



QUALITY ASSURANCE OF THE AUSTRALIAN TRUFFLE INDUSTRY

HONOURS RESEARCH PROJECT

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1. ABSTRACT

The purpose of the study was to gain an overview of the perceptions of stakeholders within the Australian truffle industry towards the development and implementation of a quality assurance scheme. Comparisons were drawn between members from different states and different size and age of operation. The major benefits and costs associated with a QA scheme were also determined as well as whether the majority of members would adopt a QA scheme if it becomes available.

The study involved the design of a user-friendly online questionnaire which was distributed via a link and description on a member's bulletin which is emailed to members of the Australian Truffle Growers Association on a monthly basis. The results were analysed both quantitatively and qualitatively, conclusions drawn and recommendations made.

The questionnaire at a glance

Potential number of respondents	110
Total number of completed surveys received	29
Effective response rate	26%
Number of responses from NSW members	16
Number of responses from VIC members	9
Number of responses from ACT members	2
Number of responses from WA members	1
Number of responses from TAS members	1

2. INTRODUCTION

The aim of this study is 'To analyse the perceptions of key stakeholders in the Australian Truffle Industry to the introduction of a Quality Assurance scheme for inoculated seedlings, trees and truffles.'

The targeted key stakeholders include, but are not limited to:

- Inoculation nurseries
- Truffle growers
- Truffle wholesalers and marketers
- Buyers of fresh truffle

This aim was achieved through the following objectives:

- What tools are members currently utilising to promote quality in their product?
- What are the benefits and drawbacks associated with an industry specific quality assurance scheme?
- If a quality assurance scheme is developed will the majority of people in the Truffle Industry adopt the program?
- What is the general consensus? Are the majority of respondents in favour of the implementation of a QA scheme?
- If a quality assurance scheme is implemented will this guarantee the purity of Australian produced Truffles?

The two main stakeholder groups to be analysed are truffle farmers and inoculation nurseries. There was also some data and feedback received from a fresh truffle importer and wholesaler and a soil testing company.

The initiation of this study emerged from an industry study conducted by the Rural Industries Research and Development Corporation (RIRDC) in July 2008 titled 'Taking Stock of the Australian Truffle Industry'. The study made a strong emphasis on the need to evaluate an industry specific QA scheme and assess the benefits association with such a scheme. As a member of the Australian truffle industry the author has a personal affiliation with the industry and its future prospects.

The study is necessary because it is clear that there is a push and demand for the development of a QA scheme. In order for the implementation to be successful and gain a high level of uptake from key stakeholders within the industry an analysis of the thoughts of these key stakeholders is critical. The research will reveal any issues and costs, but also the benefits that members feel are important so these can be taken into consideration when a QA scheme is developed. Strategies and practical solutions can be structured with the implications of key industry stakeholders in mind and ensure the industry remains prosperous into the future.

The results will be of significance to members of the Australian Truffle Growers Association. Members within the production horticulture industry should also be concerned with the findings of this report, as the patterns shown by surveyed industry members reflect directly upon the wider horticulture industry.

The depth of study could have been seemingly endless so only members of the Australian Truffle Growers Association were invited to participate.

3. LITERATURE REVIEW

This section is split into four main sections.

- (a) What is a truffle?
- (b) The Australian Truffle Industry
- (c) Quality Assurance
- (d) Justification for this research

(a) What is a truffle?

The fresh truffle is the edible fruiting body of a subterranean fungus known as a Mycorrhiza¹. Mycorrhizae form a symbiotic relationship with a host tree because they cannot synthesize sugars and other carbohydrates on their own. The tree provides the truffle with a source of carbohydrates and nutrients, and in return the fine thread-like filaments (mycelia) of the truffle, coats the tips of the tree roots to form mycorrhiza which assists the tree to absorb soil minerals and nutrients⁴. In effect the mycorrhiza is able to increase the effectiveness of the trees roots and provide phosphorus and trace elements that would normally be unavailable to the tree.

Truffles are one of the most valued and sought after food crops in the world⁴. One major source of their high market value stems from their unique, but extremely desirable, aroma and flavour. Their mystique and associated gourmet experience has been described as second to none¹. Another reason for their high market value is to date only a small percentage of trees in truffières have yielded truffles. The conditions under which truffles actually form and fruit is quite variable². The third reason for their high market value is their short supply. Worldwide production has steadily decreased over the last 100 years (see *The Australian Truffle Industry - overview*).

There are many types of truffles found all over the world. The four of most culinary value are the French Black (*Tuber melanosporum*), the Italian White (*Tuber magnatum*), the Bianchetto White (*Tuber borchii*) and the summer truffle (*Tuber aestivum*)³. Almost all of the Australian truffle industry is focused on growing the French Black and hence it is the most highly cultivated in Australian plantations (known as Truffières). According to food wholesalers in Australia the French Black can fetch market prices of over AU\$3000 per kilogram⁴.

(b) The Australian Truffle IndustryOverview

Truffles are a relatively new crop in Australia⁴. The first plantings began in the 1990s in Tasmania and Western Australia with the first truffles being harvested in 1999. Truffières have now been established in Victoria, New South Wales, the ACT, South Australia and southern Queensland.

The industry is entering a new phase of growth and investment⁴. Australian truffle production could grow by as much as 10 times by 2013⁵. Whilst the exact annual production of fresh truffle in Australia is unknown it is estimated to have been approximately 1.5 tonnes for the 2009 harvest season⁶. Given that the industry is still relatively young local production is increasing consistently every year.

A high proportion of Australian growers are small-scale growers (*see table 1*). The total area planted in Australia is estimated to be 575 Ha distributed among an estimated 160 plantation sites nationally⁴. Table 1 shows the estimated number of truffières planted in each state and also by type of operation. Approximately 110 of these are members of the Australian Truffle Growers Association. The highest producing states are Tasmania and Western Australia due to the industry being established in these states first.

Table 1 Types and numbers of truffières planted in the states of Australia

DESCRIPTION	WA	TAS	NSW	ACT	VIC
Large scale corporate truffière (>5ha)	2	2	0	0	0
Large scale investment truffière (>5ha)	1	3	0	0	0
Smaller scale contracted or licensed truffière (<5ha)	0	25	30	1	20
Smaller scale independent grower truffière (<5ha)	5	5	30	1	15
Total	8	35	60	2	35

Data source: (Lee, 2008)

Traditionally truffles have been harvested out of wild forest areas in France with very rudimentary harvesting techniques. Over the last century the harvest of wild truffles has declined significantly, from 1000-2000 tonnes in the early 1900s to around 100 tonnes per annum during the 1990s⁷. The destruction of natural growing areas especially during the world wars, changes in urban land use, pollution and climate change are considered to be the main causes of this decline⁸. As a consequence of this truffles are increasingly being produced on cultivated farms planted with inoculated trees⁷. Recent data from the Ministry of Agriculture in France shows that in 2007-08 production volumes were around 13 tonnes⁴.

Industry Supply Chain

At present most of Australia's truffle supply is sold to the domestic market, especially for the restaurant and fine food wholesale market segments⁴. Some of the larger growers within the industry have developed dedicated resources for sales and marketing of truffles, while the majority of smaller growers outsource the marketing and distribution to wholesalers. A few of the larger growers have successfully sought stable export markets¹⁷.

The Australian Truffle Industry is at a huge advantage in that the Australian climate is 6 months apart from the climate of not only Europe but also Asia and North America. Therefore, Australia's harvest season does not line up with that of these international competitors and this leaves huge opportunities for the export of fresh truffle, which has a shelf life of only 3 weeks, to countries in the northern hemisphere during their summer period.

Industry Risks and Constraints

A conglomeration of several industry papers has resulted in the following potential risks and constraints to further growth of the industry:

- A limited local market. The need to develop capabilities for international market research and marketing is real. Failure to do so is likely to have an adverse impact on pricing.
- Imported inoculum used for inoculation of tree stock. Potential risk of contamination during inoculation from imported *Tubers* or *Tuber mycorrhizae*⁴.
- Truffle yield from trees. Low numbers of producing trees and variable yield per tree is a major concern¹⁴.
- Quality Standards for markets. The cause for concern here stems from the fact that customers are very subjective in their assessment of a quality truffle.
- Internal communications. An improvement in communications and transfer of technical resources through the supply chain would be beneficial for the industry as a whole⁹.

Comparison with a similar industry - The Australian Persimmon Export Company

The Australian Persimmon Export Company or APEC was in a similar situation to that of the present Truffle Industry a few years back (Rudge, pers. comm. 2009)¹⁰. APEC now consists of 30 growers so industry penetration is low, but it is entirely grower owned

and controlled¹¹. It has been very successful in implementing quality assurance into its product by adopting compulsory quality standards which must be followed by all members¹¹.

APEC was formed in 1989 when a core group of growers embraced the concepts of working together¹¹. It was clear that an export market needed to be developed and in order to do this a quality product must be produced. The APEC website states 'our product is our reputation and therefore our lifeblood'.

The incorporated industry group has focussed on developing a quality brand product for targeted markets. The targeted markets are mainly Asian countries, particularly Singapore, Malaysia, Hong Kong and Thailand. They market their product under two distinct registered brands – Sweet Gold and Golden Star¹⁰.

The success of APEC has come from having all members adhere to a quality standard, and each individual grower takes control and responsibility for their market outcomes. Grower members of APEC personally visit their export markets every year to build relationships with their consumers and agents – ensuring that what they do is what their customers want.

