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The Australian Lavender Industry

A Review of Oil Production and Related Products

A report for the Rural Industries Research and Development Corporation

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Foreword

Interest in growing lavender in Australia has increased significantly over the last 5 years. There are now plantings in all States with the most interest in Victoria and southern New South Wales.

The objective of this report is to review the current situation in the Australian lavender industry, including its location, varieties grown, products and markets. Against this background the report then assesses current research and development activities in the industry and identifies future research needs.

The report concludes that present market indications are that the therapeutic market sector will continue to grow and the traditional perfumery market will remain relatively static. Consequently the production, varietal and application issues relating to the therapeutic market segment will be the highest priority for the lavender industry to research in the future.

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Peter Core
Managing Director
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Executive Summary

Interest in the growing of lavender in Australia has increased significantly over the last 5 years. The temperate climatic requirement for growing *Lavandula* species has resulted in plantings in all states of Australia but the most interest appears to be in Victoria and southern New South Wales.

The majority of lavender plantings target the craft and aromatherapy applications and in most cases are allied with tea rooms, bed and breakfast operations or open gardens and nurseries. The main use for lavender by these growers is dried flowers followed by fresh flowers and then oil production forming the minor component of their business. Other products include lavender honey, lavender based body care products and therapeutic formulations containing lavender oil.

The Lavender Growers Association (TALGA) is now a well established body. TALGA convenes regular conferences inviting Australian and overseas researchers to present the latest developments in lavender production and applications of lavender products. The association faces the major challenge of representing many growers from varying climatic regions, with ranging end products, with different market focus and of varying scale of operational size. Australian Lavender Industries provides a different focus for lavender growers with commercial training and workshop presentations.

Virtually all Australian lavender plantings contain *L. angustifolia*, but in conjunction with a range of other lavenders such as *L. intermedia* (Lavandin) and other species such as *L. allardii*.

The variation in scale of oil production operations is considerable with the majority of lavender growers producing less than 10 kg of oil per annum, approximately 50 - 60 growers. At the other end of the scale is the operation of Bridestowe Estate in Tasmania producing 1200 kg of oil per annum. Bridestowe Estate produces oil solely from *L. angustifolia* and is world recognised for its high quality oil. This oil quality has been produced for many decades and is complex, both organoleptically and chemically, owing to a range of genotypes selected specifically to match in quality lavender oil of the French type. As this oil has been the major Australian product for a long time, the Bridestowe Estate oil properties have been used to elaborate the Australian Standard for lavender oil (*L.angustifolia).* In the past only international standards have been in place,
Standards Australia is presently publicising new standards for Australia that will be in alignment with the ISO Standards for lavender. Four standards will be set, one each for the oil from *L. angustifolia,* Lavandin Abrial, Lavandin Grosso and Spike lavenders (*L. latifolia*).

For future marketing, nomenclature of *Lavandula* oils will have to be promoted correctly and accurately. This provides a potential opportunity to market these oils separately and differentiate between the oils for specific markets based on their specific applications.

Owing to the range of species grown as well as the different cultivars of *L.angustifolia,* the majority of oil produced by the large number of small growers does not meet the Australian standard for *L.angustifolia*. Many producers in fact produce a blend of oils reflecting the range of species and cultivars that they have planted. Interest in pure *L.angustifolia* oil is increasing owing to a strong world demand for high quality lavender oil and higher prices than lavandin oil.

There is a growing demand for all of the lavender range of oil types - *L. allardii* and lavandin oils are sought after by the aromatherapy market as is *L.angustifolia* oil for their therapeutic applications. Currently oil produced for the therapeutic market must conform to the BP standard as products are mainly marketed into the aromatherapy segment. This presents difficulties for producers and distributors as not all oils have a BP standard eg*: L. Allardii*. Also there is an increasing demand for the hydrosols derived from all lavender varieties.

The high incidence of incorrect identification and naming of species and varieties within the genus *Lavandula* further complicates the issue of standards. Many nurseries are incorrectly identifying various lavender species and labeling plants with only generic terms such as “English” or “French”. For prospective oil producers to source the correct cultivars, especially of *L.angustifolia*, this situation is totally unacceptable.

