Know-how for Horticulture™

An industry driven process to promote the expansion of a competitive Australian export cauliflower industry

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Department of Agriculture
Western Australia

Project Number: VG98014

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Horticulture Australia

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Final Report for Horticulture Australia project VG98014
(Project completion date: 31 July 2003)

Compiled by

Rachel Lancaster *et al*.

Department of Agriculture – Western Australia

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Final Report for Horticulture Australia: Project VG98014

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Purpose of the Report:
Project VG98014 investigated:

- The development and implementation of an industry plan for the export cauliflower industry to realise long-term growth in the industry.

- Evaluation of current cauliflower and broccoli varieties which will help these export brassica industries to improve agronomic practices and meet market specifications.

- Evaluation and industry implementation of improved production techniques that will increase the profitability of the export cauliflower industry.

Date of Report: July 2003

Contents

1.0 Media summary

The export cauliflower industry has grown rapidly in the past but has now reached a mature phase where growth has slowed. The main export markets for Australian cauliflower are Singapore and Malaysia. The slowing of industry growth is of concern as the industry was valued at $27.9 million in 2001/2002. Most production occurs in Western Australia, where cauliflower is the second highest value export vegetable after carrots.

An industry plan which addresses issues which limit potential future growth, has been developed by industry representatives. The plan provides an industry vision, objectives and action statements in regard to the identified issues. An outcome of this project was the implementation of strategies identified in the plan to increase the productivity and profitability of the export cauliflower industry. Examples of the strategies include the formation of small neighbouring on-farm groups that allow producers to assist each other to improve production practices and the implementation of new technology identified by other research programs.

The identification of cauliflower varieties that are suitable for the export market or can be grown in periods of the year where it has been difficult to produce high quality curds was a valuable outcome of the project. This has allowed producers to reduce the number of varieties grown and there is a greater concentration on the intensive management of fewer varieties.

Recommendations from this project include the update of the industry plan approximately every five years and ensuring future research projects match the objectives outlined in the industry plan. The continuation of the small neighbouring on-farm groups is recommended to ensure that new information is effectively transferred to producers.

2.0 Technical summary

The Australian export cauliflower industry has grown rapidly over the past twenty years. The industry was valued at approximately $27.9 million in 2001/2002, with the main export markets being Singapore and Malaysia. The majority of export cauliflower production has occurred in Western Australia. Over the past five years, the industry has reached a mature phase and industry growth has slowed. This is of continuing concern to all sectors of the export cauliflower industry.

To address the reduction in industry growth, an industry plan was developed by representatives of the export cauliflower industry including producers, packers and exporters. The vision for the industry was stated as 'maintaining and improving industry productivity, competitiveness and profitability'. The plan included a SWOT (strength, weaknesses, opportunities and threats) analysis which provided the basis for the development of objectives and action statements. The plan has provided a focus point for members of the industry to identify areas where substantial improvements can be made.

Some of the objectives in the industry plan have been acted upon with improvements in communication and producer group organisation. Research projects have also been initiated to address issues highlighted in the plan such as reducing the number of harvests required. The further investigation and implementation of technology identified in other projects, such as fertiliser incorporation, was also an outcome of this project which has contributed to an increase in marketable yield and a reduction in costs for producers.

The identification of cauliflower varieties either suitable for production for a longer period of the year or allowing the harvesting of curds during times of the year when it has been difficult to produce high quality curds were outcomes of the industry plan. Joint funding for variety evaluation was sought from seed companies, who nominated the most suitable growing period for existing varieties and new numbered lines that were yet to be proven commercially. Several varieties have been identified that have been accepted by the export cauliflower industry, including Monarch, Summer Love, Celsius and Omeo.

The formation of small neighbouring on-farm groups, aimed at improving the flow of information between cauliflower producers, is a result of this project and will be ongoing. The neighbouring on-farm groups meet regularly and discuss on-farm issues that affect cauliflower production, including plant nutrition, variety characteristics, irrigation technology and pest management. An important aspect of the groups is that each meeting is held at a different farm and an inspection of the host farmer's crops is conducted as the first activity. Bench marking between different farmers' crops has also been adopted by some groups as a method of identifying where all members of the group can improve their production practices.

It is recommended that the export cauliflower industry plan be updated regularly, possibly at five year intervals. It is important the plan is kept up-to-date, to allow response to changing internal and external pressures on the industry, which may mean new actions need to be included in the plan while those that are outdated can be removed.

It is also recommended the small neighbouring on-farm groups continue and where possible expand to other areas. These groups can transfer in-depth technology and information that will help improve the overall profitability of the industry.

Future research directions should aim to address the issues in the export cauliflower industry plan, specifically targeting improved cost competitiveness of the industry.

3.0 Introduction

The Australian export cauliflower industry was valued at $27.9 million in 2001/2002, with 87% (19,980 tonnes) of total export cauliflower production originating in Western Australia (ABS, 2003). The industry is of significance to Western Australia as it is the second largest vegetable item exported after carrots. The production areas for export cauliflower production in Western Australia are shown in Figure 1.

Figure 1: Main production regions for export cauliflower in Western Australia (marked in red).

The value of export cauliflower has fluctuated around $20 million for several years and the industry is believed to have reached the stabilisation or plateau phase of a mature industry (Table 1).

Table 1: Export of cauliflower from Australia and Western Australia, the major producing State for cauliflower.

Year	Value (fob)		Volume (t)	
	Australia ($ million)	Western Australia ($ million)	Australia (kg)	Western Australia (kg)
1991/1992	12.72	11.59	9,940	9,187
1992/1993	15.48	13.21	12,297	10,500
1993/1994	17.58	14.46	13,800	11,434
1994/1995	20.61	17.76	14,727	12,695
1995/1996	24.37	22.28	18,860	17,438
1996/1997	25.17	21.00	19,334	16,408
1997/1998	22.46	19.70	17,292	15,043
1998/1999	23.05	21.00	16,951	15,521
1999/2000	22.87	20.17	16,899	14,810
2000/2001	29.81	27.27	23,894	22,179
2001/2002	27.95	24.12	22,874	19,980
2002/2003	24.67*	21.02*	17,373*	14,893*

* estimated figures until end of June 2003. 2002/2003 actual exports not available at the time of publication.

The future expansion of the export cauliflower industry was of concern as the rapid growth in the industry had slowed and was highly dependent upon two major markets, Singapore and Malaysia. An organised plan, outlining future strategies for the industry, was required to address potential issues of increasing competition in export markets and to improve the future growth of the industry. The main focus of this project was to facilitate the development and implementation of the export cauliflower industry plan. The identification of a small number of suitable varieties for production in the lower south-west of Western Australia was also a component of this project. The varietal evaluation study was initiated by a local producer group as the selection of the correct cauliflower variety is essential to ensure high quality curds are available in constant supply.

The aims of the project were:

- Development of a strategic plan for the export cauliflower industry
- Implementation and facilitation of actions outlined in the industry strategic plan
- Assessment of the suitability of new cauliflower varieties for export markets and production in the lower south west of Western Australia
- Development and implementation of new technology identified from other research programs and producer ideas.

The implication for the export cauliflower industry of this project is the critical analysis of the medium-term future of the industry and the development of actions to ensure the Australian export cauliflower industry retains a strong presence in existing markets, while developing opportunities in new markets. The implication from the variety assessment is the identification of core, high quality varieties that will continue to separate Australian cauliflower from other competitor's product.

4.0 Development of an export cauliflower industry plan

4.1 Introduction

An analysis of the Australia export cauliflower industry was conducted in 1997 by the Department of Agriculture Western Australia. The analysis discussed the current state of the export cauliflower industry and the likely future growth of the industry in the face of increasing competition. The recommendations of the analysis indicated the export industry was highly dependent upon two main markets, Singapore and Malaysia which are subject to increasing competition, particularly from low cost producers, such as China. The analysis also identified the need to improve the competitiveness of the industry. The development of an industry plan was recommended to address existing and future issues that affect industry growth of Australian export cauliflower. As the majority of Australia's export cauliflower is produced in Western Australia, the current practices and information for Western Australia formed the basis of the industry plan.

4.2 Method for the development of the industry plan

The development of an industry strategic plan required consultation with different sectors of the export cauliflower industry from the outset. The process to develop the industry plan was conducted in two stages. The first stage consisted of initial meetings that were held in Perth and Manjimup, the key areas for export production. The purpose of the initial meetings was to inform members why a strategic plan would be beneficial for the industry and also to gain majority agreement that a working group be formed to develop the industry plan.

The initial meetings, held in May 1999 were well attended by various sectors of the export cauliflower industry, including producers, packers and exporters. Ms Deborah Pearson from Deborah Pearson Consulting was engaged to act as a facilitator for the meetings. Ms Pearson's role included:

- providing background information to the attendees on the need for an industry plan
- introduce industry plans that have been completed by other horticultural industries
- outline the benefits and consequences of producing an industry plan
- gain majority assent that a working group should be appointed from interested industry members to develop the industry plan.

At the initial meetings, guest speakers from the wine and flower industries provided an insight into why their industries developed a plan for future sales growth of their products. There was substantial discussion at both meetings on the relative merits of producing an industry plan, with agreement being achieved to produce a plan.

The second stage of producing the industry strategic plan was the formation and meetings of a working group. The group consisted of eight people, all of whom were directly involved in the export of cauliflower, either as growers, packers or exporters. Three meetings on the development of the industry plan were held over seven months. There were many issues raised at the meetings, with continued discussion allowing the issues to be categorised into main subject areas such as the production (cost of seedlings, labour etc.), post harvest and export development.

4.3 Industry plan for export cauliflower

An industry plan has been published and provided to members of the Western Australian export cauliflower industry. Feedback on the contents of the industry plan has been in the majority positive, with producers, researchers and exporters referring back to the plan when considering further directions for industry growth.

The export cauliflower industry plan, although published and distributed to industry members, is an evolving document which needs to ensure the industry remains responsive to changing production and market conditions. Key industry members meet regularly to review the document and to ascertain that actions outlined in the plan are being acted upon while still being relevant to the current industry conditions.

The contents of the industry plan are outlined from pages seven to sixteen of this report.

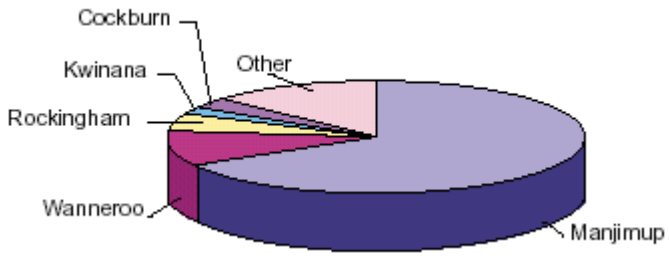
Cauliflowers in Western Australia: an Industry Plan

4.3.1 Assessment of the current cauliflower industry (a snapshot of cauliflower production in Western Australia)

4.3.1.1 Location

The Western Australian cauliflower industry is largely centred around the south-west of the State which, with its cool winter climate and medium to heavy loam soils is well suited to year round cauliflower production and accounts for 77% of the State's output. The Shire of Manjimup alone accounts for about 60% of the State's cauliflower production (Figure 2). The second most significant region is the Swan Coastal Plain which has lighter soils and a warmer climate. The Swan Coastal Plain is also suitable for year round production.