APEC exports have averaged two thirds of the total exports of persimmons out of Australia since the mid 1990's and account for 75% of the imports of Australian persimmons into Singapore¹¹.

(c) Quality Assurance

What is Quality Assurance?

In the context of the Australian truffle industry quality assurance encompasses all planned and systematic actions and programs that are designed to provide confidence that the product (i.e. inoculated trees, fresh truffles or value added products) or service (eg agronomic consultancy) will meet customer expectations¹⁶. Also of extreme importance is that quality assurance will ensure that the product meets a given set of requirements (See explanation of grading system in "Truffle industry specific quality assurance schemes implemented overseas" section). A quality assurance system or scheme can help to not only increase a company's credibility but also that of the whole industry and allow the party to compete better with others.

A well known quality assurance paradigm is the Plan-Do-Check-Act (PDCA) approach¹². This is method of QA management is designed to work as a repetitive cycle to improve business processes.

Relevance of QA to the Australian Truffle Industry

Quality assurance is a big talking point within the industry at present. QA was a topic of this year's National Truffle Industry conference in Tasmania. As part of a focus on industry sustainability "quality standards, biosecurity and market research are to be emphasised"¹³. A recent RIRDC report titled 'Taking Stock of the Australian Truffle Industry' by Barry Lee in July 2008 highlighted the need for a QA scheme to be explored. It said: "Recommendation 3: review and assess the benefits associated with an audit and certification process for inoculated seedlings, trees and truffles".

The second point here is the domestic demand for truffles is nearly saturated. During discussions on 14th April, 2009 Mr W Haslam stated that last year Australia produced an amount of fresh truffle that is approximately what the domestic market consumes. The fear that as the local market becomes saturated farm gate prices will diminish can only be overcome by the export of fresh product overseas. Initially the French may be unfamiliar with Australian produced truffles and consequently be unwilling to accept their native French Black Truffle imported from Australia. However, with adequate export market research and market development Australia's reputation as a quality truffle supplier will build⁴. The influx of tourists to these international continents looking to try truffles at a period when locally produced fresh truffle is not available will put Australia's export market in good stead. Not only is the intention of QA to ensure a top quality, high grade product but also to create a clean, green image of Australian produced truffles which are easy to market. This will guarantee that a high price is maintained and the export market is lucrative for the industry.

The next point is the huge threat of contamination occurring during the inoculation process. Much of the inoculum used for inoculation of seedlings is imported from overseas¹⁴. Inferior species of truffle such as the Chinese *Tuber indicum* and *Tuber sinense* have very little market value¹⁴. There is also the threat of competing mycorrhiza such as *Scleroderma* taking the place of potential infection sites for the desired fungus. In the field they reproduce prolifically and can out-compete the French Black Truffle fungus – leading to a very low or even absent production¹⁴. To find out after several years that much of the desired fungus has been displaced would be detrimental for growers. The damage that these contaminants can cause may also ruin the reputation of Australian grown truffles, particularly when marketing the product overseas. Quality assurance will be pivotal to ensure these contaminants are kept out of the country and most importantly out of inoculation nurseries and truffières.

QA for on farm practices such as nutrition, weed suppression and soil moisture levels are extremely important. On farm practices have a significant impact on the size, quality and amount of truffles produced. This is still an area of scientific mystery and much research on the cultural techniques is still being studied¹⁴. Over time and with a quality assurance scheme implemented specific guidelines will be developed to produce superior and consistent quality truffles.

Recent industry studies

There is considerable literature on growing and cultivating truffles (^{1,3,14}) but literature on quality assurance and quality assurance schemes specifically for truffles is very limited. Many published documents and industry reports highlight the need for a QA scheme to be developed in Australia.

‘Taking Stock of the Australian Truffle Industry’ by Barry Lee in July 2008 is one and there are numerous others. Several RIRDC supported research studies on the cultivation of French black truffles have been conducted since the mid 1990s. Table 2 below summarises a few of these. The important point here is the key findings from these studies. Many highlighted the importance of quality assurance and the relevant ones are as follows:

- The highest quality truffle produce is required to maximise the economic benefits for farmers¹⁵
- To protect the integrity of the industry, and ensure production of a certified quality truffle, inoculation nurseries need to be able to guarantee the quality of trees distributed to growers⁷
- 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 truffle¹⁶

Table 2 Truffle research projects supported by the RIRDC

Project/Year	Title	Researchers
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 Black Truffle. Establishment and production in Tasmania	D Garvey P Cooper
PTT-3A/2004	Increasing the productivity of truffières in Tasmania	D Garvey P Cooper

The most recent RIRDC document is one titled 'Australian Truffle Industry R&D Strategic Plan 2009-2011'. This study was conducted in July 2009 and sets out three year industry priorities. The five major objectives for the next three years are the following¹⁷:

- Objective 1.** Establish an action group to work with AQIS on Import Legislation covering Chinese or other identified truffle varieties
- Objective 2.** Understanding, strengthening and developing market analysis and market drivers for Australian truffles
- Objective 3.** Establishing a Grading Standard for Australian truffles
- Objective 4.** Research into diseases with a focus on affects of rot in truffles
- Objective 5.** Consumer education, industry communication and engagement, and advancement of accreditation standards for Australian truffles.

There are several industry studies that have been conducted and dealt with various issues to do with quality in the Australian nursery industry such as "Business profiles for Australian nurseries" by Brumfield and M^cSweeney. The research assessed the current state of the production nursery sector in relation to aspects of nursery management and performance¹⁸.

External QA programs and certifications available to industry members

Whilst there is not yet a quality assurance scheme specifically for truffle cultivation in Australia there are several QA systems and standards in use for other produce lines. One is SQF2000 which is very sophisticated and requires a strong market link¹⁰. Another is Freshcare which, unlike SQF2000, has relatively low costs of implementation and maintenance, but is primarily focused on food certification rather than the growing processes¹⁹.

The ISO9000 series of standards define minimum requirements for business quality assurance schemes²⁰. Whilst the certification system is internationally recognised it is not industry specific and is most appropriate for the manufacturing industry²⁰. It is also too complex for small operations and expensive to implement and maintain.

The Nursery Industry Accreditation Scheme, Australia (NIASA) for production nurseries outlined in the NGIA's Best Management Practice Guidelines manual²¹ is adopted by many inoculation nurseries (Blakers per. comm. 2009²²). Whilst it is cost effective and in the most part applicable, truffles require different cultural and growing practices to a traditional pot plant, in that the focus is on growing the fungus and not the plant¹⁴. It is clear that conventional practices for things such as pest and disease control will need to be modified and industry guidelines developed specific for truffles. Another

downside of NIASA is that it is very business process based and appears to be more of a marketing tool than a practical, quality driving set of procedures¹⁰.

Organically grown produce appears to be becoming increasingly popular in supermarkets and fresh food shops. The Organic Growers of Australia (OGA) certification system is designed to be ethical, cost-effective and charge no levies on organic sales²³. The market for organic produce overseas is also expanding rapidly so being organically certified will have great marketing opportunities, not to mention the social and environmental benefits for the whole community²³. However, there are issues with non-organic inputs being used on an organic farm.

What is an industry specific QA scheme likely to involve?

After many discussions with people within the Australian truffle industry and the wider horticultural industry we came up with 5 points which describe what an industry specific QA scheme for truffles is likely to involve. It was extremely important to make this known to participants prior to them answering the questions in the questionnaire. Perceptions and attitudes towards a QA scheme are likely to vary greatly depending on what is required of the individual operation. These 5 points are:

1. A grading system to ensure final product meets specifications
2. Grower and inoculation nursery certification. Whilst the methodology and theory associated with the inoculation of host trees is usually confidential the integrity of the process is crucial for the industry.
3. Environmental certification (eg. ISO 14000, Freshcare environmental Code)
4. Annual audits - many documents have suggested the need for an audit process. Most have focused on inoculation nurseries, in particular to certify that trees have been successfully infected with *Tuber melanosporum* and free of competing mycorrhizal fungi. Also of importance is DNA analysis for true to type *Tuber melanosporum*⁴.
5. Good Agricultural Practice. This appears to form grounding in most industry specific QA schemes²⁴. This would cover the process of benchmarking such as industry best practice techniques. Technical support to growers is also an important issue which would need to be covered under Good Agricultural Practice.

Truffle industry specific quality assurance schemes implemented overseas

My research has not discovered any truffle industry specific QA schemes in use. There is however a standard for grading truffles in the EU and this, until recently, was the only known standard worldwide for the grading of truffles¹³. This is appropriate because of the established truffle markets in the EU countries. The standard was developed by the United Nations Economic Commission for Europe (UNECE) in 2004 and titled 'Recommendation Standard for Fresh Truffles'²⁵.

The New Zealand Truffle Association (NZTA) has recently launched its own version of a grading system based on that of the EU. The system was completed largely by the NZTA (in particular Dr Ian Hall) with input from committee members of the Australian Truffle Growers Association. The purpose of the standard is to define the quality requirements of truffles at the export control stage, after preparation and packaging and a recommendation for local sales²⁶. The document clearly sets out the requirements of the following important provisions:

- Provisions concerning quality: Truffle minimum requirements, maturity requirements and classification (eg Grade A, B, C or D)
- Provisions concerning sizing: size is determined by the weight of the truffle
- Provisions concerning packaging: Uniformity and packaging
- Provisions concerning labelling: Identification, nature of the produce, origin of the produce and commercial specifications

The document was developed with the interests of Australian growers in mind also. Both the NZTA and Australian Truffle Growers Association are closely aligned so an Australian version of the grading system is likely to be very similar²⁶.