In respect to the development of the industry associations, there is a definite requirement for an industry appointed representative or executive officer to be employed by TALGA. Whilst the present volunteer committee is highly active and enthusiastic to further the development of the lavender industry in Australia, there exists a need for TALGA to be professionally managed and represented to industry and government bodies.

The most significant area of research required is in regard to breeding and selection to further improve the genetic basis for lavender production. To enable successful oil production in other regions of Australia considerable emphasis will have to be placed on the selection and potential breeding of lavenders suitable for these regions to achieve quality standards and also economic yields.

Expertise in the cultivation, harvesting and extraction of lavender varies greatly throughout the lavender growing community. There is a requirement for Australian focused research and development to optimise cultivation techniques aiming at maximising both oil production and quality.

Many participants in this review have raised the concept of a national register of *Lavandula*. Although not strictly research, such a facility is required for the industry to have a source of certified cultivars that will perform as the grower intended from their selection.

Further research and development of the therapeutic properties of lavender oil is also a high priority for the industry.

The lavender industry must first clearly define the market directions and priorities that it wishes to concentrate on as this will determine the research priorities for the future. Present market indications are that the therapeutic market sector will continue to grow and the traditional perfumery market will remain relatively static. Consequently the production, varietal and application issues relating to the therapeutic market segment will be the highest priority for the lavender industry to research in the future. All these factors will need to be examined in conjunction with each other to produce products acceptable to the market.

Introduction

The production of lavender oil must first be described into the various oil 'types' which are determinate on the variety from which the oil has been extracted.

Lavenders belong to the Lamiaceae family and within this family the genus *Lavandula* can be divided into three sections:

- Spica
- Stoechas
- Pterostoechas

Three species, *L. intermedia* (Lavandin), *L. latifolia* (Spike) and *L. angustifolia* (Lavender) are the main commercial species that belong to the Spica group.
The other two groupings are used for dried flowers or home gardens as, although they contain an essential oil, are of no interest to world perfumery markets.

World lavender production is predominantly centred on Lavandin cultivars as they have a more vigorous growth habit and yield greater quantities of oil. The present world production figures vary but average at approximately 1200 tonnes per annum produced traditionally in Europe and increasingly in the United States.

In contrast, the world production of *L.angustifolia*, traditional lavender oil, is approximately only 200 tonnes per annum, but again predominantly emanating out of Europe.

The key differences in these two products are their oil composition. In general terms lavender oil (*L.angustifolia*) is low in camphor (less than 1%) and contains no bornyl acetate. Lavandin oil (*L.intermedia*) has camphor levels generally of 10-12% and linalool of up to 20%.

The production of lavender oil in Australia has been centred at Bridestowe Estate near Lilydale in north-eastern Tasmania. The plantings are the resultant selection of *L. angustifolia* over many years by the Denny family. Bronson and Jacobs Pty Ltd, an Australian company trading in essential oils, aromatic extracts and isolates, now own this production area. Production is in the order of 1.2 tonne per annum. This enterprise currently generates approximately 60% of its revenue from tourism.

Many small production areas have been planted with increasing frequency over the last 10 years, predominantly in Victoria and southern New South Wales but also in Western Australia and South Australia. Virtually all of the smaller enterprises are targeted at the tourism and aromatherapy supply market. These production areas are predominantly in the size range of 0.25 to 1 ha. Only some four to five production units exceed the 1.5 ha scale of planting and the volume of oil produced is predominantly in the 5 to 10 kg per annum range. Consequently the total level of oil produced by all growers aside from Bridestowe Estate would only be approximately 0.5 tonne.

Various figures are stated as to the amount of *L.angustifolia* oil that is imported into Australia but it is probably in the order of 25 tonnes per annum and Lavandin imports in the order of 30 to 50 tonne per annum.
Consequently considerable interest by existing and potential growers in production for import replacement is occurring in Australia at present.

Organic lavender oil(s) are increasing in demand at approximately 35% per annum at present compared to a general increase of 5% per annum for conventionally produced oils. The price received for organic lavender oil(s) is generally twice that of conventionally produced oils when sold in small lots.

