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Taking Stock of the Australian Truffle Industry

by Barry Lee

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Foreword

Truffles are one of the most highly sought after and valued foods in the world despite being a relatively new crop in Australia.

Recognising the potential for commercial truffle production, the Rural Industries Research and Development Corporation (RIRDC) commissioned a number of research projects and awards in the 1990s to help Australia's emerging truffle industry grow and expand. More than a decade later, the industry is entering a new phase of investment and growth.

This report, commissioned by RIRDC following discussions with The Australian Truffle Growers Association, provides a snapshot of the current status of the industry in Australia. It examines production estimates, potential for growth, pricing estimates and the necessary infrastructure required for a profitable and sustainable Australian truffle industry. This research was funded by RIRDC on behalf of the Australian Government.

This report provides a reference for researchers and industry members involved in the production, processing and marketing of truffle products in Australia, and for those considering investing in this new and exciting industry.

The production of this report was funded by RIRDC core funds which are provided by the Australian Government.

This report, an addition to RIRDC's diverse range of over 1800 research publications, forms part of our New Plant Products Research and Development Program, which aims to facilitate the development of new rural industries based on plants or plant products that have commercial potential for Australia.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/fullreports/index.html
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Peter O'Brien

Managing Director

Rural Industries Research and Development Corporation

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Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AU\$	Australian Dollars
EU	European Union
ha	Hectare
HACCP	Hazard Analysis and Critical Control Points
Kg	Kilogram
\$M	\$ Million
NSW	New South Wales
pa	Per Annum
QA	Quality Assurance
QLD	Queensland
R&D	Research and Development
RIRDC	Rural Industries Research and Development Corporation
SA	South Australia
USD\$	US Dollars
VIC	Victoria
WA	Western Australia

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Executive Summary

What the report is about

During the 1990s, Rural Industries Research and Development Corporation (RIRDC) assisted the Australian truffle industry by supporting a number of research projects and awards. The industry has since grown and expanded, and is now entering a new phase of investment and growth. Following discussions with The Australian Truffle Growers Association, RIRDC commissioned this review into the status of the truffle industry, the industry's research requirements and future priority issues.

Who is the report targeted at?

This report is targeted researchers and industry groups involved in the production, processing and marketing of truffle products in a broad range of markets in Australia as well as in Europe, Asia and North America.

Aims/Objectives

The aim of this report is to investigate the current status of the Australian truffle industry and the research and development requirements to ensure future growth and development. In particular it addresses the following key issues:

- the status and location of the industry across Australia
- production estimates
- potential for growth
- pricing estimates
- industry infrastructure requirements for future growth.

Methods used

The methodology comprised a combination of desktop research and industry consultation, conducted throughout the following stages:

- **Assessment of Industry, Markets and Industry Resources**
Survey of industry groups, distributors, end-users including chefs, and researchers.
- **Development of State and National Industry Profiles**
Industry characteristics by location, grower type, cultivated area, yields and markets.
- **Strategic Analysis**
Review of industry issues and SWOT analysis.
- **Future Industry Priorities**
Key issues and research investment opportunities.

Results/Key findings

Finding 1 – Estimated Industry Growth

Truffières in Australia are projected to experience a rapid rate of growth over the next five years, from an estimated 250 hectares (ha) of mature truffière land in 2007 to almost 600 ha by 2013. This represents an average rate of growth of over 20 % per annum.

Finding 2 – Estimated Production and Yields

The production or harvest of truffles has steadily increased since 2002 to an estimated 800 kg in 2007. The Australian Truffle Growers Association estimates that, based on an annual increase in production from existing truffières alone, Australia will produce between five and ten tonnes of truffles by 2013.

Finding 3 – State Locations

The three main truffle growing areas in Australia are Tasmania, Western Australia and NSW.

This is expected to remain unchanged until 2013, with significant new truffière developments planned or underway in these states, including:

- the Oak Valley Truffle Project 2007 which is a 60 ha development in WA
- the Tasmanian Truffle Project No. 3 which is a 73 ha development in Tasmania
- new plantings in NSW and Victoria

Finding 4 – Changing Structure of the Industry

The management of truffière land area is projected to change due to increases in numbers of large-scale investment growers (defined as Type 2 growers in the report). In particular it is estimated that by 2013, the proportional share of truffière land area managed by these growers will significantly increase from 8 % to 31 %.

Finding 5 – Australian Market Demand

The Australian wholesale market for French black truffles is estimated to be to the order of one tonne or almost \$AU2 million per annum.

Finding 6 – Export Market Research and Development

There is a need for further research into potential export markets and market development, especially for Asia. In particular the research should determine price trends due to production and demand factors in international markets.

Finding 7 – Australian Market Growth

Educating consumers and markets about Australian truffles is important to the growth of the industry, especially for processed and value-added truffle products which offer a significant ‘import replacement’ market opportunity for Australia.

Drivers for industry growth:

- growth in Australian market demand for French black truffles grown in Australia
- counter-seasonal exports to northern hemisphere markets
- Asian market proximity and growth in demand for Australian truffles
- continued limited supply of truffles in Europe
- knowledge of production and demand factors affecting market pricing trends
- increased yields of truffles from Australian truffières
- development of quality standards to ensure consistency of Australian truffles
- development of preserved and value-added truffle products using Australian truffles
- development of technical and research resources for the industry
- efficient communication and management of whole-of-industry issues.

Constraints for industry growth and sustainability:

- variable understanding of strategic export markets such as Asian markets
- lack of consumer and market education about Australian truffles
- variable understanding between growers on optimal climate and soil conditions to grow truffles in Australia
- variable knowledge between growers on truffière establishment, tree handling and management systems to maximise the growth of truffles in Australia
- variable yields, volumes and quality of Australian truffles
- lack of quality assurance for propagation of seedlings and trees using guaranteed sources of inoculum
- biosecurity risks especially from imported truffles
- lack of guidance on quality grading standards for Australian truffles
- competition and/or substitution from other country suppliers
- variability of grower skill levels
- lack of access to technical and research resources
- limited further processing facilities for Australian truffles.

Implications

As the Australian truffle industry enters a new phase of investment and growth, the major challenge will be developing market opportunities and managing growth constraints without imposing additional administrative costs upon the industry. The Australian Truffle Growers Association, which was established in 2006, has an important role in coordinating management of whole-of-industry issues and priorities. Potential issues include:

- industry marketing and consumer education
- industry quality and grading standards
- biosecurity issues
- industry sustainability and climate change
- research and development.

Recommendations

Objective: Improvement of the Economic Viability of Truffle Cultivation in Australia

Recommendation 1. Support strategic research in the industry to improve production yields and consistency of harvest of Australian truffles across all grower types.

Recommendation 2. Conduct a risk assessment study for imported Chinese truffles and their potential biosecurity risks to the Australian truffles industry.

Recommendation 3. Review and assess the benefits associated with an audit and certification process for inoculated seedlings, trees, and truffles.

Recommendation 4. Develop the availability of independent technical skills and resources in the fields of mycology and truffle cultivation in truffières.

Objective: Development and Growth of Markets for Australian Truffles

Recommendation 5. Support projects to educate consumers and markets about Australian truffles and the Australian truffle industry.

Recommendation 6. Conduct export market research and market development projects especially for Asian markets. In particular, the research should determine price trends due to production and demand factors in international markets.

Recommendation 7. The industry as a whole should review strategies to underpin future prices for Australian truffles. These strategies may include branding, labelling, packaging and quality standards.

Recommendation 8. Carry out new product development for import replacement, associated with further processed and value-added truffle products. In addition, research should be focussed upon new product developments which use applications of truffle odour chemistry.

Recommendation 9. Further develop, review and implement the grading standard for Australian truffles, currently in draft form with The Australian Truffle Growers Association.

Recommendation 10. Review and assess the benefits of processing and packaging technologies that may enhance the distribution and shelf-life of truffles.

Objective: Management of Industry Communications and Whole-of-Industry Issues

Recommendation 11. The industry should ensure that it has the resources and processes in place to manage and respond to potential whole-of-industry issues over the next five years. To this end, The Australian Truffle Growers Association is an industry organisation which has a role in addressing whole-of-industry issues.

1. Introduction

The Australian truffle industry originated in Tasmania with the establishment of the first truffière in 1992 and the harvest of the first Australian French black truffle in 1999.

During the 1990s, RIRDC assisted the industry by supporting a number of research projects and industry awards. The industry has since grown and reached a new level of maturity over the last ten years. It now appears to be entering a new phase of industry investment and growth.

With limited supply and robust world prices for the prized French black truffle, Australia has an opportunity to establish itself as the largest supplier in the southern hemisphere.

Following discussions with The Australian Truffle Growers Association, RIRDC commissioned this review of the status of the industry, its research requirements and future priority issues.

1.1 Objectives

This report investigates the current status of the Australian truffle industry and the research and development requirements for future growth and development. In particular it addresses the following key issues:

- the status and location of the industry across Australia
- production estimates
- potential for growth
- pricing estimates
- industry infrastructure requirements for future growth.

1.2 Methodology

The methodology comprised a combination of desktop research and an extensive industry consultation, which was conducted in four stages:

Stage 1 – Assessment of Industry, Markets and Industry Resources

Survey of industry groups, distributors, end-users including chefs, and researchers

Stage 2 – Development of State and National Industry Profiles

Industry characteristics by location, grower type, cultivated area, yields and markets

Stage 3 – Strategic Analysis

Review of industry issues and SWOT analysis

Stage 4 – Future Industry Priorities

Key issues and research investment opportunities

1.3 Data Quality

Growers in the industry are broadly located and disparate in terms of their investment and activities. Some growers have invested significant capital to develop strong and growing commercial enterprises, while other growers have invested in truffles as a part-time hobby pursuit. As a consequence, the availability of accurate data on truffles in Australia (and internationally) is limited. In an effort to balance this limitation, this study includes estimates provided by growers and other industry groups. While this source of data may also have limitations, inaccuracies have been potentially minimised through cross-verification with other sources.

It is also noted that not all industry members were able to contribute to this study. Notwithstanding any limitations in the raw data, there is nonetheless a high level of confidence in the estimates, trends and issues associated with findings from the data.

2. An Overview of Truffles

2.1 What are Truffles?

Truffles are unique, edible, underground mushrooms. They have a pungent aroma and taste that can permeate and enhance many foods such as soups, dips and patès, salads, sauces and dressings, omelettes and main meals. They may also be served whole. The mystique and gourmet experience associated with their unique aroma, flavour and taste accounts for their demand by consumers and high market value.

Truffles grow underground on the roots of trees which either naturally host the fungi or have been artificially inoculated with truffle spores. These truffles form a symbiotic relationship with trees as truffles are unable to synthesize sugars and other carbohydrates to make their own food. The tree provides the truffle with a source of carbohydrates and nutrients, and in return the fine thread-like filaments of the truffle, coats the tips of the tree roots to form mycorrhiza which helps the tree to absorb soil minerals and nutrients.

There are many types of truffles. The main truffle types are French Black or Perigord truffle (*Tuber melanosporum*) named after the Perigord region of France, the white truffles (*Tuber magnatum* (Piedmont) or *Tuber borchii* (Tuscan)) typically associated with the Piedmont region of Italy, the Chinese truffle (*Tuber sinense*, *Tuber indicum* and *Tuber himalayense*) from Asia, and the burgundy or summer truffle (*Tuber uncinatum* / *aestivum*) from central Europe, Turkey and north Africa.

Truffles may vary in size and shape. They may range in size from that of a small nut to the size of a tennis ball and may appear rounded with either a smooth or knobbly surface.



Plate 1. A French Black Truffle from Western Australia

Source: Wine and Truffle Company

2.2 The Global Truffle Industry

A recent review of the world truffle industry conducted by the Australian Bureau of Agriculture and Research Economic (2008) shows that Italy, France, Spain and China are the major exporting countries, while France, Japan, United States, Germany and Switzerland are the major importing countries (Figures 1 and 2).

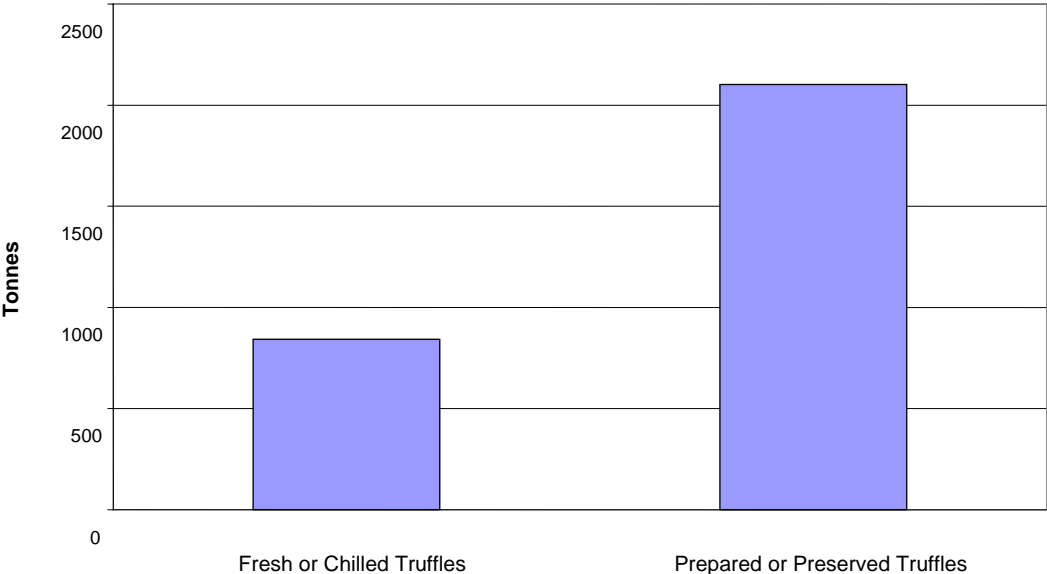


Figure 1. World Trade of Truffle Products Three Year Average 2003-05 (tonnes)
 Source: ABARE (2008)

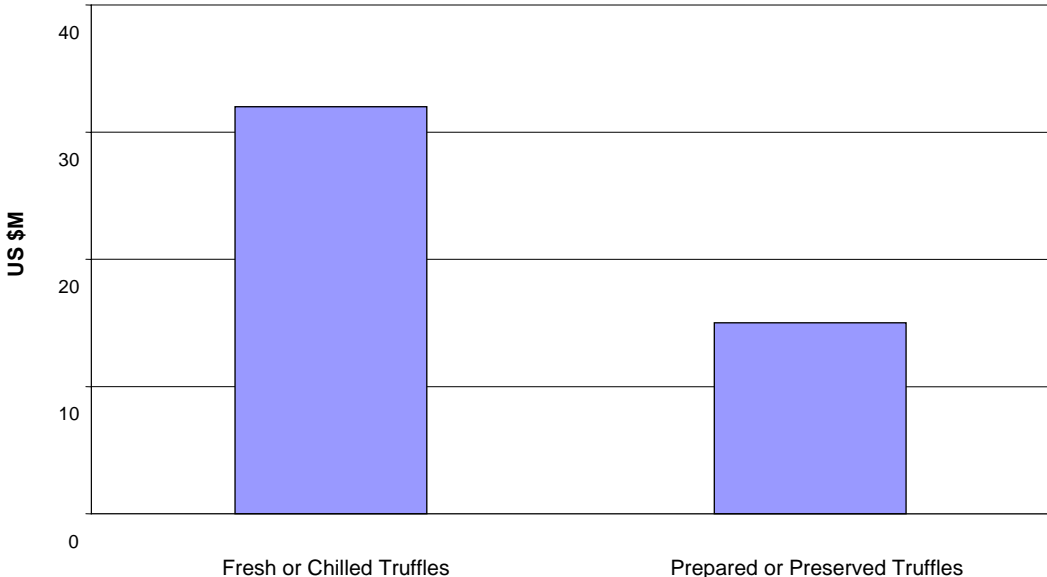


Figure 2. World Trade of Truffle Products Three Year Average 2003-05 (US\$M)
 Source: ABARE (2008)

France, Italy and Spain are well-known for their production of high quality truffles, and while China is a large producer, the Chinese truffles are considered to be of inferior quality to those from Europe.