(d) Justification for this research

This study is necessary because it is clear that there is a push and demand for the development of a QA scheme. In order for the implementation to be successful and gain a high level of uptake from key stakeholders within the industry an analysis of the thoughts of these key stakeholders is critical. The research will reveal any issues and costs, but also the benefits that members feel are important so these can be taken into consideration when a QA scheme is developed. Strategies and practical solutions can be structured with the implications of key industry stakeholders in mind and ensure the industry remains prosperous into the future.

The targeted key stakeholders (growers, inoculation nurseries, truffle wholesalers and marketers) are a vital part of the system of delivering a reliable supply of good quality truffles which meet or exceed the expectation of consumers.

4. METHODOLOGY

The primary form of research for this study was a descriptive industry based questionnaire. In an attempt to survey all members of the Australian Truffle Industry the questionnaire was placed on the University's website at a specific URL. To protect the personal information of member's, should they wish to remain anonymous, potential participants were directed to the Association's website in July's edition of the member's bulletin which is emailed out by the Australian Truffle Growers Association on a monthly basis. The Association's website contained the link to the questionnaire on the University's website.

The questionnaire form (Appendix 2) was designed with strict consideration of participant anonymity and was developed with a strong liaison to the Australian Truffle Growers Association. The proposed research was reviewed and authorised by the executive committee of the association. Consultation occurred with numerous industry leaders from several bodies both internal and external to the Australian truffle industry. These included, but were not limited to:

- Horticulture Australia Limited
- The Nursery and Garden Industry Victoria
- The New Zealand Truffle Association
- Several companies who operate within the Australian Truffle Industry
- A company who operates within the fresh fruit and vegetable industry. In particular they provide training in quality assurance to large companies and conduct quality inspections and testing of fresh produce.

The questionnaire was reviewed and piloted by two industry people prior to the link being released.

The questionnaire was designed for quantitative and qualitative analysis and each question was carefully worded. Boyd-Squires (1989) states that the design of the question and its contents are important to the success of any research²⁷. Four sections made up the questionnaire:

1. The first section asked questions about the operation such as size and location.
2. The second section explored the quality systems currently in place for the business including internal production techniques and external production standards.
3. The third asked participants to specify their level of agreement to a range of comments via a rating system. The system followed was that developed by Rensis Likert known as the Likert scale. The five point scale allowed participants to rate each of the statements from strongly disagree (1) through to strongly agree (5).

4. The final component required participants to nominate their overall level of agreement towards a QA scheme and explain what they think the main benefit and the main drawback of an industry specific QA scheme would be.

At the end participants were able to provide their contact details should they be willing to be contacted at a later date for further discussion on the topic of QA. Ample room within the questionnaire was left for participants to make any comments they felt necessary.

To assure the highest possible response rate to the questionnaire hard copies were also made available to members at the national conference in Launceston, Tasmania prior to release of the online version for those who were unable to complete online. At two weeks after the questionnaire was released and available for completion the response rate was very low (only 6 respondents). The technique we used to improve the response rate was a follow-up email by the Association in late August containing the direct link to the questionnaire so members could navigate straight to it rather than finding the link on the association's website. At the completion of the survey period we had a total of 29 respondents.

To guarantee no double-ups (eg a participant pushing the submit button more than once) the date, time and IP address from the computer on which the questionnaire was completed were included in the results submission email.

5. RESULTS AND DISCUSSION

This chapter has been divided into the following sections:

- (a) Rate of response
- (b) Business profiles
- (c) Quality systems currently in place for the business
- (d) General consensus
- (e) Analysis of ratings given to statements
- (f) Main benefits and drawbacks of a QA scheme
- (g) Members general comments about QA

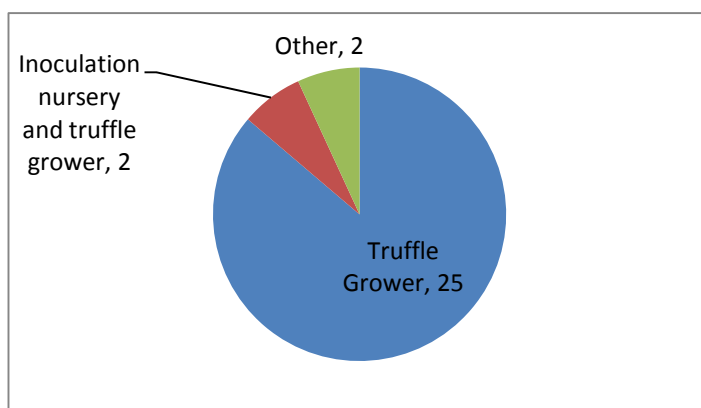
* The raw data used for the analysis can be found in appendices three and four.

(a) Rate of response

Of the 110 members of the Australian Truffle Growers Association we received responses from 29 of these. This is a response rate of 26 percent which provides a substantial amount of data to draw some conclusions and make some important inferences for the industry.

Of these 29 respondents 25 were solely truffle growers (Figure 1). Only two respondents nominated that they are inoculation nurseries and both of these are also growers. The two remaining respondents were in the category 'Other' and include an agronomic consultancy business and a buyer and distributor of fresh truffle.

Figure 1. Responses by stakeholder category



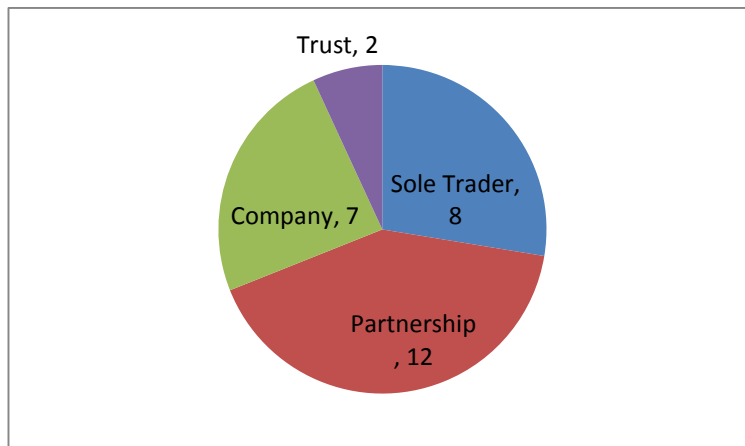
(b) Business profiles

This section details some characteristics of the operations of participating industry members.

Business ownership structure

Participants were asked to nominate the legal or ownership structure of their operation. The dominant group was the Partnerships with 41 percent of respondents adopting this structure (figure 2). Sole traders made up 28 percent and companies made up 24 percent. The two remaining respondents adopted a Trust ownership structure. All participants selected 'Owner/Director' as their position in the operation.

Figure 2. Ownership structure of respondents



Size and Location of the operation

Participants were asked to nominate the state in which their business operates. The majority was from New South Wales with more than half of the total respondents (Table 1). Western Australia and Tasmania had the lowest participation rate with only 1 from each state. This was unexpected since these are the two states in which the industry was pioneered and are the two highest producing states in Australia⁴.

Table 3. Matrix of size and state in which the business operates

SIZE/STATE	NSW	VIC	ACT	WA	TAS	TOTAL
< 1ha	4	3	0	0	0	7
1 - 5ha	10	4	1	0	0	15
> 5ha	1	1	1	1	1	5
Other*	1	1	0	0	0	2
TOTAL	16	9	2	1	1	29

Other* includes the two operations which are not growers of fresh truffle but key stakeholders in the industry.

Participants nominated the physical size of their operation. The most common size bracket was between 1 and 5 hectares with 15 respondents in this category. The high number of smaller operations seems consistent with the data presented in 'Taking Stock of the Australian Truffle Industry'. In discussion with members at this year's national conference in Launceston, Tasmania it appeared that many people have planted 1 hectare as a trial. This may have been highlighted more clearly had the survey been designed with the smallest size bracket equal to 1 hectare or less. Being a new industry requiring much research into the cultural and growing requirements for initiating fruiting there is a feeling of scepticism among the industry that this may be another example of an industry where there is a great deal of promotion but lacks long term success.

The smallest category was greater than 5 hectares with only 5 respondents. These bigger producing operations appear evenly distributed throughout Australia with one from each state.

Age of the operation

The most common age of the operation of respondents is between 4 and 10 years with 52 percent in this category (Table 4). There is a considerable number in the youngest category (less than 4 years) with 12 respondents. The greater than 10 year category with only 2 respondents is consistent with the concept that the industry is still young⁴.

Table 4. Matrix of size and age of the operation

SIZE/AGE	< 4yrs	4-10yrs	> 10yrs	TOTAL
< 1ha	5	2	0	7
1 - 5ha	5	10	0	15
> 5ha	1	3	1	5
Other*	1	0	1	2
TOTAL	12	15	2	29

(c) Quality systems currently in place for the business

Part 3 of the survey asked respondents to select from a list any internal production techniques they use presently and any external production standards or certifications they currently employ.