Figure 2: Cauliflower production by Western Australian shires



Source: Australian Bureau of Statistics

4.3.1.2 Comparative advantage of the Western Australian Cauliflower industry

High quality product – market analysis indicates that Western Australian cauliflower, whilst appearing more expensive than produce from the Eastern States or the USA and China, benefits from a quality advantage. This quality is in high demand in South East Asian markets.

Technological base – on-farm technology and management together with cool chain management facilities such as cool stores and refrigerated transport ensure the perishable cauliflower arrives at the market place in good condition with a long shelf life.

Year round reliable supply – production from the south-west of Western Australia is heaviest from October to April whilst the Perth region has peak production from April to December.

Export orientated industry – the industry benefits from good transport facilities including the State's extensive sealed roads, a modern port in Fremantle and Perth's international airport. The limited domestic market has lead to the horticultural industry being export focused.

Proximity to main export markets – Western Australia has good transport links to markets in South East Asia. As a result there are already established relationships with importers in Singapore, Malaysia, Hong Kong and throughout the region which benefits cauliflower exporters.

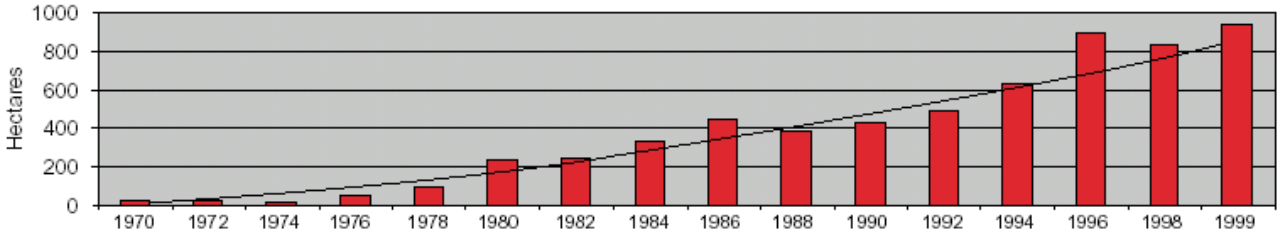
4.3.1.3 Production

Cauliflower production in both volume and value terms, has increased in Western Australia over the past 30 years, particularly in the south-west of the State (Figure 3). In 1999, Western Australia produced nearly 30% (21,000 tonnes) of the total Australian cauliflower production of 73,000 tonnes per annum. Victoria produced about 22% of the nations output with NSW and Queensland producing 15% – 20% and Tasmania and South Australia producing 6% – 7%. Cauliflower exports are dominated by Western Australia, which supplies nearly 90% of cauliflower exported from Australia (Figure 4).

4.3.1.4 Yield

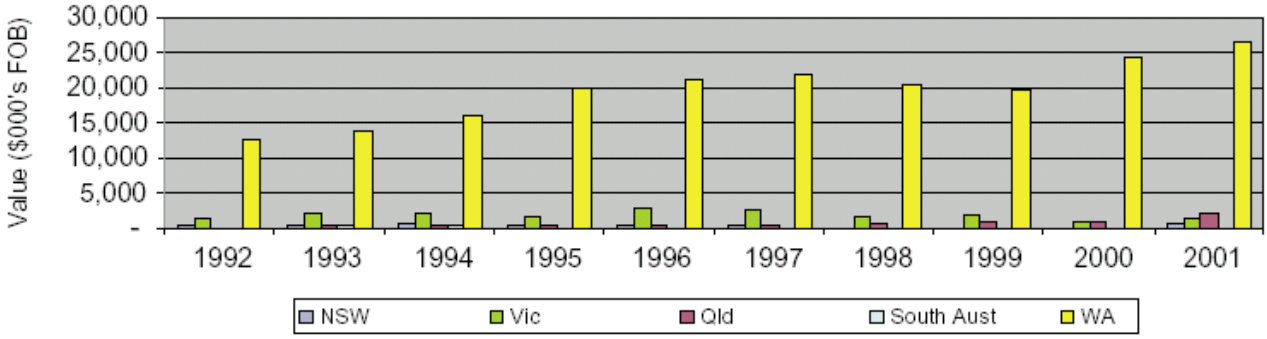
Yields appear to have declined over time (Figure 5). The decline in yield is in part due to growers focusing more on export market requirements with changes in varieties being grown, management and harvesting techniques. In contrast average world cauliflower yield has increased by about 25% over the past decade.

Figure 3: Area of cauliflower production in the south-west of Western Australia



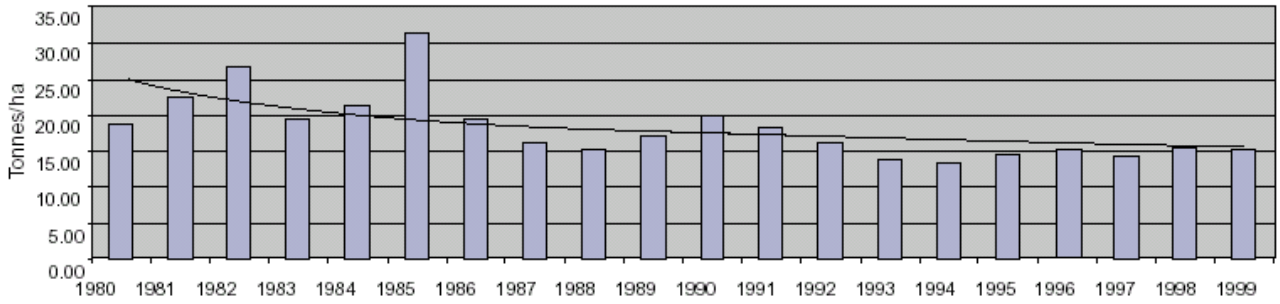
Source: Australian Bureau of Statistics.

Figure 4: Cauliflower exports by State



Source: Australian Bureau of Statistics.

Figure 5: Cauliflower yield in the south-west of Western Australia

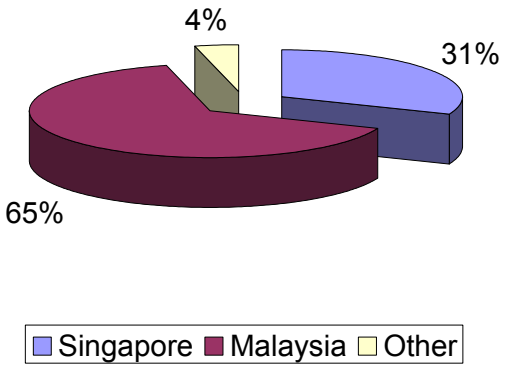


Source: Australian Bureau of Statistics

4.3.1.5 Markets

Australian per capita consumption of cauliflower has fallen since 1945. Whilst this has been offset by slight population growth, domestic demand will most likely remain static. The Eastern States market is well supplied by local growers. Western Australia's cauliflower industry is export focused, facing limited opportunities in the Eastern States and a small domestic market. World demand for cauliflower has increased over the past 20 years. Western Australia exported A$27 million of cauliflower in 2001. The major markets for West Australian cauliflower are Singapore and Malaysia, which account for 96% of exports (Figure 6). The Singapore market is considered a 'mature market' with prices declining in Singapore dollars from 1989 until 1995. Western Australian exporters have been cushioned from the falling Cost Insurance Freight (CIF) price by the devaluation of the Australian dollar. The importance of the Malaysian market has increased over the past 20 years and Western Australian produce now accounts for over 85% of the Malaysian market's requirements. There is potential to consolidate existing markets through promotional campaigns and value adding. Newer markets such as Indonesia and Japan are also being investigated to enable the West Australian cauliflower industry to consolidate its position.

Figure 6: Export markets for Western Australian cauliflower, 2001



Source: Australian Bureau of Statistics

4.3.2 SWOT analysis of the export cauliflower industry

Strengths

- Most of the technology used by industry is up-to-date. Product quality is high, however, this strength is not unique.
- Close proximity to market.
- Same time zone as major markets
- Long-standing and good customer relationships in export markets.

- Well developed and suitable natural resource base.
- Industry focus on export as a priority.

Weaknesses

- Market expansion limited by lack of marketing.
- Failure to promote cauliflower as a long-term option to existing growers.
- Cost structures are such that smaller growers may not survive.
- Future decline in the grower base as cauliflower growing is seen as unattractive.
- No uniform industry (Western Australian) branding.
- Disjointed purchasing arrangements (high input costs).

Opportunities

- Aggressively defend what we have already through improved post harvest handling and value adding.
- Improve efficiency through new technology, innovation and improved business practices.
- Develop new approaches to managing on-farm and packing shed labour.
- Identify alternative rotational crops to share equipment, overheads and technology.
- Conduct a pro-active, coordinated marketing campaign in export markets.
- Develop a Western Australian export cauliflower brand, with marketing agents using uniform packaging.
- Improve market information gathering and dissemination.
- Develop cauliflower growing for export in new areas in Western Australia which complement existing production areas.

Threats

- Control problems with diamond back moth, leading to supply problems at certain times.
- Continued spread of clubroot disease.
- Escalation in the cost and availability of labour for on-farm work and packing sheds.
- Increased competition from other suppliers (China, USA).
- Lack of competitiveness in export markets due to apparent falling yields and rising costs.
- Loss of favoured positions (relationship) with customers.
- Decline in available natural resource base (alternative land use, government regulations etc.).

4.3.2.1 Background to industry concerns

- Export cauliflower industry has grown strongly, but has reached a plateau, with decline in the industry possible in the future.
- Existing markets are being actively targeted by competitors.
- Time lag in responding to market signals is at least 12 months.
- Production of curds (yield) appears to be stagnant or falling (per ha).
- Australian dollar devaluation has been holding prices steady, revaluation could expose a serious problem.
- Industry is focussed on maintaining the status quo, satisfying established markets.
- A cultural/philosophical change may be required for industry to develop new opportunities.
- Some cauliflower enterprises are vulnerable to competition from large-scale operations.
- Australian cauliflower is a commodity item to overseas customers, competing on price.
- Australian cauliflower is focussed on supplying Asian wet markets, which are price sensitive.