Outside of Europe and China, there are an increasing numbers of farms, known as truffières, in Australia, New Zealand, United States, Argentina, Chile, Israel and South Africa. These managed truffières cultivate and produce truffles on artificially inoculated trees, however overall production from these countries is small in comparison to Europe.

2.3 French Black Truffles

Fresh French black truffles are one of the most highly sought after and valued foods in the world. Fine food wholesalers in Australia advise that they sell for over AU\$3,000 per kg; ranking third behind saffron and beluga caviar in value.

Fresh truffles attract the highest demand and prices. It is estimated that up to 60% of annual production in France is sold fresh each year, and the remaining is sold for further processing and value-adding (Garvey and Cooper 2001). While the supply of truffles occurs during November to March, demand and prices appear to be strongest during the traditional Christmas period.

Preserved truffles are used mainly during out of season periods when fresh truffles are not available. They are prepared by simply boiling the truffle in a brine solution and then sealing in glass or cans.

Value-added truffle products are made from fresh or preserved truffles and include truffle purees, dried peelings or pieces in oils, pates, terrines, olives and butters.

The French are the world's largest consumers of French black truffles, followed by the United Kingdom, Belgium, Germany and Switzerland (Garvey and Cooper 2001). Japan is the largest consumer of these truffles outside of the European Union.



Plate 2. A Range of Value-Added Truffle Products

Source: Wine and Truffle Company

Truffle producers in France have traditionally been small farmers who gathered truffles in natural or wild forest areas. Over the last century the harvest of wild truffles has declined significantly, from around 1,000-2,000 tonnes in the early 1900s to 12-150 tonnes per annum during the 1990s (Hall 2007; Garvey and Cooper 2001). Figure 3 shows the production trend during the 1990s.

Recent data from the Ministry of Agriculture in France shows that in 2006-07, the production of French black truffles was around 13 tonnes and average prices ranged from 120 to 677 Euros per kg (approximately AU\$200 to \$1,140 per kg) (Figure 4).

While in 2007-08, for the period up until 20 January 2008, production volumes were around nine tonnes, which is similar to 2006-07 volumes on a pro-rata basis. Average prices during this period ranged from 230 to 745 Euros per kg (approximately AU\$390 to 1,250 per kg).

Australian industry members, during a recent visit to France, observed wholesale prices in the range of 800 to 1500 Euros per kg (approximately AU\$1350 to 2500 per kg) and confirmed that French growers expect the pricing to remain strong, for at least a decade while supply is low and demand high.

The destruction of natural growing areas especially due to the two world wars, changes in land for urban use, pollution and climate change are considered to be the main causes of this decline (Amaranthus 2007; Hall 2007; DPS Strategy 1996) and are likely to continue limiting production of truffles from wild or native areas. As a consequence, truffles are increasingly being produced on cultivated farms with inoculated truffle trees or truffières (Garvey and Cooper 2001). However, native oak and hazel forests still remain as a major source of harvested French black truffles in France.

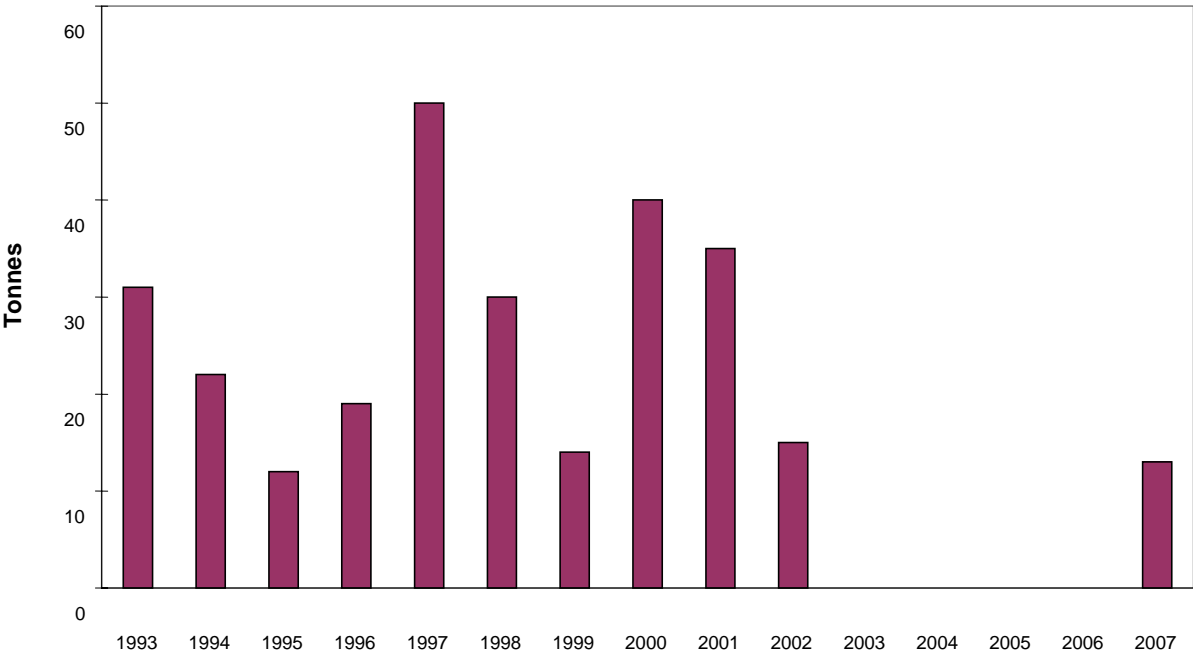


Figure 3. French Truffle Production 1993-2007 (tonnes)

Source: data from Hall (2007)

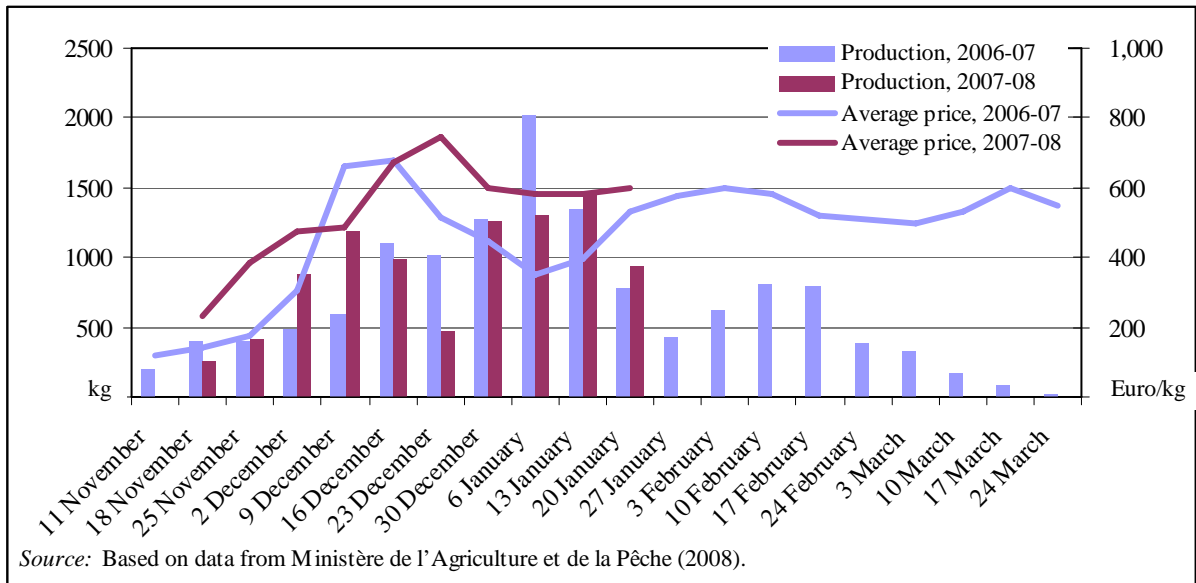


Figure 4. French Black Truffle Production and Wholesale Prices 2006-08

3. The Australian Truffle Industry

3.1 Location

The Australian truffle industry is located in the colder climate areas of Australia including south eastern Western Australia, Tasmania, and the highland areas of New South Wales, Victoria, South Australia and south-eastern Queensland. The preferred climatic conditions for truffles are wet cool winters and warm summers, however local area issues such as soil moisture and microclimate have an important influence (Malajczuk and Amaranthus 2007; Terry, pers. comm. 2008). Figure 5 shows the broad location of the various truffle growing areas throughout Australia.

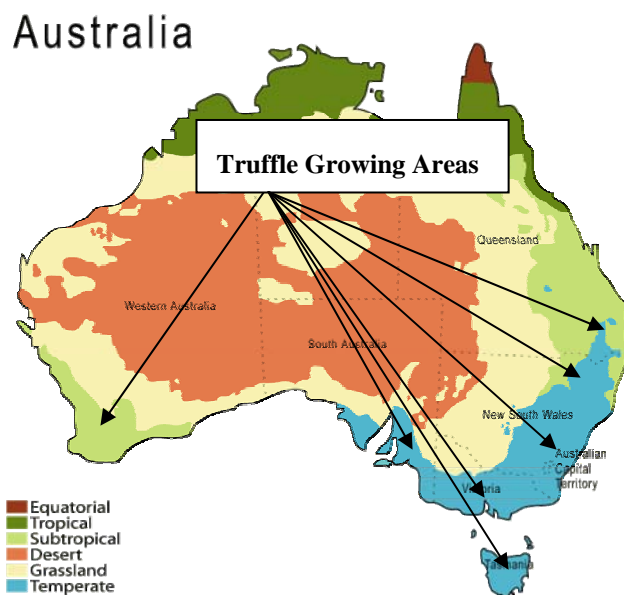


Figure 5. Truffle Growing Areas in Australia

Source: Wikimedia Commons

Unlike their European counterparts, Australian truffières are generally not located on calcareous soils. Many areas which produce high quality truffles in France are characterised by high pH, free draining and iron-rich soils, typically in red limestone rock areas. Similar calcareous soils are relatively scarce in Australia and, where available, are often in use by horticultural industries such as viticulture. Australian truffières have managed their soil characteristics by the application of lime, fertilizer and irrigation systems.

3.2 Type of Truffles

Almost all of the Australian truffle industry is focused on growing the French black truffle. However, it is understood that at least one grower is also cultivating the burgundy or summer truffle (*Tuber uncinatum* or *Tuber aestivum*).

3.3 Supply Season

The eastern states of Australia generally supply truffles from May to September, while the season commences and ends about a month earlier in Western Australia. However growers note that the supply season can experience considerable variation.

Australia's supply season does not compete directly with that of Europe, which occurs from November to March. As a southern hemisphere producer, Australia is a potential counter-seasonal supplier of French black truffles.

3.4 Types of Growers

The industry consists of a range of growers with differing production, capital and human resource investments and commitments. For the purposes of this study, four grower types have been defined and are shown in Table 1.

Table 1. Description of Types of Truffle Growers

Grower Type	Description	Typical Size	Example
1	Larger scale corporate truffière	>5 ha	Corporate group
2	Larger scale investment truffière	>5 ha	Investment or Managed Investment Scheme
3	Smaller scale contracted commercial truffière	<5 ha	Growers for corporate groups
4	Smaller scale independent commercial truffière	<5 ha	Independent growers

As shown at Table 2, the total grower population is estimated to be to the order of 160 sites however this estimate is considered to be conservative due to the dynamic growth occurring in the industry.

Table 2. Estimates of Sites Current and Proposed Truffière Cultivation

Grower Type	Description	Number of Sites	Estimated Area (ha)	Estimated Trees
1	Larger scale corporate truffière	14	80	35,000
2	Larger scale investment truffière	4	180	80,000
3	Smaller scale contracted or licensed commercial truffière	72	170	80,000
4	Smaller scale independent commercial truffière	70	145	45,000
		160	575	240,000

Figures 6 and 7 show that Grower Types 1 and 3 currently hold the greatest area of mature truffière land (69%). Mature truffière land is defined as the area that has been under cultivation for at least five years. This is the estimated minimum period before truffière's may be able to produce truffles (Hall 2007; Lonsec 2007).

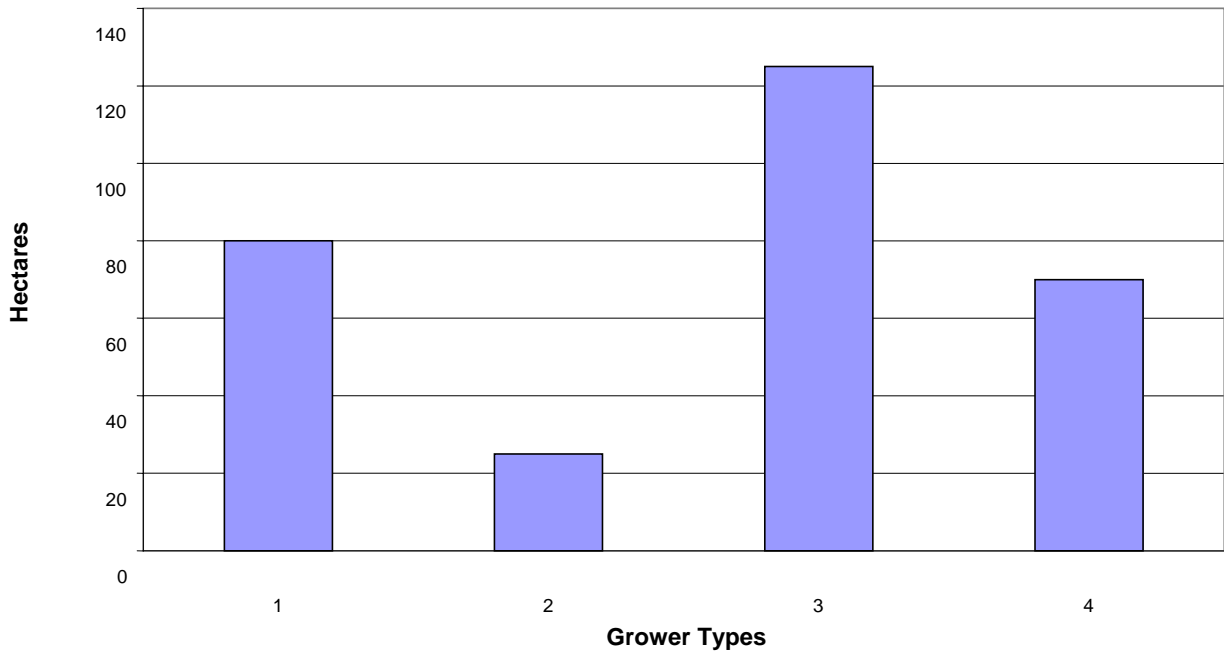


Figure 6. 'Mature' Truffière Land Area (*) By Grower Type (2008)

(*) Minimum maturity of 5 years

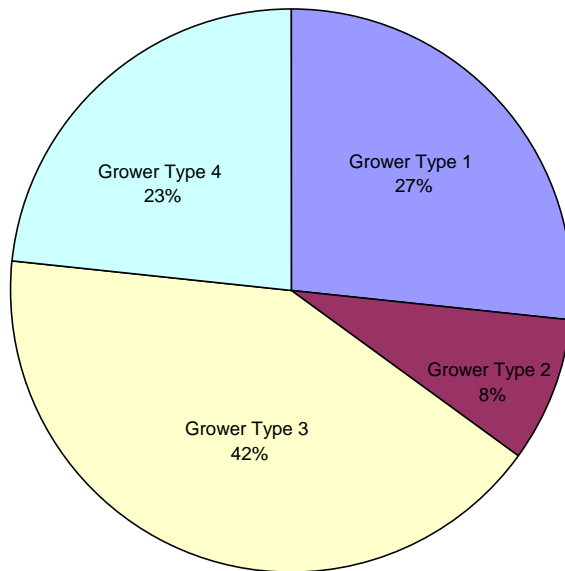


Figure 7. 'Mature' Truffière Land Area (*) By Grower Type (2008)

(*) Minimum maturity of 5 years

3.5 Sales and Marketing Supply Chains

To date, most of Australia's truffle supply has been directed to the Australian market, especially for the restaurant and fine food wholesale market segments which are strong supporters of the Australian industry. While some major grower groups have dedicated resources for the sales and marketing of truffles, other growers outsource the distribution and marketing of their truffles to other food wholesalers.