Australian Associations

The Australian Lavender Growers Association (TALGA), formed in 1995, has some 500 members throughout Australia. In addition an alternate association, Australian Lavender Industries (ALI) has some 200 members. It is estimated that 100 members may be subscribed to both organisations. Therefore the estimate of total members potentially as lavender growers in Australia would be 600. ALI is a commercially based organisation whereas TALGA is a non profit association whose executive is elected from the membership.

Many of these growers are involved in these associations purely as home gardeners with an interest in lavender. At the 2001 International Lavender Conference held in Wagga Wagga by TALGA, 150 attendees were present representing some 80 Lavender farms of varying scale from all states of Australia. This number is much more indicative of the number of commercial lavender operations throughout Australia.

The key difference between the two associations is that ALI operates as a private business whilst TALGA is a non-profit organization run by volunteers.

TALGA produces a newsletter, 'The Goode Oil" and actively manages a web site, http://www.talga.com/ providing information on the association as well as general information relating to lavender production and marketing. ALI also produces and manages a web site providing similar information, http://www.lavenderaustralia.com/ TALGA also has a register of sellers and buyers that has been implemented but not well supported to date.

There is a number of regional sub-groups within TALGA. Examples of these are the Mornington Peninsula Group, another group in the Portland region and the Monaro Country Co-operative. These groups actively conduct farm field days and workshops on lavender propagation, cultivation and promotion of TALGA on a regional basis. In addition TALGA has area liaison members for each state to handle regional issues.

The Mornington Peninsula group consists of a small number of producers from the region that have a variety of different styles of operation ranging from larger tea gardens to small producers of stripped lavender flowers. The members cooperate amongst themselves with product and actively complement each other. All members market under the banner of the "Mornington Peninsula Producers" and are presently investigating a lavender trail through the region similar to the existing wine trail.

The Monaro Country Co-operative has a base of 30 growers in southern New South Wales and as far as Canberra. The co-operative operates a retail outlet, "Lavender House" at Bombala, selling a full range of lavender products. This group also conducts regular workshops on cultivation and distillation.

As of the 1st of July 2001, TALGA has initiated a levy of 5% of the subscription fee to be allocated to a research and development fund. Other methods of funding procurement are currently under examination by the association.

TALGA recognises the breadth of the association's members ranging from the cottage industry to emerging commercial enterprises. Within this context TALGA has identified the need to be more highly focused upon the primary production of lavender oil needs of the membership whilst maintaining the integrity of the cottage industry roots. Association management, industry plan, marketing, research and development, levies, import replacement, new product development and industry and government representation are the key issues being targeted by the current executive along with greater resource provision to members.

Lavender Products

A range of diverse products are presently derived from lavender production in Australia.

Dried flowers are used in potpourris and the craft industry. Flowers are mainly cut by hand once the first few florets open and are either hung in bunches to air dry indoors or placed on a concrete or asphalt surface to dry in the sun. Dried flowers are either stripped from their stems or are used as complete long stems for craftwork such as basket weaving. *L. intermedia* is the most commonly grown hybrid for the dried flower market owing to its vigorous growing, upright habit and high yield of flowers. Varieties are important when seeking long stems and good retention of florets in the flower head. The most commonly grown are "Grosso", "Seal", "Super", "Miss Donington" and "Yuulong".

L. angustifolia varieties are also grown for stripped lavender owing to the more traditional nature of their fragrance. However, flower yields are not as high as *L.intermedia*. Varieties commonly grown are "Hidcote", "Munstead", "Egerton Blue", "Folgate", and "Bosisto". Stripped flowers are also used in teas and sachets and increasingly in other foodstuffs e.g. ice cream, mustards and baked products.

Many growers produce for the fresh flower market. The flowers are harvested by hand and sold in bunches to local markets and florists. Again the *L.intermedia* is the main species grown followed by *L.angustifolia*. The similar varieties of dried flower production are also grown for fresh flowers. *L.allardii*, another hybrid, appears to be the next most commonly grown owing to the long stiff stems, which present and keep well in floral arrangements.