Internal production techniques

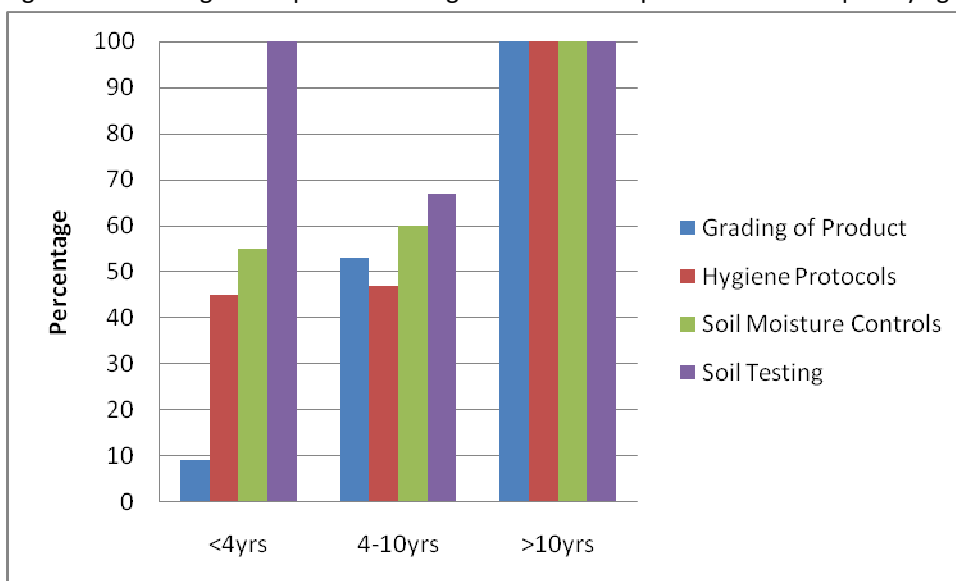
Soil testing was the most used internal production technique among the participating growers with 78 percent implementing the technique. Business process controls was the least used internal production technique with only 5 respondents.

Of the 27 growers who participated in the survey 37 percent use grading of product as an internal production technique (Table 5). Looking at this result when responses were placed into the three age categories shows a major increase the older the operation is. Only one of the operations less than 4 years old use this technique, 53 percent in the 4 to 10 year category, and 100 percent of greater than 10 year old operations use the technique (Figure 3). This result appears consistent with the earlier assumption that truffles are not usually formed until trees are a minimum of 4 years of age¹⁴. The single operation using this technique in the less than 4 year category was also an inoculation nursery and may use grading of product for use as inoculum.

Table 5. Number of respondents using various internal production techniques

Internal production techniques	Count	%
Grading of Product	✓✓✓✓✓✓✓✓✓✓	37
Hygiene Protocols	✓✓✓✓✓✓✓✓✓✓✓✓✓✓	48
Root sampling/analysis for contamination	✓✓✓✓✓✓✓✓	30
Soil moisture controls	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓	59
Soil tests	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓	78
Business process controls	✓✓✓✓✓	19

Figure 3. Percentage of respondents using various internal production techniques by age of operation



The percentage of respondents using hygiene protocols and soil moisture controls also showed the same trend as above (Figure 3). Soil testing was used by all growers in the less than 4 year and greater than 10 year categories with the rate falling away to 67 percent in the intermediate 4-10 year category.

External production standards or certification systems employed

The level of uptake of external production standards or certification systems is considerably lower than internal production techniques. Three respondents who are not using any external production standards expressed opinions that the external production standards are not yet applicable to them.

Whilst the number of respondents employing organic certification was low (only 2) several people indicated an interest in participating in an organic certification scheme. One person indicated they will be seeking organic certification once their trees come into production and another stated that they are about to begin starting out preparing for organic certification. The operations of the two respondents who do employ organic certification are both less than 4 years old (Table 6). The particular organic certification program specified by the two growers was Organic Growers of Australia.

Table 6. Number of respondents employing various production standards by age of operation

External production standards	All		< 4yrs		4-10yrs		> 10yrs	
	Count	%	Count	%	Count	%	Count	%
Industry accreditation	2	7	0	0	1	6.7	1	50
Organic certification	2	7	2	18	0	0	0	0
Customer quality system	5	19	1	9.1	3	20	1	50
Food safety certification	3	11	0	0	2	13	1	50
Environmental certification	0	0	0	0	0	0	0	0

The number of respondents following a customer quality system is 5. The percentage of growers employing this appears to rise from 9.1 percent for growers less than 4 years old to 20 percent for those 4 to 10 years old and then 50 percent once the operation exceeds 10 years. The result for operations greater than 10 years may be inconclusive given there are only two respondents in this category.

All respondents adopting food safety certification come from the 4 to 10 and greater than 10 years of operation categories. This seems reasonable given the assumption that truffles are not usually formed until trees are 4 years old¹⁴. With no fruit to sell there is no need for food safety certification.

Despite being asked to specify the names of any external programs employed only 5 out of the 9 respondents who selected they do employ an external production standard or certification did so. This could indicate that some of the respondents believe they are following a known external program but in fact are naïve to what the program involves.

(d) General consensus

In questions 4 and 5 respondents were asked to rate their level of agreement with a series of statements. The rating system was based on a 5 point likert scale ranging from strongly disagree to strongly agree. Most of the common statistical techniques can only be used to describe numerical data²⁸. Since the data here is ranked (ordinal) the statistical techniques that can be used are limited. The non-parametric technique called a Wilcoxon Rank Sum Test is of most use with this data type and is used to analyse particular statements in this section. In particular to determine if any apparent differences in population locations are statistically significant.

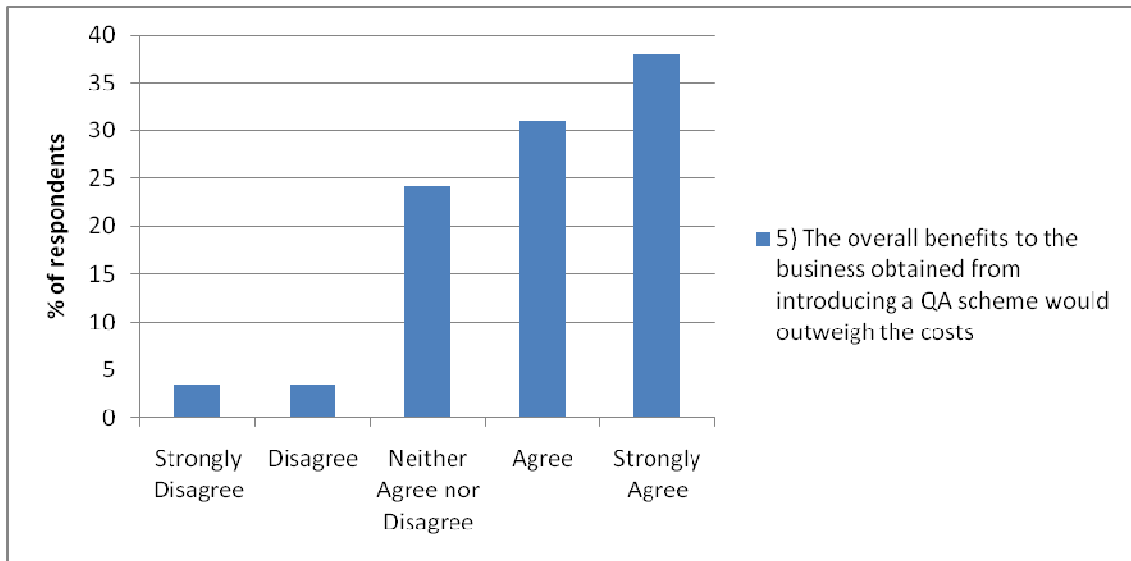
Question 5a was a statement to determine the general level of consensus from participants:

“The overall benefits to the business obtained from introducing a QA scheme would outweigh the costs”

This question received a high level of agreement from respondents. With a mean of 3.97 and a median of 4 (Agree) participants were generally in favour. However, the level of variation in responses is quite large for a 5 point scale with a standard deviation of 1.05. The most common result was strongly agree with 11 respondents selecting this option (figure 4).

20 out of the 29 respondents agreed with the statement. Only 2 respondents disagreed with the statement but both provided comments supporting their point of view. One respondent’s reason was that they believe that a QA scheme will take all of the mystery and magic away from the product and thus lower the value. The other respondent is not a big fan of regulation in private enterprise and feels it is just an impediment and cost to production. This respondent believes that producers are individually responsible for quality control at the production end and this will build their standing in the marketplace. Whilst this respondent felt the costs outweighed the benefits they did indicate that they will participate in such a scheme and follow common procedure if required.

Figure 4. Frequency of respondents selecting different levels of agreement towards question 5(a) expressed as a percentage



A cross tabulation for question 5a with a break up of responses from different size and age of operation can be found in Appendix 5.

To break this high level of support for the topic down further we have looked at the differences between groups of age of operation. Since the data is ranked (ordinal) the appropriate statistical technique is the Wilcoxon Rank Sum Test. The pool of results is split into the following two groups:

Population A = Growers with operations less than 4 years old.

Population B = Growers with operations between 4 and 10 years old plus growers with operations greater than 10 years old.