4.3.2.2 Why are cauliflower yields falling?

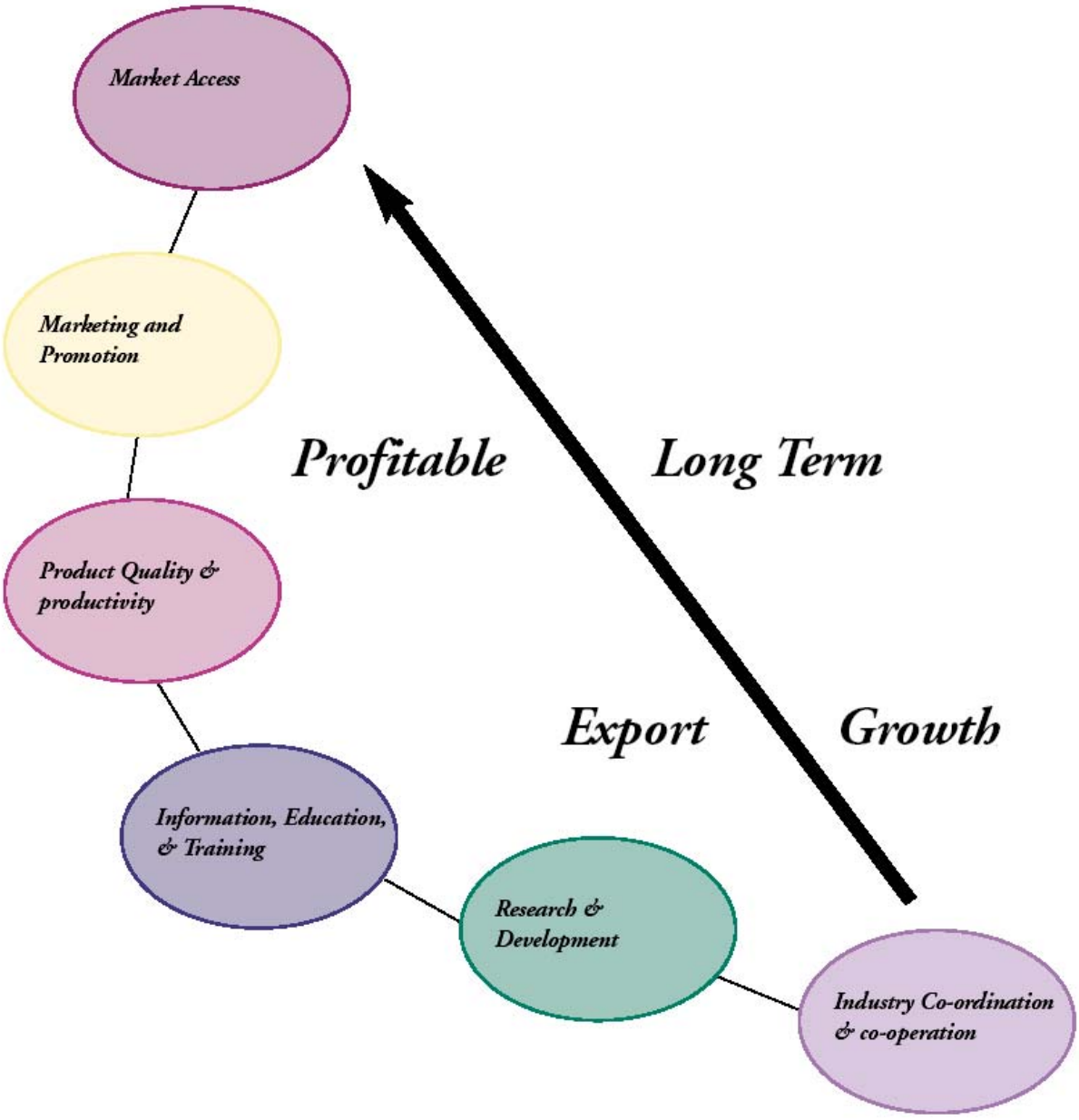
- Increased incidence of club root disease.
- Diamond back moth is spreading and control is difficult.
- Current varieties do not adequately cover the full 12-month supply season. Increased yield would result from the development of improved varieties to cover all supply times or through growing cauliflower in different areas.
- Growers are now servicing the market demand for smaller curds (i.e. weight of 800-900 g).

- Declining seed quality of current varieties.

4.3.3 Vision for the Western Australian cauliflower export industry

A vision for the future of the export cauliflower industry was developed by members of the working group. "*The Western Australian cauliflower industry will maintain and improve its productivity, competitiveness and profitability".* To ensure that the vision becomes a reality, the industry needs to follow a series of steps (Figure 7).

Figure 7: Steps to realise the vision:



4.3.4 Issues for Western Australia cauliflower exports

4.3.4.1 Growers – Issues

4.3.4.1.1 Seedlings

- Cost of seedlings for export growers can be high.
- High price may be due to low volume and the high cost of hybrid seed used to produce export cauliflower.
- Quality of the seedlings is variable with certain varieties producing lower yields than previously. This is thought to be due to seed quality rather than being a nursery issue.

4.3.4.1.2 Planting

- Paddock selection is sometimes poor, with costly mistakes made.
- Ground preparation must be done in advance, farm planning/organisation should be improved.
- A formal planning system is needed prior to planting (Quality Assurance approach).
- Research is needed to fine tune basic agronomy for major varieties.
- Automatic planters, used in Europe, should be evaluated for export crops.
- Contract planting services may lead to efficient use of capital and labour.

4.3.4.1.3 Growing

- Adopt more efficient irrigation systems (centre pivots, underground mainlines, low impact sprinklers, irrigation scheduling devices).
- Adoption of improved management strategies are needed for pests and diseases.
- Adoption of new spray technology to reduce chemical costs and improve their effectiveness.
- Improved education of agricultural supply personnel (fertiliser, pesticides etc.).
- Cost of growing inputs using the current retail relationship is high.
- Investigate alternative growing systems.
- Investigate State wide and National alliances.

4.3.4.1.4 Harvesting

- Varieties need to be improved with particular emphasis on ease of cut, even maturity and number of picks required.
- Maintaining experienced labour with a low turnover to reduce harvest costs.
- Labour supply tends to be transient and the use of contract harvesting crews may be more efficient.
- Improving harvesting efficiency through developing improved cutting implements.
- Reduce covering costs.
- Harvest and postharvest costs need to be reduced and there is a need to investigate new technology for field packing.
- Reducing labour costs through development of technology that may lead to once over mechanical harvesting.

4.3.4.1.5 Post harvest

- Examine field packing and cooling in paddock.
- Refrigerated vehicles for cartage (contract) and in-field storage.
- Reduce in-field damage (bruising).
- Reduce in-field dehydration.
- Improve cartage efficiency, rationalise use of trucks from field.
- Investigate the collective development of ‘on-farm’ coolstores.

4.3.4.2 Packers – Issues

4.3.4.2.1 Inconsistent volume over time
- Inconsistent volume over time leads to logistic problems in sheds
- Inconsistent supply creates marketing problems

4.3.4.2.2. Labour
- Identification and retention of quality staff is a problem.

4.3.4.2.3. Cartons and packing materials
- There are a limited number of manufacturers of cartons and packing materials.
- Small runs of cartons and packing materials lead to high prices, one brand/logo could lead to large runs and cost efficiencies.
- Possibility of bulk handling as an option.

4.3.4.3 Post harvest - Issues

4.3.4.3.1 Efficiency
- Supply fluctuations lead to storage problems at sheds
- There is limited controlled atmosphere storage available and no long life bags in use.
- Alternative crops are needed to fill holes in schedules, these would use existing infrastructure.
- Packing shed efficiency is closely related to the quality of the raw product input.

4.3.4.3.2 Waste
- The cost of waste disposal is rising.
- The volume of waste is high at times due to pests, diseases and oversupply.
- The use of current waste as a processed or value added product needs development.
- There is agreement on the need to conduct a general study into waste.

4.3.4.4 Exporters – Issues

4.3.4.4.1 Freight
- Export cauliflower is well served by sea freight to SE Asian markets, costs are likely to rise.
- The Trade Facilitation Group of shipping companies control freight pricing.
- Air freight is expensive, rates are high due to limited availability due to other products which have a higher price.

4.3.4.4.2 New markets
- Cooperation within the industry is needed to develop new export markets.
- A single brand should be investigated.
- Cauliflower is not part of the staple diet in potential new markets, like Indonesia and Thailand, however, this could change as Western food becomes increasingly popular.
- Infrastructure such as cool rooms and refrigerated transport is lacking in new markets.
- Competition exists for new markets. China can dump excess produce on new markets.

4.3.4.4.3 Communication with growers
- Communication with growers about markets and demand needs to be improved. An industry news sheet may be suitable.

4.3.4.5 Indirect (intangible) Issues

- There is a perception that the Cauliflower Improvement Group and the Cauliflower Planning Group need development in order to effectively support the industry.
- Regulations (government) can restrict industry outlook.
- Research and development is important to drive innovation for the benefit of industry.
- Improved education and training programs are needed for growers and labour.
- Costs of inputs are rising faster than returns.
- Choice of inputs should reflect industry best practice.

4.3.5 Strategies to address issues and an action plan

4.3.5.1 Objective 1 – Strengthen grower base

Strategy
- promote positive media exposure about the export cauliflower industry.
- plan and sponsor study tours.
- develop the Cauliflower Improvement Group (Inc.), with positive articles released regularly.
- develop rotational options to improve the viability of growers.

Action plan
Media Exposure
The Western Australian Department of Agriculture to provide articles concerning developments in the cauliflower industry to the media. Information for the articles to come from the industry. The export cauliflower industry, through industry groups are also to promote themselves.

Plan and sponsor study tours
The Western Australian Department of Agriculture in conjunction with industry groups to select people for study tours.

Study tour to focus on:
- growing and post-harvest techniques.
- improved grower collaboration and strategic supply alliances.
- targeting young growers to act as agents of change.
- ensuring knowledge and insights are passed on to other growers after the tour through a formal reporting structure.

The best time for the study tours is late August to early September. There could be benefit from having a suitable person visit Western Australia to look at the cauliflower industry and work with growers in the short-term.

4.3.5.2 Objective 2 – Improved industry coordination
There is a perception amongst the industry that the Grower groups lack support and consequently direction.

Strategy:
- flatten the industry coordination structure.
- assist the grower groups to develop a structure and obtain resources to effectively develop the industry.

Action plan
It is proposed that the Cauliflower Improvement Group amalgamate with the Cauliflower Planning Group. The functions of the Planning Group would be taken on by a sub-committee of the Improvement Group who could report to industry. This proposal will have to be discussed by both

Committees. The revised industry committee needs the services of an executive officer and support from the Industry.

4.3.5.3 Objective 3 – Reduce inputs costs for growers

Strategy

- Investigate the bulk buying of inputs, in discussion with local suppliers. Follow on issues:
  - collaboration between sheds.
  - a credit system to facilitate the business.
  - orders for inputs should go through local companies to maintain services.
  - outside case studies should be examined to aid the development of a local model, these should include other industries in different States.
  - investigate, develop and adopt technology for the efficient use and application of pesticides.

Action plan

In order to demonstrate the benefits of collaboration, small focus groups will be formed comprising 6-8 neighbouring farmers. The Western Australian Department of Agriculture and the Cauliflower Improvement Group will initiate these focus groups. The focus groups will act as a forum for the sharing of information between farmers. Once the focus groups are functioning well, each group will be charged with undertaking specific industry driven research. The focus groups will report to other members of the export cauliflower industry at regular meetings of all industry members. These meetings are to be organised by the Executive Officer.

4.3.5.4 Objective 4 – Develop a system to use labour better.

Strategy

- ideally the industry would establish a separate entity to develop a contract cutting/packing labour service. This seems unlikely given the problems incurred by sheds trying this approach previously. Instead it may be more practical for farmers to share labour.
- examine technical issues that may reduce labour, feasibility of mechanised harvesting.

Action plan

The sharing of labour between farmers is a possible solution and is to be investigated by the small focus groups comprising 6-8 neighbouring farmers. The Western Australian Department of Agriculture is conducting research work to reduce the number of harvests and examine the potential for mechanised harvesting. This work will be presented to industry via the Cauliflower Improvement Group for discussion. A review of mechanised harvesting options may be included as a component of a study tour.

4.3.5.5. Objective 5 – Reduce seedling costs and improve seedling quality

Strategy

- adopt more labour efficient machinery, e.g. automatic planter.
- develop alternative growing systems, e.g. direct seeding.