Honey produced using lavender flowers as a source of nectar has been identified by a number of growers as a potential product. Interest extends to the possible therapeutic activity of lavender honey as well as the normal culinary use. At present, the amount of true lavender honey marketed appears to greatly exceed the actual capacity of growers to produce true lavender honey. Honey produced from lavender has no aroma or taste associated with lavender scent. Honey products marketed as lavender honey that taste or smell of lavender are not true lavender honey and have been supplemented with lavender oil. At present only a handful of lavender plantings are big enough and sufficient a monoculture to produce a honey strictly derived largely from the lavender nectar. Care needs to be taken in the future marketing of this product to ensure that the market does not begin to accept a lavender flavoured honey as lavender Honey. Such products need to be labeled correctly as "lavender flavoured honey".

Many lavender growers also diversify into pot plant production, propagating plants predominantly from cuttings, particularly if their business focuses on the tourism market. The main issue with such propagation is the very poor identification and labeling of plants when sold.

Lavender oil is produced for a number of different markets. The traditional market has been for fragrance applications, predominantly in body care products. Products range from bath and shower gels, body lotions, hand creams, to talcum powders, shampoos etc. The application of lavender oil in aromatherapy products has been steadily increasing despite the considerable historical use of lavender oil in aromatherapy. This increase appears to be driven by a renewed awareness in the potential therapeutic benefits of lavender oil, but also an awareness of the potential therapeutic benefits of other *Lavandula* species/hybrids.

The lavender species origin of the oil for such products is very contentious due to the variation in the therapeutic nature of the different oils derived from the different species. This raises the issue of correctly distinguishing between lavender oil (*L.angustifolia*), lavandin (*L.intermedia*) and other *Lavandula* species/hybrids. With the majority of the world lavender oil production resulting from

Lavandin, highl camphor oils predominate the world markets. The renewed market interest at present is not for these styles of oils but for *L.angustifolia* or lavender oil. At present both oils are regularly, but incorrectly traded under the generic term of "lavender oil". This issue is further complicated by the fact that only *L.angustifolia* is on the Australian Register of Therapeutic Goods and therefore is the only oil that can currently be labeled as therapeutic. Considerable anecdotal evidence exists for therapeutic activity in species/hybrids other than *L. Angustifolia.* This area is currently under investigation.

The Charles Sturt University carried out a survey of the attendees of the 2001 TALGA conference. The following results where obtained in respect to the range of lavender products produced.

Products of lavender	**% of respondents**
Dried flowers	76
Fresh flowers	42
Essential oil	66
Value added products	52

75% of respondents produced at least 2 types of lavender products

Estimated income from lavender

Estimated Annual Income	**% of respondents**
< $5,000	61
$6,000 - $20,000	28
$21,000 - $30,000	-
$31,000 - $40,000	-
>$40,000	11

Note: many respondents indicated that as their lavender farm was still being established there was no lavender-related income as yet.

Lavender varieties - Issues

As indicated in the introduction three species, *L. intermedia* (Lavandin), *L. Latifolia* (spike lavender) and *L. angustifolia* (lavender, French type) are the main commercial species. The resultant essential oils from these species vary greatly, to such an extent that individual standards for the essential oil have been established for each species and its commercial hybrids.

Standards Australia has adopted standards for these oils from the ISO Standard in regard to the main components in each of the essential oils and the acceptable range for each of these components. The *L.angustiflolia* standard has been set based on the main source of commercial quantities of oil for many decades, namely the oil composition as produced by Bridestowe estate, selected and designed to satisfy the fragrance market.

Yuulong lavender Estate near Ballarat is the repository for the National Registered lavender collection containing some 120 varieties of the genus *Lavandula*. This collection is invaluable for growers of lavender requiring positive identification for any of their plants.

In general identification of individual members of the genus *Lavandula* leaves a lot to be desired in Australia with many nurseries incorrectly identifying and labeling plants. Generic terms such as "English" and "French" lavender are used regularly, with no reference to species name. Although this may not be of too great an issue for the home gardener, the sourcing of incorrect or misleading plant stock for commercial producers can be devastating.