Table 7. Frequency of results for question 5 of questionnaire

<4yrs:	4	3	4	3	4	5	4	5	4	3	5					
4-10yrs + >10yrs	4	4	3	4	5	5	5	5	5	5	3	3	5	4	1	2

The objective is to compare the two populations and determine whether the view of QA perceived by growers with older operations are different to that of growers with younger operations. The appropriate null and alternative hypotheses are as follows:

H₀: The two population locations are the same

H_A: The two population locations are different

Since n_A = 11 > 10 and n_B = 16 > 10, we can use the standardised test statistic:

$$z = \frac{T - E(T)}{\sigma_T}$$

Set level of significance = 5%. Therefore, we will reject the null hypothesis (that the two population locations are the same) if the calculated value of the standardised test statistic is greater than $z_{\alpha/2} = 1.96$

* The full calculation of the Wilcoxon Rank Sum Test can be found in Appendix 6.

The calculated value of the standardised test statistic is -0.25. Since $z = -0.25 < 1.645$ we do not reject the null hypothesis. We can conclude that there is no significant evidence that growers with older operations have a different overall perception of QA than growers with younger operations.

(e) Analysis of ratings given to statements

In question 4 respondents rated their level of agreeance with a series of statements on the same 5 point scale as in question 5. To analyse the results of these ratings statements have been grouped into five recurring themes. The first of these is complexity.

Statements relating to COMPLEXITY

In plain language terms the theme of complexity refers to the amount of inputs and resources required to implement and maintain an industry specific QA scheme. The two statements in this group give an overview of member's thoughts towards this issue.

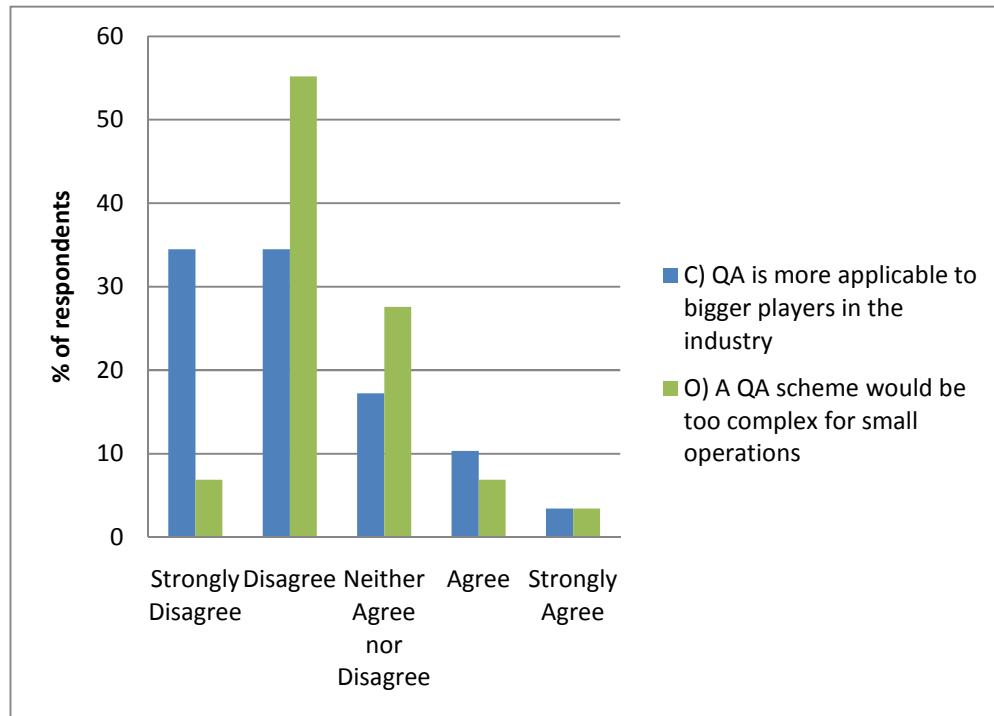
This theme is looked at implicitly through the rankings given to the following two statements by respondents:

- 4 c) "QA is more applicable to bigger players in the industry"
- 4 o) "A QA scheme would be too complex for small operations"

The majority of respondents disagree with both of the above statements. 69% of respondents disagree that QA is more applicable to bigger players in the industry. 62% disagree that a QA scheme would be too complex for small operations, only 3 respondents agree. The median of both statements is 2 (disagree).

From figure 5 below it is noticeable that respondents are stronger in their opinions towards statement 4(c) (QA is more applicable to bigger players in the industry). 34% of respondents strongly disagree to this statement compared to only 7% for statement 4(o).

Figure 5. Frequency of respondents selecting different levels of agreement towards questions 4(c) and 4(o) expressed as a percentage



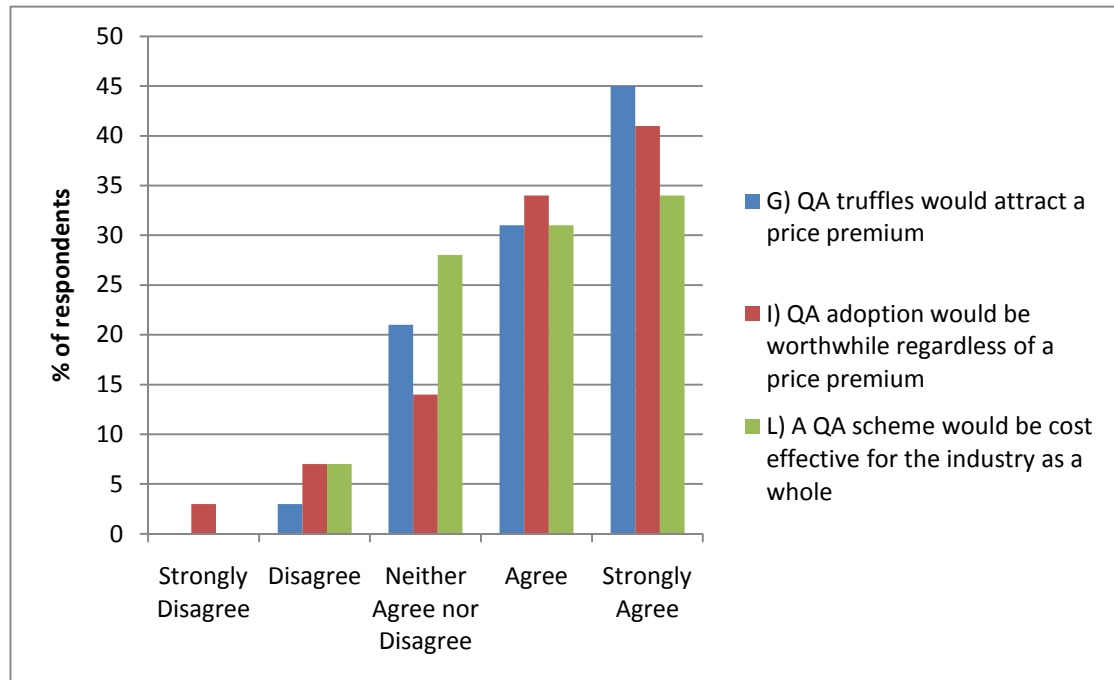
Statements relating to COST EFFECTIVENESS

Statements in this group together form a picture about the perceived benefits obtained from the development and implementation of a QA scheme at both an individual business level and the industry as a whole considered in light of the additional resources and costs required. The four statements grouped in the theme of cost effectiveness are the following:

- 4 g) "QA truffles would attract a price premium"
- 4 i) "QA adoption would be worthwhile regardless of a price premium"
- 4 l) "A QA scheme would be cost effective for the industry as a whole"
- 4 p) "A QA scheme would be too expensive to implement and maintain"

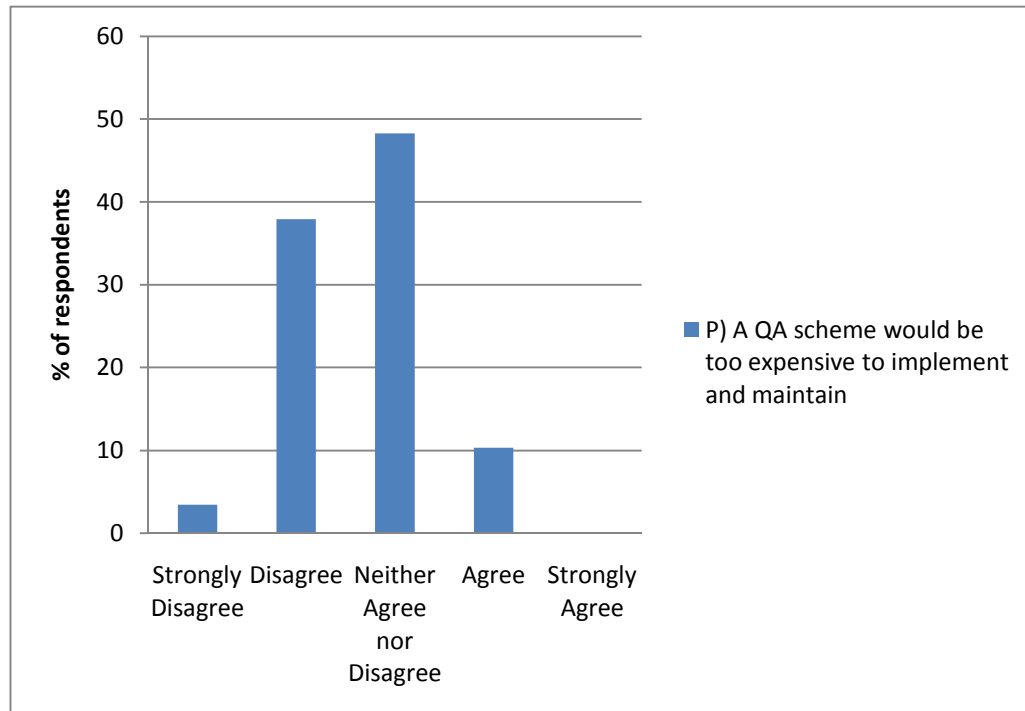
From figure 6 below it is evident that there is a high level of agreement among respondents towards statements 4(g), 4(i) and 4(l). Not only will a desired price premium be attracted by quality assured truffles this is not the sole reason for adopting a QA scheme. From these results it appears that respondents believe there are other major benefits to be gained by individual operations and the industry, aside from a price premium.