Action plan

- grower groups to lobby for greater quality control of seed imports.
- grower groups to investigate sourcing seed from different countries or possibly produce seed domestically.
- the Western Australian Department of Agriculture to examine the costs and benefits of alternative growing systems.

4.3.5.6 Objective 6 – Raise yields

Strategy
- identify, develop and promote superior new varieties.
- improve grower knowledge of basic cauliflower agronomy. Follow on issues:
  - greater emphasis on tailoring information for individual requirements.
  - establish small 'hands on' workshop groups.
  - update and distribute current information.
  - promote safe quality food / quality assurance approach to cauliflower growing.

Action plan
Grower groups to identify superior varieties in conjunction with seed companies. The Western Australian Department of Agriculture and the Cauliflower Improvement Group to initiate small focus groups of farmers. The Western Australian Department of Agriculture staff to work closely with a small group of farmers providing economic and agronomic farm models to indicate the benefits of improved practices. The Western Australian Department of Agriculture to provide updated information on cauliflower production to growers. Liaison with the New Opportunities in Australia Horticulture (NOAH) Group on other possible rotation crops for cauliflower growers.

4.3.5.7 Objective 7 – Develop and adopt cost effective new post harvest technology

Strategy
- promote SQF/QA approach to cauliflower growing to enable effective scheduling of product by pack houses.
- search for the best available technology, e.g. "USA fast chill".
- develop recommendations for future post harvest projects, including access to funding.
- develop post harvest options for other rotational commodities.
- access specialist skills through the involvement of Universities and research organisations.

Action plan
A study needs to be conducted into the following post harvest issues to assess their potential for improving post-harvest handling:
- field packing
- field cooling
- covered sheds
- old sea containers / tautliners converted to mobile cool rooms
- application of clean water to harvested cauliflower in the field to allow evaporative cooling
- covers on harvesters

Post harvest options raised by NOAH must be disseminated to the export cauliflower industry.

4.3.5.8 Objective 8 – Improve the export marketing of cauliflower

Strategy
- Investigate the benefits and problems of developing a cauliflower brand.
- Examine options for the active promotion of Australian cauliflower in export markets i.e. 'Safe food' aspects.

Action plan
The export cauliflower industry to examine the potential for branding in supermarkets in Malaysia and Singapore and other export destinations. NOAH is charged with looking at value adding options. Information from this group to be relayed to the Export Cauliflower Group.

4.4 What has changed as a result of the export cauliflower industry plan?

Some of the actions within the industry plan have been implemented by the Western Australian cauliflower industry and there is a continual process of seeking improvements in production practices and industry organisation. There have been some key outcomes that have occurred as a result of the industry plan and a detailed discussion of the outcomes is provided in this report.

The key outcomes of the industry plan are:

- The establishment and support of small on-farm groups of closely located export cauliflower producers, who help each other to improve production practices
- The reorganisation of the industry producer group in Western Australia and the appointment of an industry paid Executive Officer
- Development of new production methods which has improved yield and returns to producers
- Establishment and assessment of evaluation demonstrations for new cauliflower cultivars with the support of voluntary contributions from non-producer sectors of the export cauliflower industry.
- Examination of the potential for mechanical harvesting of export cauliflower.
- Increased awareness by producers of the strategic direction of the export cauliflower industry.
- Organisation by producer representatives of on-farm local trial work to demonstrate improved production practices.

5.0 Mechanical harvesting of cauliflower

5.1 Introduction

The production of cauliflower and broccoli is labour intensive, particularly to harvest the crop where approximately 40% of all labour requirements occur. The export cauliflower industry plan identified the reduction of the labour component as a key objective for the industry. Increasing mechanisation of harvesting operations was considered to be a method that could be used to achieve a reduction in labour. Mechanisation would assist in the reduction of costs associated with employing people but also assist to alleviate the difficulties that occur accessing skilled cauliflower harvest staff. However, major constraints to the development of mechanical harvesting for cauliflower is the spread of curd maturity and the need to handle curds gently. Gentle handling of cauliflower curds is necessary to prevent bruising and damage to the curds, which can lead to the development of black spots and provide a pathway for pathogen establishment on the curd.

Prototypes of mechanical harvesters for cauliflower have been developed by researchers in the United Kingdom (DEFRA, 2002) however, to date, it is believed that a commercial mechanical harvester has not been developed for cauliflower. There has not been the impetus to develop a commercial mechanical harvester in the United States of America due to the availability of low cost labour. A mechanical harvester for commercial quantities of processing broccoli is being used in France.

To assess the feasibility for developing a mechanical harvester, advertisements for an expression of interest to develop a harvester were placed in Western Australian newspapers. After the provision of further briefing information, five companies submitted an expression of interest that provided information on their background, previous projects, staff capabilities and likely methodology for a feasibility study into the mechanised harvesting of cauliflower. This information would then be used to develop the terms of reference for a full proposal should mechanised harvesting be thought viable.

The five expressions of interest were assessed by a small group that included a cauliflower producer, an agricultural engineer and people with experience in the production of farm machinery.

5.2 Findings from the expression of interest

The levels of methodology varied among the companies and it was generally considered feasible that a mechanical harvester could be built that would not cause substantial damage and bruising to cauliflower curds, compared to the current hand cutting system. Despite this general agreement, most companies indicated the following points were major issues in respect to the development of a cost-effective commercial mechanical harvester:

5.2.1 Spread of maturity of cauliflower.

The spread of maturity of cauliflower curds could be overcome by using a mechanical system for selective harvesting but whether this would be cost effective was queried. Whilst it is possible to develop a harvester which picks cauliflower selectively this is likely to be too expensive when in the form of a seeing eye harvester. Such a harvester would have an electronic eye, as used to pick tomatoes in greenhouses. The cost of the hardware and software and logistical problems of operating such a system, often in wet and muddy conditions, would preclude this option.

A harvester could be developed that had rollers, which rolled around the side of the cauliflower plant, so gauging width of the plant and hence whether the plant was ready for harvest. This system had two major problems:

- the cauliflower curd is sensitive to damage and bruising, which often does not show immediately. Previous research conducted by the Department of Agriculture has

shown that curd damage and bruising may develop into discolouration and rots while the curds are in storage on route to export destinations in South East Asia.
- the width of a cauliflower curd is not an accurate indicator of the state of maturity of the curd (i.e: curds can often be small (approximately 600 g) but are mature enough to be harvested).

A machine built to perform a selective harvest would be required to move through the cauliflower crops several times. This may cause substantial damage to the plants as leaves of the cauliflower could be easily broken off. The excessive removal of leaves from cauliflower plants would lead to exposure of the curds to the sun. The curds are currently covered by the leaves to prevent exposure to the sun and the development of undesirable yellow and pink discolouration in the curd. Damaged leaves can also provide an entry point for diseases, which reduce the quality of the crop.

Due to the factors outlined, a mechanical harvesting system based on selective harvesting is unlikely to be cost effective and practical in a commercial situation. A system that involves a one pass harvest would be more likely to be adopted for commercial mechanical harvesting, as long as the cauliflower curds were not damaged in the harvesting process. The key issue in the development of a once over harvester is uniformity of curd weight without the curds becoming over mature.

5.2.2 Uniformity of curd size

Achieving uniform curd size is difficult as the growth of cauliflower is influenced by many factors such as climate, position in the paddock, irrigation uniformity and nutrition uniformity. Although work has been conducted to address some of these issues, which has helped to reduce the spread of harvest, it is unlikely that it will be possible to achieve simultaneous 'ideal' weight or maturity for all curds in a crop. However, it may be possible to adjust agronomic conditions to ensure that a majority of cauliflower curds mature at the same time. It has yet to be determined what is the minimum percentage of similar curds required to be economically feasible to machine harvest.

In a one pass harvesting system, the utilisation of curds that are not of a suitable weight or maturity specification for exports markets would need to be addressed. The current export market specifies curds ranging in weight from approximately 0.7 kg to 1.3 kg. Smaller curds could be sold domestically as a gourmet item and some producers are currently doing this. The larger curds, over 1.4 kg, could be processed into cauliflower florets for sale as a fresh product or freezing in mixed bags of vegetables. At present, grading for maturity and weight is conducted by people working in the field cutting the curd, with people working in the packing shed mainly checking for quality. If all curds were harvested, then the grading process in the packing shed would be made more complicated with the three grading lines (small, export and large).

Factors that can influence the uniformity of production for cauliflower curds in the desired weight and maturity specifications were analysed. These factors need to be addressed to minimise the number of out of specification curds, which would reduce the viability of mechanical harvesting for cauliflower. Agronomic factors which may influence the uniformity of curd weight and maturity include:

5.2.2.1 Seedling selection

Investigations by McVeigh *et al*. (1998) indicated there was a correlation between seed germination and seedling uniformity. Anecdotal evidence indicates that weak seedlings produce poor quality curds that develop late compared to the remainder of the crop. There is a need to investigate the potential benefits of seedling selection on synchronised curd development.

5.2.2.2 Variety

Different varieties of cauliflower grow at differing rates. Modern hybrid varieties produce smaller curds than the open pollinated varieties common approximately 20 years ago, however anecdotal reports from producers suggest the maturity of the hybrid varieties has not become more even

compared to the older varieties. To assist the development of mechanised harvesting, breeding for evenness in maturity would be required.

5.2.2.3 Climate

An important factor in determining curd maturity is climatic conditions. Variety evaluations (Department of Agriculture Western Australia, 1999 – 2003) and anecdotal evidence indicate cauliflower matures more evenly during the warmer summer months with fewer harvests being required. The cooler months see the harvesting process becoming more labour intensive as more harvests are required to remove a crop. Variations in topography can also affect the rate of maturity of a crop as cauliflower located on slopes with a northern aspect tend to mature more quickly than those located on slopes with a southern aspect (T. Charsley, personal communication). To improve the potential for even crop maturity, producers should endeavour to locate sites for cauliflower that have minimal variations in topography across the crop area.

5.2.2.4 Irrigation

Anecdotal evidence indicate that an even irrigation pattern resulting from pressure regulated sprinklers or centre pivots aids the synchronised maturity of curds as each plant receives a similar amount of water compared to non-regulated sprinklers.

5.2.2.5 Nutrition

The supply of nutrients to the crop is believed to have a large affect on the uniformity of cauliflower curds. A more even supply of fertiliser appears to assist in the reduction in the number of harvests required. Providing an even supply of base fertiliser by incorporating the fertiliser in a narrow strip was investigated in this project and the results from trials are listed in this report (see section 6.0).

5.3 Other considerations related to the mechanical harvesting of cauliflower

5.3.1 Waste disposal

Cauliflower that is to be exported is currently trimmed of all leaves as only the curd is packed. The practice of trimming the leaves is currently done in the paddock as part of the harvesting operation. It is likely that a mechanised system would involve the harvesting of the whole cauliflower (including leaves), which would require the trimming of the leaves prior to packing for export. It would be preferable if leaves are removed prior to cool store to reduce the area of individual cauliflowers from which moisture could be lost during cool store. There are two differing ideas on how to treat the leaf waste:

5.3.1.1 Transport curd in leaf to packing shed

The curd could be transported in leaf to the packing shed where the waste would be trimmed off. In this way the curd could would be protected whilst being transported to the shed with handling and bruising minimised. At the shed, trimming and grading would happen in one process. A problem with the system of transporting both curd and leaf is that cauliflower bins would be filled quickly as the curd in leaf is very bulky. Additional costs would be incurred transporting the bins to pack houses, where there is no return to the producer for the leaf transported. There is also the issue of the cost and willingness of packing sheds to become involved in waste disposal.

