be specifically identified. Generally, CEH is included within larger statistical categories such as *undercover* or *protected* cropping; both of which broadly align with the definition of protected cultivation set out above.

1.3 REPORT STRUCTURE

The approach taken to achieve the overall objective (as set out in Section 1.1) of the report begins with a description of the structure, size and extent of the greenhouse agriculture industry at the global, national and NSW levels. Chapter 3 outlines those economic, climatic and resource endowment factors which are important considerations for the location of CEH facilities. Chapter 4 discusses the potential for CEH development in NSW and identifies any potential obstacles to expansion of industry and Chapter 5 provides conclusions and recommendations.

2 STRUCTURE, SIZE AND NATURE OF THE GREENHOUSE HORTICULTURE INDUSTRY

This chapter provides some background information on the current state of greenhouse horticulture; initially at the global level and then by focusing in upon the Australia as a whole and then more specifically upon New South Wales (NSW), and, in so far as is possible, at the regional level within NSW. We should highlight here, however, that identification of greenhouse economic activity, and more specifically that associated with CEH, via the statistics that are available internationally and in Australia is problematic. This is because that economic activity is usually aggregated within more wide-ranging classifications of production activity such as *undercover* or *protected* cropping. The statistics which follow are gathered from a variety of sources and we have made every effort to acknowledge any such differences in definitions.

2.1 THE INTERNATIONAL GLASSHOUSE INDUSTRY

According to Hickman (2016) the total estimated world greenhouse production area is some 473,466ha (using a definition of "greenhouse" that only includes permanent structures and excludes simple high or low tunnels). However, this must be considered to be very much an estimate since the definition of greenhouse used in the some 130 countries that report data varies widely. Hickman (2016) estimates that that 90% of this world production area is covered with plastic and only 10% with glass, meaning that it is estimated that globally some 47,347ha of land are covered with permanent glass covered structures.

The total global area which is covered by greenhouses has increased substantially over the past twenty years. Chang et al. (2013) quotes figures which estimate that global area has increased from 0.7 million ha in the 1990's to 3.7 million ha in 2010. Much of this increase can be attributed to a rapid of expansion of the use of plastic covered greenhouses, particularly in China where it is estimated that up to 3.3 million ha were occupied by these structures in 2008 (Chang et al. 2013) (less than 1% of total greenhouse area in China is estimated to be covered by glass greenhouses (Costa, Heuvelink, and Botden 2003)).

Figure 2-1 summarises the main global greenhouse production countries in terms of area in 2009. China, Spain, South Korea, Japan and Turkey have a combined cumulative greenhouse covered area amounting to 96% of total greenhouse coverage, Australia is ranked 28th in terms of total area with 1,310ha.

Identifying the extent to which these areas consist of operations which might be classified as under the definition of CEH we use here is very difficult. The vast proportion of the areas quoted above are occupied by plastic covered structures in which a huge range of environmental control – from nothing to relatively sophisticated computerised systems – is carried out. It is also likely to be the case that the majority of holdings are relatively small-scale. There is, however, an increasing trend for very large greenhouse vegetable operations run by large companies - Table 2-1 below lists operations of this type over 100ha.

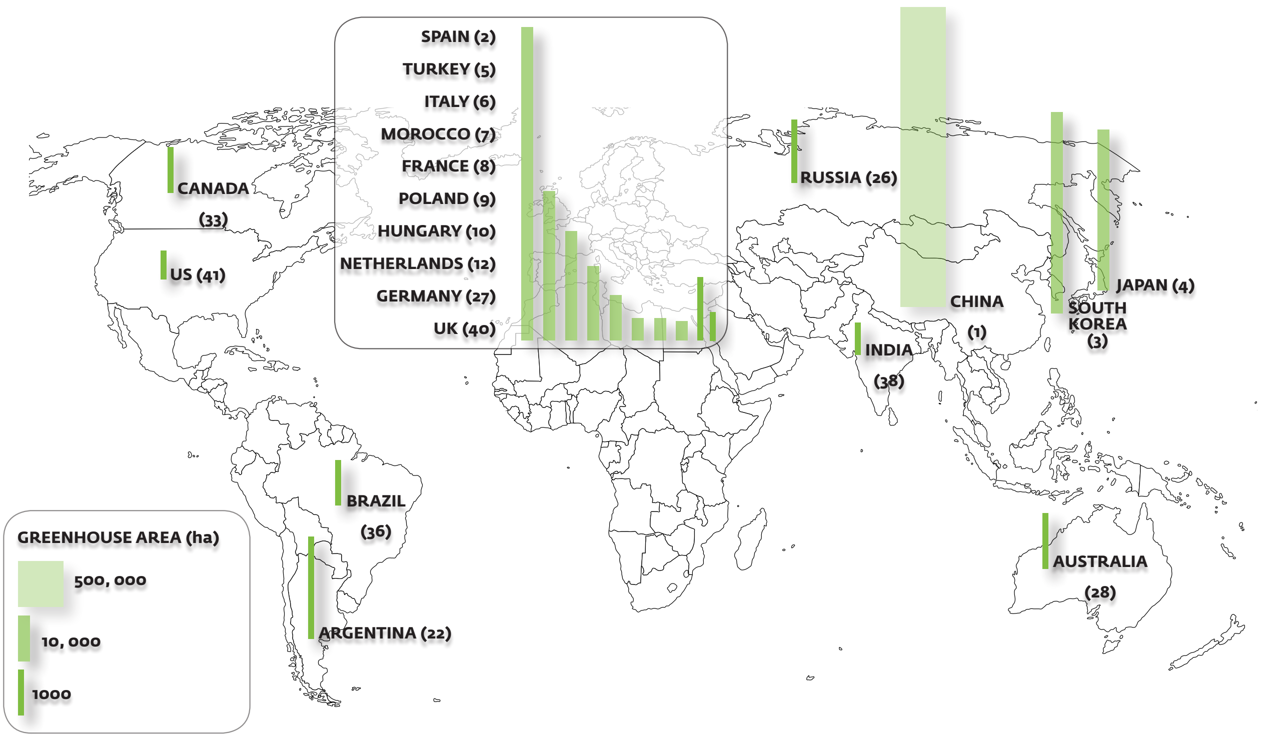

Figure 2-1: Major global greenhouse cultivation areas in 2009

Source: Reproduced from Chang et al.(2013) Figure 1

Note: numbers in parentheses indicate a country's rank in terms of total greenhouse area

Company name	Country	Area (ha)
Group Azura	Morocco	751
Le Gaga	China	666
Desert Glory	Mexico	592
Melones	Mexico	350
Del Campo Reserve	Mexico	229
Agricola la Primavera	Mexico	162
Yuzhny	Russia	148
Pero Veg. Co.	Canada	135
Divemax	Mexico	135
Bioparques de Occidente	Mexico	130
Nature Sweet Arizona	USA	129
Agrikombinat Moskovsky	Russia	120
Grupo Batiz-Wilson Batiz	Mexico	115
Royal Pride	Netherlands	102
Gilad Desert Produce	Israel	100

Table 2-1: Large World Greenhouse Vegetable Operations (greater than 100ha)
Source: Hickman (2016), Table 87, page 62

All of these firms are operating using CEH, although the extent and type of operation differs between them. For example Hickman (2016) notes that a large proportion of the firms operating in Mexico are using plastic covered metal structures which are unheated, which have insect netting side walls but that have computerised irrigation and fertilisation systems.

2.1.1 MAIN GREENHOUSE PRODUCTS

A variety of different crops can be grown under our broad definition of greenhouse growing, however, CEH is only viable for high-value crops and globally, production in these environments has been focused upon the following:

- Tomato
- Capsicum
- Lettuce
- Cucumbers
- Eggplant
- Herbs

Note that, so far, development of large-scale CEH facilities in Australia has been predominantly confined to tomato production.

2.1.2 GREENHOUSE VERSUS FIELD PRODUCTION

Greenhouse production gives growers control over almost all aspects of the growing environment. This allows high yields to be achieved along with a tighter control over quality than is possible in an open field setting. Table 2-2 below, compares yields that can be obtained for selected crops in greenhouse environments to yields that are achieved in open fields, the increase in yield that can be achieved in the controlled environment ranges from 250% for capsicums to 800% for lettuce.

Crop	Greenhouse (kg/m2)	Field (kg/m2)	Yield increase (%)
Tomatoes	76	18	422
Capsicum	30	12	250
Cucumber	100	20	500
Lettuce	80	10	800

Table 2-2: Potential yields of selected crops: greenhouse vs field
Source: Smith (2011)

Higher yields in greenhouses are also achieved with fewer inputs (of water, fertiliser, etc.) per unit of output. Smith (2011) notes that the water conversion rate for greenhouse tomato production compared to field production (i.e. grams of tomato produced per litre of water used) is 38.2 to 7.4 which means that greenhouse production is some 5 times more efficient in water usage. A study of hydroponically grown greenhouse lettuce in Arizona concluded that greenhouse yields were 11 times greater than those achieved by conventional field production, but the former only used 20 litres of water per kg of output per year while the latter needed 250 litres (Lages Barbosa et al. 2015). However, this study also finds that energy usage in the greenhouse is much higher than in the field; 82 times more energy was required per kg of output per year. Lages Barbosa et al. (2015) conclude that a major factor in assessing the sustainability of hydroponic greenhouse production will be energy availability and furthermore that this points to water-scarce settings with an abundance of renewable energy as being potentially suitable for it.

Large-scale greenhouse production is expensive compared to conventional field production, but high yields translate to high returns on investment which can range from 20 to 25% according to Smith (2011), although Andersen (2017) notes that 8 to 12% is probably a more realistic rate of return.