Figure 6. Frequency of respondents selecting different levels of agreement towards questions 4(g), 4(i) and 4(l) expressed as a percentage



The fourth statement in this group 4(p): A QA scheme would be too expensive to implement and maintain, was included in the survey to test and ensure validity in participant responses. If respondents show a high level of agreement with the first three statements then it can be expected that the agreement with this statement would be low. This does appear to be the case with only 10% of respondents agreeing, and no one strongly agreed (figure 7). However, with a mean of 2.66 and a median of 3 (neither agree nor disagree) respondents don't believe as strongly to this statement compared to statements 4(g), 4(i) and 4(l). Figure 7 shows this also with the highest percentage of respondents in the "neither agree nor disagree" category.

Figure 7. Frequency of respondents selecting different levels of agreement towards question 4(p) expressed as a percentage

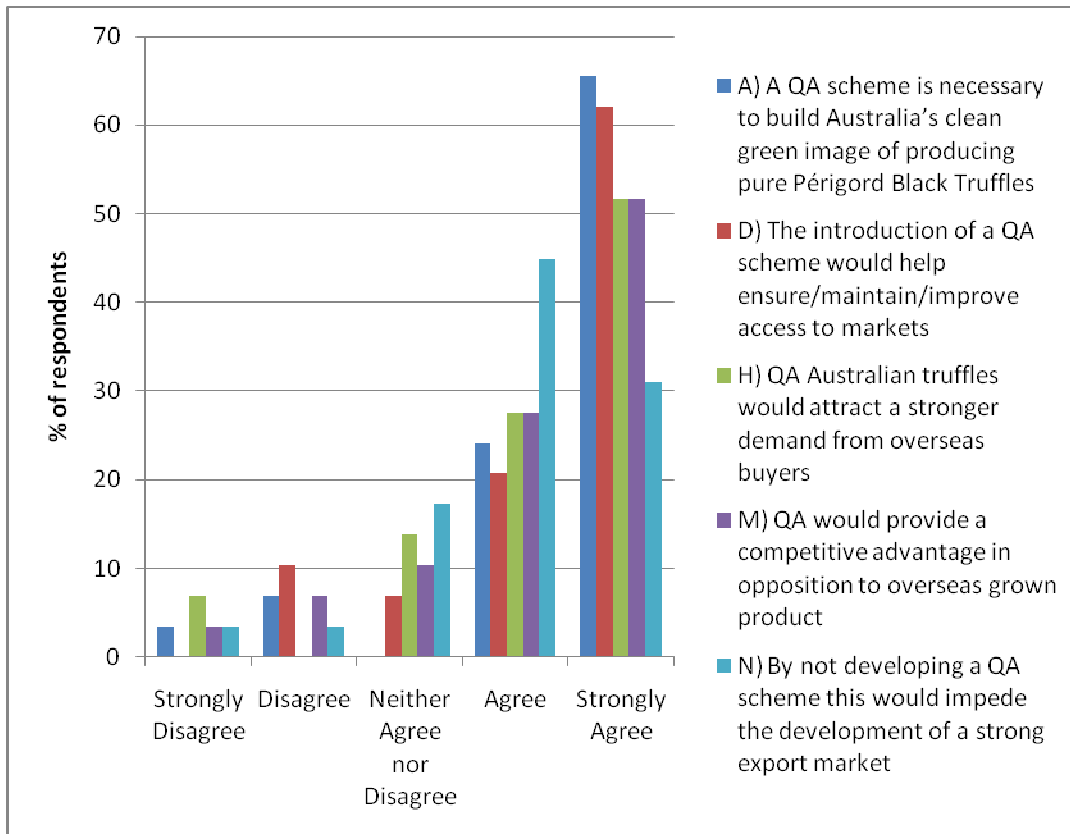


Statements relating to INTERNATIONAL COMPETITIVENESS

The statements grouped in the theme of international competitiveness refer most strongly to the industry as a whole, but also to individual business. They stem from the capacity of a quality assured product being more desirable and at a competitive advantage relative to internationally produced truffles. The five statements in this group are:

- 4 a) "A QA scheme is necessary to build Australia's clean green image of producing pure Périgord Black Truffles"
- 4 d) "The introduction of a QA scheme would help ensure/maintain/improve access to markets"
- 4 h) "QA Australian truffles would attract a stronger demand from overseas buyers"
- 4 m) "QA would provide a competitive advantage in opposition to overseas grown product"
- 4 n) "By not developing a QA scheme this would impede the development of a strong export market"

Figure 8. Frequency of respondents selecting different levels of agreement towards questions 4(a), 4(d), 4(h), 4(m) and 4(n) expressed as a percentage



Once again there appears to be a consistent level of agreement within this group of statements (figure 8). Statements 4(a), 4(d), 4(h) and 4(m) all have means greater than 4 and medians of 5 (Strongly agree). The frequency of strongly agree for statement 4(a) and 4(d) is extremely high with 66% and 62% respectively selecting this option. Statement 4(a) and 4(d) did however have 10% of respondents disagree. 4 respondents selected either strongly disagree or disagree for either 4(a) or 4(d) or both. Of these 4 all had operations greater than 1 hectare in size (ie. 1-5ha or >5ha).

It is clear that there is a high level of agreement that a QA scheme will improve the performance of Australian grown truffles and open up and maintain markets. The large majority of respondents believe a competitive advantage can be obtained over international competitors with the implementation of a QA scheme.

Statements relating to INDUSTRY IMPROVEMENT

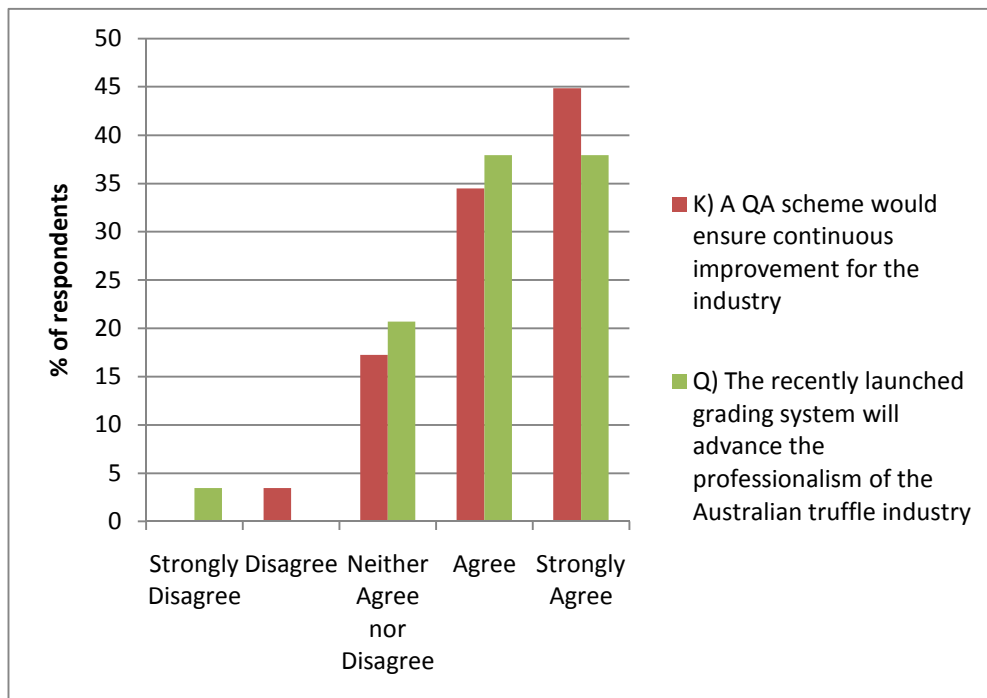
The three statements in the group industry improvement are the following:

4 f) “Greater regulation of the truffle industry will be an impediment to the industry’s growth”

4 k) “A QA scheme would ensure continuous improvement for the industry”

4 q) “The recently launched grading system will advance the professionalism of the Australian truffle industry”