The correct identification of species and variety is essential to the development of any lavender business to enable the correct selection of plant material suitable to the particular growing environment and more importantly for the intended market of the final products. This is particularly important for oil production where varietal differences are the main controlling factor in respect to the oil quality obtained.

A number of growers have placed orders for specific varieties based on their planned target markets and have only discovered that they have been supplied a completely different variety once the plants were in the ground. Consequently it is highly advisable to research the varietal traits well before purchasing and, if in doubt, have a sample verified.

At present there is no easily accessible repository of varieties and expertise available for such verification purposes in Australia. There exists a considerable need for some form of varietal certification process for lavender varieties. In fact this issue is not confined to Australia, labeling of lavender plants worldwide appears poorly conducted in most countries. Australia does have the potential and expertise to become a world leader in regulating lavender taxonomy.

Australian Oil Producers

Australian lavender oil producers fall into two categories, small scale, cottage industries and larger commercial scale producers. The small scale, cottage type operators typically produce amounts of oil no greater than 100 kg per annum and in the main less than 25 kg per annum. A large scale producer(s) would be catagorised as producing greater than 250kg of oil per annum. At present there is only one main large scale commercial producer of lavender oil in Australia, Bridestowe Estate in Tasmania, whilst a couple of New South Wales producers are in the process of scaling up their plantations to produce large volumes in the future.

Small scale producers predominantly market to local art and crafts shops, small aromatherapy companies and tourist markets whilst the large scale producer(s) either currently sell or are attempting to sell to the manufacturers of perfumery and cosmetic products. The latter industries are more heavily regulated and discerning of quality and specification. Therefore the market segments that are of interest to the small scale producer will not be the same as a large scale producer. It also follows that the requirements for satisfying quality and specification will not be the same.

The issues that relate to quality and specification, such as varieties, crop management, extraction techniques, blending and packaging, are therefore distinctly different for the small scale producer compared to the large scale producer. Consequently, the requirements for research and development will also be different for each scale of operation.

The major producer, Bridestowe Estate, has approximately 100 hectares of lavender currently under production but yields over the last few seasons have been very low compared to the theoretical potential of the production unit. Many issues have been cited as to the poor performance of the lavender but most are a result of the long-term monoculture nature of the site. Consequently, the present owners, Bronson and Jacobs, are investigating the expansion of production at a new site in the Northern Midlands of Tasmania. Personnel from Essential Oils of Tasmania Pty Ltd, also a

Bronson and Jacobs subsidiary, are planning to apply commercial technology developed for peppermint and fennel production to this new lavender production area.

As mentioned above, a number of regional groups of lavender producers exist in Victoria and southern New South Wales. Other regions of current production in New South Wales are centered around Wagga Wagga and also Bowral. The latter area has high emphasis on tourism due to the relatively close proximity to Sydney and the high tourism activity of the region. Many individual lavender plantings exist in other areas of the state but again focus on regional tourism in the main. South Australia has similar small plantations.

In addition lavender production is currently underway in Western Australia at Bunbury, Busselton and Margaret River regions. Plantations have also been established in some higher altitude regions in South Eastern Queensland. These plantings are solely *L.angustifolia* cultivars that have been sourced for their ability to grow well in this warmer climate.

Despite the fact that Tasmania has the largest single lavender plantation, very few other lavender based businesses are present. A couple of smaller farms are operating in the south and the Midlands as well as on King Island. These are generally in combination with other ventures such as bed and breakfast accommodation.

In respect to all other Australian lavender oil producers, the following survey of the attendees of the 2001 TALGA conference, carried out by the Charles Sturt University, indicates the type of oil production and actual scale of their enterprises currently involved in oil.

Varieties of lavender grown

97% of respondents who grow lavender grow *L. angustifolia*, with the majority of these growing at least 2 varieties (see table).