Current and accurate price data is difficult to obtain and often commercial-in-confidence. At the time of preparation of this report, wholesale prices for Australian truffles in 2008 are not yet available, and truffles from the northern hemisphere will not be available till the end of the year.

Factors determining price include:

- production supply in Australia and overseas
- quality of truffles in terms of freshness, shape, size and aroma
- seasonality and availability.

3.6 Imports and Exports

The Australian Bureau of Statistics (ABS) publishes data on Australia's imports and exports of truffle products. Garvey and Cooper (2001) have raised concerns about the accuracy of the ABS export data, suggesting that it may include other mushroom products, inflating the values. However, the ABS import data appears consistent with industry estimates. Accordingly, only the ABS import data is shown below at Figures 8 and 9. However, the ABS export and import data is shown at Appendix 1 for reference purposes.

Data from the ABS shows that by value, Australia is a net importer of truffle products, with imports increasing by 100 % from AU\$248,000 in 2004 to AU\$492,000 in 2006.

Imports of fresh or chilled truffles in 2006 amounted to 279 kg or AU\$260,000. However, as shown at Figures 10 and 11, value-added truffle products, which are dried, prepared or preserved account for the greater proportion of import value and volume than fresh truffles.

Imports of fresh or chilled truffles and value-added truffle products appear to be driven by Australian truffle growers and wholesalers importing products from Europe during the period of November to March, which is Australia's off-season. More recently, there has been an increase in the volume of imports of fresh truffles from China during the northern hemisphere winter. As an example, import volumes into Australia increased from 50 kg to 176 kg between 2006 and 2007.

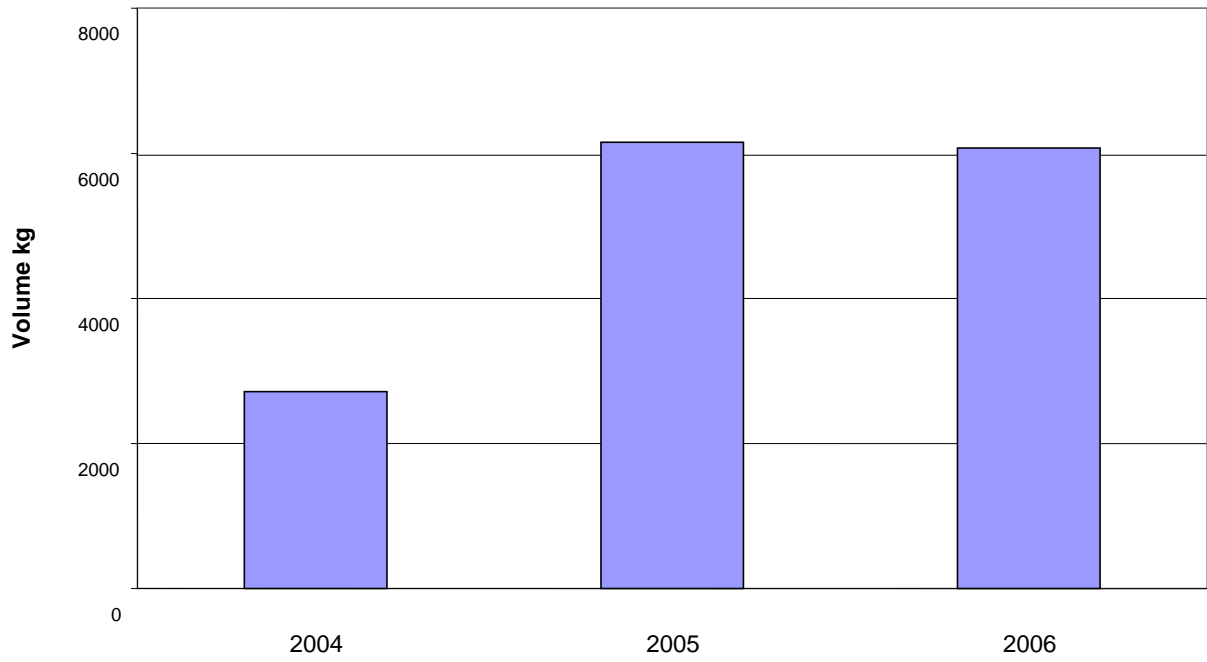


Figure 8. Total Australian Import Volume 2004-06 (kg)

Source: ABARE (2008)

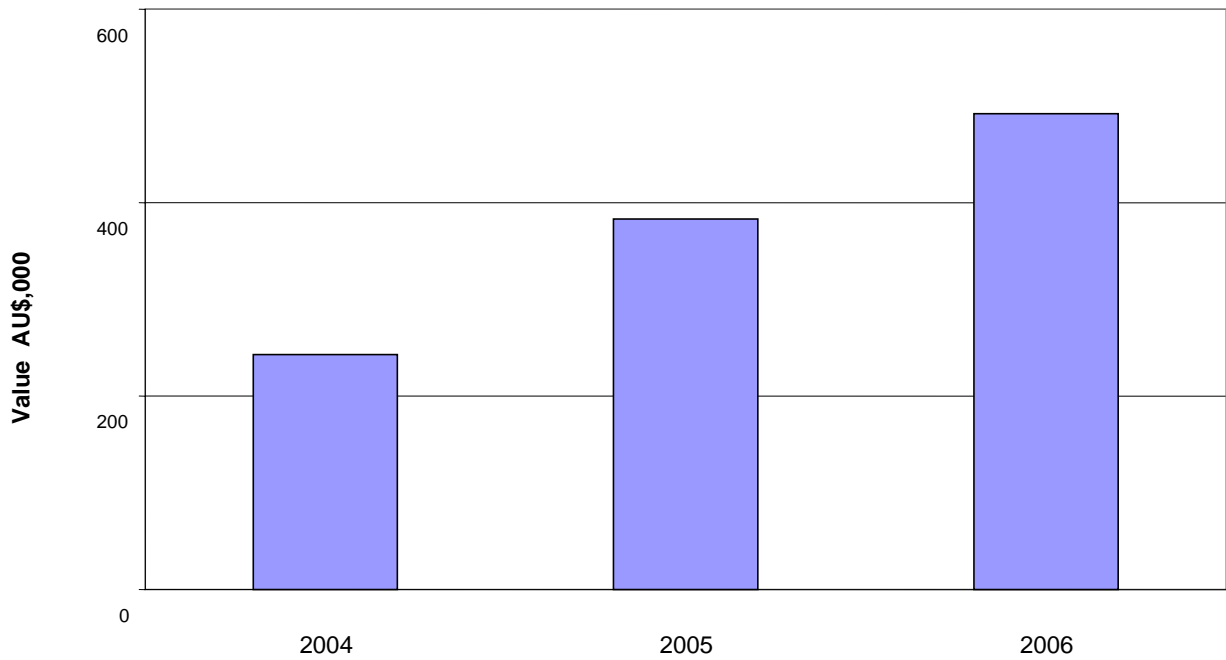


Figure 9. All Truffle Products Total Australian Import Value 2004-06 (AU\$'000)

Source: ABARE (2008)

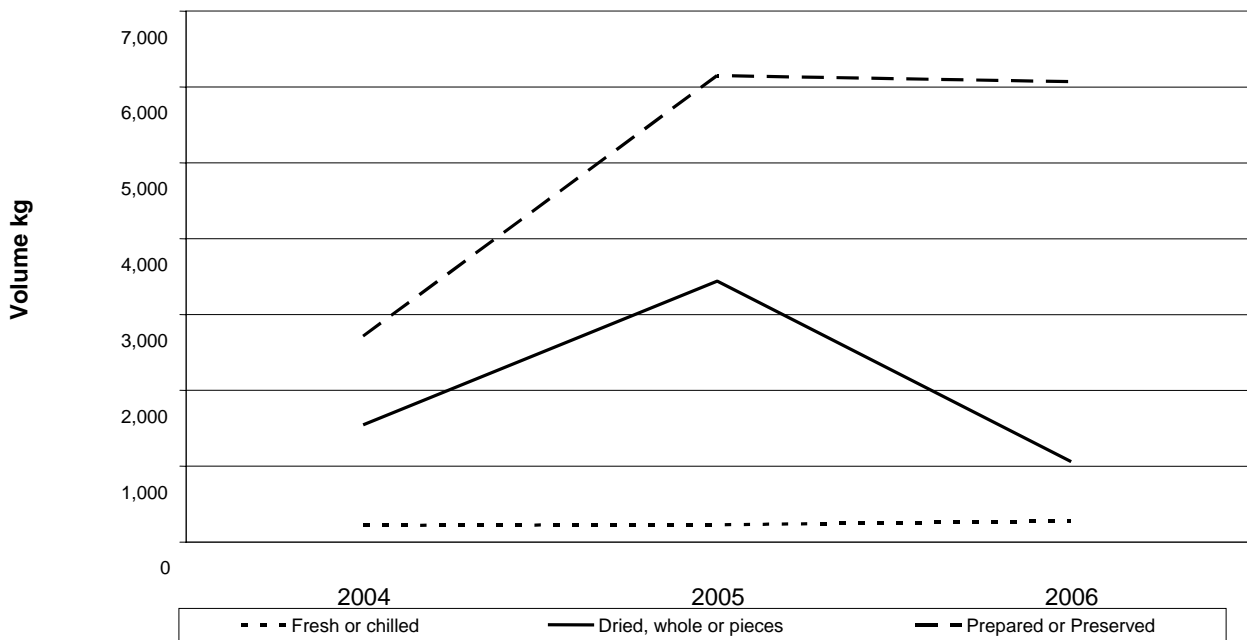


Figure 10. Fresh, Dried and Prepared or Preserved Truffles Australian Total Import Volumes 2004-06 (kg)

Source: ABARE (2008)

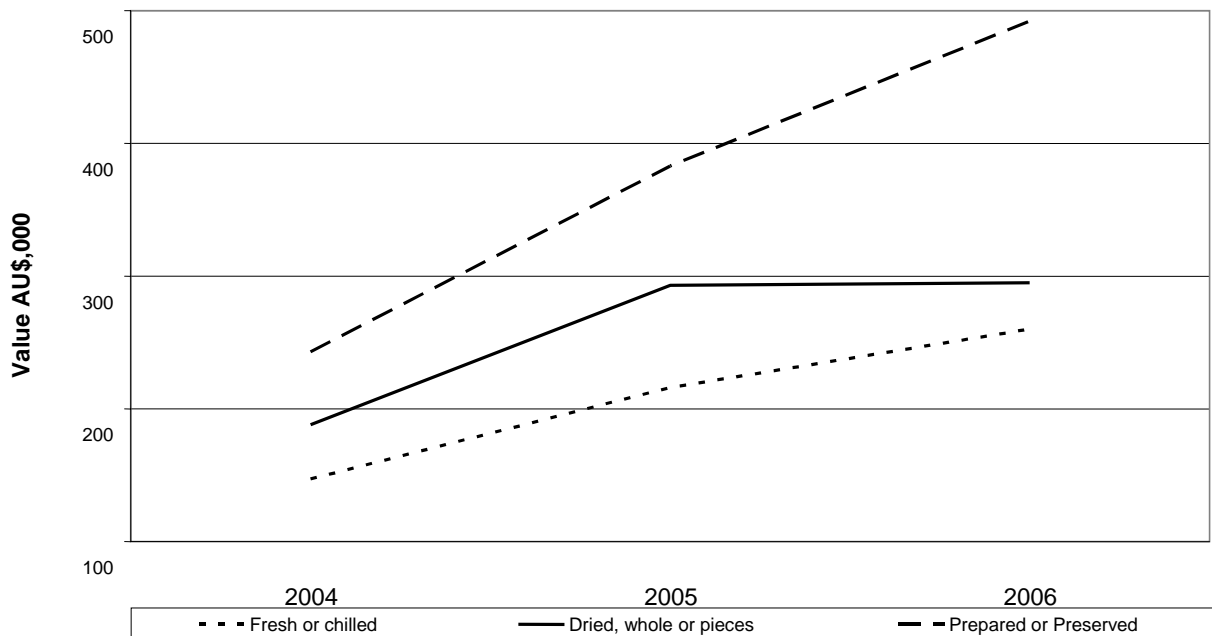


Figure 11. Fresh, Dried and Prepared or Preserved Truffles Australian Total Import Value 2004-06 (AU\$'000)

Source: ABARE (2008)

3.7 Truffles and Australian Rural Research

RIRDC has previously supported research into the production of French black truffles under its New Plant Products Research Program. In the early 1990s it commissioned an investigation of the key issues to develop a strategy to produce and market French black truffles to Australian and international markets. A summary of this previous research supported by RIRDC is shown at Table 3 below.

Table 3. Truffle Research Projects Supported by RIRDC

Project/Year	Title	Researcher(s)
DPS-1A/1996	Evaluation of the potential of growing <i>Tuber melanosporum</i> as a crop on mainland Australia for export and domestic consumption	P Stahle D Ward
PTT-1A, PTT-2A/2001	French Back Truffle. Establishment and production in Tasmania	Duncan Garvey Peter Cooper
PTT-3A/2004	Increasing the productivity of truffières in Tasmania	Duncan Garvey Peter Cooper

Some of the key findings from this above research, which are relevant to this study include:

- the French black truffle represents a significant new industry opportunity for Australia
- the highest quality truffle produce is required to maximise the economic benefits for farmers
- to protect the integrity of the industry, and ensure production of a certified quality truffle, inoculation facilities need to be able to guarantee the quality of trees distributed to growers
- the marketing potential of the Australian truffles should be underwritten by both the best technology available and a quality scheme that certifies the quality and species of the Australian grown French black truffle.

4. State Profiles of the Australian Truffle Industry

Introduction

In this section, industry structure and production profiles are reported on a state-by-state or region basis. The following key information has been estimated based upon available reports, industry feedback and estimates.

Please note that land area and tree number data has been aged to represent ‘mature’ truffière areas which have been under cultivation for at least five years.

4.1 Western Australia

Western Australia is the major producer of truffles accounting for around 150 kg in 2006 (Malajczuk and Amaranthus 2007). During 2007, truffle production is estimated to have increased to over 500 kg or about 65% of the estimated Australian production volume of 800 kg during 2007.

Industry Location

The truffle growing industry is dominated by activity in the Manjimup and Pemberton areas of south-eastern Western Australia. There are over 80 ha of truffière in and around the Manjimup area. In general, the truffles are produced on host trees including hazelnut (*Corylus avellana*) and various species of oak (*Quercus robur*, *Quercus suber*, *Quercus ilex*).

The Manjimup Wine and Truffle Company has the largest area with around 20 ha at its Hazel Hill truffière where it produced its first truffles in 2003. In 2005, this site produced a one kilogram truffle; reputedly the largest recorded truffle in the southern hemisphere. The Manjimup Wine and Truffle Company is also associated with the Oak Valley Truffle Project which comprises an area of around 60 ha.

The second largest grower of truffles in this area is the Five Acre Nursery. Other growers have established truffières in areas further north near Perth.

Number and Types of Growers

Table 4. Types and Numbers of Truffle Growers in WA

Grower Type	Description	Number
1	Larger scale corporate truffière (generally >5 ha) e.g. Corporate group	2
2	Larger scale investment truffière (generally >5 ha) e.g. Investment group	1
3	Smaller scale contracted or licensed grower truffière (generally <5 ha) e.g. Growers for corporate groups	0
4	Smaller scale independent grower truffière (generally <5 ha) e.g. Smaller growers	>5
	Total	>8

Production Resources

It is estimated that in total there is over 110 ha of land under current or proposed truffière cultivation in WA. Host trees have been provided to the industry through either in-house facilities or by local commercial nursery suppliers.

In 2008, only 30 ha of land, or 18,000 inoculated trees, are five years of age or older. However, as shown at Figure 12 and 13, the land area and population of five year old trees is expected to increase

to over 110 ha and 54,000 trees respectively by 2012, due to the Oak Valley Truffle Project.