2.2 THE AUSTRALIAN GREENHOUSE INDUSTRY

Horticulture is Australia's third largest agricultural sector (after the livestock and broadacre sectors) with an estimated gross value of production of $9.1bn in 2015/16 and it employing about 67,000 people (ABARES 2017). However, glasshouse horticultural production contributes a relatively small proportion to these totals for the sector, although establishing exactly how much it contributes is difficult. Smith (2013) states that the Australian protected cropping industry produces $1.3bn farm-gate value per annum and employs over 10,000 people. Ibisworld quotes revenue figures for the Australian under cover vegetable growing sector for 2016-17 at $576mn (but note that this figure also includes the value of mushroom production) (Mullaby 2016). This report also notes that market share in this sector is dominated by four key players: the Costa Group (42.3%), Perfection Fresh Australia (10.7%), Flavorite Hydroponic Tomatoes (8.5%) and Sundrop (4.9%). These companies dominate the production of mushrooms and tomatoes.

Within Australia it is again difficult to find statistics which give a detailed picture of the specific types of greenhouse horticulture which are taking place. The primary source of data is the Australian Bureau of Statistics (ABS) Agricultural Commodities collection which uses estimates from the national Agricultural Census (which occurs on a five-yearly basis) and Rural Environment and Agricultural Commodities Surveys (REACS) (which are carried out in intervening years between the main census). The REACS estimates are based on samples of the population of all agricultural business above a minimum cut-off turnover value of A$5,000. Given that greenhouse horticulture forms a relatively small proportion of the total of agricultural enterprises and that only some of these will be selected in the annual sample and respond to the survey, this means that making comparisons across time of the area and numbers of business involved in the identified categories is problematic. For example, in 2008-2009 there were 71,988 businesses across Australia involved in crop production and cultivating 33.44 million ha of land. Only about 115,000ha of this land (about 0.34% of total crop area) was sown with vegetables by some 5,832 businesses and of that only 527ha and 982 businesses were classified as being undercover.

We report data from the 2008-2009 production year since up to this time more detail is available regarding individual crops than is available for more current years. We then compare this data to the latest figures (for the 2014-2015 production year), in so far as we are able to do so meaningfully.

Seven production categories are identified and reported in the ABS data up to, and including, 2008-2009, as taking place *undercover* [1] these are:

1. Nurseries;
2. Cut flowers;
3. Capsicums (excluding chillies);
4. Cucumber;
5. Lettuce (head);
6. Lettuce (looseleaf, butterhead, coloured fancy) , and;
7. Tomatoes (fresh market). [2]

The Tables which follow report area (ha), production (tonnes) and number of growers, broken down by State for each of these categories (or combinations of categories) for 2008-2009 and for 2014-2015.

Nurseries and cut flowers is by far the most important of these categories in terms of area of undercover production and numbers of businesses. Comparison of the data for the two time periods presented in Table 2-3 shows that total area has declined between the two periods (by about 100ha) and that the number of businesses has fallen some 400 (N.B. since the data in these tables are estimates provided by survey responses some caution must be used in the interpretation of differences, especially when they are small). The majority of these businesses appear to be small scale (the average size over all businesses is only 0.5ha in 2014-2015) and this category of production does not usually require the type of production that CEH entails (apart from a very few, specialised cut-flower operations), hence this category will not be considered further in any great detail in this report.

	2008-2009		2014-2015	
	Area (ha)	**Number of growers**	**Area (ha)**	**Number of growers**
NSW	226	480	149	343
Victoria	217	366	251	293
Queensland	153	438	132	309
South Australia	35	100	np	35
Western Australia	66	124	65	137
Tasmania	0	46	7	37
Northern Territory	19	16	2	9
ACT	0	2	np	3
Total	**716**	**1,572**	**606**	**1,166**

Table 2-3: Nurseries and cut flowers - Undercover area and number of businesses 2008-2009 and 2014-2015

Source: ABS (2010 and 2016)

Note: *np* = data not available for publication

[1] 'Undercover' is defined as production that takes place in greenhouses, cold frames, cloth houses and lath houses; Page 79 of ANZIC 2006 (Australian Bureau of Statistics and Statistics New Zealand 2006)

[2] In the currently available data only four undercover categories are reported; Nurseries and cut flowers, Capsicums (excluding chillies), Lettuce, and Tomatoes (Fresh market).

The data shown in the remaining tables relate to the major vegetable crops which can be grown very productively in CEH facilities. The tables show that the majority of undercover production is undertaken in NSW, Victoria, South Australia, West Australia and Queensland with very little occurring in the Northern Territory, Tasmania and the ACT. Tomatoes are the most important undercover crop in terms of area, quantity produced and number of businesses, followed by capsicums and then lettuce. Note, again, however that this data refers to the totality of undercover production and covers a wide range of possible production methods.

	2008-2009			2014-2015		
	Area (ha)	Production (tonnes)	Number of growers	Area (ha)	Production (tonnes)	Number of growers
NSW	7	253	25	20	271	26
Victoria	14	555	10	16	965	17
Queensland	0.2	1	1	0.1	70	19
South Australia	71	3,150	91	78	3,442	107
Western Australia	40	2,259	17	33	1,530	10
Tasmania	4	602	7	3	616	1
Northern Territory	0	0	0	0	0	0
ACT	0	0	0	0	0	0
Total	**136.2**	**6,820**	**151**	**150.1**	**6,894**	**180**

Table 2-4: Capsicums (excluding chillies) - Undercover area, production and number of businesses 2008-2009 and 2014-2015
Source: ABS (2010 and 2016)

Table 2-4 shows that there has been little change in undercover capsicum production between the two periods. Area and quantity produced have increased slightly, and the number of businesses has increased more substantially, however, all of these differences could simply reflect sampling differences between the two periods.

	Area (ha)	Production (tonnes)	Number of growers
NSW	45	1,773	181
Victoria	1	50	4
Queensland	47	3,363	25
South Australia	62	2,537	93
Western Australia	25	780	22
Tasmania	0.29	22	4
Northern Territory	2	105	5
ACT	0	0	0
Total	**182.29**	**8,630**	**334**

Table 2-5: Cucumber - Undercover area, production and number of businesses 2008-2009
Source: ABS (2010)

Data for production of undercover cucumbers has not been reported after 2008-2009 by the ABS and so we cannot make any comparison over time. The only point of note that can be drawn from Table 2-5 is that, again, the average size of operation is small at only about 0.5ha.

Table 2-6 shows that only a small change has occurred in undercover lettuce production over the two periods. Area and production quantity have declined over time, and number of businesses has increased. These differences are small and could, again, simply reflect sampling differences.

In contrast to the preceding tables the data reported for tomatoes in Table 2-7 highlights that a substantial change has occurred between 2008-2009 and 2014-2015. Area has increased by 40ha and number of growers has decreased (by 77), however, production has increased dramatically from 24,482 tonnes in 2008-2009 to 50,244 tonnes in 2014-2015, an increase of 205%. This represents an increase in average yield from about 158 tonnes per ha in 2008-2009 to 258 tonnes per ha in 2014-2015, i.e. almost a doubling of yield. This remarkable increase can be explained by the construction of a number of large glasshouses operating CEH systems over recent years.

	2008-2009			2014-2015		
	Area (ha)	Production (tonnes)	Number of growers	Area (ha)	Production (tonnes)	Number of growers
NSW	21	1,546	35	27	1,816	29
Victoria	14	583	21	np	np	12
Queensland	11	170	18	12	406	26
South Australia	4	145	5	2	255	1
Western Australia	2	454	3	np	np	32
Tasmania	0	0	0	np	np	1
Northern Territory	0	0	0	0	0	0
ACT	0	0	0	0	0	0
Total	**52**	**2,898**	**82**	**41**	**2,477**	**101**

Table 2-6: Lettuces - Undercover area, production and number of businesses 2008-2009 and 2014-2015
Source: ABS (2010 and 2016)
Note: *np* = data not available for publication

	2008-2009			2014-2015		
	Area (ha)	Production (tonnes)	Number of growers	Area (ha)	Production (tonnes)	Number of growers
NSW	57	6,099	133	42	15,732	102
Victoria	17	5,615	52	31	11,306	30
Queensland	5	1,831	12	7	1,709	21
South Australia	72	9,537	127	106	19,685	96
Western Australia	2	639	5	5	769	5
Tasmania	2	761	10	4	1,043	8
Northern Territory	0	0	0	0	0	0
ACT	0	0	0	0	0	0
Total	**52**	**24,482**	**339**	**195**	**50,244**	**262**

Table 2-7: Tomatoes (fresh market) - Undercover area, production and number of businesses 2008-2009 and 2014-2015
Source: ABS (2010 and 2016)

2.3 LOCATION OF HORTICULTURAL PRODUCTION IN AUSTRALIA

Historically protected horticultural production has been located close to areas of high population density since products (generally vegetables) needed to be transported to market and then to the final consumer as quickly as possible. This prevails in the location of protected horticultural production in Australia to the present day as Figure 2-2 below shows. Figure 2-2 uses data from Land Use of Australia 2010-11 with the highlighted areas showing the location of land occupied by uses classified under land class code 5.1.0 "Intensive Horticulture"[3]. It should be noted that the highlighted areas on the map are significantly enlarged so that they are visible on this map. The land use data identifies locations down to a scale of 50m² and so even the very largest production facilities would be practically invisible without this modification.

The map shows that intensive horticulture is concentrated around major metropolitan centres with the densest conglomeration of production facilities being located around the Sydney metropolitan area.

Figure 2-3 presents the same information for the state of NSW.

[3] This code incorporates a number of sub-categories: 5.1.1 Production Nurseries; 5.1.2 Shadehouses; 5.1.3 Glasshouses; 5.1.4 Glasshouses – hydroponic, and; 5.1.5 Abandoned intensive horticulture. Identification below the overall 5.1 level was not possible from the publicly available data.