Variety/species grown	**% growing variety**
L.angustifolia only	9.2
L.dentata	3.1
L.angustifolia & L.intermedia	44.6
L.angustifolia & L.dentata	1.5
L.angustifolia, L.allardii & L.intermedia	16.9
L.angustifolia, L.intermedia & L. stoechas	7.7
L.angustifolia, L.allardii, L.intermedia & L.stoechas	7.7
L.angustifolia, L.allardii, L.intermedia & L.latifolia	3.1
L.angustifolia, L.intermedia, L.stoechas & L.latifolia	1.5
L.angustifolia, L.allardii, L.intermedia, L.stoechas & L.latifolia	4.6

Estimated oil production per year

Volume of oil (L)	% of respondents
1 L or less	31.7
2 - 10L	45.3
11 - 50 L	18.1
> 50 L	4.5

Note: many respondents indicated that as their lavender farm was still being established no or little oil had been produced

(Source - Dr Jenny Wilkinson CSU)

The figures on oil volumes produced contrast greatly between even the largest mainland Australia growers and Bridestowe Estate at the present time.

In general most growers initially plant *L.intermedia* varieties owing to their vigorous, robust habit and ease of growing. The tendency now appears to be to plant more *L.angustifolia* predominantly due to the increased interest in aromatherapy.

The number of growers presently commencing production as well as the planned increases in plantings by existing growers will result in a small increase in the Australian production figures. However the planting of at least two (potentially 3) large-scale oil only plantations will significantly increase Australia's lavender oil production in the next 5 years.

Current Research

Much of the recent research in the rest of the world centres around the therapeutic activity of lavender based products. Most of these trials are targeted at determining the effect of lavender fragrance on the human emotional state (Son-KiCheol et al, 2001) (Miki-S et al, 1997) (Lis-Balchin-M; Hart-S, 1999). Generally lavender used in this context is considered within a range of essential oils. The general findings indicate that *L.angustifolia* oil does have influence on our physical and mental state acting in the nature of a sedative whereas *L. allardii* has been demonstrated to be a stimulant. *L.allardii* also has been demonstrated to have anti viral qualities. This has not been detected for oil from *L.angustifolia* and *L.intermedia*.

Other studies have examined the potential for lavender as a local anaesthetic (Lis-Balchin-M; Hart-S 1999). They have indicated that any such activity appears to be due to the compounds linalool and linalyl acetate present in the oil. Many historical references can be found that promote the application of lavender oil in this manner.

Similar studies have been carried out as comparative assessments of a range of essential oils and their efficacy as anti-microbial agents. Oils derived from a range of lavender species repeatedly rate highly in efficacy trials leading to the conclusion that many of the present usages that lavender has been advocated may have significant merit (Inouye et al 2001) Much of this research has been focussed on *L.angustifolia* with few trials using oil derived from other *Lavendula* species. For more detailed information in this regard there are number of papers presented at the 2001 International lavender Conference that provided for further reading, eg. Rasooli (2001), Ryan and Wilkinson (2001).

Another novel use for lavender oil that has been recently studied is the potential for the oil as a pesticide (Landolt-PJ 1999). In a study of the efficacy of 27 different essential oils on codling moth, lavender oil was the most effective in controlling this parasite.

In Australia, the Charles Sturt University (CSU) has a number of lavender related projects underway. As mentioned above minimal research into the anti-microbial activity of a range of oils from different species has been conducted. CSU is presently undertaking such trials and initial results look promising. The outcome from such research is that potential may exist to market specialised oil(s) from specific lavender varieties into the anti-microbial market.

Studies on the wound healing activities of *L.angustifolia* and *L.allardii* oils are being conducted by CSU in an attempt to verify the somewhat anecdotal evidence that application of lavender oil helps wound healing and reduces scarring. This work is also examining oils from different geographic origins to determine any variation in efficacy and how that may relate to individual compounds within the oils or at least the balance of compounds, Wilkinson (2001). Within this research, lavender honey is also being examined as a wound dressing substrate.

Further research on a small preliminary scale has been undertaken to look at the possible chromosome manipulation of lavender using mutagenic compounds. Very little research has been conducted in regard to breeding of superior lavender lines and such research holds the potential for significant benefits to the industry in the long term.

Other areas of Australian research focus on oil analysis and more in-depth examination of oils and their individual components, Shellie R, Marriott P and Cornell C (2000).