5.3.1.2 Trim curd whilst harvesting

An alternative to transporting the curd in leaf to a pack house is to have two or more people who act as leaf trimmers working on the rear of the mechanised harvester. In this way, leaf waste can be minimised and transport costs reduced as the leaves would remain in the harvest paddock. Those trimming the cauliflower would also conduct preliminary grading, throwing out those curds which do not meet market specifications. An issue with this system is a reduction in the potential speed of a mechanical harvester. A harvester can only move as fast as the people can trim leaves and conduct a preliminary grade of the curds.

5.3.2 Multi-purpose harvester

The expression of interest called for the development of harvester to mechanise cauliflower production, however, it may be possible to mechanise the production of other crops such as broccoli. Broccoli lends itself more readily to automation as the market is prepared to accept a wider spread of head size. In addition, broccoli is less susceptible to damage, particularly visible damage, than a cauliflower curd. However, it would be necessary to reduce the amount of damage that could occur to a broccoli head to a minimum in order to maintain a satisfactory shelf life and quality for export of the product. The broccoli plant lends itself more readily to mechanised harvesting as the stalk of the plant is much taller than a cauliflower curd stalk and therefore a cutting system will be able to access the plant more readily.

5.3.3 Economics of mechanised harvesting

The companies who had expressed an interest in developing a feasibility study all felt the engineering side of a mechanical harvester for cauliflower would be achievable. The problem would be in making a machine that was affordable to producers. Accordingly, there needs to be a study into the benefits of using a mechanical harvester to harvest cauliflower and other, complimentary row crops such as broccoli and lettuce. This study would take the form of a benefit cost analysis and factors to be studied should include:

Benefits

- reduced labour costs
- reduced fuel costs as numbers of harvests is reduced
- increased areas of production due to changes in crop layout within a paddock to suit mechanisation
- improved curd quality as a result of cut curds being delivered to cool storage more quickly, as harvesting time is reduced
- cross subsidisation with part of the cost (and benefits) of a multi-purpose harvester being carried by other crops such as broccoli

Costs

- capital and running cost of mechanised harvester
- possible increases in damage levels of curds leading to reduced pack outs
- waste and waste disposal – that percentage of the crop which cannot be marketed and the removal of leaves from the cut curds
- possible spread of diseases, if harvest contractors move from farm to farm without adequate sanitation
- possible increased seedling costs as seedling selection becomes more rigorous

5.4 Conclusion

Prior to the development of a prototype of a mechanical harvester, there needs to be further work carried out on the agronomy of cauliflower production and the economics of a revised production system. The agronomy work should concentrate on isolating the main factors influencing the synchronisation of curd size and maturity. Once the key factors have been determined, these factors need to be combined with the aim of bringing a high percentage of the crop to within market specifications at the same time.

In parallel to the agronomy work, the economics of mechanical harvesting needs to be investigated. A benefit cost analysis should focus on how much of the harvest can be wasted through immaturity or over maturity and still have a net benefit over manual harvesting for the producer. In addition, the analysis will be able to model the benefits for the grower, of using a mechanised harvester for cauliflower and possibly other crops. In this way an indicative purchase price can be estimated for a harvester that would be affordable for brassica producers.

A feasibility study to develop a prototype for mechanical harvesting should be conducted if the agronomy work demonstrates that it is possible to synchronise a large percentage of the crop and the economic analysis indicates a realistic purchase price for a harvester. In addition to engineering issues, the feasibility study should include other issues such as crop lay out in paddocks under a mechanised harvesting system and changes that may be required to post harvest handling and marketing requirements.

5.5 References

DEFRA (Department for Environment, Food and Rural Affairs) (2002) Agriculture Link: Newsletter for the Agriculture and Horticulture Industries. DEFRA, United Kingdom.

McVeigh, V.; Lancaster, R.; Phillips, D. and Tan, S.C. (1998) Export Cauliflower Quality Improvement 1996-1998. Final Research Report VG94043. Horticulture Australia.

6.0 Improving fertiliser application practice

6.1 Introduction

The expression of interest for the development of mechanical harvesting for cauliflower indicated the synchronisation of crop maturity is an area of work that was required prior to the development of a prototype harvester. Crop nutrition was identified as an area where improvements could be made that would assist in the more even growth of cauliflower crops. The development of a precision incorporator in the Horticulture Australia funded project Clubroot: Total Crop Management (VG00044) has allowed a new method of fertiliser application to be developed for export cauliflower. The precision incorporator was developed for the application of fungicides and other products that would be useful for the management of the brassica disease clubroot.

The lower south-west of Western Australia is a major export cauliflower producing area in Australia. The predominant soil type in the area are red – brown and yellow brown loamy gravels and friable loamy earths (Tille *et al*.; 1998) which are high in organic matter and have a high phosphorus fixing capacity (McPharlin and Phillips, 1989). Producers apply enough phosphorus to last the life of the cauliflower crop as a basal fertiliser at transplanting. Post transplanting application of phosphorus does occur on a limited basis although only as a supplement to the basal fertiliser applied at transplanting.

To avoid adsorption of phosphorus onto the surface of clay particles and organic matter, the traditional method for fertiliser application in the region was to place two narrow bands of fertiliser, approximately two centimetres wide. For a range of crops, the banding of fertiliser containing phosphorus, especially on high phosphorus fixing soils, is usually more efficient than other methods of application (DeWit, 1953). A seedling is transplanted in the middle of the off-set fertiliser bands and the roots of the seedling must grow out from the transplant cell pack towards the fertiliser bands. During the cooler months, it can take two to three weeks for the roots of the transplanted seedling to reach the fertiliser band, during which time there is slow growth of the seedlings. Another cause of slow growth can be poor drainage of soils under very wet conditions. To overcome this, producers on some soil types form raised beds on which crops are planted, in order to assist with drainage.

The precision incorporator allows the placement of fertiliser so that the fertiliser surrounds the transplanted seedling. By surrounding the seedling with fertiliser, the plant can access the nutrients required for growth as the roots emerge from the transplant cell pack. The use of the precision incorporator to apply fertiliser, both on flat ground and on raised beds, was examined to determine if there was more even growth of cauliflower plants, providing a more even harvest at crop maturity.

6.2 Methods

An experiment was established on a friable loamy earth soil (termed karri loam), in both 2000 and 2001 at the Manjimup Horticultural Research Institute. Cauliflower seedlings were produced by a commercial seedling nursery and mechanically transplanted at seven weeks after germination into the prepared field site. Experiment 1 was transplanted on the 26 July 2000, while experiment 2 was transplanted on the 10 July 2001. The seedlings (*cv*. Virgin in experiment 1 and *cv.* Liberty in experiment 2) were planted 40 cm apart within a row, with 80 cm between rows.

The cauliflower seedlings were supplied with a basal fertiliser at transplanting of 1000 kg/ha SuperSpud® (11% N, 12.4% P, 12.2% K, 0.05% Cu, 1% Mg, 0.06% Mn, 5% S, 0.05% Zn) in 2000 and 1300 kg/ha SuperSpud® in 2001. Nitrogen, boron, zinc and molybdenum were supplied to the plants, using foliar application, throughout the growing season as required. The experiments were

established during the winter months as any benefits of the system are more likely to be noticed when the plants are growing slowly due to the cool, wet conditions.
The experimental design was a two (methods of fertiliser placement) times two (ground treatment) factorial in a randomised block design with three replications for both experiments. The four treatments for each of the experiments are listed in Table 2.

Table 2: Treatments for experiments one and two.

Treatment Number	Fertiliser application method	Ground treatment
1	Incorporated strip	Raised bed
2	Incorporated strip	Flat ground
3	Banded	Raised bed
4	Banded	Flat ground

For the incorporation (in strips) method, fertiliser is applied using two small rotary hoes attached to a seedling transplanting machine. The fertiliser at the required rate is dropped in front of the rotary hoes and mixed through the soil to a depth of 10 cm. This method gives two 20 cm wide strips of mixed fertiliser and soil into which the cauliflower seedlings are transplanted. For the banding method, fertiliser is applied in two very narrow bands approximately five centimetres below and off-set from the cauliflower seedlings, which are transplanted between the fertiliser bands. The two methods of fertiliser placement were used in combination with a ground treatment of formed raised beds or prepared flat ground. The beds were made using a commercial bed former and were 1.7 m wide and approximately 15 cm high. The plots for both experiments were 30 m long.

For experiment 1, the fresh weight of the plant shoot (FWS) was measured at 8 and 11 weeks after transplanting, while for experiment 2, the FWS was measured at 7 and 12 weeks after transplanting. The FWS was obtained by removing the cauliflower plants at ground level and weighing each plant individually. For experiments 1 and 2, six and eight plants per sampling time were assessed respectively. The shoot weights were assessed before the formation of visible curds.

The cauliflower curds were harvested at maturity for experiment 2 and the total yield and number of picks required to fully remove the crop were recorded. The data was analysed using Genstat (Windows v6) as a two way ANOVA in randomised blocks. No yield data was obtained for experiment 1 due to irrigation failure during curd formation which severely reduced the overall yield and quality of the curds.

6.3 Results

There was no significant difference in the total yield when fertiliser was applied either as an incorporated strip or banded. Despite the lack of significance, there was an increase in the total yield when fertiliser was incorporated on both raised beds and flat ground. For example, applying fertiliser in strips resulted in an increased yield of cauliflower curds of 6.4% on raised beds and 11% on flat ground compared with banded fertiliser (Figure 8).

The number of harvests required to fully remove the cauliflower crop are indicated in Figure 8. Although not statistically significant, fewer harvests are required when the fertiliser is incorporated, with most of the crop being removed within the first three harvests.

In experiment 1, there was a slight increase in the shoot fresh weight when the fertiliser was incorporated in strips although this was not significantly different from the shoot fresh weight of the plants where the fertiliser was banded (Table 3). In experiment 2, the application method of the fertiliser did have a significant influence on the shoot fresh weight. The method of ground treatment did not have a significant influence on the shoot fresh weight of the plants in either of the

experiments. The average curd weight in experiment 2 was also higher when the fertiliser was incorporated for both the raised bed and flat ground treatments (Table 4).

Figure 8: Total yield and number of picks required to harvest the crop for Experiment 2 (2001). lsd (total yield) = 3.25 (p = 0.071 (ns)), lsd (number of picks required) = 1.41 (p = 0.090 (ns)).