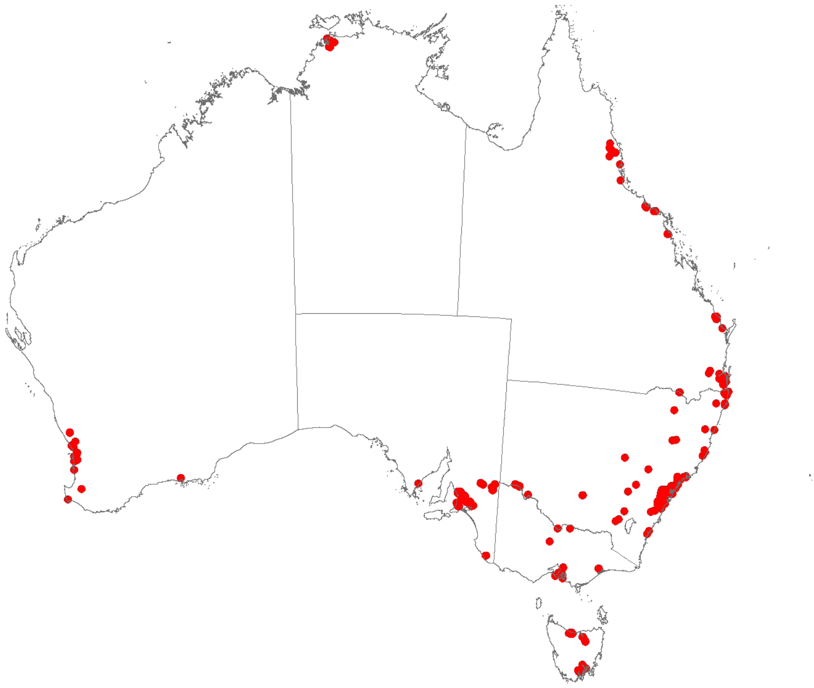

Figure 2-2: Location of Intensive Horticulture (Land Class Code 5.1) in Australia 2010-11
Source: ABARES, Land Use of Australia, 2010-11
Note: borders around areas being identified as occupied by intensive horticulture have been significantly enlarged to increase visibility

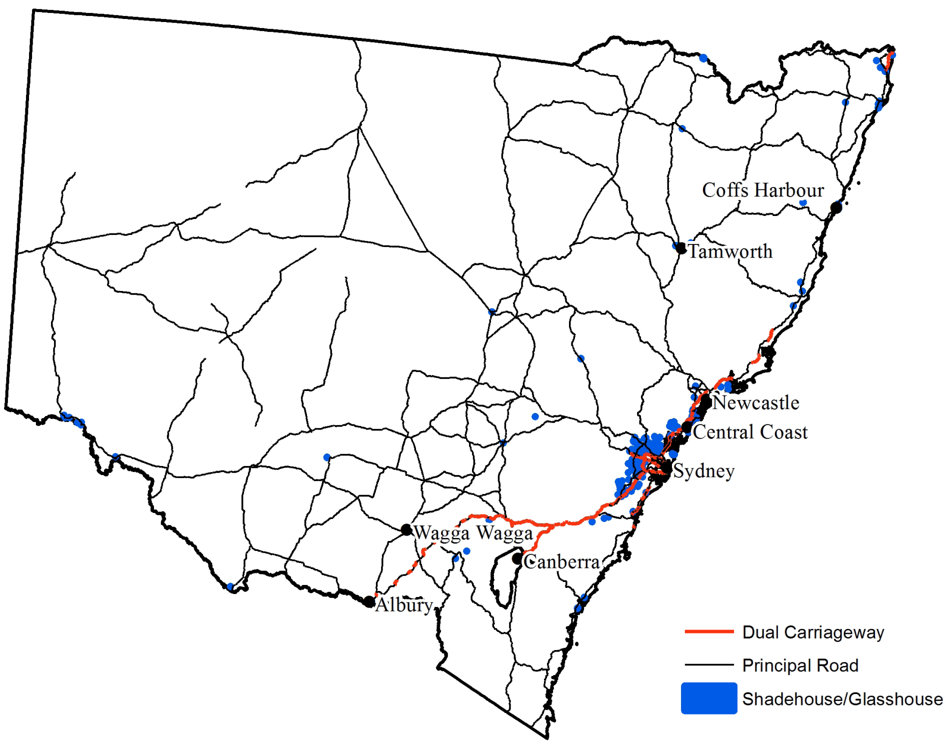

Figure 2-3: Location of Intensive Horticulture (Land Class Code 5.1) in NSW 2010-11

Further, and more up-to-date, data is provided in Table 2-8 which details area and number of businesses for reported categories of undercover production in 2014-2015 broken down into SA4 regions in NSW. This shows that the majority of undercover area and number of businesses are in the nursery and cut flower categories and that those businesses are most densely concentrated around the Sydney metropolitan area. The data also precisely reveals the extent to which the 20ha Costa Group tomato glasshouse in Guyra has boosted production of tomatoes in NSW. 9,091 tonnes of tomatoes were grown in this one facility in 2014-2015 (a yield of 451 tonnes per ha) representing 60% of total fresh market tomato production in NSW.

SA4 region	SA4 code	Nurseries		Cut Flowers		Capsicums (excl. Chillies)		Lettuce		Tomatoes		Totals	
		Area (ha)	No. bus	Area (ha)	No. bus	Area (ha)	No. bus	Area (ha)	No. bus	Area (ha)	No. bus	Area (ha)	No. bus
Capital Region	101	4.72	21	0.00	0	0.01	3	0.03	3	0.05	6	5	34
Central Coast	102	6.34	23	12.41	9	0.00	0	0.00	0	2.78	9	22	42
Central West	103	1.55	7	1.53	3	0.00	2	0.00	0	0.00	10	3	23
Coffs Harbour - Grafton	104	1.50	20	0.03	7	1.51	6	0.00	0	5.28	27	8	61
Far West and Orana	105	0.38	2	0.00	0	0.00	0	0.00	0	0.00	0	0	2
Hunter Valley excl Newcastle	106	0.05	3	0.00	0	0.00	0	9.22	8	0.00	0	9	10
Illawarra	107	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Mid North Coast	108	3.84	23	0.50	8	0.00	0	0.00	0	4.72	6	9	37
Murray	109	1.61	9	0.00	0	4.15	3	0.00	0	0.01	2	6	14
New England and North West	110	0.06	17	0.00	0	0.00	0	3.43	3	20.16	1	24	21
Newcastle and Lake Macquarie	111	0.00	0	38.32	3	0.00	0	0.00	0	0.00	0	38	3
Richmond – Tweed	112	17.30	50	4.20	2	0.00	1	0.00	0	1.22	7	23	60
Riverina	113	0.03	3	0.00	0	14.16	4	0.00	0	4.35	6	19	13
Southern Highlands and Shoalhaven	114	0.03	3	0.00	0	0.00	0	0.00	0	2.98	30	3	33
Sydney - Baulkham Hills and Hawkesbury	115	19.28	47	10.18	23	0.00	6	0.00	0	0.20	7	30	83
Sydney – Blacktown	116	2.67	1	2.67	1	0.00	0	0.00	0	0.00	0	5	3
Sydney - City and Inner South	117	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Sydney - Eastern Suburbs	118	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Sydney - Inner South West	119	0.00	0	0.67	1	0.00	0	0.00	0	0.00	0	1	1
Sydney - North Sydney and Hornsby	121	0.01	1	0.00	0	0.00	0	0.00	0	0.00	0	0	1
Sydney - Northern Beaches	122	2.54	5	0.00	0	0.00	0	0.00	0	0.00	0	3	5
Sydney - Outer South West	123	1.23	7	2.62	4	0.00	0	3.12	6	0.00	0	7	18
Sydney - Outer West and Blue Mountains	124	1.12	10	0.00	0	0.00	0	0.00	0	0.00	0	1	10
Sydney – Parramatta	125	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Sydney - South West	127	4.73	11	7.09	14	0.00	0	11.39	8	0.00	0	23	34
Sydney – Sutherland	128	0.00	1	0.00	0	0.00	0	0.00	0	0.00	0	0	1
Sydney Region Totals		**31.59**	**85**	**23.22**	**44**	**0.00**	**6**	**14.51**	**14**	**0.20**	**7**	**69.51**	**156**
NSW Totals		**69.01**	**267**	**80.21**	**76**	**19.84**	**26**	**27.19**	**29**	**41.74**	**112**	**238**	**509**

Table 2-8: Area and number of businesses for reported categories of undercover production in NSW SA4 regions 2014-2015

Source: ABS (2016)

3 FACTORS DETERMINING THE LOCATION OF GLASSHOUSES

3.1 INTRODUCTION

This chapter considers the factors which determine the optimal location of greenhouse horticulture in Australia. As Section 2.3 notes, it has historically been the case that greenhouse production has been concentrated close to metropolitan centres. This is largely a function of market proximity. Greenhouse horticulture produces crops which quickly deteriorate in quality once they have been picked and so need to be transported to the final consumer as rapidly as possible. As is discussed in Section 3.3 improved transport infrastructure and efficient supply chains means that market proximity is no longer a major constraint on location; however, facilities that are located far from markets need to be large so that transport costs are spread across a high volume of high value product.