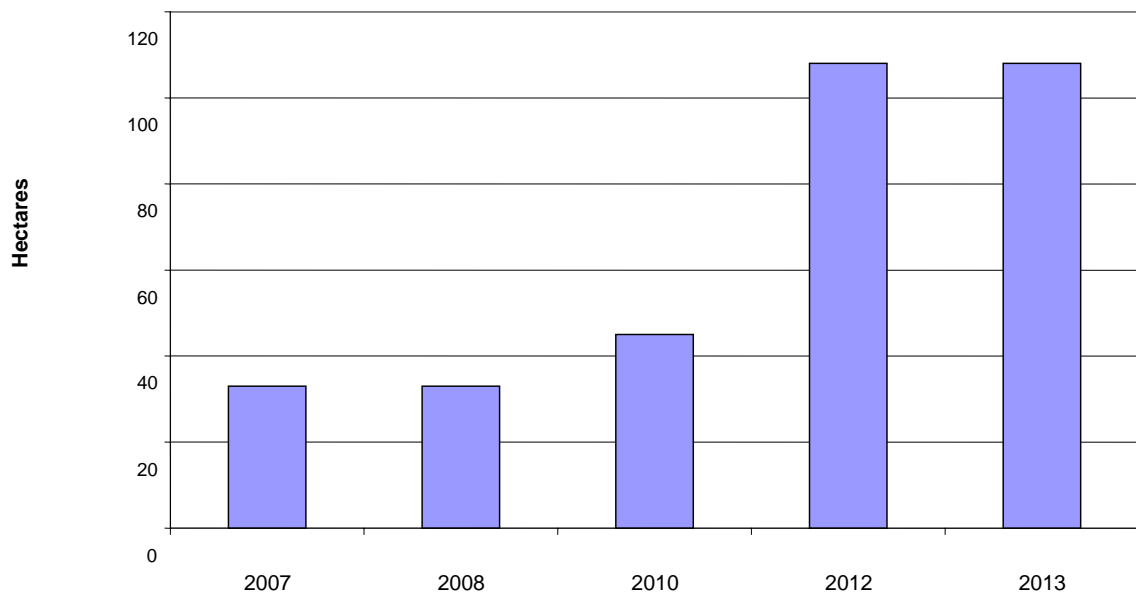


Figure 12. WA Estimated Land under Truffière Cultivation
(Minimum maturity of 5 years)

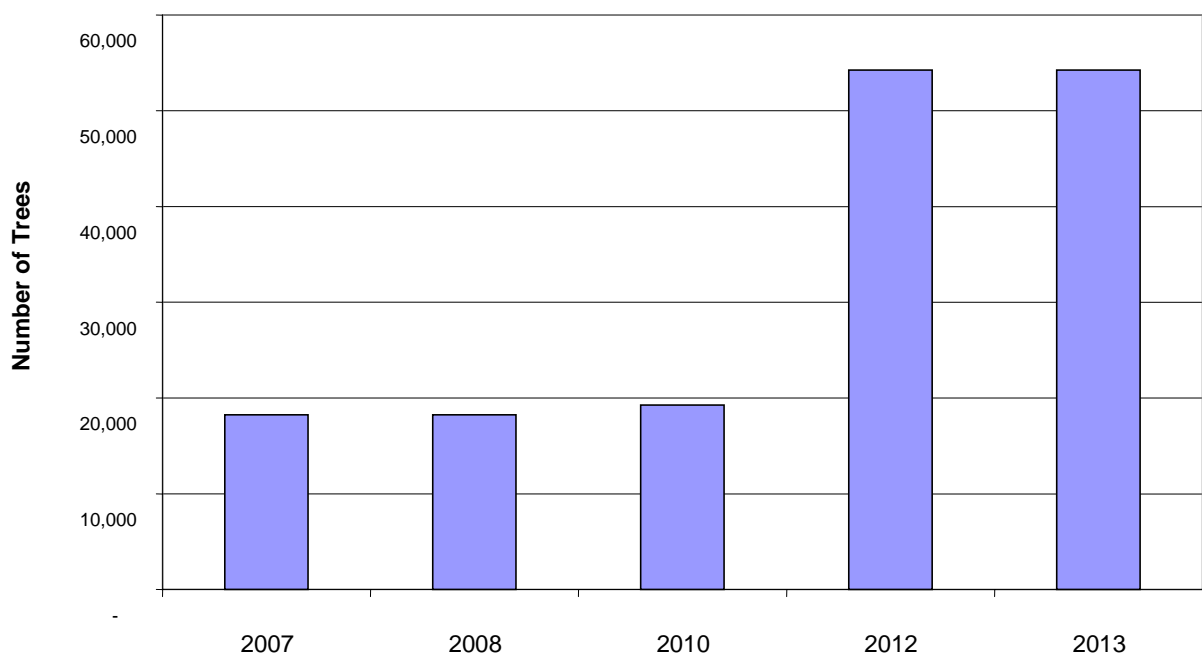


Figure 13. WA Estimated Number of Trees under Truffière Cultivation
(Minimum maturity of 5 years)

Truffle Yield Estimates

Truffles are generally harvested during the period May to July. The Hazel Hill truffière has been reported as providing a yield of 16 kg per ha during 2006 or year nine of its operation.

Industry Risks and Constraints

Industry identified the following risks and constraints to further growth:

- **Quality Assurance of Inoculation**

The inoculation of trees with *Tuber* mycorrhizae is critical. Whether conducted in-house or at an external nursery, the inoculation of trees with *T. melanosporum* should be subject to quality assurance and/or DNA verification of both Tubers and trees by experienced mycologists.

- **Production Risks from Competing Fungi including Imported Chinese Black Truffles**

Stringent biosecurity measures are important during production to prevent introduction of unwanted Tuber species. The Chinese black truffle (*Tuber indicum*) and related species (e.g. *T. sinense* and *T. himalayanense*) pose a significant risk to the industry due to its tendency to out-compete and reduce yields of French black truffle (*T. melanosporum*). These species of Tuber have become established in overseas truffière's through inappropriate use of inoculum (Hall 2007; Malajczuk and Amaranthus 2007). Furthermore, *T. indicum* may be substituted for *T. melanosporum* and mislead consumers as to the authenticity of Tuber species.

- **Yield of Truffles from Trees**

To date, only a small percentage of trees in truffière's have yielded truffles. For example, during 2006 less than 8% of trees produced truffles at Hazel Hill. While oak and hazel trees can be successfully inoculated with *Tuber* mycorrhizae, the conditions under which truffles actually form and fruit is quite variable (Malajczuk and Amaranthus 2007).

- **Supply Period**

The Western Australian industry is able to supply during May to July, which is generally about one month earlier than the eastern States. Nonetheless, this three month window of supply is limited and opportunities to supply 'longer shelf-life' fresh or further processed *T. melanosporum* for extended periods would support industry growth in both Australian and export markets.

- **Quality Grading Standards for Markets**

Feedback from chefs and wholesale distributors affirms the importance of quality assurance to the industry. Furthermore, traceability of produce back to a specific truffière will ensure that misleading or deceptive practices, such as substitution with imported truffles, do not occur.

- **Technical Expertise**

Major parts of the Western Australian industry have supported the development of research programs within the state's universities. Research has focussed on a number of issues, ranging from tree propagation and production of truffles, to the storage and aromatics associated with truffles. However, in general there is limited technical expertise available to the industry. PhD research programs need to be supported to develop this resource.

Future Priorities and Research Issues

- Quality assurance systems for production, including biosecurity risk assessments and HACCP plans.
- Management systems to optimise yields and productivity from truffières.
- Shelf-life extension technologies and further processing to support the extension of supply periods for both Australian and export markets.
- Support of research programs that expands the availability of a technical resource for the industry.

4.2 Tasmania

The Australian truffle industry originated in Tasmania with the establishment of the first truffière in 1992 and the harvest of the first Australian French black truffle in 1999. Accurate industry data is not readily available, however based upon industry investment documents (www.lonsec.com.au) it is estimated that the Tasmanian industry produced approximately 50-100 kg of truffles in 2006. Production estimates are not available for 2007.

Industry Location

Tasmania's truffle growing industry is predominantly located in the central-south and central-north of the state. There are two major truffières of 12 ha and 38 ha size at Needlesdale, and another 73 ha truffière is under development near Deloraine. In general, the truffles have been produced on host trees including hazelnut (*Corylus avellana*) and *Quercus* species of oak.

Perigord Truffles of Tasmania (PTT), Truffles Australis and Tasmanian Truffle Enterprises are the major industry groups in Tasmania and have now expanded their activities to colder areas in other states. PTT has an estimated 'network' of over 25 farms with 75 ha of land area throughout Tasmania.

Number and Types of Growers

Table 5. Types and Numbers of Truffle Growers in Tasmania

Grower Type	Description	Number
1	Larger scale corporate truffière (generally >5 ha) e.g., Corporate group	2
2	Larger scale investment truffière (generally >5 ha) e.g., Investment group	3
3	Smaller scale contracted or licensed grower truffière (generally <5 ha) e.g., Growers for corporate groups	>25
4	Smaller scale independent grower truffière (generally <5 ha) e.g., Smaller growers	>5
	Total	>35

Production Resources

It is estimated that over 250 ha of land is under current or proposed truffière cultivation. Host trees for the truffières have been provided to the industry through local commercial nursery suppliers. Historically the inoculated trees have been a mixture of hazels and oak, however it has been reported that there is a trend towards increasing numbers of oaks and lesser plantings of hazels.

In 2008, there was only 160 ha of land and approximately 60,000 inoculated trees which were five years of age or older. However, as shown at Figure 14 and 15, the land area and population of mature five year old trees is expected to increase to over 250 ha and 100,000 respectively. This is largely due to the Tasmanian Truffle Project No. 3 which is a 73 ha investment truffière at Deloraine.

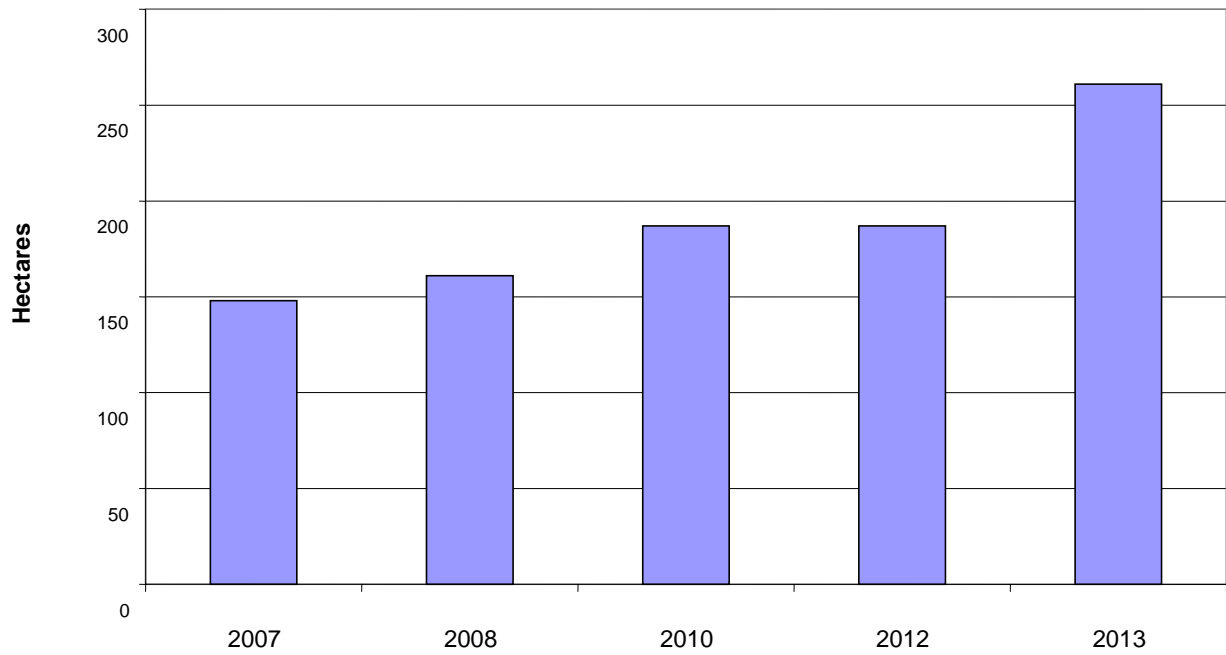


Figure 14. Tasmania Estimated Land under Truffière Cultivation
(Minimum maturity of 5 years)

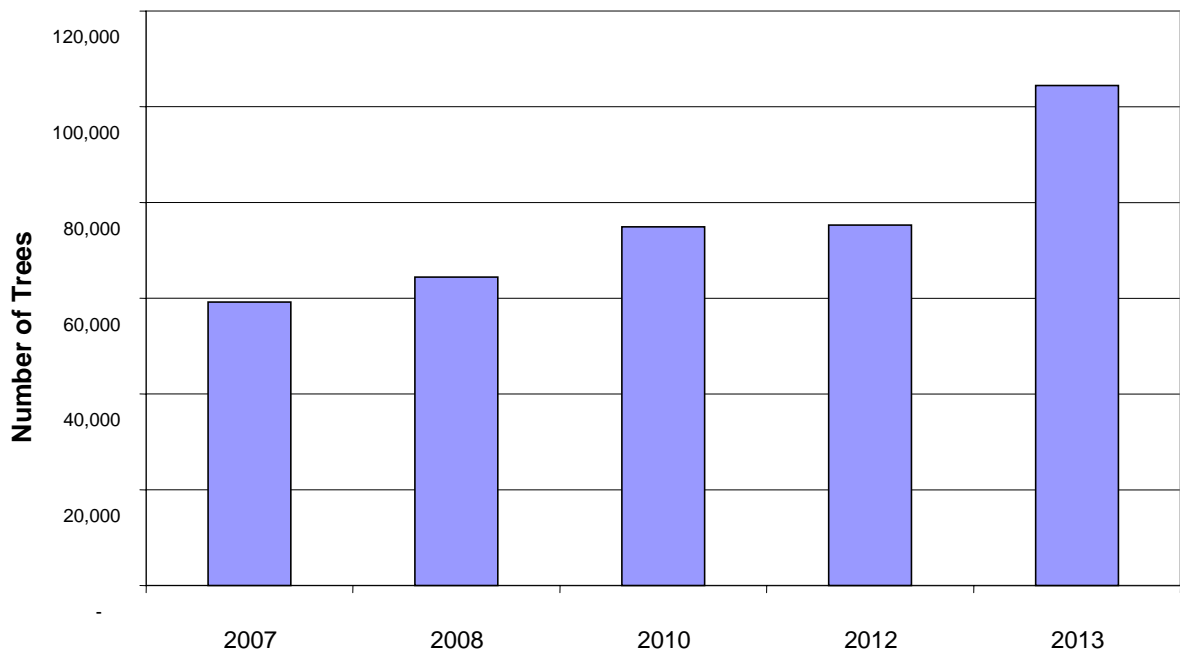


Figure 15. Tasmania Estimated Number of Trees under Truffière Cultivation
(Minimum maturity of 5 years)

Truffle Yield Estimates

Truffles may be harvested during an extended period from June to September. The Needlesdale truffière (TTE Project 1) has been reported as producing 11 kg from its 12 ha after five years (Lonsec 2007).

Industry Risks and Constraints

Industry identified the following risks and constraints to further growth:

- **Market Research and International Marketing**
Like Western Australia, the Tasmanian industry mainly supplies the Australian restaurant market and fine food wholesalers. However, the industry has recognised that the Australian market is limited and that the growing supply of Tasmanian truffles will need to be exported to northern hemisphere markets. In this respect, the industry will need to develop capabilities for international market research and marketing and trading in truffle commodity markets.
- **Risks to Nursery Inoculation due to Imports**
Tasmania is serviced by a nursery industry with established inoculation systems for the production of trees with mycorrhizae. However, during industry discussions, concerns were raised about the potential risk of contamination during inoculation from imported *Tubers* or *Tuber* mycorrhizae.
- **Yield of Truffles from Trees**
The number of trees that produce truffles and the truffle yield per tree were raised by several growers as a key issue for industry growth.
- **Quality Standards for Markets**
While the principle of quality standards for Australian truffles was endorsed, some industry groups considered that the practical application of the standards may prove difficult. The major cause for concern was that customers are subjective about their assessment of a quality truffle.
- **Technical Resources and Communications**
The major organisations in Tasmania have in-house and contracted technical resources. Smaller growers in the industry rely upon the nursery industry to provide technical expertise and support. Nevertheless, industry still noted that there was limited independent technical expertise and resources available to the Australian truffle industry as a whole. In this regard, the need for technical support and industry communications with smaller growers was recognised. It was considered that improved industry communications would support the development of local or regional networks and enable communities to become more capable in industry issues such as marketing and production.