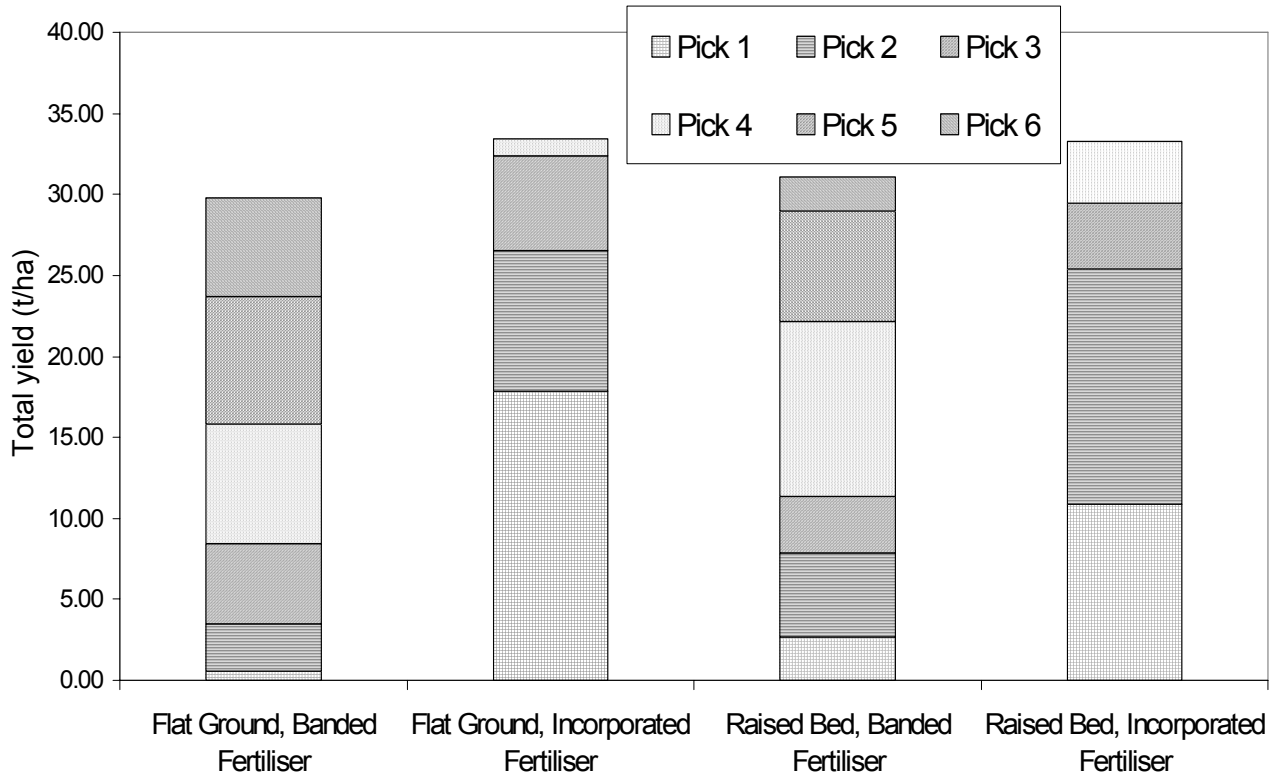


Table 3: Shoot fresh weight of cauliflower (Experiment 1 – *cv*. Virgin, Experiment 2 – *cv*. Liberty)

Fertiliser application method	Ground treatment	Experiment 1 2000 8WAT*	Experiment 1 2000 11WAT*	Experiment 2 2001 7WAT*	Experiment 2 2001 12WAT*
Banded	Raised bed	222.22	1078.33	89.375	848.04
Incorporated Strip	Raised bed	232.33	1123.94	152.9583	1040.04
Banded	Flat ground	201.28	1083.44	71.16667	726.13
Incorporated Strip	Flat ground	255.44	1118.50	146.2917	1046.42
lsd (5%) fertiliser placement method		ns	ns	18.04 (p < 0.001)	108.3 (p = 0.001)

*WAT = weeks after transplanting

Table 4: Average cauliflower curd weight in experiment 2 measured at harvest. There was no significant difference between any of the treatments at a 5% level of significance.

Fertiliser application method	Ground treatment	Average curd weight (g)
Banded	Raised bed	1173.48
Incorporated Strip	Raised bed	1180.03
Banded	Flat ground	1040.93
Incorporated Strip	Flat ground	1144.40

6.4 Discussion

There was no significant yield difference between the ground (flat or raised bed) treatments nor was there a significant interaction between the ground treatment and the fertiliser placement method. Raised beds are not commonly used in the lower south-west of Western Australia due to the undulating topography, which increases the risk of soil erosion. These results indicate the formation of raised beds on well drained soil would not be of benefit for increasing the total yield and it is likely the negative impacts of soil erosion would be too great. The increase in yield when the fertiliser is incorporated compared to banded is likely to be due to the small increase per plant in the weight of the curd.

Although there was no significant difference between the treatments for the average curd weight, small increases in curd weight per plant can produce a large yield increase for an entire planting. This is of importance to producers in the lower south-west of Western Australia as they are usually paid by exporters for their cauliflower curds on a per kilogram basis. An average increase in curd weight for plants transplanted using the incorporated strip method on flat ground of 103.47 g would equate to a per hectare increase of 3.23 t/ha.

There was a small difference in the number of harvests required when fertiliser was banded compared to the strip incorporation of fertiliser. Commercial producers are reluctant to harvest when there are very few curds mature as harvest costs (including labour) can outweigh the return for the product. As cauliflowers are currently hand harvested, a reduction in the number of harvests is important as labour is a major cost for cauliflower producers. The acquisition of labour is also an issue, particularly when competing industries such as fruit and wine require labour at the same time. The need for producers to find adequate, skilled labour is partially alleviated by the reduction in harvests required to remove most of a cauliflower crop. The reduction in harvests using the incorporated fertiliser is also a step toward achieving a large percentage of a crop that is more uniform in its maturity, increasing the potential for mechanical harvesting.

Although there was no major significant differences in this experiment, it was decided not to repeat the experiment again due to the logistics of planting the experiment during the winter months. The yield increase and reduction in the spread of harvest achieved were an incentive for some producers to use the fertiliser incorporation system on a commercial basis. Commercial scale demonstration areas of incorporated fertiliser for cauliflower were implemented to allow other producers to assess the benefits of the new fertiliser application method (see section 7.0).

6.5 References

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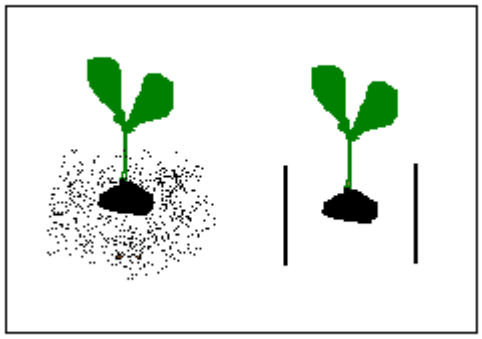
7.0 Demonstration of improved fertiliser application practice

A small number of large cauliflower producers implemented the fertiliser incorporation application method based on the results of the small scale research experiments. These growers have continued to use the technology continually since 2001. However, apart from the initial uptake, some producers were reluctant to take up the new method as it required the modification of planting machinery at a cost of approximately $4000 - $6000. These producers had expressed interest in the method but were still 'sitting on the fence' and assessing the results from those producers who were commercially using the fertiliser application method. To allow other cauliflower producers to assess for themselves the benefits to be gained from the strip incorporation of fertiliser such as yield increase and an improvement in crop evenness, demonstration areas were planted. The purpose of the demonstration areas was to show producers on a commercial scale, the use of the fertiliser incorporation technology compared to the traditional method of banding fertiliser. The principle of incorporated fertiliser compared to banded fertiliser is shown in Figure 9.

Figure 9: Stylised diagram showing side view of incorporated fertiliser (left) surrounding the roots of the transplanted seedling, while banded fertiliser (right) is located approximately five centimetres below and off set from the transplanted seedling.



The demonstration plots were established in July 2002, as the benefits from the change in the fertiliser application practice are most noticeable during the cool winter months. Four properties were selected which were all located in the lower south-west region of Western Australia. The soil type on the demonstration farms ranged from a sandy loam to a clay loam. The soils in this region adsorb phosphorus readily due to their high clay and organic matter content. Cauliflower is often grown after the pasture phase in a rotation commonly lasting from two to seven years, depending upon available land area.

To establish the demonstration, two rows of cauliflower were transplanted using the fertiliser incorporator in the middle of a commercial planting of a producer's crop (Figure 10). Each cauliflower row was between 100 m and 250 m in length. The fertiliser used for the incorporated rows was 1500 kg/ha SuperSpud® and this was compared against the commercial planting surrounding the incorporated fertiliser rows. A major factor determined from the demonstration plots and also from the experience of commercial producers using the new method is that incorporated basal fertiliser needs to contain a sufficient quantity of available phosphorus. Some fertilisers currently used for banding under cauliflower do not contain sufficient available phosphorus and when applied in an incorporated strip, the growth of the cauliflower is reduced, particularly as the plant nears maturity (i.e: the plants 'run-out' of fertiliser).

To ensure the cauliflower plants have sufficient fertiliser to form a marketable curd, it is recommended that a fertiliser containing a high percentage of water soluble phosphorus is used. Alternatively, commercial experience has indicated that a fertiliser with a low percentage of water soluble phosphorus can be used if phosphorus has been consistently applied in previous years (e.g: the application of superphosphate to pasture paddocks).

The demonstration sites were also used as an initial meeting topic for the neighbouring farm groups (see section 10.1). The commercial scale demonstration areas were an integral part of the technology transfer for the new fertiliser incorporation system as the benefits of a new method can be difficult for commercial producers to assess from small scale research plots. The demonstration areas allowed producers to assess for themselves the relative growth of the plants with incorporated fertiliser compared to the cauliflower plants that had been grown using only banded fertiliser.

As a result of the demonstrations, more cauliflower producers have converted their machinery to allow fertiliser incorporation. Where necessary, tailoring of fertiliser programs was provided to producers to assist them in the change from banded to incorporated fertiliser. This has been important to ensure adequate 'take–up' of the new application method and to overcome minor problems that occurred on a commercial scale.

Figure 10: Demonstration rows of cauliflower using incorporated fertiliser technique being planted on a commercial farm. The producer's commercial crop was planted next to the demonstration rows so a direct comparison could be made between the incorporated and banded fertiliser method.

8.0 Study tour of innovative technology for cauliflower producers

The industry strategic plan outlined the need for new technology to be taken up by cauliflower producers that would make their businesses more profitable. The committee developing the industry plan, indicated that study tours to other major brassica producing areas, would be a beneficial step to identifying worlds' best practice technology. Two study tours were proposed, one to Werribee in Victoria to analyse current production systems outside of Western Australia and the other to France and California, a major brassica production region in the United States of America. August or September were agreed to be suitable months for the overseas study tour as work commitments were less in comparison to the summer months. The study tour to Victoria was scheduled for May to coincide with the Werribee Field Days.

In France, a major purpose of the study tour was to examine the mechanical harvester being used for commercial crops of processing broccoli and to determine if this system would be suitable for Australian export cauliflower. The growing system that allowed mechanical harvesting to be conducted would also be examined. To develop the itinerary for the French component of the study tour, contact was made with a French horticultural consulting company, Cornuejols Consultants. This company would organise suitable locations to visit based on the specifications and interests listed by the export cauliflower growers. Cornuejols Consultants would also organise the logistics of conducting the tour in France and provided an English interpreter at each farm location visited.

The purpose of the visit to California was to examine the cauliflower industry in that region. California competes with Australia in the South East Asian markets and a visit to the region would provide insights into their production, harvesting, cool chain management, packaging and exporting systems.

Advertisements were placed outlining the program for the study tour and the estimated costs for the study tour. There were no expressions of interests for the Victoria study tour from export cauliflower industry representatives. Many industry representatives have previously been to Victoria and seed companies and other agricultural supply companies run alternative study tours, particularly to the Werribee Field Days.