Whilst some CEH systems control all aspects of the growing environment, the majority operate inside glass (or plastic) covered structures that rely on natural light. Costs of controlling the growing environment in these facilities will also be a function of the climatic conditions which prevail at the physical location: for example, locations with low average annual temperatures will require heating and locations with high average annual temperatures may require cooling (and locations with extreme annual ranges of temperature may require both heating and cooling at different times of the year). The production potential of a greenhouse and the costs of production will thus depend upon climate. Section 3.2 considers climatic conditions across Australia and attempts to identify those areas of the country with optimal climatic conditions for greenhouse horticulture. Sections 3.3, 3.4 and 3.5 then go on to discuss locational issues related to market proximity, access to resources and policy.

3.2 PRODUCTION POTENTIAL

The production potential of greenhouse horticulture (i.e. undercover production systems which rely upon natural light) is largely determined by climatic factors; although the importance of each factor depends upon the extent to which those climatic factors can be controlled in the greenhouse environment. For example, closed CEH systems such as vertical farming are virtually independent of the outside environment and hence can be located anywhere (but note that the costs involved in running these systems will be affected by outside temperature, humidity, etc.). The most important of these climatic factors is solar radiation.

3.2.1 SOLAR RADIATION

Photosynthesis requires light and hence crop yield is directly proportional to sunlight levels (although some crops are intolerant of too much daily sunlight). Hence the amount and duration of solar radiation that any location receives will be a key determinant of yield. The amount of solar exposure that any location in Australia receives depends upon latitude and the amount of cloud cover that an area experiences on average. Figure 3-1 maps average daily solar exposure across Australia. Much of mainland Australia has high levels of solar exposure (ranging between 15 and 24 megajoules per m^2), with solar exposure reduced on the coastal areas in the south because of the higher moisture content of the air and so increased incidence of cloud.

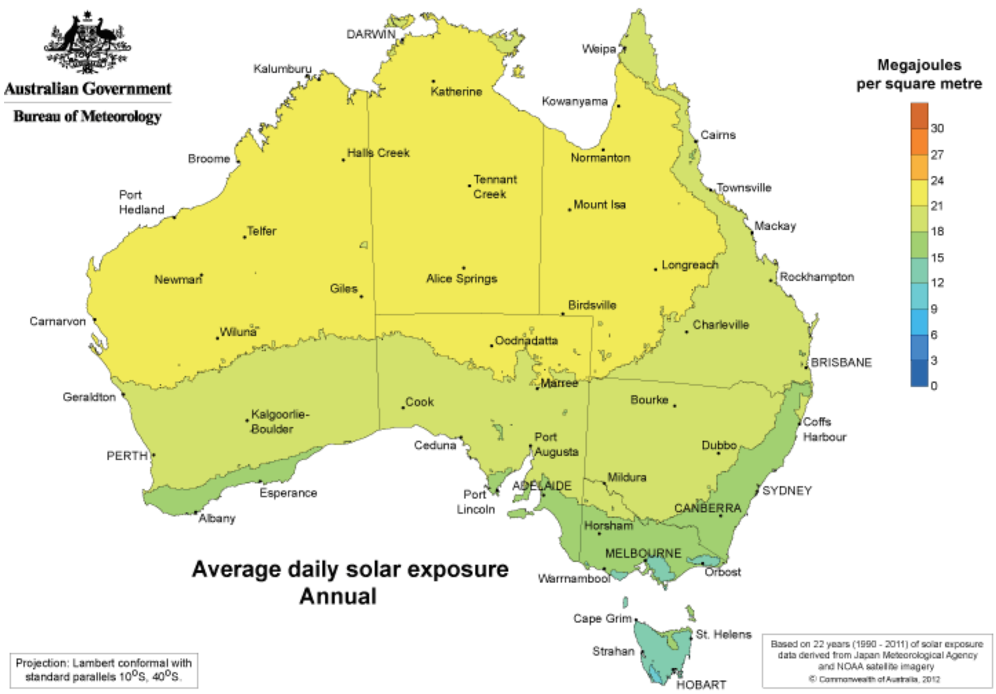

Figure 3-1: Average daily solar exposure (megajoules per m^2) 1990 - 2011 in Australia

Source: Bureau of Meteorology (BOM) (2016) [4]

[4] http://www.bom.gov.au/jsp/ncc/climate_averages/solar-exposure/

3.2.2 TEMPERATURE

Photosynthesis and hence plant growth is conditional upon temperature and all crops have optimal temperature ranges within which growth rates are optimised. The temperature for optimal tomato growth, for example, is 20 – 22°C during the day and 17 – 19°C overnight (Peet and Welles 2004). So the extent to which average daily maximum and minimum temperatures at any location deviate from this optimal temperature determines how much heating, or cooling, must be carried out.

Figure 3-2, Figure 3-3 and Figure 3-4 map average daily mean, maximum and minimum temperatures over Australia. Temperature at any location is principally determined by proximity to the equator and so the further north any location is, the higher the mean, maximum and minimum temperatures they experience. Temperature is also effected by topography. For example, it is evident from the maps that the higher parts of the Great Dividing Range in south-eastern Australia show cooler temperatures.

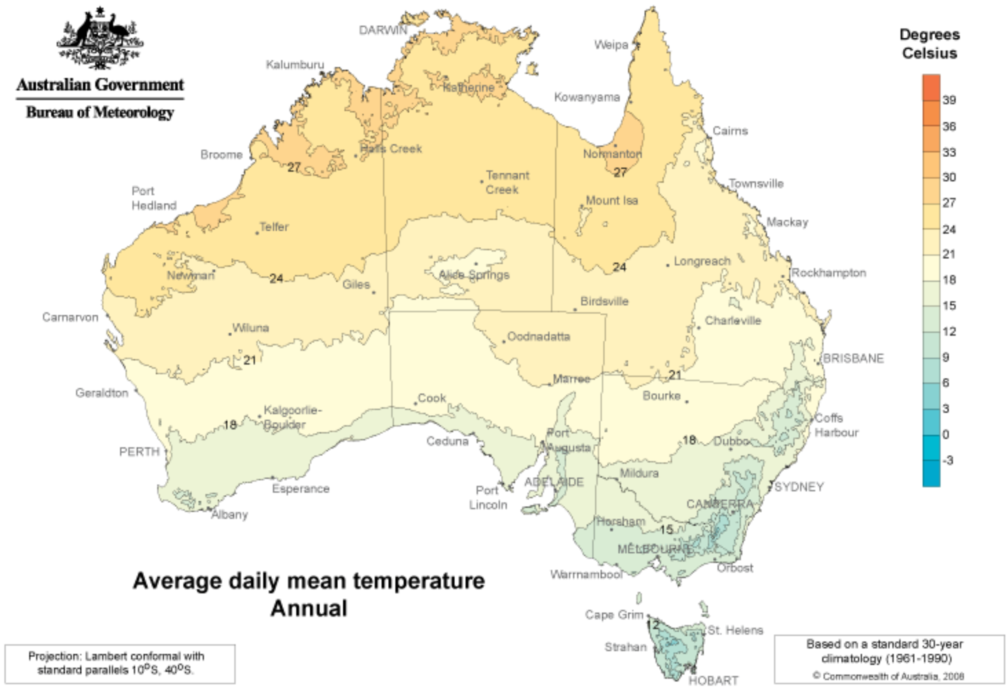

Figure 3-2: Average daily mean temperature (°C) 1961 – 1990 in Australia

Source: BOM (2016)

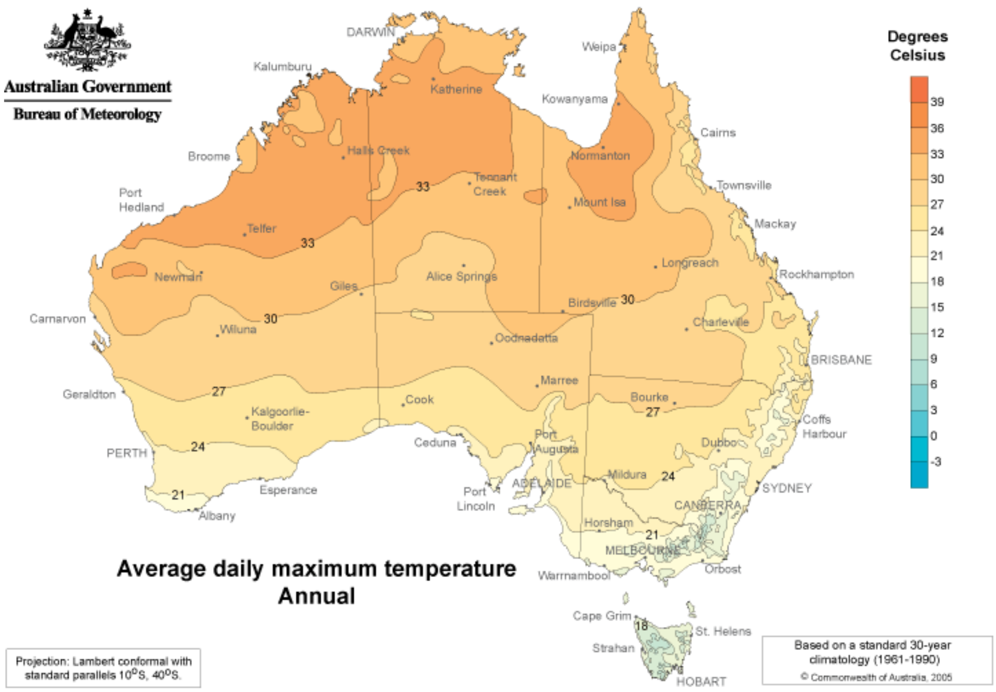

Figure 3-3: Average daily maximum temperature (°C) 1961 – 1990 in Australia

Source: BOM (2016) [5]

[5] http://www.bom.gov.au/jsp/ncc/climate_averages/temperature/

Temperature ranges in Australia are generally conducive to greenhouse agriculture except in the northern regions of Queensland, the Northern territory and Western Australia, where high mean daily temperatures would require substantial cooling to be carried out in greenhouses to maintain optimum temperature over long periods of the year. In other areas, some cooling may be necessary at the height of summer, and some heating required in the depths of winter, but these periods of time are small compared to other areas in the world.