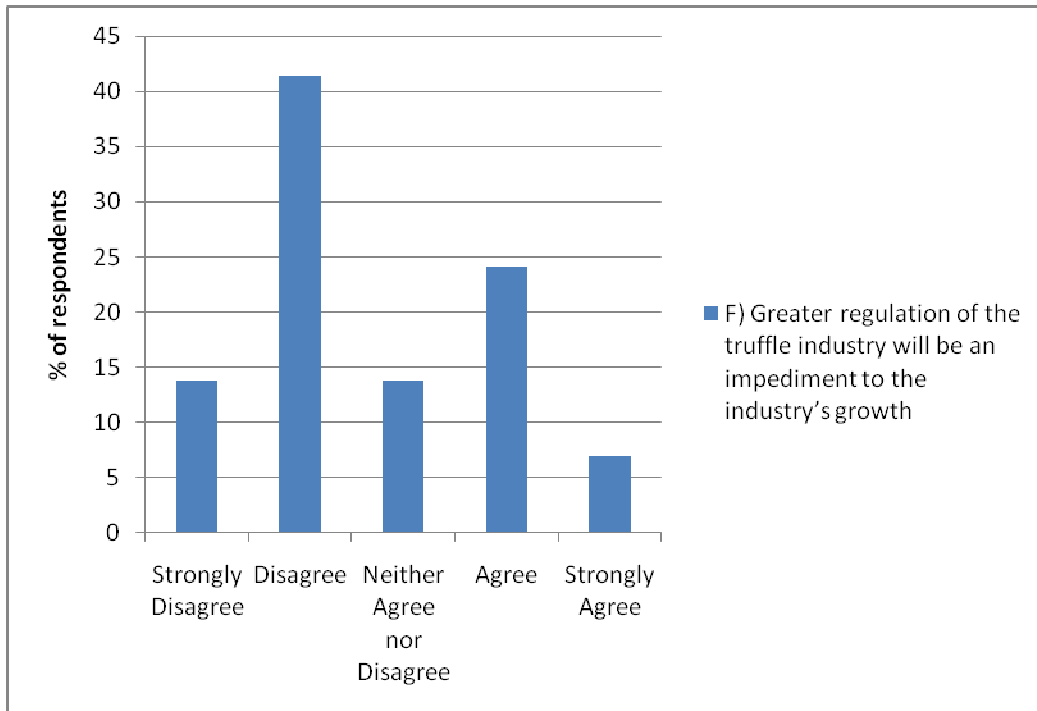
Figure 9. Frequency of respondents selecting different levels of agreement towards questions 4(k) and 4(q) expressed as a percentage



The majority of respondents agree or strongly agree (79%) that a QA scheme would ensure continuous improvement for the industry and the recently launched grading system will advance the professionalism of the industry. The one person who strongly disagreed that with 4(q) was a grower from NSW and the one person who disagreed with 4(k) was the grower from Tasmania.

The turnaround statement here to ensure validity of responses is 4(f). The results to this statement are widely spread with a standard deviation of 1.20. This can be visually seen in figure 10 also with each level of agreement receiving at least 2 responses from participants. Whilst 55% of respondents disagreed with the statement nearly one third (31%) agreed.

Figure 10. Frequency of respondents selecting different levels of agreement towards question 4(f) expressed as a percentage



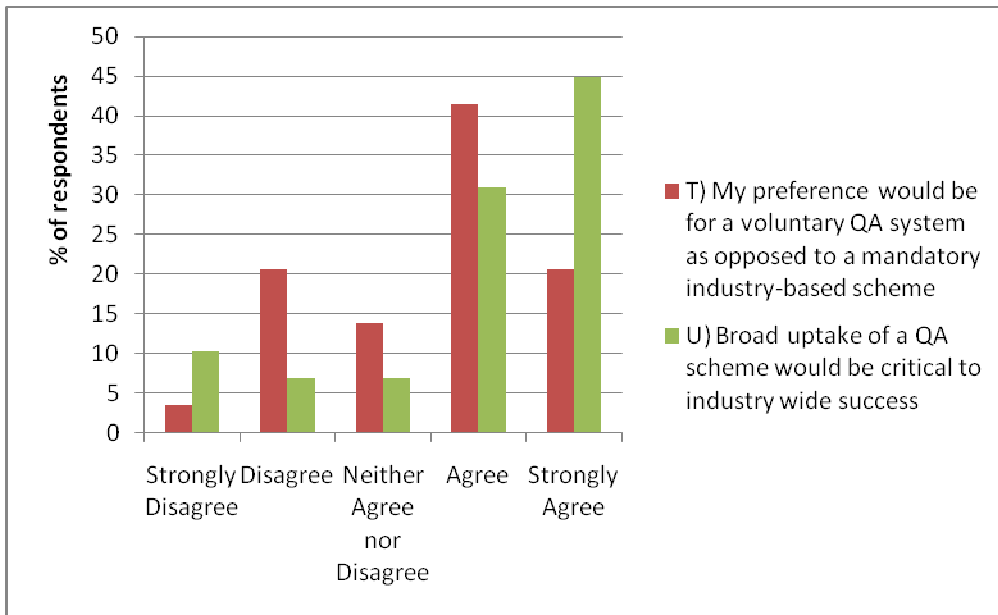
Statements relating to WILLINGNESS TO PAY and EXPECTED LEVEL OF UPTAKE

The statements from the questionnaire relating to this theme are the following:

- 4 s) "I would support the raising of funds by the association to pay for administering a QA scheme"
- 4 t) "My preference would be for a voluntary QA system as opposed to a mandatory industry-based scheme"
- 4 u) "Broad uptake of a QA scheme would be critical to industry wide success"

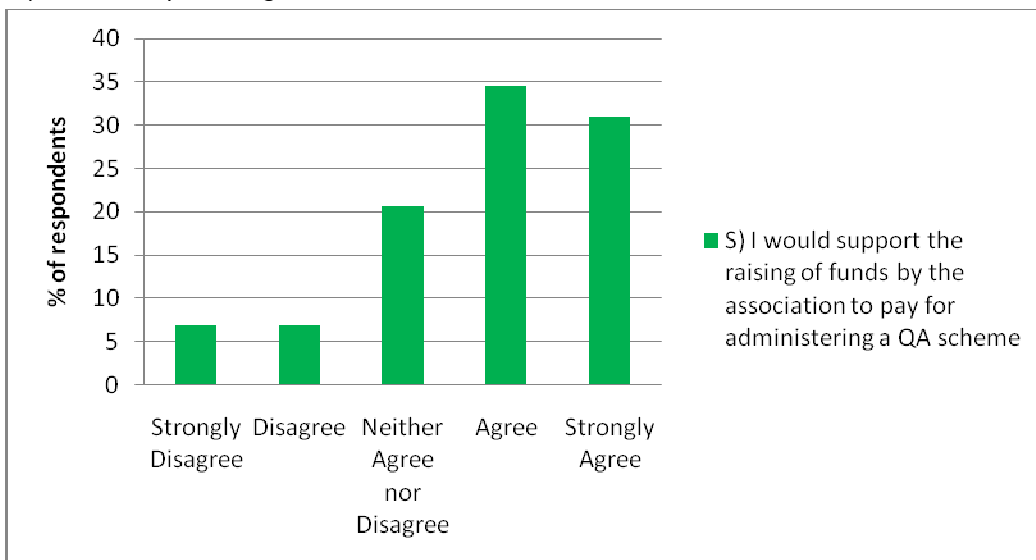
The response to the statements 4(t) and 4(u) is quite variable (standard deviations of 1.15 and 1.33 respectively). The modal class is "Agree" for 4(t), voluntary versus mandatory QA scheme, and "Strongly Agree" for 4(u), broad uptake of a QA scheme would be critical to industry wide success. For both statements there appears to be a fall away in responses of "neither agree nor disagree" with the majority of respondents either agreeing or disagreeing with the statements (figure 11).

Figure 11. Frequency of respondents selecting different levels of agreement towards questions 4(t) and 4(u) expressed as a percentage



The statement: “I would support the raising of funds by the association to pay for administering a QA scheme” is a critical one as it really tests whether a respondent is willing to provide financial support for such a scheme. From the data in Appendix 4 we can see that 66% of respondents are in agreement and willing to pay. This result is also observed in figure 12.

Figure 12. Frequency of respondents selecting different levels of agreement towards question 4(s) expressed as a percentage



To dig deeper into the topic of willingness to pay we can test to see if there is any significant difference in rankings provided by groups of different ages using the Wilcoxon Rank Sum Test. The pool of results is split into the following two groups:

Population A = Members with operations less than 4 years old.

Population B = Members with operations between 4 and 10 years old plus growers with operations greater than 10 years old.

Table 8. Frequency of results for question 4s of questionnaire

<4yrs:	3	4	5	5	5	4	4	4	4	5	5	2					
4-10yrs + >10yrs	4	5	5	4	4	3	3	3	1	4	3	2	4	5	5	3	1

The objective is to compare the two populations and determine whether the view of willingness to pay for QA perceived by growers with older operations is different to that of growers with younger operations. The appropriate null and alternative hypotheses are as follows:

H₀: The two population locations are the same

H_A: The location of population A is to the right of population B

Since n_A = 12 > 10 and n_B = 17 > 10, we can use the standardised test statistic:

$$z = \frac{T - E(T)}{\hat{\sigma}_T}$$

Set level of significance = 5%. Therefore, we will reject the null hypothesis (that the two population locations are the same) if the calculated value of the standardised test statistic is greater than z_α = 1.645

* The full calculation of the Wilcoxon Rank Sum Test can be found in Appendix 7.

The calculated value of the standardised test statistic is 1.31. Since z = 1.31 < 1.645 we do not reject the null hypothesis. We can conclude that there is no significant evidence that opinions expressed by members with younger operations (<4 years) are any different to those of members with older operations in terms of willingness support the raising of funds by the association for administering a QA scheme.

From the result of responses to this statement and the general consensus statement (Question 5a) we can expect a high level of uptake among the participating members.