Recent advances in agronomic studies have been mainly conducted by European researchers. For example mechanical transplanting of lavender seedlings (K"nev-KG et al 1990), mechanized interrow cultivation (Todorov et al 1990), effects of irrigation (Nedkov and Slavov 1990) , nitrogen and density studies (Ceylan et al 1996) . Very little research on lavender production in Australia has been conducted outside that of Tim Denny on Bridestowe Estate. Consequently these works form the basis of most cultural, harvesting and extraction procedures in Australia.

The Monaro Country Lavender Co-operative has been conducting a State Government funded project to analyse oil produced by their growers over the last two years. These analyses have been conducted by the New South Wales Department of Agriculture. In addition data on climatic information, irrigation regime, soil types, distillation factors have been collected in order to correlate with the oil analysis results. This funding has recently ceased and the group is keen to investigate other sources of funding to continue the research.
The New South Wales State Government also funded the development of an industry plan for lavender oil. This is in its final stages of completion.

CSU has also been conducting headspace analysis of a range of varieties of lavender to look at the potential for chemotaxonomic differentiation of varieties. This would enable a rapid identification test that could potentially be conducted in the field, (Haig, Min and Antolovich 2001).

In Victoria, the Department of Natural Resources and Environment Werribee has produced a map of the southern Victorian region detailing suitability for lavender production. This information has been derived through a compilation based on regional climatic data, altitude and soil type.

The University of Tasmania has examined the composition of the oil from Bridestowe Estate cultivars over a number of years. The University now holds a collection of very low camphor selections and is currently seeking funding to further this research.

Crop Management

The pest and disease control measures required for cultivating lavender are minimal compared to conventional agricultural crops. Problems that do arise are generally site specific and seasonal in nature and can be controlled with conventional pest and disease eradication programs. Growers have not identified any recurring pests or diseases that require annual preventative control measures. Unless specific diseases of certain varieties become apparent in the future, pest and disease programs will not be widely required.

The majority of growers have small production areas that need to be kept highly presentable for tourists to view. Consequently most growers hand weed their plantations and even Bridestowe Estate with its large production area employs gangs of hand weeders for weeks at a time. Whilst the revenue from tourism covers such high labour costs, chemical weed control is seen as a minor requirement not requiring significant research. Similarly organic essential oil producers will have no interest in pesticide research unless it relates to biological pesticides.

In the case of development of large "stand alone" oil production plantations, chemical weed control strategies will be imperative to the success of such ventures. At present relatively few herbicides are registered for application in lavender crops. Many of the current chemicals are utilised outside label recommendations. Such practices are very dangerous both legally and for the implications of potential contamination of the final oil product. More and more buyers have access to highly sensitive analytical technology to determine pesticide residues in essential oils.

Irrigation and nutrition in lavender production are two areas of management that appear to have conflicting perceptions of importance by growers. Lavender is actively promoted as a xerophyte, in other words, water hardy, not requiring irrigation, at least once established. Unfortunately this characteristic appears to be taken to the extreme by some growers and flower and oil yields subsequently suffer. As with many other essential oil producing plants there will be key stages of growth that are critical to flowering and essential oil accumulation. Unfortunately little information is available pertaining the effects of irrigation and application of fertilisers to lavender. New Zealand lavender oil production over recent years has shown that oil yield as well as oil quality is compromised during unseasonally dry conditions.

At present most growers have relatively young plantings and the nutritional status of the plants has not been seen to be a high priority. Older plantings will definitely require some management in this regard. At Bridestowe Estate the continual cropping of the lavender plantation is raising issues of sustainability of long term lavender plantings. Trials with rotational or lay phases and green manures are being conducted at Bridestowe Estate to restore organic matter levels and soil structure. Trace element issues may also arise in the longer term especially in regions where key trace elements may be limiting in the inherent soil matrix. In France and the United Kingdom lavender plantings remain for on average 20 years without any rotation. Similar issues would be anticipated to occur in these production areas over time if the issue of sustainability is not addressed. Australian producers could obtain a significant long term advantage in the world market if the issues effecting sustainability could be better understood and managed.