Parks and Worrall (2005) note that the mean maximum ambient temperature during summer in much of Australia exceeds the temperature for optimum production of some crops (such as lettuce and cucumber). Greenhouse technologies such as evaporative cooling, shading and fogging can be used to reduce temperatures. The temperature to which air can be cooled using evaporative cooling is indicated by wet bulb temperature; with cooling being achieved to within 2ºC of that temperature in well-designed facilities. Parks and Worrall (2005) use a map of maximum daily wet bulb temperatures across Australia to specify areas at risk of high temperatures that will affect greenhouse production (see Figure 3-5). Such areas are those with maximum wet bulb temperatures exceeding 26ºC.

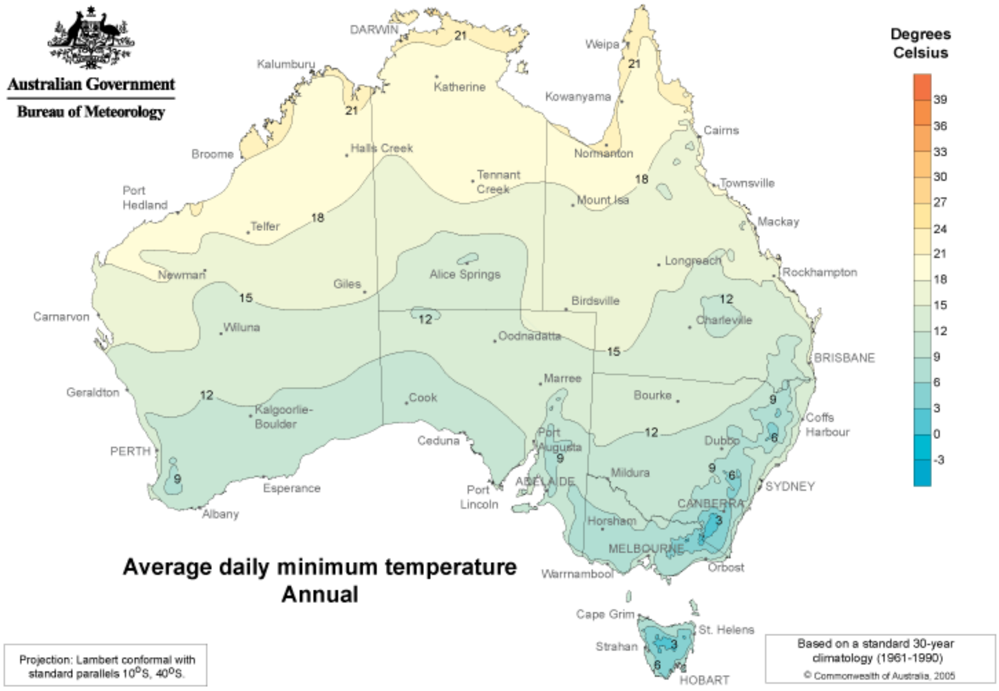

Figure 3-4: Average daily minimum temperature (ºC) 1961 – 1990 in Australia

Source: BOM (2016)

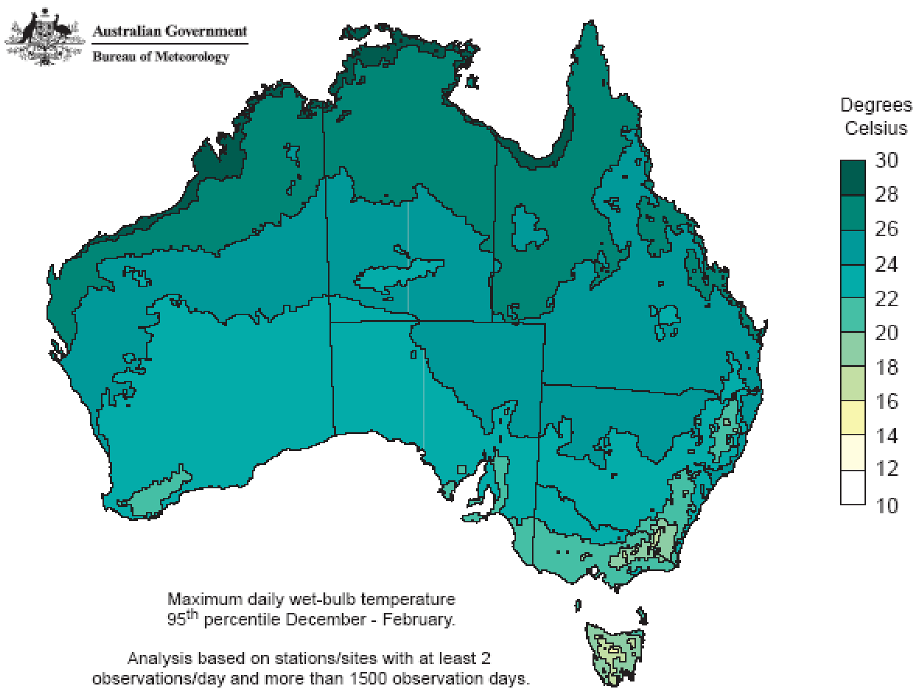

Figure 3-5: Maximum daily wet-bulb temperature 95th percentile December-February in Australia

Source: BOM (2004)

3.2.3 HUMIDITY

Smith (2007) states that the ideal relative humidity range in a greenhouse should be between 60 – 80%. If humidity is too high then plant transpiration slows, and high humidity can result in a greater incidence of disease because germination of pathogen fungal spores is increased on wet leaf surfaces (Peet and Welles 2004). In the majority of greenhouse production systems humidity is controlled by heating and ventilation (systems for which range from roof or sidewall vents, to fans or various combinations of methods). Ventilation to control humidity obviously then requires that the air entering the greenhouse has a relatively low relative humidity.

Figure 3-6 and Figure 3-7 show average daily relative humidity levels across Australia at 9am and 3pm respectively. As air warms its ability to hold more moisture increases so relative humidity decreases during the day as temperature increases. The maps show that relative humidity increases with proximity to the coast, but most areas of the country - except the very central regions where relative humidity is generally too low – have levels which are conducive to greenhouse horticulture.

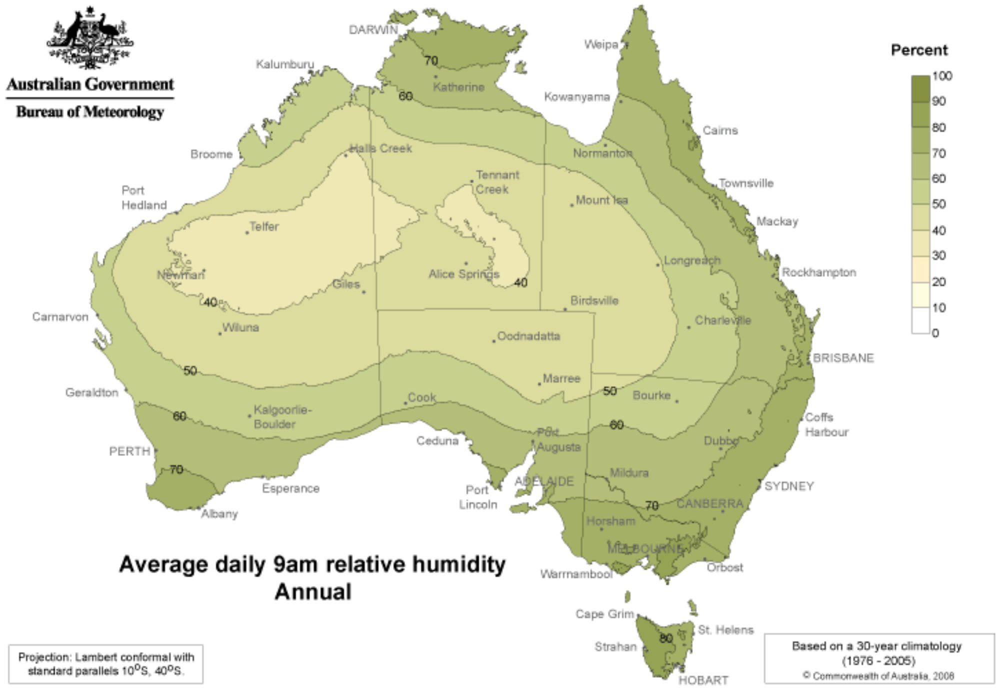

Figure 3-6: Average daily 9am relative humidity (%) 1976 - 2005 in Australia

Source: BOM (2016) [6]