Future Priorities and Research Issues

- Market research and international marketing.
- Quality assurance risks to nursery inoculation processes due to imported *Tubers* and *Tuber* mycorrhizae.
- Management systems to optimise yields and productivity from truffières.
- Quality standards systems for markets and a common product description language may be required.
- Communications of technical information within local or regional grower groups.

4.3 New South Wales

NSW growers produced an estimated 25 kg of truffles in 2006. While estimates for 2007 are not available, production is expected to grow as the size of land with mature trees more than doubled during 2006-07, from 20 ha to almost 50 ha.

Industry Location

The truffle industry in NSW has the most number of growers in Australia with over 60 sites. These sites are located in the colder parts of NSW, ranging from the south coast and snowy mountains through the southern highlands and north to Orange and Bathurst. There are also growers located near Ebor on the tableland areas of northern NSW. There are over 30 independent growers and many of these have become members of The Australian Truffle Growers Association in order to share information and resources about the industry. It is estimated that PTT have relationships with around 30 other truffières throughout NSW.

Number and Types of Growers

Table 6. Types and Numbers of Truffle Growers in NSW

Grower Type	Description	Number
1	Larger scale corporate truffière (generally >5 ha) e.g., Corporate group	0
2	Larger scale investment truffière (generally >5 ha) e.g., Investment group	0
3	Smaller scale contracted or licensed grower truffière (generally <5 ha) e.g., Growers for corporate groups	30
4	Smaller scale independent grower truffière (generally <5 ha) e.g., Smaller growers	>30
	Total	>60

Production Resources

More than 100 ha of land is estimated to be under current or proposed truffière cultivation. Oak and hazel host trees have been provided to the industry through commercial nursery suppliers.

In 2008, there were only 60 ha of land and 22,000 inoculated trees with a minimum maturity age of five years. However, as shown at Figures 16 and 17, the land area and population of mature trees is expected to increase to almost 100 ha and 40,000 trees respectively by 2013.

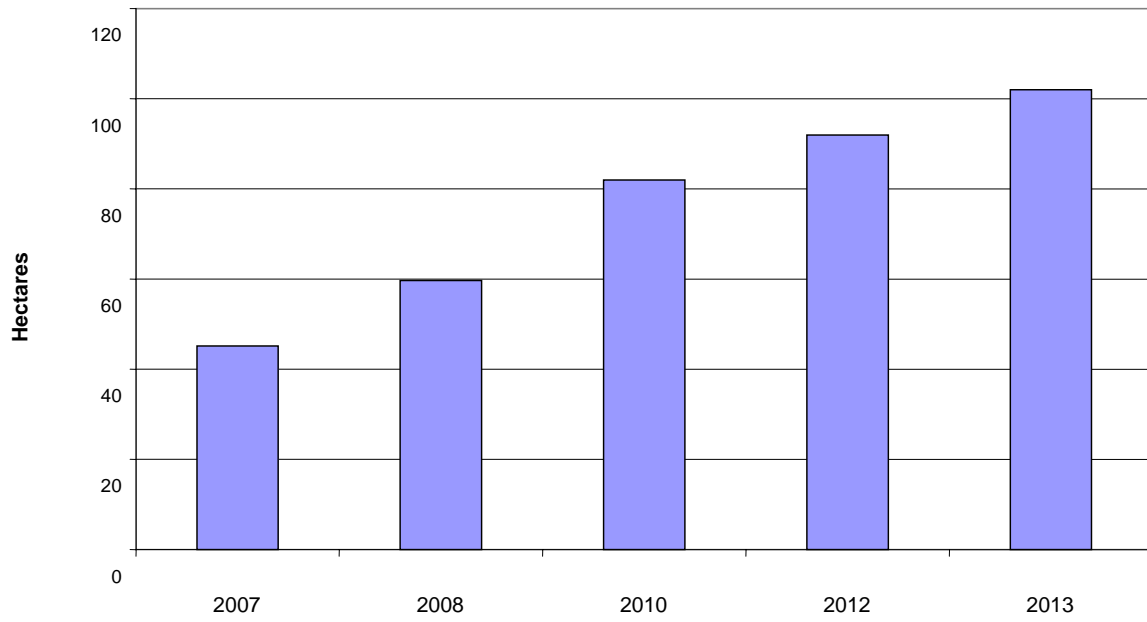


Figure 16. NSW Estimated Land under Truffière Cultivation (*)
(Minimum maturity of 5 years)

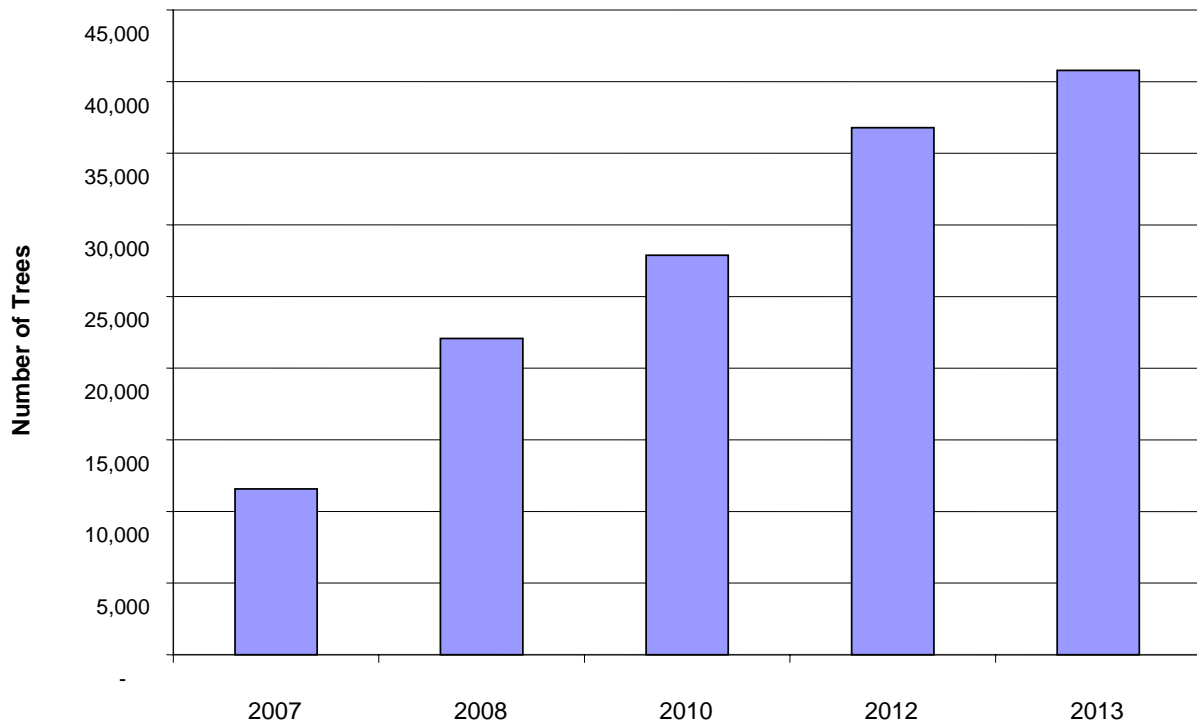


Figure 17. NSW Estimated Number of Trees under Truffière Cultivation
(Minimum maturity of 5 years)

Truffle Yield Estimates

Truffles may be harvested during the period June to August. Reliable information on truffle yields in NSW is difficult to obtain and is generally not available.

Industry Risks and Constraints

Industry identified the following risks and constraints to further growth:

- **Market Information**
Growers expressed their concern that there was very limited information about truffle pricing and supply. There is a need to understand price trends and the production and demand factors which influence pricing.
- **Distribution Channels**
Smaller growers raised concerns about distribution channels for smaller production volumes. It was suggested that smaller growers should collaborate to support a common distributor and develop sufficient volume and scale to warrant labelling and branding.
- **Quality Assurance for Markets**
Quality standards for Australian truffles were endorsed as an important issue for the growth of the industry.
- **Technical Support**
Growers were concerned by an apparent lack of independent technical resources to assist with production issues, including the certification of inoculated trees, monitoring of spore growth on tree root systems and yield rates.
- **Best Practice Production**
Smaller independent growers consider skills in best-practice production and technical site-specific methods to be critical for further industry growth. While some suggested a technical handbook would be of benefit, others believed that such a handbook could not be sufficiently site specific for growers. Access to technical resources for smaller growers was considered a priority issue.

Future Priorities and Research Issues

- Market research and market trend information.
- Distribution channel and outlets for smaller growers of truffles.
- Quality assurance and product description systems for markets.
- Technical resources to support growers.
- Technical manuals and field notes to support best practice in truffières to optimise yields and productivity.

4.4 ACT

There are at least two significant truffières within the ACT, however to date limited quantities of truffles have been produced.

Industry Location

The growing sites are located in rural areas of the ACT, often close to the NSW state border. These growers have become members of The Australian Truffle Growers Association in order to share information and resources about the Australian truffle industry.

Number and Types of Growers

Table 7. Types and Numbers of Truffle Growers in ACT

Grower Type	Description	Number
1	Larger scale corporate truffière (generally >5 ha) e.g., Corporate group	0
2	Larger scale investment truffière (generally >5 ha) e.g., Investment group	0
3	Smaller scale contracted or licensed grower truffière (generally <5 ha) e.g., Growers for corporate groups	1
4	Smaller scale independent grower truffière (generally <5 ha) e.g., Smaller growers	1
	Total	2

Production Resources

In 2008, approximately six ha of land was estimated to be under current or proposed truffière cultivation (Figures 18 and 19). Oak and hazel host trees for the truffière's have been provided to the industry through commercial nursery suppliers.

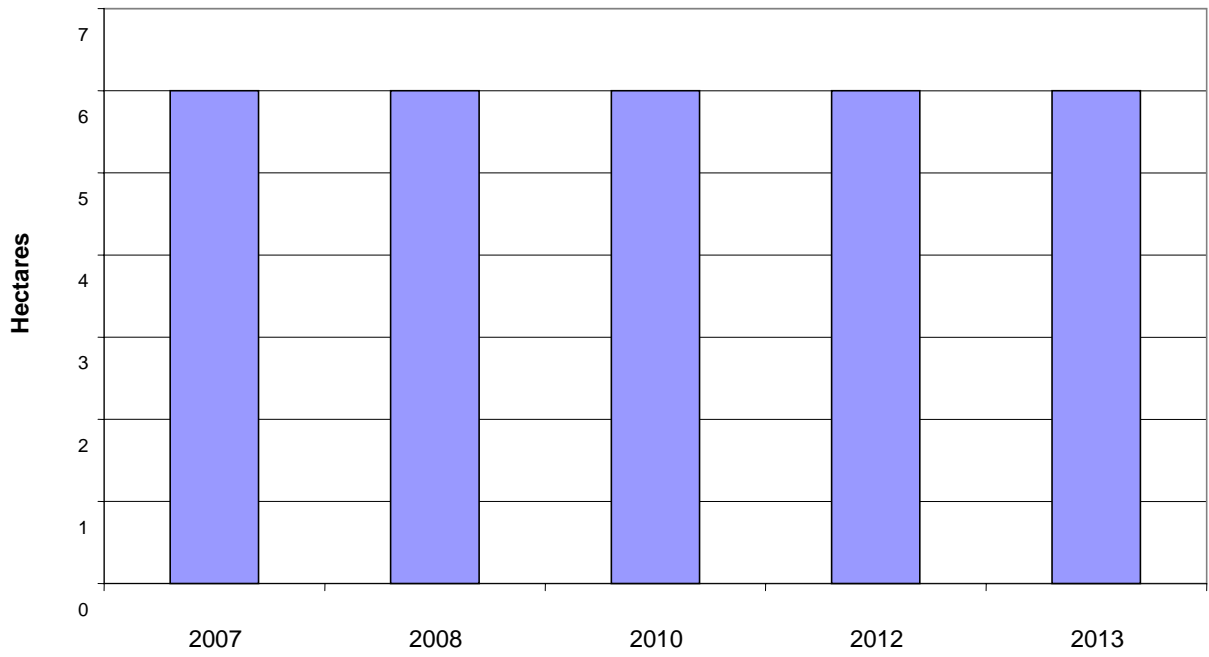


Figure 18. ACT Estimated Land under Truffière Cultivation
(Minimum maturity of 5 years)

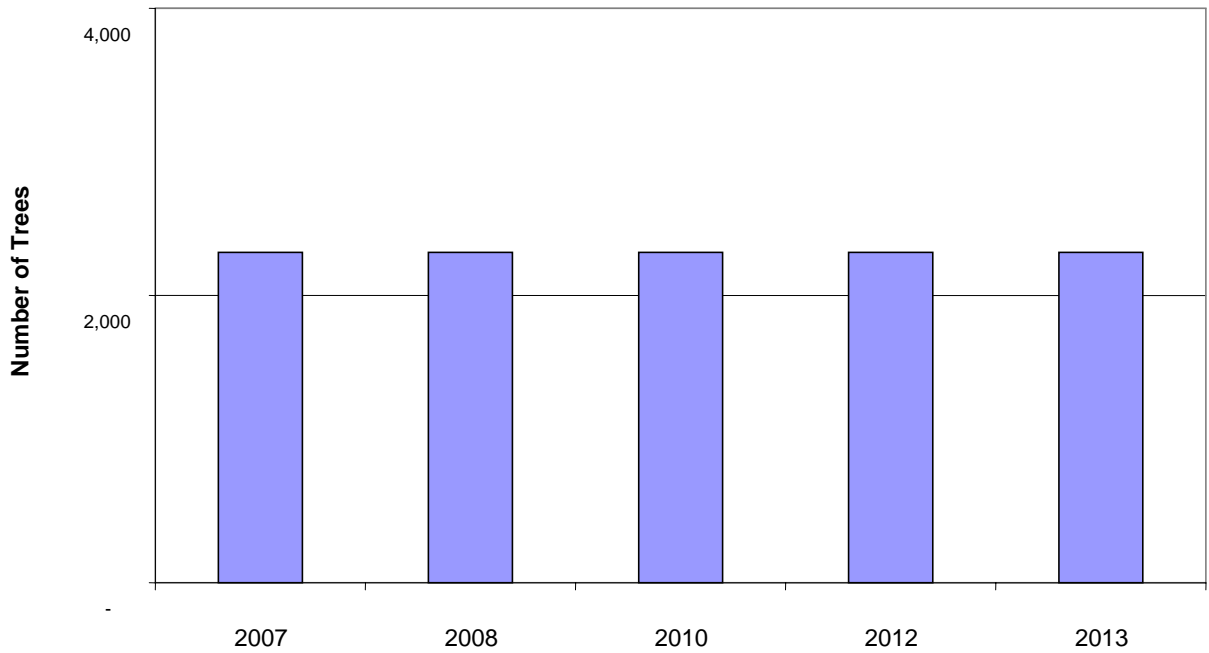


Figure 19. ACT Estimated Number of Trees under Truffière Cultivation (*)
(Minimum maturity of 5 years)

Truffle Yield Estimates

Truffles may be harvested during the period June to August. Reliable information on truffle yields in ACT is difficult to obtain and is generally not available.

Industry Risks and Constraints

Industry identified the following risks and constraints to further growth:

- **Market Research and Education**

Growers need to understand the Australian market more clearly, particularly the differences between fine dining restaurant, food service and retail markets. As truffles are generally not a well-understood food product in Australia, consumer education is required. In a similar manner, further research is needed to identify the requirements of overseas markets, especially in Asia.

- **Markets and Pricing**

There is growing supply capacity in Australia and this may have an adverse impact on Australian truffle pricing. The industry needs to invest in strategies to underpin future prices for Australian truffles. These strategies may include branding, labelling, packaging and quality standards.