(f) Benefits and drawbacks of a QA scheme

In question 5b and 5c, following on from the general consensus question, respondents were asked to specify what they believe is the main benefit and the main drawback to the implementation of a quality assurance scheme. 26 of the 29 respondents completed this section and their responses can be seen in table 4 below.

As a summary the stand out benefits were:

- Improved marketing opportunities to help producers of all sizes sell their product overseas
- Stability and maintenance of high prices
- Formation of clear guidelines for better practice
- Product can be graded objectively

The stand out drawback was cost. In particular the financial cost associated with implementation and the time required to comply. 11 out of the 26 people who completed this section raised cost as an issue.

For many people they were able to come up with a main benefit but either left the drawback section blank or stated 'none'.

Table 9. Main benefits and main drawbacks as specified by respondents

Main benefit	Main drawback
Being able to identify the value of and place my truffles (from a less than 1ha truffière) into established markets	Cost may be too high
Only as some guidelines for better practice, but this information should be available from other sources	I don't want to be part of a compulsory system. I expect any QA system to be more of a burden than a help
Improved access to export markets	
Assurance of having produced a quality product	None
Ultimately, higher income	Other than non-participation in such a scheme by some producers, none
Maintaining a price premium therefore maintaining the reputation of truffles	Perhaps the cost as a small grower, although I don't know what this would be at present

Understanding the grading system and what the market requires, and what the market will not tolerate. It should include a good grading system, so that producers are not competing against each other unfairly. Maintaining a good name for truffles as a product by ensuring the purchaser can buy what he expects for the price he pays	There should be none in a sound QA scheme. An inhibitive price for annual audits is what causes people within agriculture to avoid QA systems. Small growers can be penalised disproportionately. Signing a code of conduct may help sort out the commitment or otherwise of producers. I have been involved in QA systems inin the past and can comment on the success/otherwise of these
Better marketing opportunities	Costs
Adoption of a grading system would give surety of price and maximise returns. A QA scheme gives customers confidence that the product is properly infected. It would also encourage investment companies to develop large truffières with more confidence of getting a return on investment. An industry recognised QA scheme would prevent the influx of opportunistic nurseries providing questionable inoculated trees which could destroy the truffle industry	There would be an additional cost involved in the development and implementation of a QA scheme which would need to be added to the tree price. The advantages of a QA scheme would outweigh any price concerns.
Trust of clients	None
I cannot see any, as we have our own QA and do not try to sell lesser quality truffles. This works as we have no trouble selling truffles in Australia and overseas every week at high price	Very little as we will continue to do what we have done for the past 4 seasons and would only adopt the QA if forced to
Better control of quality if aroma and flavour could be graded	None
	QA will take all the mystery and magic away from the product and thus lower the value
Hopefully maintenance of a high quality truffle standard and therefore a good price	None, unless it is expensive
Credibility	Process control/management
Improved marketability	Cost and bureaucracy
To be able to compare product objectively	
I have already introduced my own QA to my buyers. A standard QA would ensure confidence in the marketplace, hence supporting the consumer to buy and use the product	For me there is no drawback
Standardisation of quality	None
Maintenance of price	Cost and time to comply

Acceptance by buyers that truffle produced is high quality	Regulations to adhere to and ongoing expenses
Improved understanding and benchmarking	Increased non-productive requirements
the QA is mainly the responsibility of growers and marketers	Cost factor
Stabilisation of pricing mechanism for the product	The costs involved
Certainty	

(g) Members general comments about QA

Ample room for comment was made available throughout the questionnaire for respondents to elaborate on their perceptions towards the introduction of a QA scheme and suggest any aspects they feel need consideration. Below are comments and suggestions that have been transcribed from the responses word-for-word and grouped according to the recurring themes. Some comments have had sections cut to protect the confidentiality of respondents.

Comments from people who are generally not in favour of QA.

- We use our own QA standards and work to Australian Food standards without all the bullshit involved in certification. All our systems and production facilities exceed the requirements and will be certified when required.
- I personally am not a big fan of regulation in private enterprise and believe that producers need to understand that quality control at the production end will build their standing in the market place.
- I am a believer that you build your reputation in all industries on the quality of your product, and that regulation is just an impediment and cost to production. I believe that small growers need to work with larger producers to sell their truffles and avoid the price discounting that has started to appear in Australia and some overseas markets this season.
- The French have been successfully harvesting and selling Black Truffles for a thousand years. If they have done this without QA why do we need to do so?

Comments from people who are generally in favour of QA

- In our previous lives . . . , QA systems have been essential for developing and maintaining standards.
- QA is good for the truffle to be sold as is certification of the actual inoculation process for seedlings and confirmation of the actual t. variety.
- The truffle industry in Europe without a broad QA scheme is infested with inferior Chinese truffles that devalue the product. Australia needs to be able to provide customers with an assurance that the product is the pure French Black and the only way this can be achieved is through a QA scheme.

Comments on the cost of a QA scheme

- The raising of funds would have to be substantiated before any agreement for increases.
- The expense of auditing in other industries has been a negative – this price may be kept low if auditing happens.
- Overall level of adoption of QA by members of the industry does in the end depend on cost – it cannot be inhibitive for members, and should not penalise people who are compliant by adding a big audit fee.

Comments on the unique aroma and flavour of truffles

- We see a lot of truffles from Australia and overseas. We select the truffles first according to the “nose” then the shape. A truffle with no flavour or an unpleasant aroma is rejected.
- The implementation of a QA standard will be very hard to define. The shape of truffles is easy to appreciate. The reason why people buy truffles is for the flavour. The flavour should be the criteria for grading. Even scientifically the flavour is hard to take into account only the physical aspect of the truffle will however be a start.
- A QA scheme will only be effective if the aroma/flavour of the truffle can be quantified. Aromas and flavours are subjective and hard to define clearly enough to be able to be understood by reading a report or comment. This in my opinion is the key issue.
- I suggest you talk to the chefs that buy and use the product. They are the ones who are the real quality control as they will only buy off sellers that can deliver the best product.
- The subtleties between the perfume and flavour of Black Truffle are way too complex to leave to an ENose machine.

Other general comments

- I think many of us would not be sure what a QA system would involve and therefore can not answer accurately questions about cost, complexity, etc.
- Difficult to make some decisions without knowing the type of QA, its focus and the cost!
- I believe it will be necessary to introduce industry training along with the introduction of QA so the smaller farmer does not become alienated through the process.
- I agree with what the Australian Truffle Growers Association is trying to do but I still want to remain independent and be able to offer our truffles to whoever wishes to buy them.
- The publication of a booklet on QA protocols would be the first step to educate industry members.
- The integrity (or lack of) of persons in the supply chain is ultimately what counts ... half of the boxes ticked in audits cannot be policed. Clear messages on dos and don'ts will help.
- Signing a code of conduct may help sort out the commitment or otherwise of producers.

6. CONCLUSION

It is clear that the need to market product overseas is coming at the industry head on. The literature has shown that in order to be competitive on an international scale Australian producers need to be able to produce a quality product. Many published documents and industry reports highlight the need for a QA scheme to be developed in Australia.

Most respondents are using basic internal production techniques, such as soil testing, hygiene protocols and the like in an attempt to promote quality in their product and enhance productivity. Soil testing is the most used technique among growers with 78 percent implementing the technique. Grading of product is used mainly by operations greater than 4 years old. The data for soil moisture controls and hygiene protocols showed a similar trend with a higher level of use by the older operations.

The level of adoption of external production standards and certification systems is lower than that for internal production techniques. Some of the external systems being implemented by a small percentage of respondents are industry accreditation (NIASA), organic certification (Organic Growers of Australia), a customer quality system and food safety certification. No respondents indicated that they have implemented an environmental certification. A few of the smaller growers suggested they will be looking at adopting external production standards and certifications once their trees come into production.

There are many benefits and drawbacks associated with an industry specific QA scheme. The most pertinent benefits raised by respondents are improved marketing opportunities to help producers of all sizes sell their product overseas, stability and maintenance of high prices, formation of clear guidelines for better practice and fresh truffle can be graded objectively. The most significant drawback raised was cost. In particular the financial cost associated with implementation and the time required.

The level of general consensus among respondents towards QA is high. The response to the statement "The overall benefits to the business obtained from introducing a QA scheme would outweigh the costs" was positive. The majority of respondents agree with this statement, while only 7 percent disagree. The most common response was strongly agree.

The expected level of adoption is also reasonably high. Response to the statement "I would support the raising of funds by the association to pay for administering a QA scheme" had a considerable amount of support. 66 percent of respondents showed a

willingness to pay by agreeing with the statement. The result is consistent among operations of different ages.

Whilst the evidence suggests that a QA scheme will lead to a greater quality, more desirable product there is still no guarantee of the purity of Australian produced Truffles. Truffles can be an important niche industry for Australia but the literature shows that the industry will require further investment into research and development and marketing before success in quality can be assured.

7. RECOMMENDATIONS

Based on the understood theory and the results presented areas which require focus for research in the near future are the following:

Recommendation 1: Conduct a risk assessment study for imported Chinese truffles and their potential biosecurity risks

Recommendation 2: Conduct export market research and market development projects, especially for Asian markets

Recommendation 3: Draft and audit a certification process for inoculated seedlings, trees and truffles

8. LITERATURE CITED

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