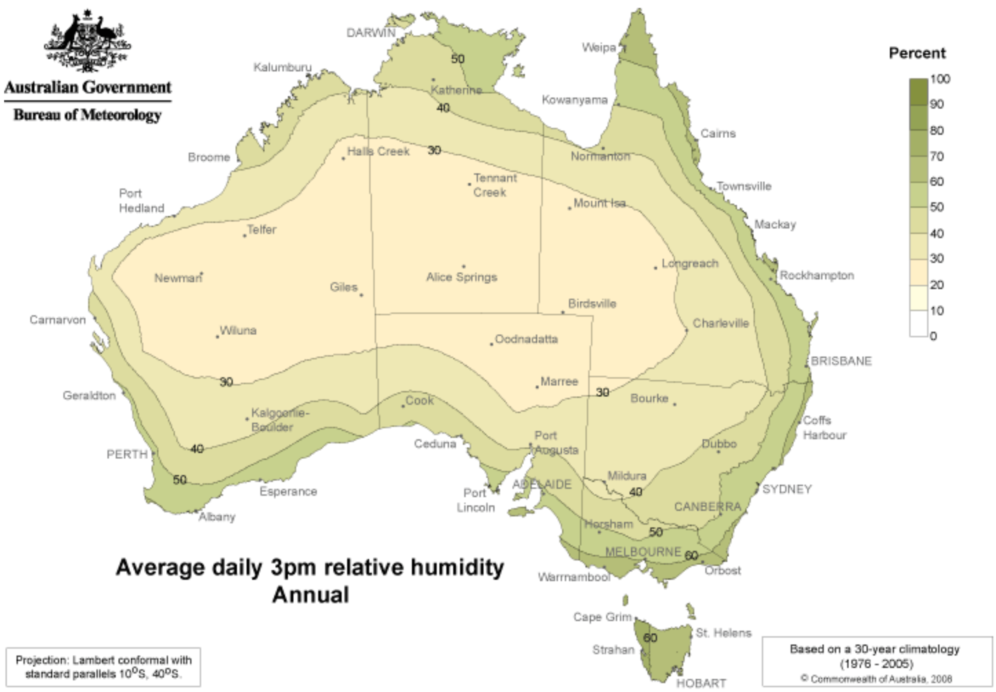

Figure 3-7: Average daily 3pm relative humidity (%) 1976 - 2005 in Australia

Source: BOM (2016) [7]

[6] http://www.bom.gov.au/jsp/ncc/climate_averages/relative-humidity/

[7] http://www.bom.gov.au/jsp/ncc/climate_averages/relative-humidity/

3.2.4 CYCLONES

Glasshouses in Australia are generally designed with a glass supporting structure rated for wind speeds of 41m/s (Andersen 2017) and hence areas of Queensland, Western Australia and the Northern Territory which are subject to tropical cyclones are not suited to location of glasshouses. Tropical cyclones rated higher than category 2 will produce wind gusts much higher than this structural limit.

3.2.5 HAIL

Hail which is of a diameter greater than 50mm is likely to cause catastrophic damage to a glasshouse. Risk of hail incidence is indicated by the average annual number of thunder-days (see Figure 3-8) with those areas having a higher number of annual thunder-days more likely to be at risk of damage from hail. In NSW Schuster, Blong, and Speer (2005) note that the most active hail fall regions are the Northern Tablelands, Northern Rivers and parts of the Northwest Slopes.

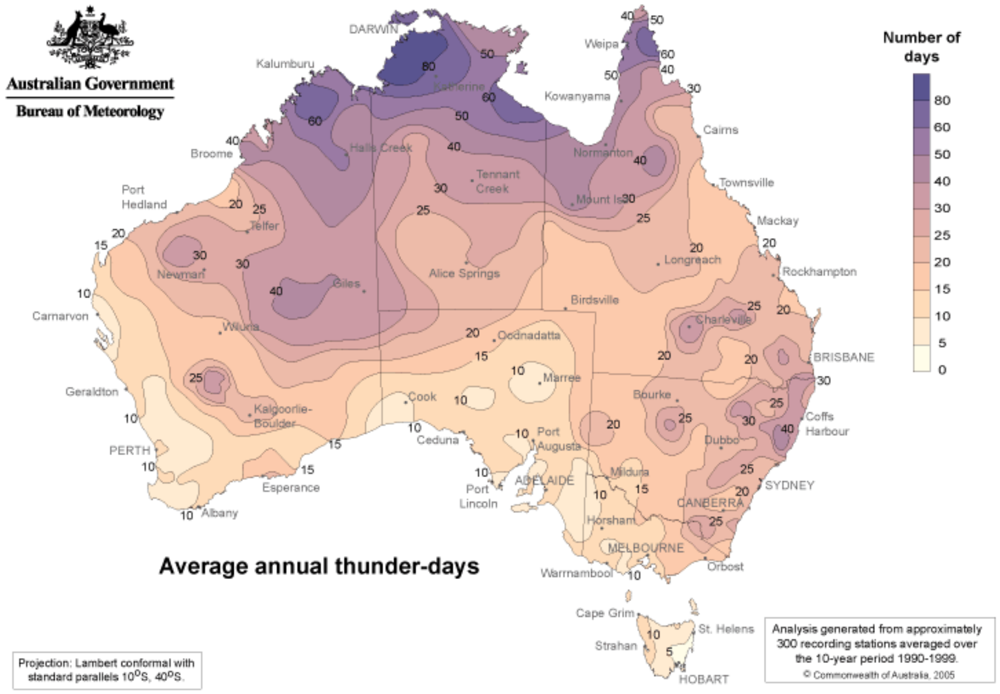

Figure 3-8: Average annual thunder-days 1990-1999 In Australia
Source: BOM (2016) [8]

3.3 PROXIMITY TO MARKETS

Close proximity to markets is no longer a major constraint on location of greenhouse horticultural operations - except of course, in the most remote and sparsely populated regions of the country – since improvements in road infrastructure and efficient supply chains means that fresh produce can be transported to the major markets quickly. However, distance from market is a function of operation size. Small producers need to be closer to market since they are generating a small quantity of product over which they can spread their freight costs. It is only the larger producers which can consider their proximity to market as having a lower priority than other factors since they are producing very high volumes of product and so freight costs form a relatively small proportion of overall costs.

An advantage of location of greenhouse operations in regional areas rather than in the peri-urban fringe is that land is cheaper and this factor will be important for any business considering development of large-scale operations.

3.4 ACCESS TO RESOURCES

Key resources for all greenhouse horticulture enterprises are water, fuel and labour.

3.4.1 WATER

A reliable water supply is a necessity for any horticultural production. Greenhouse horticulture can be a much more water efficient method of cultivation than field cropping and it also has an advantage in eliminating the risk of damage from heavy rainfall events. Peet (2004) quotes figures which compare the amount of water required to produce 1kg of field tomatoes in Israel with production in a climate-controlled greenhouse in the Netherlands. In the former case 60 litres of water is required and in the greenhouse only 22 litres, which reduces to 15 litres if drain water is recycled. Volume of crop produced in a greenhouse is, however, much higher than in open fields and so over the course of a production year the water requirement per hectare in a greenhouse is greater than in the field.

Smith (2007) details some simple analysis which allows a comparison to be made between Australian state capitals with regard to potential water availability (i.e. average annual rainfall and assuming that 100% is captured for use) and water needs (given the assumption that each joule of light a location receives over a year will require 3ml of water for plant transpiration and drainage).

[8] http://www.bom.gov.au/jsp/ncc/climate_averages/thunder-lightning/

Assuming that water used in the greenhouse is recycled at a rate of 40% Figure 3-9 shows the potential percentage of fulfilment of water needs across the capitals. All capitals are in potential water deficit excepting Darwin and Sydney where a potential 20% surplus of water supply exists.

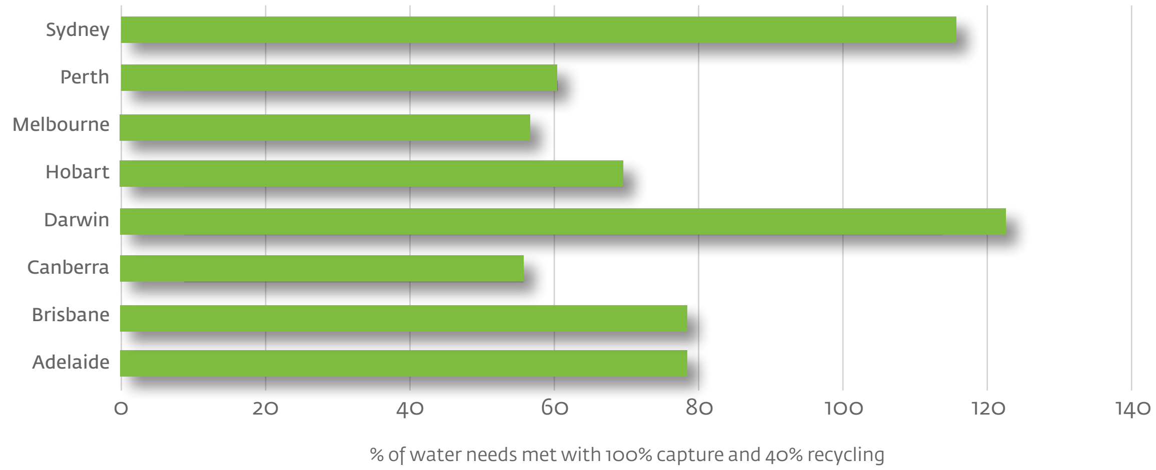

Figure 3-9: Fulfilment of water needs (%) with 100% capture and 40% recycling at various locations across Australia
Source: (Smith 2007)

3.4.2 FUEL

Greenhouses need a reliable source of fuel to provide heating and to also provide CO^2 which is pumped into the greenhouse to promote plant growth. Traditionally greenhouses have used liquefied petroleum gas (LPG) or diesel for heating, but several modern facilities now use liquefied natural gas (LNG). Access to supply of fuel is not an issue in all but the most remote areas of Australia, but fuel price can have a large impact on the profitability of the business.

Again we use some simple analysis adapted from Smith (2007) to illustrate this aspect of production. He uses the following simple rule of thumb to calculate the energy requirement of a greenhouse dependent upon the difference between the mean annual temperature at any location and the target greenhouse temperature; *for each degree centigrade difference between the mean external daily temperature and the target greenhouse temperature requires a heating energy requirement of 5m³ of LNG*. Assuming an average LNG price of $10/gJ, that 1m3 of LNG is equivalent to 38.8mJ of energy and that the target average greenhouse temperature is 20°C then Figure 3-10 shows the annual cost per hectare of energy required for heating, given monthly average daily temperatures at each location.