- **Quality Standards and Graders**

Uniform standards are required for the sale of truffles. Quality standards exist in Europe and are under draft in New Zealand, and these support the sales and marketing of truffles. To support these potential standards, trained and experienced ‘truffle graders’ will be required at either the grower or wholesale points in the supply chain.

- **Imported Truffles**

As with other States, growers raised concerns about the biosecurity and substitution risks associated with imported Chinese truffles.

Future Priorities and Research Issues

- Market research.
- Consumer and market education.
- Strategies to underpin future prices for Australian truffles.
- Quality assurance systems for markets.
- Biosecurity threats.

4.5 Victoria

Victoria has an estimated 30 truffières, and while truffles have been produced from a number of these sites, production volumes are unknown.

Industry Location

The industry is located in the colder parts of Victoria including the ranges around Ballarat, Yarra Valley and the Gippsland area. There are over 15 independent growers and many of these have become members of the Australian Truffle Growers Association in order to share information and resources about the Australian truffle industry. It is also estimated that PTT have relationships with some 20 truffières throughout Victoria.

Number and Types of Growers

Table 8. Types and Numbers of Truffle Growers in Victoria

Grower Type	Description	Number
1	Larger scale corporate truffière (generally >5 ha) e.g., Corporate group	0
2	Larger scale investment truffière (generally >5 ha) e.g., Investment group	0
3	Smaller scale contracted or licensed grower truffière (generally <5 ha) e.g., Growers for corporate groups	Approx 20
4	Smaller scale independent grower truffière (generally <5 ha) e.g., Smaller growers	>15
	Total	>35

Production Resources

Over 90 ha of land is estimated to be under current or proposed truffière cultivation. Oak and hazel host trees have been provided to the industry through commercial nursery suppliers. In 2008, only 15,000 trees or 40 ha are be considered to be mature. However, as shown at Figures 20 and 21, the land area and population of mature is expected to increase to almost 90 ha and 35,000 respectively in Victoria.

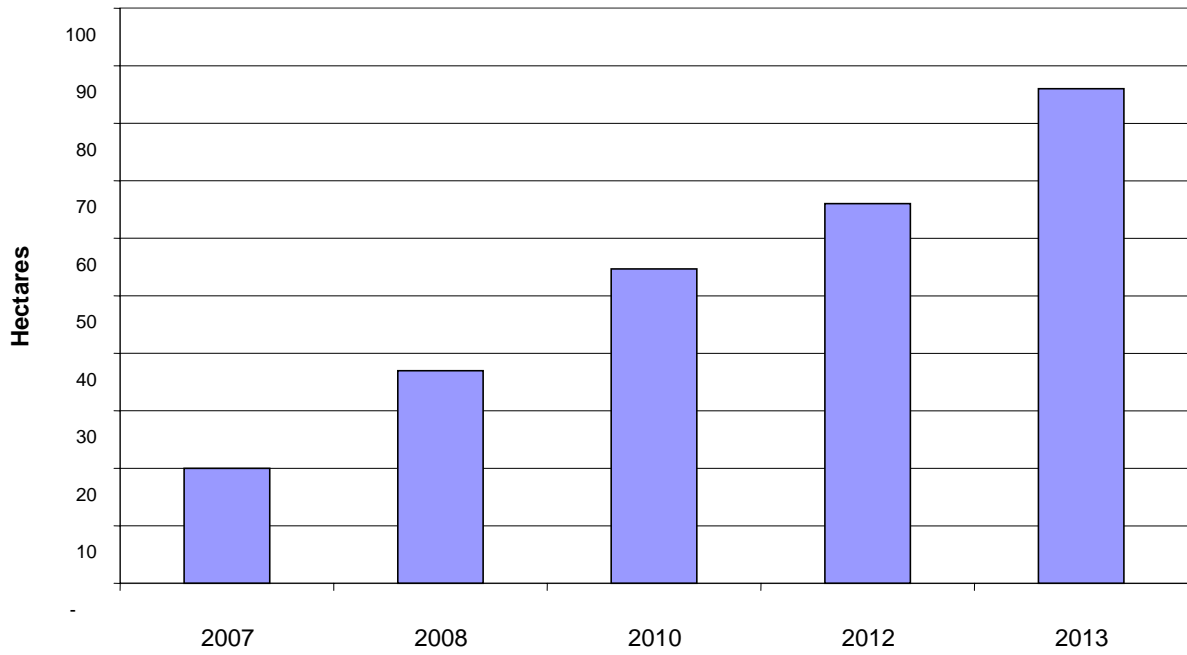


Figure 20. Victoria Estimated Land under Truffière Cultivation
(Minimum maturity of 5 years)

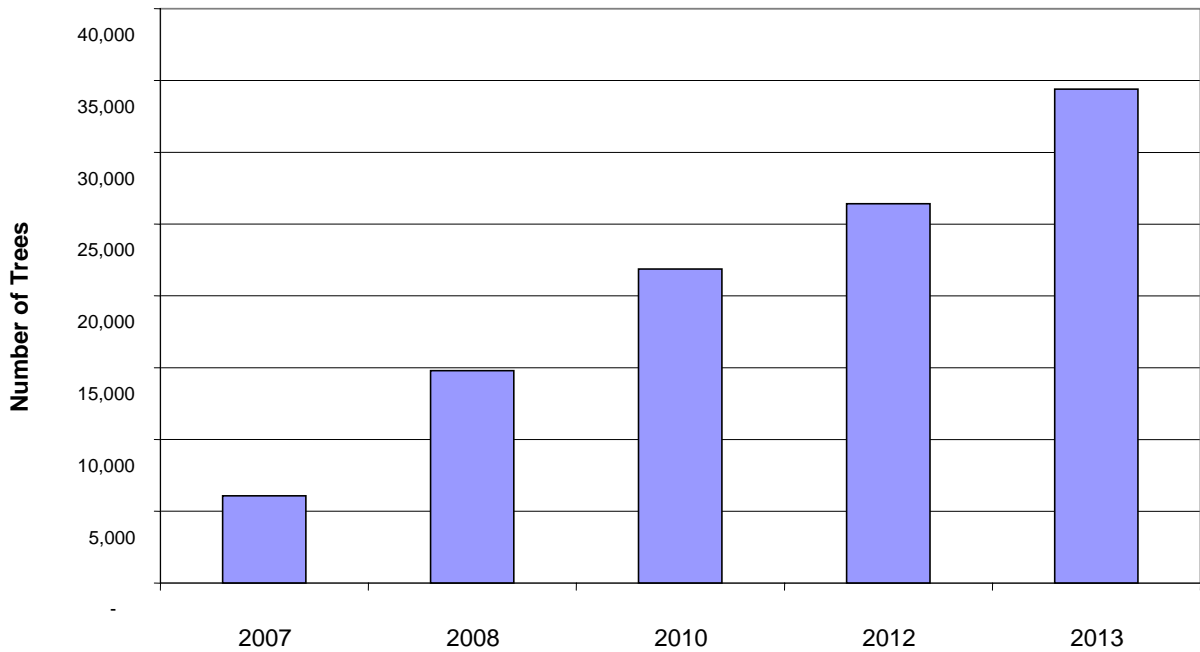


Figure 21. Victoria Estimated Number of Trees under Truffière Cultivation
(Minimum maturity of 5 years)

Truffle Yield Estimates

Truffles may be harvested during the period June to August. Reliable information on truffle yields in Victoria is difficult to obtain and is generally not available.

Industry Risks and Constraints

Industry identified the following risks and constraints to further growth:

- **Consumer Education**
Consumers in Australia are generally not familiar with truffles and their uses. While many chefs have an appreciation of their value, many consumers are unfamiliar with truffles and are unable to appreciate them as a valuable food item.
- **Technical Support of Export Markets**
As production increases in Australia, export markets will need to be developed. Truffles have a shelf-life of approximately 2-3 weeks and technical protocols may need to be developed to support the integrity and value of exported truffles.
- **Packaging and Distribution Systems**
Growing commercial volumes will require the use of packaging and distribution systems which maintain the integrity and value of the truffles. At present, there are no standards for packaging and distribution.
- **Grower Knowledge**
While many growers have access to technical support, a significant number of growers were new to the industry and lacked skills and knowledge for the establishment of truffières and the production of truffles.
- **Quality Standards of Truffle Trees**
While the nursery industry is able to provide a reliable supply of inoculated trees for truffle production, many growers raised the need for a 'certification' process which enabled the trees to be tested and certified for *Tuber melanosporum*. The availability of technical expertise and possibly DNA testing facilities were considered necessary.

Future Priorities and Research Issues

- Consumer and market education.
- Technical support for export markets.
- Packaging formats for truffles.
- Quality certification systems for trees.
- Technical resources to support growers.

4.6 South Australia

The size of the industry in South Australia is unclear; however there is at least one grower with approximately 1,100 trees under cultivation in the Hahndorf/Adelaide Hills area. It is estimated that these trees shall reach maturity in 2011-12.

4.7 Queensland

The size of the industry in Queensland is also unclear; however there is at least one grower in the Stanthorpe area. Truffle volumes are unknown.

5. Discussion of Results

5.1 Estimated Growth of the Industry

The industry is anticipated to experience a rapid period of growth over the next five years, from an estimated 250 ha of mature truffière land in 2007 to almost 600 ha by 2013. This represents an average rate of growth of over 20% per annum (Figure 22).

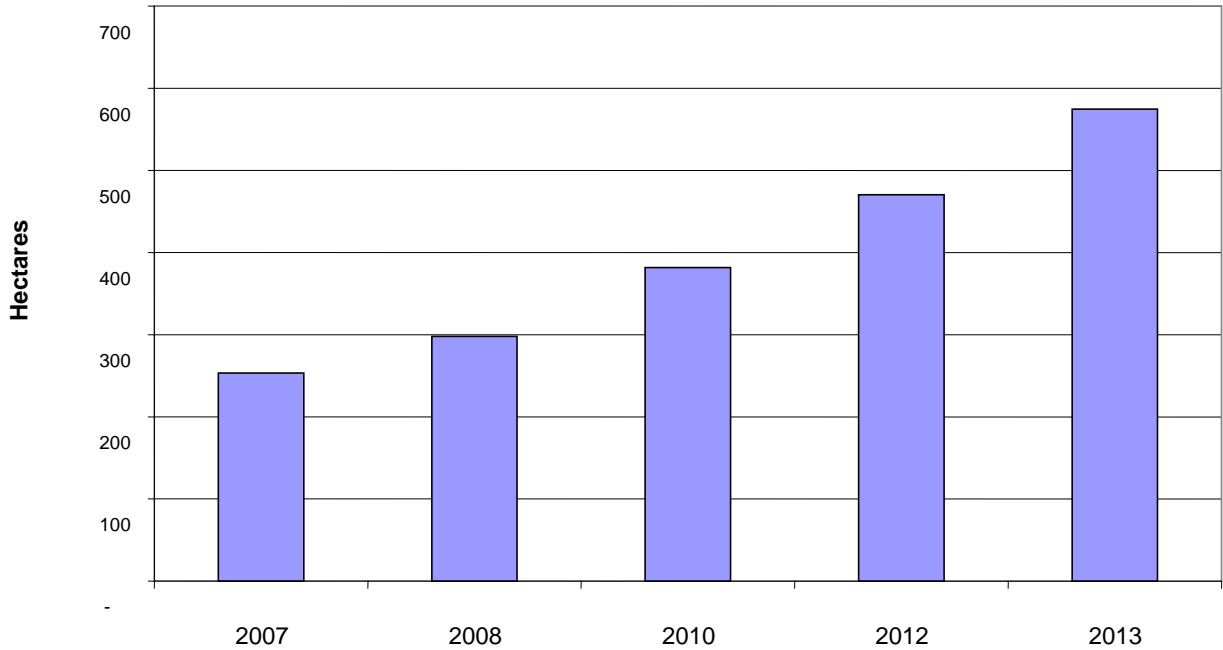


Figure 22. Estimated Land under Truffière Cultivation
(Minimum maturity of 5 years)

5.2 Estimated Production and Yields

Production

Following the harvest of Australia’s first French black truffle in 1999, the production or harvest of truffles has steadily increased since 2002 to an estimated volume of 800 kg in 2007. Figure 23 shows the rate at which these production volumes have increased between 2002 and 2007. Over the next five years, this rapid growth in production appears set to continue.

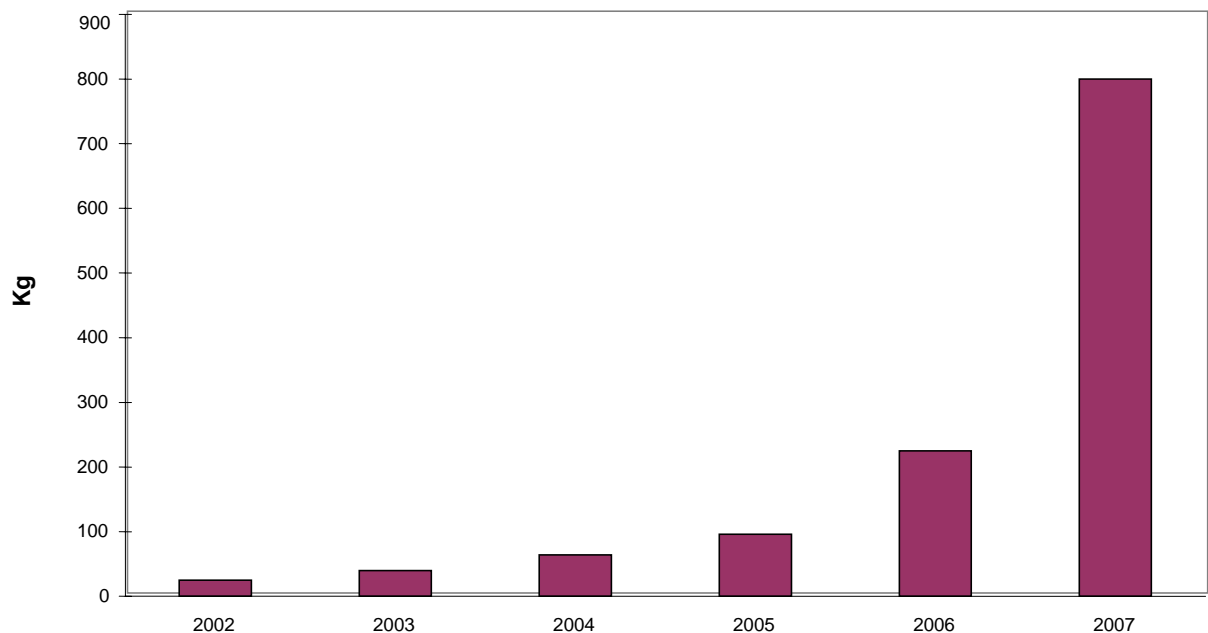


Figure 23. Estimated Truffle Production in Australia (kg) (2002-07)

Sources: Based on data from Malajczuk (2007), Dixon (2007), ABARE (2008)

Yields

As shown at Tables 9 and 10, it is estimated that the number of mature trees will grow from 115,000 to 240,000 between 2008 and 2013.

The average annual yield in European truffière's, many of which have not been irrigated, is 15-20 kg per ha (Hall 2007). However, yields of 50 kg per ha have been reported in North America and New Zealand (Malajczuk and Amaranthus 2007; Lonsec 2007). In exceptional cases, some European and New Zealand truffière's have reported yields of over 100 kg per ha (Hall 2007).

Assuming a yield of 50 kg per ha, the potential production from Australia's projected 575 ha of truffières in 2013 is almost 30 tonnes. However, this assumes a 100% yield from the 'mature' truffière areas and does not take into consideration various site-specific factors which may reduce yields.

Nonetheless, industry groups estimate that truffle yields in Australia are set to exceed five tonnes within five years. The Australian Truffle Growers Association has estimated that, based on the production volume from existing truffières, and assuming accepted figures for annual increases in production from these truffières alone, Australia production will reach between five and ten tonnes by 2013.