There was a limited response to advertisements for the overseas study tour. Of the people who expressed an interest, most were not directly involved in the export cauliflower industry or were not able to make it at the desired travel time due to other off-farm commitments. The organising committee of the study tours, deemed that it would not be a prudent use of industry funds to conduct the study tours, given the low numbers of direct industry participants. A lack of direct industry participants would have compromised the extension of the findings of the study tour, particularly in the area of new technology, after the participants returned to Australia.

9.0 Evaluation of cauliflower varieties.

9.1 Introduction

There are many varieties of cauliflower available that are suitable for the export market. For producers, varietal selection is critical as it is a major factor that can influence whether a satisfactory yield is obtained.

Cauliflower varieties have been bred to be suitable for specific environmental conditions. Wien and Wurr (1997) noted that the formation of curds in cauliflower is primarily influenced by temperature. The amount of vernalisation required varies between different varieties, enabling production of cauliflower to occur in some growing regions throughout the year (Wiebe, 1990). Producers in warmer climates and those that grow during the summer months, must select varieties that have a low vernalisation requirement to ensure that a marketable curd is produced. Varieties are not identified to producers by their specific vernalisation requirements but are placed into categories such as 'summer' and 'winter' varieties.

Production of certain varieties in the correct environmental period is important as the quality of the curd can be severely compromised if grown at an unsuitable time of year. The weight of cauliflower may also be influenced by the time of year of production. Cauliflower varieties grown in the correct environmental conditions are more likely to reach their full weight and quality potential compared to when they are grown at a less suitable time of year. This is very important for export cauliflower producers who are paid for their product on a packed weight basis. A small increase in the weight of individual cauliflowers can translate to a large yield increase on a per hectare basis.

The large number of commercial cauliflower varieties available is confusing for producers. The local grower group in Manjimup, Western Australia commissioned screening evaluations to assess the growing characteristics of existing commercial and potentially new varieties for the region, with the aim of identifying a limited number of varieties that would be suitable for production in the region. The purpose of the screening trials was to compare different cauliflower varieties against the varieties that are commonly used in the district for export cauliflower production and to determine the best growing period for new non-commercial varieties. In the Manjimup region, there is also a small amount of broccoli grown for export. To ensure the best varieties were also identified for broccoli, a limited range of broccoli varieties were also tested for some of the months in which the screening evaluations were conducted.

9.2 Method

Thirty seven variety evaluation plantings were conducted for three years from August 1999 to August 2002. Twenty four of the plantings evaluated both cauliflower and broccoli varieties while the remaining thirteen plantings evaluated only cauliflower varieties. Over the three years of evaluation, 54 different cauliflower and 19 different broccoli varieties were evaluated. All of the evaluation trials were planted at the Department of Agriculture's, Manjimup Horticultural Research Institute in the lower south-west region of Western Australia.

The cauliflower and broccoli varieties to be evaluated were selected by participating seed companies. Seed companies that submitted varieties for the trials were Yates Seeds, South Pacific Seeds, Lefroy Valley Seeds, Syngenta Seeds and Henderson Seeds. The varieties evaluated in the plantings are listed in Table 5. This table includes both commercial varieties and numbered lines which had not yet been released by seed companies for commercial plantings.

Table 5: Commercial and unreleased seed lines of cauliflower and broccoli varieties evaluated from 1999 to 2002

Cauliflower Variety			Broccoli Variety
Advantage	CLX3706	Morpheus	Monaro
Alabama	CLX3707	Mystique	BRC9812
Ambassador	Defender	Omeo	Green Prince
Amsterdam	Discovery	Savannah	BRC7833
Aviron	Donner	Sirente	Cobra
Aviso	Escale	SPS4628	Taipan
Bulla	Fremont	SPS4668	Monterey
Casper	G376	SPS4678	Ruben
Cauldron	G389	SPS6509	BRC9805
Celsius	Galacia	SPS7458	Endurance
CF378	Gibraltar	SPS7469	BR399
CF479	Hotham	Summer Love	BR400
CF484	Huntsman	Talia	Bandit
Chaser	Kilda	Virgin	Mamba
CLF33902	L3368	Vixen	BRC9807
CLF3701	L3374	White Heat	BRC9803
CLF5044	Liberty		BR424
CLX3312	M3444		BR462
CLX3340	Monarch		Viper

The seed companies nominated the growing period for each of the varieties. Some varieties were assessed both at their known optimum growing period and also in the 'shoulder periods' to determine if the variety could be grown successfully for a longer period of the year. All of the varieties (both cauliflower and broccoli) were compared against a commonly grown commercial variety. The commercial variety (termed the 'control') was deemed to be the variety, which in the previous year, had the most seedlings planted in the lower south-west of Western Australia for each of the planting times. The control varieties are listed in Table 6.

Table 6: Control cauliflower and broccoli varieties used in the cauliflower and broccoli evaluation from 1999 to 2002

Cauliflower	Broccoli
Fremont	Marathon
Granite	Green Belt
Liberty	
Plana	
Sirente	
Virgin	

Seeds of the varieties to be planted each month were hand planted in individual cells at a commercial vegetable seedling nursery. This ensured there was no mixing of seed from different varieties. The seedlings were raised at the nursery for between six and eight weeks after seeding, depending upon the time of year.

When the seedlings were of sufficient size to be transplanted, all varieties to be evaluated for each planting were transplanted using a commercial transplanter. Throughout the evaluation from seeding to harvest, each of the varieties were managed similarly, following commercial management practices for fertiliser and pest control. The same fertiliser program was used on each of the varieties to allow each of the varieties to be compared equally. However, it is known that some varieties require more fertiliser than others and the constant fertiliser program allowed this to be identified for some varieties.

The varieties were grown until their maturity, when they were harvested based on the requirements for a commercial crop. Multiple harvests of some varieties were required to ensure each curd was harvested at its optimum maturity. Prior to harvest, each variety was assessed for their vigour relative to the control variety and also the number of 'sibs' was recorded. 'Sibs' are genetic off-types that are often noticed in commercial plantings. The percentage of 'sib' plants is variable depending upon the variety. Information recorded for curds of each variety included the days to harvest, curd weight, curd density and a quality score. The quality score is a subjective measure and is based on a scale from one to seven (Table 7). The quality score was used to assess the suitability of the curds to include in the marketable yield. Curds that had a quality score of four or less were deemed not of export quality standard and were rejected from the variety marketable yield calculations. The reason for a curd being rejected as export standard was also recorded. Reasons for reduced quality include yellowing of curds due to exposure to sunlight, over mature curds, 'curd furriness', insect, rodent or disease damage and poor shaped curds that have 'flat' domes.

Table 7: Subjective quality scoring system for cauliflower curds at harvest.

Quality score	Quality Score characteristics
1	Not marketable. Rots on curd
2	Not marketable. Poor quality with multiple defects although no rot on curd.
3	Suitable for domestic market only. Curd has severe yellow discolouration, minor insect damage and / or other defect
4	Suitable for domestic market only. Curd has minor yellow discolouration, minor insect damage and / or other minor defect
5	Suitable for export. Shape of curd may not be ideal and / or may have substantial 'curd furriness'. No yellowing on curd or insect / disease damage.
6	Suitable for export. Shape of curd may not be ideal 'round' or 'domed' or may have minor 'curd furriness'. No yellowing on curd or insect / disease damage.
7	Suitable for export. Shape of curd is equally round with high 'dome'. No 'curd furriness' or other imperfections. No yellowing on curd or insect / disease damage.

The density score is also a subjective measurement based on a scale from one to three, which gives an indication of how close the florets of the curd are located to the stem of the curd (Table 8).

Table 8: Subjective density scoring system for cauliflower curds at harvest.

Density Score	Density score characteristic
1	Very open curd (easy to see into the centre of the curd)
2	Adequate density (florets closed but not very close to stem underneath)
3	Very tight closed curd (florets curved underneath and close to stem)

The broccoli quality and density scores were determined against the guides provided in the quality description language (O'Donnell *et al*., 1998). Reasons for the rejection of broccoli heads from the marketable yield included leaf in head, poor shape and a purple tinge to the head.

Once the data was obtained for each curd in the trial, the total yield per hectare, marketable yield per hectare, average curd weight and average days from transplant to first harvest were calculated for each variety. A record was also made of the daily weather conditions, including maximum and minimum temperatures, humidity and rainfall.

Cauliflower curds that were of an acceptable quality for export were prepared as per a commercial shipment by wrapping individual curds in paper and placing them in a box. Approximately 16 to 18 curds were in each box, giving a box weight 18 to 22 kg. The boxes where stored at 1°C for 15 days. Immediately after removal from cold storage, the cauliflower curds were reassessed for their

quality and any storage faults. Broccoli heads were stored on ice in polystyrene boxes for 15 days at 1°C prior to regrading for after storage quality.

Export quality samples of new varieties of cauliflower were exported to Singapore and Malaysia to determine the acceptability of new varieties. The curds were packed the same as a normal commercial shipment, with the only difference being they were packed in unbranded cartons, allowing them to be easily identified from the other commercial cartons in a shipping container. A check list was included with the sample cartons, allowing importers to list their comments about the new cauliflower varieties. Broccoli varieties were not exported, as the current broccoli export market from Western Australia is limited.

9.3 Results

There were copious data generated from the variety evaluation due to a planting occurring each month from August 1999 to August 2002. A separate report, containing the results for each variety evaluated was produced for each month's planting. These reports were sent to seed companies, seedling production nurseries, cauliflower and broccoli producers, consultants and packing shed field staff. The reports are available upon request from the Department of Agriculture Western Australian, Manjimup Horticultural Research Institute (phone: (08) 9777 0000, fax: (08) 9777 0001, email: manjimupdo@agric.wa.gov.au).

Due to the large amount of data generated, a summary of the commercial marketable yield and days to harvest for the three varieties with the highest commercial marketable yield for each planting is listed in Table 9 for cauliflower and Table 10 for broccoli. Marketable yield is determined by grading the cauliflower to export specifications and broccoli to the specifications accepted by the domestic market. The commercial marketable yield is obtained when a small number of cauliflower curds or broccoli heads that are mature either side of the main harvest are removed from the marketable yield total as these curds and heads would not be profitable to harvest in a commercial situation. More detailed information on the varieties listed in Tables 9 and 10 as well as the other varieties tested is available from the evaluation reports.

The receipt of information from export markets about the samples of cauliflower varieties was difficult to obtain as many check lists were not returned. However, anecdotal evidence from Australian exporters indicates that for all of the sample varieties exported, there were no adverse reports regarding these varieties. Cauliflower varieties that produced high commercial marketable yield in their production time slots include Summer Love, Monarch, Granite, Omeo, Virgin and Liberty. Broccoli varieties that produced high yield include Marathon, Monaro and Ruben.

Table 9: Characteristics of the three highest commercial marketable yield cauliflower varieties for each planting time.