Costs per ha are highest in Hobart ($171,000), Canberra ($153,000) and Melbourne ($128,000) whilst Sydney, Perth and Adelaide have similar energy costs in a range between $60,000 and $80,000. Costs are low in Brisbane and zero in Darwin because of their high average daily temperatures, although greenhouses in these locations are likely to incur significant costs associated with energy required for cooling. Infrastructure required for cooling can increase costs by 30% with similar cost increases associated with increased water and energy requirements (Anon 2008).

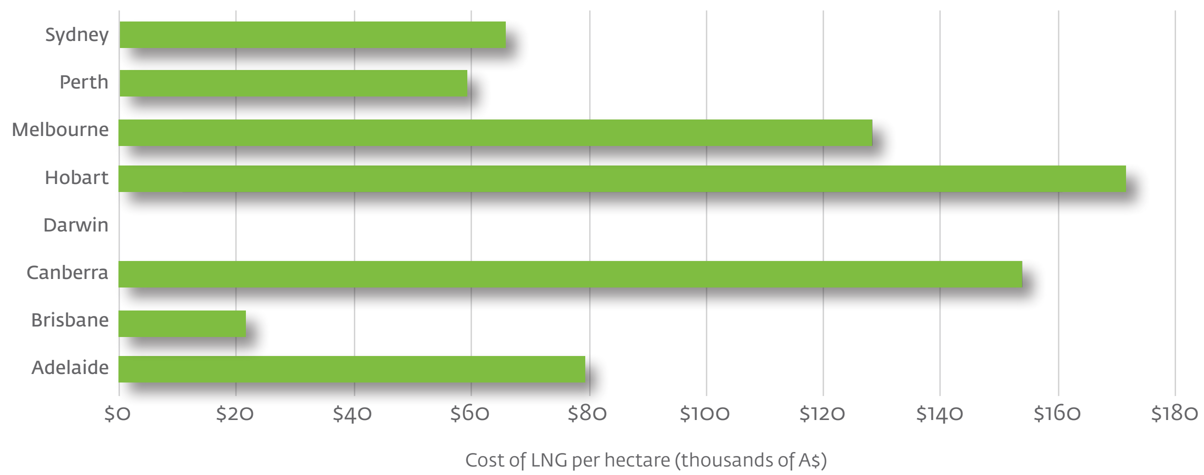

Figure 3-10: Annual heating energy (LNG) cost per hectare at various locations in Australia
Source: adapted from Smith (2007)

3.4.3 LABOUR

Large-scale greenhouse horticulture requires a significant labour force. Kurosaki et al. (2014) used observations of work practices in a 2ha CEH tomato facility in Japan and estimated that the annual work requirement was 11,293 hours per ha (which did not include packing operations or any other activities outside of the greenhouse). Assuming an average worker works 1,610 hours per year then some 7 workers would be required per ha of operation.

Much of the labour force requirement is semi- or unskilled and many of the work operations can be repetitive. For example, in a tomato greenhouse plants need to be regularly de-leafed, flowers need to be pollinated by hand and fruit needs to be picked. Whilst the most modern facilities use automation to facilitate many of these tasks the bulk of the work still has to be performed by people.

Recruiting and retaining staff for this type of work can be problematic in some areas. Using the example of the Costa tomato greenhouse complex in Guyra (in the New England region of NSW) many of the workers are recruited from overseas; predominantly Taiwanese backpackers and workers from Pacific Islands employed through the Seasonal Worker Programme. Some workers are recruited from the surrounding area for the less skilled jobs but they only usually stay for a short period.

At the other end of the spectrum demand for highly skilled growers who manage these large greenhouses is high and supply of people with suitable skills is low. Pratley (2012) argues that whilst the future for Australian horticulture is buoyant, taking advantage of these strong prospects is compromised by a shortage of professionals in the sector and by the decline in horticultural course offerings at universities.

3.5 POLICY ISSUES

Policy issues that may influence locational decisions centre on planning, environmental management, access to water and labour, and access to good transport infrastructure.

Development of new large-scale CEH facilities are unlikely to be situated close to areas of high population density and with state of the art control systems they can have a relatively small environmental impact (since there is minimal, or no, run-off of nutrients or pesticides and they can be self-sufficient in water-use), apart from an aesthetic impact upon the landscape. For these reasons planning and environmental management policy are unlikely to be important factors which influence location. Access to markets via a well-maintained road transport network is, however, likely to be an important consideration, as is access to air transportation for growers who are considering producing for export.

Re-zoning of land to urban uses in the vicinity of metropolitan areas in response to urban encroachment has had an impact in some areas (the Sydney basin, for example) in terms of reducing the numbers of small greenhouse producers in the peri-urban fringe. Re-zoning inevitably leads to an increase in land prices with the consequence that greenhouse horticulture is uneconomic in these areas for all but the most highly productive enterprises growing high-value produce.

3.6 CONCLUSIONS

The analysis presented in this chapter has been undertaken at a very simple level and so any conclusions that are drawn can only be tentative.

Plant growth is determined by climatic factors and this remains the case in all but the most closed of CEH systems. Solar radiation and temperature levels throughout the year are the primary determinants of production potential (given an adequate supply of water) and Sections 3.2.1 and 3.2.2 show that the majority of regions in Australia are favourable for greenhouse production except the most northerly. However, climate also affects the heating energy costs (see Section 3.4.2) of greenhouse production and some areas – with similar climates to Sydney, Perth and Adelaide – have much lower costs than other areas (recognising that low heating costs in areas with climates similar to Brisbane and Darwin are likely to be offset by high cooling costs).

Availability of sufficient water supply is crucial to successful greenhouse production. Section 3.4.1 demonstrates that some regions (i.e. areas with climates similar to those of Sydney and Darwin) can be potentially water self-sufficient given 100% capture of rainfall and water recycling systems.

Large-scale CEH operations have a big labour requirement and this may be difficult to fill in some regional areas without access to foreign labour.

4 POTENTIAL FOR THE EXPANSION OF CEH IN NSW

4.1 INTRODUCTION

Here we apply the locational factors outlined in Chapter 3 – as far as is possible – to the regions of NSW to assess their relative suitability for the industry. The chapter also includes a brief overview of current and future market potential for CEH products as well as providing a summary of the regulatory environment within the state as it applies to CEH development.

4.2 COMPARISON OF THE SUITABILITY OF DIFFERENT REGIONS OF NSW FOR CEH DEVELOPMENT

In terms of the climatic factors which determine production potential - and which were detailed at the national level in Chapter 3 - variation in these factors across NSW is minimal. All of NSW, except the Far West, has a climate which is conducive to CEH development. However, those areas at higher altitude - on the Great Dividing Range – have specific advantages over other regions. These advantages relate to the combination of high average daily levels of solar exposure (average solar exposure is lower along the coast because of the higher incidence of cloud cover) coupled with the lower average daily maximum temperatures that this altitude provides compared to the coastal regions. Altitude does mean that in winter these regions experience low minimum temperatures and hence any CEH facility will incur costs for heating, but this is offset by lower maximum summer temperatures and hence reduced costs (related to either fuel required for cooling or because of reduced crop yield caused by extended periods of time during which facility temperatures are above the optimal growing temperature range).

Altitude and accompanying low winter temperatures also has the advantage of reducing pest loadings.

Regional areas of NSW have cheaper land than areas closer to the metropolitan centres. However, siting of large-scale CEH operations in regional areas is dependent upon those areas having good road linkages (North and South) and a reliable supply of water, fuel and labour. The availability of labour is likely to be a major constraint on expansion. Whilst rural unemployment levels are in general higher than in metropolitan areas there is evidence that it is difficult to retain local residents in employment in these facilities and that they are reliant on a supply of overseas labour.

4.3 MARKET POTENTIAL OF GLASSHOUSE PRODUCTS DOMESTICALLY AND INTERNATIONALLY

To date CEH expansion has largely occurred in fresh market tomato production for the domestic market – although recently there has been expansion of fresh berry production; for example, Costa Group announced a Berry Growth Plan worth $80 million of capital projects in 2016 (Costa Group 2016) . This market continues to grow both in terms of market size and production, but given the volume of production from the existing large facilities there appears to be limited further scope for expansion. At the present time there are obstructions to the export of fresh tomatoes due to strict phytosanitary requirements in some Asian markets (Japan for example) which (in the case of tomatoes and some other products) have been put in place to protect those areas from introduction of Queensland Fruit Fly. Irradiation technology, and other measures, offer the possibility of overcoming this obstacle. In fact, Australia and New Zealand entered into a trade protocol in 2014 which now allows import of irradiated tomatoes to New Zealand from Australia. Further expansion will be in other products, for example; fresh berries, cucumbers and capsicums and more specialised products such as leafy green vegetables with the potential for export to Asian markets.

Whilst Australian exports of horticultural produce amounted to about $2.7 billion in 2015-2016 only about $344 million of these were vegetables and it is unclear from the statistics exactly how much of this latter figure is made up of products that might be produced by CEH, but the figure is small (ABARES 2017). At present there are few CEH producers who are specifically producing for export markets, the majority – and the vast majority of large CEH producers – are producing for the domestic market. In fact, there has been a decline in exports of Asian vegetables from Australia since the early 2000's. A report produced by RIRDC (2011) notes that exports of Chinese cabbage were eroded by 80% between 2003-2004 and 2011 which they state has been caused by a combination of competition from lower cost producers and the strength of the Australian dollar.

Horticulture Innovation Australia and AUSVEG (2017) outline a strategy aimed at increasing the value of Australian vegetable exports by 40% by 2020 basing their case for the opportunity for this expansion on;

- the growing numbers of middle class consumers in Asia and the Middle East;
- increasing demand for premium, packaged and convenient vegetable products;
- demand for safe, traceable food from reliable and sustainable sources;
- the trend towards increasing consumption of western style foods in food service outlets.