For the production of lavender honey, lavender growers are advised to seek professional beekeepers to manage bees. Specialised equipment and expertise are necessary to handle and manage bees as well as extract and clarify honey from hives. Difficulties also exist in some regions of Australia with competing nectar sources in flowering plants nearby lavender plantations. One such example is Patersons Curse. Some French research has indicated that essential oil yield may increase following

increased pollination by bees. Such findings require verification in Australia and also within the different *Lavandula* species.

Future Research

The most significant area of research required is in regard to breeding and selection to further improve the genetic basis for lavender production. The high quality oil produced by Bridestowe Estate is a direct result of many decades of selection for this particular region of Tasmania. To enable successful oil production in other regions of Australia considerable emphasis will have to be placed on the selection and potential breeding of lavenders suitable for these regions to achieve quality standards and also economic yields.

Expertise in the cultivation, harvesting and extraction of lavender varies greatly throughout the lavender growing community. Most growers source information from a couple of key industry members within Australia, look to European sources of information or refer to the publications produced by Tim Denny, the founder of Bridestowe Lavender. The development of the Bridestowe Estate plantations and many early developments in steam extraction techniques have for decades guided not only Lavender growers, but producers of other essential oils. To date input from tertiary institutions and commercial research companies directly relating to Lavender has been limited in Australia. Consequently there is a requirement for Australian focused research and development to optimise cultivation techniques aiming at maximising both oil production and quality. TALGA has nominated CSU as the center for the compilation of an oil database. This requires further reinforcement as the industry needs a central repository of information.

Many participants in this review have raised the concept of a national register of *Lavandula*. Although not strictly research, such a facility is required for the industry to have a source of certified cultivars that will perform as the grower intended from their selection.

A review of the existing cultivation techniques utilised in lavender production would enable the investigation of the potential for integration of alternate crop management techniques utilised in other industries. Many commonly used agronomic practices from mainstream agriculture and horticulture have not been applied to lavender production. Many techniques now used in other horticultural crops may have enormous benefits for the future of lavender pproduction.
In addition, minimal information is available on the interaction of environmental factors such as climate, soil type etc with lavender varieties in Australia and the resultant effect on the oil yield and composition. Preliminary work has been conducted at CSU with regard to plant development, identification, oil yield and geographic location combined with distillation process. This will require much more extensive research and development.

Some collation of the desirable environmental factors presently regarded as necessary for cultivation of lavender has been undertaken in specific regions. Research into the interactions referred to above needs to be conducted to provide more definitive information to help guide and advise future producers. At present most production units have been developed as an adjunct to another business or just because of an interest in lavender. The primary objective for the development of larger scale lavender oil production areas in the future should be acquisition of sites with the appropriate environmental conditions, soil types and aspects for optimising oil yield and quality.

Further research and development of the therapeutic properties of lavender oil is a high priority for the industry. The majority of *L.angustifolia* oil market growth in the last 5-10 years has been in this segment rather than in the fragrance market. At present many of the applications for lavender oil are still entrenched in folklore but recent scientific research is gradually assisting with the verification and consumer acceptance of such products. The scope of further research must be well targeted to

ensure that the key market segments are scientifically satisfied first. Many such products suffer from the “cure all” syndrome and are presented to consumers in a multitude of ways. The industry must determine in consultation with the retail market the priorities for particular application of lavender oil that will be researched and verified. The potential exists to examine the individual therapeutic properties of a range of different species of *Lavandula* and market these accordingly. The focus of such research should be centred on the benefits of the lavender oil as a complex essential oil product not just the activity of key components such as linalool or linalyl acetate as these compounds are readily available from other cheaper sources.

The lavender industry must first clearly define the market directions and priorities that it wishes to concentrate on as this will determine the research priorities for the future. Present market indications are that the therapeutic market sector will continue to grow and the traditional perfumery market will remain relatively static.

Consequently the production, varietal and application issues relating to the therapeutic market segment will be the highest priority for the lavender industry to research in the future. All these factors will need to be examined in conjunction with each other to produce products acceptable to the market. Research into individual factors is important but unless it is related to the overall production system through to end product, market acceptance will be more difficult to achieve.

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