Table 9. Estimates of Land and Trees (*) Current 2008 Truffière Cultivation

Grower Type	Description	Estimated Area (ha)	Estimated Trees
1	Larger scale corporate truffière	80	35,000
2	Larger scale investment truffière	25	10,000
3	Smaller scale contracted or licensed commercial truffière	125	50,000
4	Smaller scale independent commercial truffière	70	20,000
	Totals	300	115,000

(*) Minimum maturity of 5 years

Table 10. Estimates of Land and Trees (*) Current 2008 and Proposed Truffière Cultivation by 2013

Grower Type	Description	Estimated Area (ha)	Estimated Trees
1	Larger scale corporate truffière	80	35,000
2	Larger scale investment truffière	180	80,000
3	Smaller scale contracted or licensed commercial truffière	170	80,000
4	Smaller scale independent commercial truffière	145	45,000
	Totals	575	240,000

(*) Minimum maturity of 5 years

Industry Priority: Yield is a key factor for the Australian industry's economic viability. Truffle production is highly variable throughout the country, which can affect revenue and farm cashflow. Further management and research should be focussed upon the improvement of not only the quantity but also the consistency of truffle yields in Australia.

5.3 State Locations of the Industry

As shown at Figures 24 and 25, the three main truffle growing areas in Australia are Tasmania, Western Australia and NSW. This is expected to remain unchanged until 2013, with significant new truffière developments planned or underway in these states, including:

- the Oak Valley Truffle Project 2007 which is a 60 ha development in WA
- the Tasmanian Truffle Project No. 3 which is a 73 ha development in Tasmania
- new plantings in NSW and Victoria.

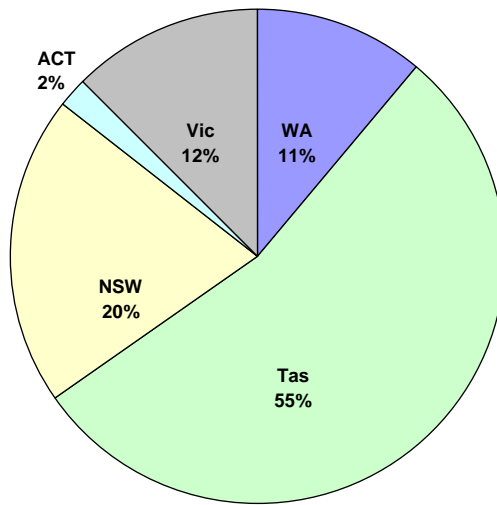


Figure 24. State Location of 'Mature' Truffière as at 2008
(Minimum maturity of 5 years)

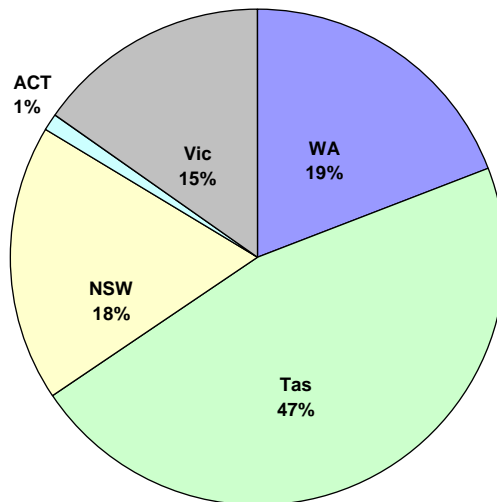


Figure 25. Estimated State Location of 'Mature' Truffière by 2013
(Minimum maturity of 5 years)

5.4 Changing Structure of the Industry

The management and control of truffière land is projected to significantly change by 2013 (Figure 26). At present, 69% of mature truffière land area is managed by Type 1 ‘larger scale corporate truffières’ growers together with Type 3 ‘smaller scale contracted commercial truffières’ growers (Figure 27). However, based upon existing and proposed truffière developments, the management of truffière land area is projected to change due to the dynamic growth of Type 2 ‘larger scale investment truffières’ growers. In particular it is estimated that by 2013, the share of truffière land area for Type 2 growers shall grow from 8% to 31%, and together Type 2 and Type 3 growers shall manage 66% of the industry’s truffière land area (Figure 28).

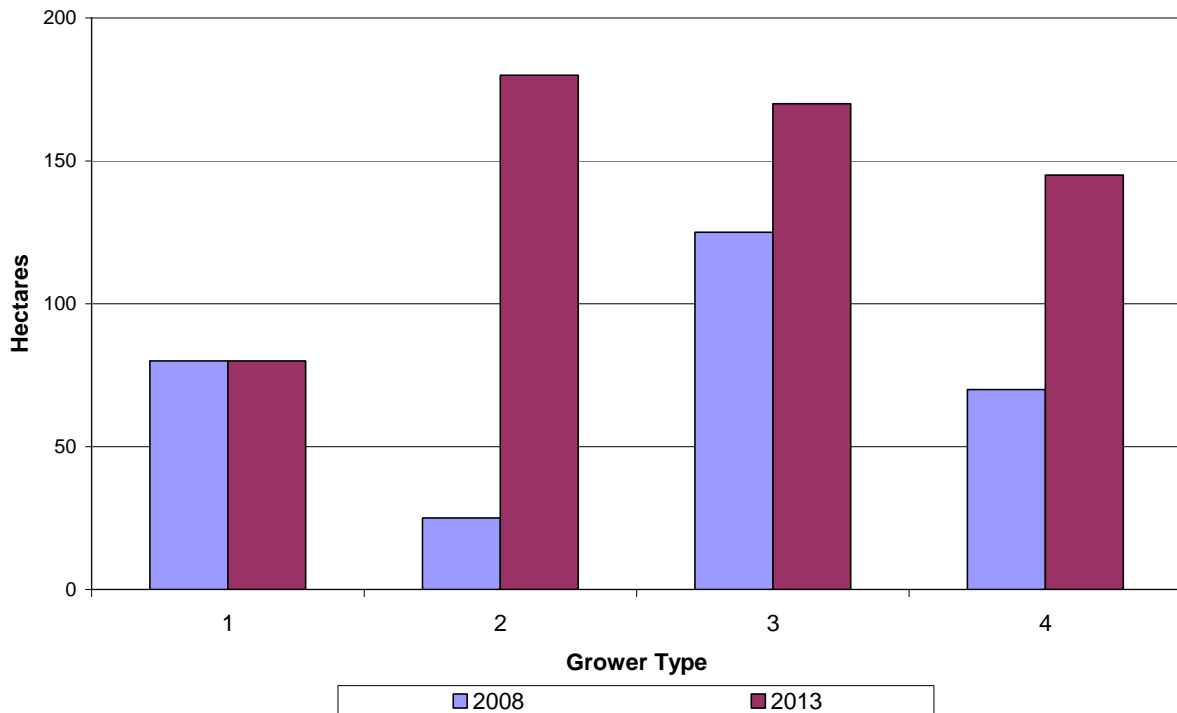


Figure 26. Projected Changes of ‘Mature’ Truffière Land Area By Grower Type (2008 to 2013)
(Minimum maturity of 5 years)

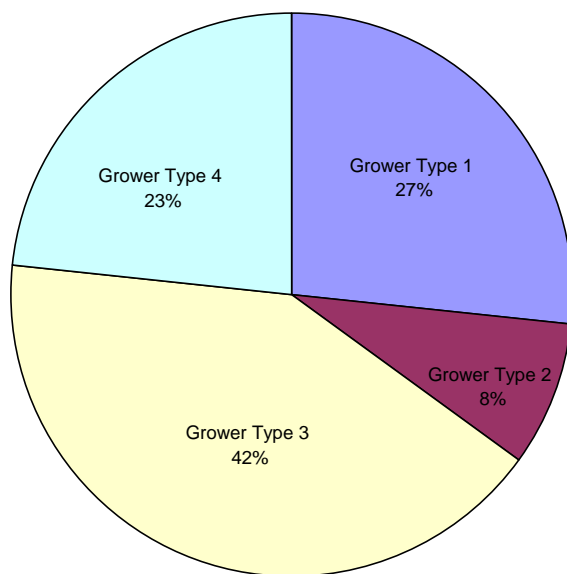


Figure 27. Grower Types of 'Mature' Truffière as at 2008 (*)
(Minimum maturity of 5 years)

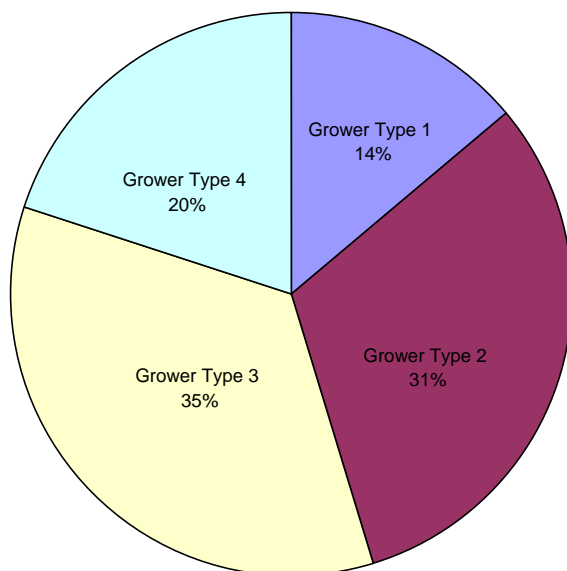


Figure 28. Estimated Grower Types of 'Mature' Truffière as at 2013 (*)
(Minimum maturity of 5 years)

5.5 Australian Market Estimates and Products

Fresh Truffles

To date, the Australian market has largely been serviced by imports of fresh truffles (including French black truffles), which were valued at AU\$278,000 in 2007. Growth of the local truffle industry over the last decade has led to significant increases in production. An estimated 800 kg of truffles was harvested in 2007, with a wholesale value of AU\$1.6 million at AU\$2,000 per kg. Assuming that the Australian market is able to consume the total volume produced in 2007, the wholesale market for French black truffles, including imported product, is estimated to be one tonne or almost AU\$2 million per annum. This is consistent with other industry estimates by Lonsec (2007).

In addition, this estimate of the size of the Australian market is also relatively consistent with feedback from wholesale importers and distributors that at present there is no significant additional demand from customers. Notwithstanding this, the Australian market for fresh truffles can be grown further through the promotion and education of the market on the use of truffles. However, additional market growth shall be inherently limited by the relatively small size and nature of the fine food, restaurant and retail markets for fresh truffles in Australia.

Imported Truffles

Fresh truffles have been imported into Australia for many years. However, the recent increase of Chinese black truffle imports, from 50 kg to almost 180 kg between 2006 and 2007, is a worrying trend for the Australian truffle industry. The industry is concerned that these imports pose a disease risk and may be substituted for higher quality Australian truffles. However, others believe that the Chinese black truffle provides an alternative for consumers who may not otherwise be able to afford the experience of consuming truffles.

The market appears to be evolving into three tiers: one market sector for high quality French black truffles from overseas; another sector for Australian-grown French black truffles; and the final sector for imported Chinese black truffles. As discussed at Section 5.8, the development of an Australian truffle grading standard will support the differentiation of Australian grown truffles from imports. Australian-grown truffles may potentially be graded and recognised to be equal to, or better than, imported French black truffles.

Industry Priority: The Australian industry needs to conduct a biosecurity risk assessment of imported Chinese black truffles. Malajczuk and Amaranthus (2007) believe that Chinese black truffles pose the single greatest threat to the Australian industry. This threat exists due to:

- biosecurity risks associated with inadvertent use of *T. indicum* as inoculum in Australia
- potential impact upon truffière yields due to competition between *T. melanosporum* and *T. indicum*
- potential for truffle substitution leading to false and misleading information for consumers.

Market Price Position

While it is difficult to source reliable price data, Table 11 shows the indicative wholesale pricing of Australian truffles. Industry wholesale groups expect that this pricing position will continue.

Table 11. Indicative Wholesale Pricing for Truffles in Australia (April, 2008)

Product	Wholesale Price Range (A\$ per kg)
Imported French Black Truffles	>\$3,000
Australian French Black Truffles	\$2,000 - \$3,000
Chinese Truffles	<\$400

Further Processed and Value-Added Products

Strong demand exists for preserved and value-added truffle products, such as cooked and canned/bottled truffles, dips and patè, sauces and dressings. Australia imports 10-20 times more processed products, by volume, than fresh truffles.

At import volumes of 2,700-5,000 kg between 2005 and 2007, this represents a significant potential import replacement market opportunity for the Australian industry. For growers, these products provide a valuable outlet for poorer quality truffles.

Industry Priority: Consumer education is important for the growth of the Australian market. Processed and value-added products provide a significant import replacement opportunity for the Australian industry. In addition, research should be focussed upon new product development.

5.6 Export Markets

The major export market opportunities for Australia include Europe, Asia and North America due to the counter-seasonal supply advantage. Aside from the traditional European markets, Lonsec (2007) estimates that the market demand in Japan and SE Asia is approximately 10-15 tonnes per annum, and the United States less than ten tonnes per annum. Based upon these estimates, the Asian markets may have the potential to provide Australian growers with a large and valuable market for many years.

Estimates of market demand for Australian truffles are difficult to source. However, prices for Australian exported truffles from the Hazel Hill truffière have been reported as achieving wholesale prices of USD\$1,500-3,000 per kg (approximately A\$1,600-3,300 per kg) (Malajczuk and Amaranthus 2007).

Australia's reputation as a truffle exporter is at an important stage of development, as many markets are not familiar with Australian-grown truffles. Further market research is required in the following areas:

- market specifications on the application and use of Australian truffles and market feedback
- export product specifications for Australian truffle products and the supply chains
- export protocols for the quality and grade of Australian truffles and the packaging guidelines
- factors which shall determine international pricing for Australian exported truffles.

Industry Priority: There is a need for export market research and market development especially for Asia. In particular the research should determine price trends due to production and demand factors in international markets. The industry as a whole should review strategies to underpin future prices for Australian truffles. These strategies may include branding, labelling, packaging and quality standards.

5.7 Quality Assurance of Trees and Truffles

Nursery supplies of inoculated trees are either provided by commercial suppliers or within major industry groups. The methodology and technology associated with the inoculation of trees is usually confidential and subject to commercial patent and/or licence.

However, as the integrity of the inoculation process is critical to the industry, many industry groups have suggested the need for an audit process to certify that:

- the trees have been successfully inoculated and that the inoculation with *T. melanosporum* has been conducted free of other mycorrhizal fungi
- the truffles are true of type *T. melanosporum*. It is reported that testing facilities at Australian universities have been able to provide DNA analyses for growers for this purpose.

Industry Priority: The industry should review and assess the benefits associated with an audit and certification process for inoculated seedlings, trees, and truffles.

5.8 Truffle Grading Standards for Markets

Truffle grading standards have been developed and used in the European Union and have been under review by New Zealand and Australian industry associations. Industry groups support the development of similar standards for Australian truffles. Grading standards support the integrity of the industry and provide the industry with a range of benefits, including:

- **A market focus for the Australian industry.** This has the potential to enable the industry to differentiate between the requirements of fine dining restaurant and fine food retail markets in Australia, and specifications for export markets.
- **Potential to label and brand Australian truffles.** The potential also exists to develop a certified trust mark to identify the truffles as uniquely ‘Grown in Australia’ and enhance the reputation or integrity of the Australian industry.
- **Consistency of product.** Establishing product grades will encourage suppliers to provide truffles that consistently meet market specifications such as maturity, size, aroma, appearance, taste and colour.
- **Common industry system.** The system will provide minimum standards and guidance to both large and small growers so that product ‘dumping’ practices are minimised.
- **Differentiation and traceability of Australian truffles.** Australian-grown *T. melanosporum* will be identifiable and traceable to avoid substitution risks. A traceability system will also enable industry to support the ‘clean and green’ integrity of Australian grown truffles.

While grading standards have merit, several industry groups expressed concerns about its application at present due to limited volumes of Australian truffles.

Industry Priority: Further develop, review and implement the grading standard for Australian truffles, currently in draft form with The Australian Truffle Growers Association.

5.9 Packaging and Distribution

Fresh truffles have a 2-3 week shelf-life. The growth of commercial volumes of truffles will see an increasing requirement for packaging and distribution systems, which maintain the integrity and aromatic value of the truffles. Existing and new technologies should be reviewed and evaluated for their potential to support the packaging and distribution of truffles. As an example, such technologies may include blast freezing, vacuum packaging and high pressure processing (see Mouefakk et al. 1996) for the preservation and/or extension shelf-life of fresh truffles.