The report notes that Australian horticultural producers are at a price disadvantage compared to other producers, but have a competitive advantages in terms of quality, product/integrity and safety, seasonality and location and, further, that there is a need to develop differentiated, innovative products which can compete in these markets on non-price factors.

Large scale CEH facilities do have the capability of producing high-value, innovative, products which are consistently of high quality so there exists the potential to deliver into these export markets. However, it may be the case that the large companies that are currently in this space in Australia would be more likely to build productive capacity directly within those markets rather than export.

If penetration of Australian vegetable exports to Asia and the Middle East does increase in the future then those areas that have good transport linkages north to Toowoomba and to the new Western Sydney airport are likely to be attractive for potential investors in this industry.

4.4 OVERVIEW OF THE REGULATORY ENVIRONMENT FOR CEH DEVELOPMENT IN NSW

Policy issues that may influence locational decisions centre on planning, environmental management, access to water and labour, and access to good transport infrastructure.

4.4.1 PLANNING

Development of new large-scale CEH facilities is unlikely to be situated close to areas of high population density and with state of the art control systems it can have a relatively small environmental impact (since there is minimal, or no, run-off of nutrients or pesticides and they can be self-sufficient in water) apart from an aesthetic impact upon the landscape. For these reasons planning and environmental management policy are unlikely to be important factors which influence location. However, the efficiency of the planning process may have an influence on choice of location. The compliance costs associated with approval of new developments can vary considerably across States, as can approval timeframes. Figures reported by the Productivity Commission (2011) note that approval fees for industrial development applications in NSW (along with Queensland and the ACT) can be two to four times higher than fees in other states and whilst these fees might be relatively small compared to the overall cost of the proposed development, total compliance costs (which include in-house costs, and costs of impact and consulting studies) can be a very significant sum (an observation which applies across all States). According to data presented in this report the average development application approval time in NSW of 69 days is similar to approval times in other states, although it is also noted that the NSW average approval time ranged from a fastest time of 36 days to the slowest of 128 days [9]. Whilst planning systems differ across states and territories the Productivity Commission (2011,p XVIII) state that they all suffer from 'objectives overload', which increases process complexity and hampers the ability of planning authorities to deliver timely and consistent decisions. Legislative complexity and conflicting objectives were found to be "particularly troublesome" (p.379) in NSW and Queensland.

The NSW Government is in the process of updating the *Environmental Planning and Assessment Act 1979* with one of the stated aims being to make the planning system simpler and faster by removing unnecessary complexity (NSW Government Planning and Environment 2017). These proposed amendments to the act are currently undergoing public consultation.

4.4.2 LABOUR

If it is generally true that the kinds of jobs available in large CEH greenhouses are unattractive to existing residents in regional areas, then any change to policy which inhibits foreign workers coming to Australia will influence location. If this were the case such large operations would be more likely to locate closer to more urbanised areas in order to guarantee labour supply.

4.4.3 INFRASTRUCTURE

Access to metropolitan markets and supermarket distribution hubs via a well-maintained road transport network is a vital consideration for large-scale CEH. Regional areas of NSW generally have reasonable access to road networks, but some areas suffer from a maintenance backlog which will needs to be made up in order to make those networks "satisfactory". Poorly maintained roads increases freight costs and times and discourages new CEH or other businesses moving into those areas when they are dependent upon reliable and fast transport of their products.

Access to air transport for growers who are considering producing for export is also important.

4.4.4 GOVERNMENT SUPPORT FOR NEW DEVELOPMENT IN NSW

There are a variety of sources of financial or other support provided through the NSW or Commonwealth Government's which are available to businesses considering either growing their activity or starting-up. Predominantly these are aimed at job creation, skills development, export promotion, R&D activities and supply chain development. Business expansion or launch in regional NSW is particularly encouraged.

[9] Note that these figures are calculated across all development types and is not limited to only industrial development applications.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 VIABILITY AND RELATIVE COMPETITIVENESS OF THE NSW GLASSHOUSE INDUSTRY DOMESTICALLY AND INTERNATIONALLY

Compared to other states and territories in Australia NSW has a number of geographical, climatic and other advantages which might attract CEH.

- All areas of NSW on the Great Dividing Range and east to the coast have climatic conditions which are favourable for CEH. Areas at altitude on the Great Dividing Range have the further advantage that they enjoy high daily average levels of solar radiation and relatively lower maximum temperatures which provide good production potential for greenhouse crops.

- Whilst road networks in regional NSW are in some cases not maintained to a satisfactory level, most regions (apart from the Far West) do have reasonably direct, and fast routes to the major markets of Sydney and Brisbane. Potential for future export opportunities by air freight have also been opened up by the development of the Brisbane West Wellcamp airport as a major air freight hub, and also by the proposed of construction of the Western Sydney Airport.

- Average annual rainfall over most of NSW (apart from the Far West) has the potential to allow CEH to be self-sufficient in water supply given 100% capture of rainfall and the use of water recycling systems. In drought years, however, a secure water supply from other sources will be necessary. This requirement will mean that locations in NSW with sustainable water supplies and which have the capacity to remain sustainable given future growth in demand would be the most attractive.

- Large CEH facilities are profitable because very large volumes of high quality products which attract premium prices can be grown almost continuously over the whole of a year. Very high productivity levels (compared to field grown crops) and high levels of efficiency in production result in relatively low cost per unit produced and high returns on the initially very high capital investment required. CEH is very competitive compared to other forms of horticulture, however, there seems to be limited potential for further future expansion in domestic markets. Up until the present most of this growth has been in fresh market tomato production and this is likely to continue, although probably at a declining rate. It is also likely that there will be some future expansion of CEH at the large-scale into other crops (fresh berries, capsicums and cucumbers, for example). Growth of CEH in the longer term will be dependent on exploiting the growing markets in Asia and Middle East, and, to date, CEH products have not been significant component of Australian horticultural exports.

5.2 REGULATORY AND OTHER BARRIERS

5.2.1 PLANNING

Planning complexity, the high expense of planning applications and delays in approval processes for new developments are an issue in NSW. However, these problems also arise in other States and territories and in NSW the proposed amendments to the *Environmental Planning and Assessment Act 1979* have the stated objective of reducing delays and complexity.

5.2.2 LABOUR

The availability of sufficient labour in regional NSW is a potential major stumbling block to any further large-scale development. While regional unemployment is high, particularly youth unemployment, the types of unskilled jobs that CEH requires do not appear to be attractive to regional job-seekers and some companies are very reliant on overseas labour. Large CEH already employs a high degree of labour replacing technology and new developments in this area are being accelerated by a lack of labour in the Netherlands CEH industry which is driving the process of innovation in automation technology. Increasing automation will not completely substitute for unskilled labour and it also increases demand for medium- and highly-skilled labour, which can also be difficult to attract to regional areas.

5.2.3 INFRASTRUCTURE

Large-scale CEH in regional areas requires a fast, well-maintained road network so that products can be transported to market quickly, and production inputs can be delivered when they are required. More investment in road upgrading and maintenance will be required across regional NSW to achieve this.

5.3 OPPORTUNITY?

Large-scale CEH offers the potential to provide significant new employment possibilities in regional areas where unemployment rates are high and where out-migration of young people is high and sustained. However, construction of new large CEH glasshouses will require increasing domestic demand for CEH products and/or the opening up of export markets. Competition in Asian and Middle Eastern markets is fierce and Australia is at a cost disadvantage compared to other exporters and so export growth success will rely largely on providing high quality, high value, innovative products into those markets. BUT, since large-scale CEH is the domain of large companies it is, perhaps, more likely that those companies will develop production facilities directly within those overseas markets.

The potential for significant employment opportunities arising from CEH in regional NSW may only be a chimera if it is the case that jobs are not attractive to local residents, and if the advance of automation replaces those unskilled tasks in the near future. Furthermore, we know little about the impacts that large-scale CEH is having upon the traditional smaller-scale glasshouse businesses. Growth of large-scale CEH may simply be driving smaller-scale businesses out of the industry.

CEH has achieved a level of resource efficiency that is much higher than traditional open-field horticulture. Exceptionally high yields can be achieved with smaller, much more controlled, levels of inputs which reduce overall resource use and decrease (or eliminate) impacts of nutrient or pesticide contamination on the environment. Energy usage is high, but even here, advances in technology (Sundrop's solar thermal power plant at their development in Port Adelaide, for example, or the prospect of clean energy generating greenhouse glass) show that these developments can be energy self-sufficient, or will be in the near future. CEH is the closest we have yet come to achieving sustainable agricultural production.

5.4 DATA GAPS, AREAS REQUIRING FURTHER RESEARCH AND NEXT STEPS

- Labour constraints appear to be one of the most important potential obstacles to CEH development in regional areas. A survey of, or a series of meetings with, selected firms engaged in labour-intensive industries with similar features to CEH would provide a clearer picture of the kinds of labour issues they confront. This would enable more concrete conclusions to be drawn about labour availability and training requirements and how this matches up with the availability of training in the regions.

- Research which explores the experience of rural communities with large scale horticulture would be useful in in determining their social impact and attempting to quantify any business growth that results in supporting communities.

- The level of detail of data collected at a national level on production and numbers of businesses engaged in protected cropping has declined over recent years. Without this data it is difficult to draw meaningful conclusions about the impact that the trend to large-scale CEH is having on the industry as a whole. It would be particularly useful to be able to establish whether large-scale CEH is driving smaller – less efficient – horticultural producers out of the industry or whether there are other factors driving the general decline in numbers.

- Research is needed to identify the business experience and issues with infrastructure, natural resources and utilities in regional areas and if, or how, these issues are constraining their growth.

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