Industry Priority: Review and assess the benefits of processing and packaging technologies which may enhance the shelf-life of truffles.

5.10 Technical Resources for Production and New Product Development

While the industry has partnered with a number of research groups in Australian universities, to date there appears to be limited graduates or technical resources in the field of mycology or the study of fungi. Many growers have commented on the lack of independent technical resources to assist with production issues including:

- truffière site selection, certification of inoculated trees, monitoring of spore growth on tree root systems and yield rates.
- predator, pest and disease issues
- sustainability of truffière land use in relation to climate change issues

Industry Priority: The industry should promote the need for independent technical skills and resources in the fields of mycology and cultivation in truffières.

5.11 Industry Communications

This is an important issue for the Australian truffle industry. The industry is broad and disparate with four different types of growers across 160 sites. In addition, many growers are located broadly across regions rather than in a centralised area.

The Australian Truffle Growers Association can play an important role in communicating to industry and stakeholders. The Association aspires to represent growers as their peak industry organisation and has been in operation for almost two years. It represents approximately half of the currently planted area and almost a third of the industry growers with some 50 growers and 20 associates throughout Australia. The growers' holdings range in size from one of Australia's largest growers and nursery suppliers to smaller independent growers. In addition, the Association has a sound working relationship with its equivalent association in New Zealand, and the respective Presidents are honorary members of each other's Association. Through its website, The Australian Truffle Growers Association (www.trufflegrowers.com.au) provides its members with industry news and issues ranging from international market developments, to the development of quality standards for Australian truffles or production enquiries.

The challenge for the industry during the next phase of growth lies in co-ordinating and managing national and international priorities. The Association has a role to play in developing a whole-of-industry response to issues including:

- industry marketing and consumer education
- industry quality and grading standards
- biosecurity issues
- research and development.

Industry Priority: The industry should review and ensure that it has the resources and processes in place to manage and respond to potential whole-of-industry issues over the next five years.

5.12 Strategic SWOT Analysis of the Industry

A SWOT analysis is a commonly used strategic planning tool to review Strengths, Weakness's, Opportunities and Threats. This analysis can be used to develop and review strategies and implementation plans by the Australian truffle industry.

The SWOT analysis below focuses on the industry objective of being profitable and sustainable. The factors may be categorised as either internal or external:

- Internal factors – The strengths and weakness's within the industry
- External factors – The opportunities and threats affecting the industry.

Strategic Issue: Marketing and Commercial Focus			
Strengths	Weakness	Opportunity	Threat
<ul style="list-style-type: none"> • Quality of Australian truffles • Australia's Clean and Green reputation • Diversification of income for rural farms • World's largest producer of (counter-seasonal) cultivated truffles • Existing supply & distribution chains • Growing capacity to supply • Development of value-added truffle products • Marketing skills & experience in Type 1 and Type 2 growers 	<ul style="list-style-type: none"> • Limited marketing experience of Type 3 and Type 4 growers • Lack of strategic market research • Understanding of market requirements between retail and restaurants • Lack of market education about Australian truffles • Lack of grading system for Australian truffles • Optimum yields and consistency from truffières • Understanding of packaging needs for distribution and export 	<ul style="list-style-type: none"> • Counter-seasonal exports to northern hemisphere markets • Continued limited supply of truffles in Europe • Asian market proximity and demand • Australian market demand • Market reputation of truffles as a prized food • Truffles enhance a wide range of foods/sauces • Exploitation of nutrition and health opportunities 	<ul style="list-style-type: none"> • Market non-acceptance of Australian grown truffles • Pricing fluctuations due to international supply/demand • Product substitution from imported Chinese • Strengthening of the \$AU exchange rate

Strategic Issue: Industry Sustainability			
Strengths	Weakness	Opportunity	Threat
<ul style="list-style-type: none"> • Established nursery supplies • Availability of land resources • Wide range of growing areas • Biologically and chemically clean truffles • Established distribution channels • Trained dogs/services • In-house investment in technical resources by Type 1, Type 2 and Type 3 growers 	<ul style="list-style-type: none"> • Variable understanding on climate and soil conditions to grow truffles in Australia • Lack of strategic market projections and development • Variable truffle quality and yields • Variable skill & management systems for truffle production • Disparate communications due to differing interests of growers in the industry • Limited QA, technical and research resources eg, truffle certification, pest and disease issues • Limited further processing facilities • Relatively limited application of technology and equipment 	<ul style="list-style-type: none"> • Development of strategic industry plans for sustainability • Development of technical and research resources at an industry level • Utilisation of international technology and research 	<ul style="list-style-type: none"> • Poor quality inoculum and practices for the inoculation of seedlings and host trees • Biosecurity risks from imported or introduced truffles • Pests and diseases including predatory animals • Native and introduced fungi which may compete with Australian grown truffles • Climate change issues and variability of rainfalls, temperatures and frosts

5.13 Summary

Drivers for Industry Growth

- Growth in Australian market demand for French black truffles grown in Australia.
- Counter-seasonal exports to northern hemisphere markets.
- Asian market proximity and growth in demand for Australian truffles.
- Continued limited supply of truffles in Europe.
- Knowledge of production and demand factors affecting market pricing trends.
- Increased yields of truffles from Australian truffières.
- Development of quality standards to ensure consistency of Australian truffles.
- Development of preserved and value-added truffle products using Australian truffles.
- Development of technical and research resources for industry.
- Efficient communications and management of whole-of-industry issues.

Constraints for Industry Growth and Sustainability

- Variable understanding of strategic export markets such as Asian markets.
- Lack of consumer and market education about Australian truffles.
- Variable understanding between growers on optimal climate and soil conditions to grow truffles in Australia.
- Variable knowledge between growers on truffière establishment, tree handling and management systems to maximise the growth of truffles in Australia.
- Variable yields, volumes and quality of Australian truffles.
- Lack of quality assurance for propagation of seedlings and trees using guaranteed sources of inoculum.
- Biosecurity risks especially from imported truffles.
- Lack of guidance on quality grading standards for Australian truffles.
- Competition and/or substitution from other country suppliers.
- Variability of grower skill levels.
- Lack of access to technical and research resources.
- Limited further processing facilities for Australian truffles.

6. Implications

The cultivation of French black truffles in commercial truffières is a new and emerging industry, not only in Australia but also worldwide. Limited supply and robust world prices for the French black truffle have provided Australia with the opportunity to establish itself as the largest supplier in the southern hemisphere.

The challenge for the industry during the next phase of growth lies in co-ordinating and managing national and international priorities. This function needs to be conducted in an efficient manner, which does not impose additional administrative costs upon the industry. The Australian Truffle Growers Association has a role to play in developing a whole-of-industry response to issues, including:

- industry marketing and consumer education.
- industry quality and grading standards
- biosecurity issues
- industry sustainability and climate change
- research and development.

While many of these issues will be commercial in nature, many may also be addressed by investing in further research. Research investment can support the Australian truffle industry in many areas such as:

- market research
- production and yield management
- quality assurance and grading
- packaging and distribution
- new product development
- applications of new technology.

The successful establishment and growth of truffle cultivation in Australia brings significant benefits to rural Australia, providing not only alternative sources of income but also supporting regional communities with a new and sustainable form of agriculture.

7. Recommendations

7.1 Objective: Improvement of the Economic Viability of Truffle Cultivation in Australia

- **Recommendation 1.** Support strategic research in industry to improve production yields and consistency of harvest of Australian truffles across all grower types in the industry.
- **Recommendation 2.** Conduct a risk assessment study for imported Chinese truffles and their potential biosecurity risks to the Australian truffles industry.
- **Recommendation 3.** Review and assess the benefits associated with an audit and certification process for inoculated seedlings, trees, and truffles.
- **Recommendation 4.** Develop the availability of independent technical skills and resources in the fields of mycology and truffle cultivation in truffières.

7.2 Objective: Development and Growth of Markets for Australian Truffles

- **Recommendation 5.** Support projects to educate consumers and markets about Australian truffles and the Australian truffle industry.
- **Recommendation 6.** Conduct export market research and market development especially for Asian markets. In particular the research should determine price trends due to production and demand factors in international markets.
- **Recommendation 7.** The industry as a whole should review strategies to underpin future prices for Australian truffles. These strategies may include branding, labelling, packaging and quality standards.
- **Recommendation 8.** Conduct new product development for import replacement associated with further processed and value-added truffle products. In addition, research should be focussed upon new product developments which use applications of truffle odour chemistry.
- **Recommendation 9.** Further develop, review and implement the grading standard for Australian truffles, currently in draft form with The Australian Truffle Growers Association.
- **Recommendation 10.** Review and assess the benefits of processing and packaging technologies, which may enhance the distribution and shelf-life of truffles.

7.3 Objective: Management of Industry Communications and Whole-of-Industry Issues

- **Recommendation 11.** The industry should ensure that it has the resources and processes in place to manage and respond to potential whole-of-industry issues over the next five years. To this end, The Australian Truffle Growers Association is an industry organisation that has a role in addressing whole-of-industry issues.

8. Appendices

Appendix 1. Australian Export and Import Data for Truffle Products

(Note: Garvey and Cooper (2001) have raised concerns about the accuracy of the ABS export data, suggesting that it may include other mushroom products, inflating the values. However, they believe that the ABS import data is accurate and consistent with industry estimates).

Truffles		2002	2003	2004	2005	2006	2007
Exports, all types							
Fresh or chilled							
Volume	kg	26,463	7,152	11,815	13,484	12,200	
Value	\$'000	238	39	73	77	94	
Prepared or preserved							
Volume	kg	3				66	
Value	\$'000	0				1	
Totals	kg	26,466	7,152	11,815	13,484	12,266	0
	\$'000	238	39	73	77	95	0
Imports, all types							
Fresh or chilled							
Volume	kg	297	245	220	227	279	455
Value	\$'000	209	116	147	216	260	278
Provisionally preserved							
Volume	kg			12			
Value	\$'000			5			
Dried, whole or pieces							
Volume	kg	1,564	3,600	1,324	3,213	781	2,278
Value	\$'000	11	15	41	77	35	16
Prepared or preserved							
Volume	kg	425	1,534	1,170	2,711	5,012	
Value	\$'000	114	140	55	90	197	
Totals	kg	2,286	5,379	2,726	6,151	6,072	2,733
	\$'000	334	271	248	383	492	294

Source: ABARE (2008); ABS (2008).

Appendix 2. Industry Contacts – Growers

Growers	Organisation/Affiliation	Contact
Mr Al Blakers	Five Acre Nursery	T: 08 97712258 E: fiveacre@karriweb.com.au
Mr Peter Cooper	Perigord Truffles of Tasmania	T: 03 62612213 E: peter@perigord.com.au
Mr Graham Duell	Member, The Australian Truffle Growers Association, Incorporated	T: 0417 434464 E: g_duell@bigpond.com
Mr Wally Edwards	The Wine & Truffle Co.	T: 08 92041011 E: wally.edwards@holmanindustries.com.au
Mr Noel Fitzpatrick	Member, The Australian Truffle Growers Association, Incorporated	T: 0438 596019 E: nfitzpatrick@swin.edu.au
Ms Jennifer Gardiner	Member, The Australian Truffle Growers Association, Incorporated	T: 0439 891923 E: Jennifer.Gardiner@industry.gov.au
Mr Duncan Garvey	Perigord Truffles of Tasmania	T: 0419 341906 E: Duncan@perigord.com.au
Mr Wayne Haslam	Member, The Australian Truffle Growers Association, Incorporated	T: 0403 242454 E: wayne@bluefrogfarm.com.au
Mr Trevor Mathews	Pickering Brook Mushrooms	T: 0400 082789 E: trevmathews@hotmail.com
Mr Roy Priest	Member, The Australian Truffle Growers Association, Incorporated	T: 02 62626178 E: flamen@bigpond.com
Mr Adam Smith	The Wine & Truffle Co.	T: 0413 626244 E: awilson@wineandtruffle.com.au
Mr Ted Smith	Member, The Australian Truffle Growers Association, Incorporated	T: 02 48851924 E: tsmith@biz-solutions.com.au
Mr Tim Terry	Truffles Australis Member, The Australian Truffle Growers Association, Incorporated	T: 0418 130464 E: tim@tastruffles.com.au

Appendix 3. Industry Contacts – Market Wholesalers and Distributors

Wholesalers	Organisation	Contact
Mr Tony Bilson	Bilson's Restaurant, Sydney	T: 02 82140496 E: info@bilsons.com.au
Mr Simon Friend	Friend and Burrell Fine Foods, Melbourne	T: 0405 424860 E: simon@friendandburrell.com.au
Mr Simon Johnson	Simon Johnson Purveyor of Quality Foods, Sydney	T: 02 82448288 E: feedback@simonjohnson.com
Mr Nicholas Miriklis	The Vegetable Connection, Melbourne	T: 0414 545930
Mr Damian Pike	Damian Pike Wild Mushrooms Prahran Market, Melbourne	T: 03 98240805
Mr Georges Puechberty	GJ Food The Fine Food Connection, Sydney	T: 02 9555 7750 E: contact@gjfood.com.au

Appendix 4. Industry Contacts – Researchers

Researchers	Organisation	Contact
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Mr Andrew Claridge	Department of Environment and Climate Change NSW	E: Andrew.Claridge@environment.nsw.gov.au
Mr Max Foster	Australian Bureau of Agricultural and Resource Economics	T: 02 62722095 E: mfoster@abare.gov.au
Dr Nick Malajczuk	MAI Australia	T: 0419 042258 E: nickm@mai-australia.com.au
Professor Jim Trappe	Department of Forest Science, Oregon State University, Oregon	E: trappej@onid.orst.edu

9. References

ABARE (2008) Truffles. RIRDC 2008 (in press).

Amaranthus, M. (2007) Independent Truffle Expert's Report in Product Disclosure Statement for the Oak Valley Truffle Project 2007 ARSN: 124 296 028. pp26-34.

Burt, J (2008) Production of Black Perigord Truffles in the Warren Area of Western Australia. Draft paper in progress. Department of Agriculture and Food. Government of Western Australia.

Dixon, C (2007) Independent Expert's Report in Product Disclosure Statement for the issue of interests in of the Project in Tasmanian Truffle Project No. 3. ARSN: 124 780 392. pp13-17.

Garvey, D. (2004) Truffles, The New Crop Industries Handbook. RIRDC 2004.

Garvey, D and Cooper, P. (2004) Increasing the productivity of truffières in Tasmania. RIRDC Publication No. 03/129, RIRDC Project No. PTT-3A.

Garvey, D and Cooper, P. (2001) French Black Truffle. Establishment and Production in Tasmania. RIRDC Publication No. 01/084, RIRDC Project No. PTT-2A.

Hall, I.R., Brown, G.T. and Zambonelli, A. (2007) Taming the Truffle. The History, Lore and Science of the Ultimate Mushroom. Timber Press Oregon USA.

Lonsec Limited (2007) Investor review for Tasmanian Truffle Project No. 3. Lonsec Agribusiness Research July 2007 (www.lonsec.com.au).

Malajczuk, N and Amaranthus, M. (2007) Cultivation of *Tuber* species in Australia. Proceedings: La Culture de la Truffe dans le Monde, Brive-la Gaillarde, Feb. 2007, pp.9-18.

Mouefakk, A., Cruz, C., Montury, M., Deschamps, A., Largeteau, A and Demazeau, G (1996) Stabilisation of Black Truffle of Perigord (*Tuber melanosporum*) by High Pressure Treatment. High Pressure Bioscience and Biotechnology, Hayashi and Balny (eds) Elsevier Science B.V. Press. Pp. 401-404.

Stahle, P.P and Ward, D. (1996) Evaluation of the Potential of Growing *Tuber Melanosporum* as a Crop on Mainland Australia for Export and Domestic Consumption. RIRDC Project No. DPS-1A.

Watershed Premium Wines Ltd (2007) Oak Valley Truffle Project 2007. ARSN 124 296 028 Product Disclosure Statement/Prospectus.

Websites

Australian Truffle Growers Association www.trufflegrowers.com.au

Manjimup Wine and Truffle Company www.wineandtruffle.com.au

Perigord Truffles of Tasmania www.perigord.com.au

Truffles Australis www.trufflesaustralis.com.au