		Highest yield for planting			2nd highest yield for planting			3rd highest yield for planting		
Planting	Planting Date	Variety	Yield (t/ha)	Days to harvest	Variety	Yield (t/ha)	Days to harvest	Variety	Yield (t/ha)	Days to harvest
1	4/8/99	Aviso	23.6	100	Amsterdam	23.2	101	Bulla	23.1	107
2	8/9/99	Morpheus	21.4	84	CF479	20.0	81	Discovery	20.0	85
3	5/10/99	Discovery	22.8	80	Huntsman	22.3	77	Summer Love	22.0	82
4	10/11/99	Summer Love	29.2	75	Monarch	25.1	77	Fremont	24.2	65
5	8/12/99	Summer Love	35.2	77	Monarch	28.3	80	Vixen	28.0	65
6	5/1/00	Monarch	33.8	75	Summer Love	33.4	67	Morpheus	32.1	69
7	8/2/00	Virgin	22.9	82	Bulla	22.1	80	Aviso	21.4	80
8	8/3/00	CLX3340	24.9	99	CLX3707	20.3	131	Omeo	20.1	90
9	5/4/00	CLF3701	21.5	108	Omeo	20.7	110	CLX3340	20.4	106
10	10/5/00	CLX3340	16.9	110	Hotham	16.8	109	Monarch	16.8	115
11	7/6/00	Virgin	22.8	116	Monarch	21.4	113	Liberty	21.3	116
12	12/7/00	Galacia	37.4	110	Escale	37.2	110	Monarch	36.9	114
13	9/8/00	Virgin	33.2	93	Morpheus	32.4	96	SPS7458	31.3	85
14	6/9/00	Liberty	31.2	83	Discovery	28.6	84	Morpheus	28.5	82
15	11/10/00	Virgin	34.2	72	Monarch	33.7	90	Liberty	32.7	76
16	8/11/00	Discovery	33.1	76	Morpheus	29.9	72	Celsius	29.0	69
17	6/12/00	Monarch	32.7	69	Discovery	30.5	68	Summer Love	30.5	72
18	3/1/01	Monarch	38.2	82	Summer Love	36.8	73	Discovery	36.1	71
19	7/2/01	Summer Love	40.5	82	Monarch	37.1	84	Cauldron	37.0	72
20	7/3/01	Granite	33.1	120	Omeo	28.9	98	Liberty	27.6	84
21	4/4/01	Granite	27.2	98	Omeo	20.4	101	CLX3340	20.4	96
22	9/5/01	Omeo	24.7	120	Virgin	22.7	103	Monarch	20.6	119
23	6/6/01	Chaser	24.1	116	Bulla	22.8	113	Virgin	20.6	113
24	4/7/01	Virgin	30.1	117	Monarch	26.1	119	Bulla	25.1	119
25	8/8/01	Liberty	36.5	97	Donner	36.1	95	Monarch	33.7	99
26	8/9/01	Donner	29.3	88	Summer Love	28.1	87	Morpheus	23.3	83
27	3/10/01	Bulla	30.3	72	Aviron	30.0	75	Gibraltar	27.7	70
28	6/11/01	Monarch	34.7	78	G389	31.7	76	Summer Love	28.9	76
29	7/12/01	Summer Love	36.7	69	Monarch	34.5	77	Aviron	34.2	66
30	8/1/02	Summer Love	40.3	72	Monarch	40.2	83	Aviron	36.3	67
31	6/2/02	Liberty	34.6	64	Monarch	33.4	79	L3374	31.5	68
32	5/3/02	Granite	30.9	114	Summer Love	29.6	83	Monarch	27.5	91
33	2/4/02	CLF33902	29.5	99	Omeo	22.0	92	Monarch	22.0	101
34	7/5/02	CLF33902	25.8	107	Virgin	24.6	107	Chaser	23.1	113
35	6/6/02	CLF33902	29.5	110	Virgin	27.6	110	Gibraltar	26.0	106
36	3/7/02	Liberty	27.3	109	CF536	26.9	108	CF535	26.6	104
37	6/8/02	Liberty	37.6	96	G370	34.6	98	Donner	31.1	89

Table 10: Characteristics of the three highest commercial marketable yield broccoli varieties for each planting time.

		Best for planting			2nd best for planting			3rd best for planting		
Planting	Plant	Variety	Yield (t/ha)	Days to harvest	Variety	Yield (t/ha)	Days to harvest	Variety	Yield (t/ha)	Days to harvest
1	4/8/99	Marathon	10.7	86	BRC9812	9.9	85	Monaro	7.1	85
2	8/9/99	Marathon	8.3	74	BRC9812	5.3	74	BRC7833	0.5	57
3	5/10/99	BRC7833	10.6	59	Marathon	9.0	64	Green Prince	7.0	59
4	10/11/99	Green Belt	6.5	55	BRC7833	5.2	55	Green Prince	4.0	60
5	8/12/99	BRC7833	7.5	56	Green Prince	7.1	56	Green Belt	7.0	59
6	5/1/00	Green Prince	6.2	61	Cobra	6.1	59	BRC7833	6.1	55
7	8/2/00	BRC9812	9.6	74	Green Belt	7.5	74	BRC7833	5.9	74
8	8/3/00	BRC9812	8.2	76	Marathon	4.9	82	*	*	*
9	5/4/00	Endurance	9.1	90	Marathon	7.6	90	BRC9812	7.0	89
10	10/5/00	Marathon	7	93	Endurance	6.8	95	Monterey	0.6	99
11	7/6/00	Mamba	10.3	93	Monaro	7.6	93	Marathon	7.0	95
12	12/7/00	BRC9812	12.8	96	Marathon	10.6	96	Monaro	10.2	96
13	9/8/00	Monaro	11.1	82	Marathon	11.0	82	Bandit	10.9	82
14	6/9/00	Monaro	14.6	76	Marathon	12.2	76	BR400	10	76
15	11/10/00	Monaro	11.7	63	Green Belt	9.8	63	BR399	8.2	65
16	8/11/00	Viper	11.7	56	BR399	10.4	57	Green Belt	7.2	56
17	6/12/00	Viper	11.7	54	BR399	10.0	56	Green Belt	8.0	57
18	3/1/01	Viper	14.1	58	Green Belt	9.0	61	*	*	*
19	7/2/01	Green Belt	12.5	64	Viper	12.3	56	*	*	*
20	7/3/01	Ruben	9.2	75	Bandit	7.5	74	Monterey	7.2	75
21	4/4/01	Mamba	10.0	103	Ruben	6.9	99	Bandit	5.9	99
22	9/5/01	Marathon	7.8	96	Ruben	5.9	96	Bandit	4.9	96
23	6/6/01	Marathon	7.8	96	Ruben	7.0	96	Monaro	5.1	96
24	4/7/01	Marathon	7.5	101	Bandit	6.3	99	Ruben	6.2	99

*Only two broccoli varieties were examined in this month's planting

9.4 Discussion

The evaluation of varieties has allowed producers to select a high yielding variety of cauliflower and broccoli for a particular time of year. The intention of the variety evaluation was to determine those varieties that produced the highest yield for the longest period of the year. Growing many different varieties throughout the year can cause difficulties for both seedling nurseries and producers. Seedling nurseries have to keep seed stocks of many different varieties on hand, all of which may not be requested by producers to be sown. This adds to the operating costs for the nurseries as some seed may have to be discarded if not sown by a recommended date or the viability of the seed may be reduced if it has been in storage for some time. Cauliflower and broccoli producers may also have increased costs and inconvenience when planting many different varieties. This can be due to:

- varieties having different maturity times, which makes crop scheduling more difficult, particularly when successive crops of different varieties are to be grown
- management costs of keeping track of the appropriate planting time for different varieties
- preparation of land for different varieties
- increase in costs associated with irrigation, fertiliser and crop protection when dealing with many varieties

Producers have reported that by selecting the correct variety of cauliflower, yield per curd has increased by approximately 100 g, which is equivalent to an approximate increase in yield of 3.1 t/ha (based on an average plant spacing of 40 cm between plants and 80 cm between planting rows). An increase in yield per hectare is important to export cauliflower as well as broccoli producers in the lower south-west of Western Australia as they are paid for their product on a weight basis.

Field walks of the variety evaluation plantings were held regularly. This allowed producers to see the growth of the varieties in the field and to assess the quality of the curds and heads produced immediately prior to harvest. Each of the field walks was attended by up to 40 people. Since the completion of these variety evaluation studies, some of the better performing varieties that were identified are being grown commercially. The cauliflower varieties include Monarch, Summer Love, Discovery and Omeo while the broccoli varieties include Monaro and Ruben. Producers have reported the variety evaluations have been helpful to their business as they could ‘fine tune’ when the best planting time for certain varieties using independent information that has not been supplied by seed companies. Some varieties of cauliflower such as Granite, although only being suitable for production for a limited period of the year, are still favoured by producers as the curds are very heavy. It is likely that in the future, producers will continue to grow some varieties that have desirable characteristics as these characteristics outweigh the costs incurred when growing a single variety for a limited period.

9.5 References

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10.0 Technology transfer activities

10.1 Neighbouring on-farm groups

The export cauliflower industry plan outlined the need to reorganise the Warren Cauliflower Planning Group, which represents approximately 70% of export cauliflower growers. The Warren Cauliflower Planing Group was formed in 1988. The major function of the Group was to collect industry statistics and develop planting programs in consultation with exporters, with the aim of preventing over or under supply of cauliflower. Since the early 1990s, the Group has collaborated with Horticulture Australia and the Department of Agriculture Western Australia, to ensure that research and development within the export cauliflower industry is relevant and targeted at existing problems.

In recent years, the Group has felt that a new focus was required. Part of the new focus included the reorganisation of the committee structure for the Group and the appointment of an Executive Officer to handle the Group's affairs. During 2001, the Group was renamed as the Warren Cauliflower Group (Inc.).

A key component of the new Group is the formation of small on-farm groups that meet regularly to discuss cauliflower production issues. Issues raised at these individual groups that have relevance to others in the export cauliflower industry are tabled at the main committee meeting of the Warren Cauliflower Group (Inc.).

The on-farm groups consist of neighbouring cauliflower producers of approximately ten people. These groups meet about every two months, with each meeting being held on a different property belonging to one of the members of each on-farm group. The groups provide a relaxed atmosphere where producers can look at other producers cauliflower crops, ask questions and discuss the merits of the production system. After examination of the crops, the group continues to discuss production issues in detail, such as the benefit of a particular fertiliser or chemical application program. These discussions are conducted over refreshments to ensure the atmosphere of the meeting remains low key and non-intimidating, as the producers are more likely to openly discuss their growing programs in this situation. A key understanding of the on-farm groups is that members can speak openly and ask questions. This often does not occur at large group meetings attended by many producers as some producers have a fear of voicing their opinions and asking questions in the company of a large number of their peers.

Some of the on-farm groups have begun a bench marking program among the members. The details of the bench marking program is kept confidential within the members of the group but is used by all members to highlight areas were their own production systems can be improved. This is particularly the case when costing fertiliser, chemical use and application methods. As more on-farm groups move towards bench marking, the collective, anonymous results from each on-farm group will be shared among the other groups.

10.2 Other Technology Transfer Activities

Technology transfer activities were an integral component of this project. Publications were sent to approximately 200 people who are associated with the cauliflower industry, including producers, agricultural suppliers, packing sheds, exporters, seed companies, seedling nurseries and consultants.

10.2.1 Publications

Evaluation of cauliflower and broccoli varieties. Report number 1 (August 1999 to November 1999)
Evaluation of cauliflower and broccoli varieties. Report number 2 (September 1999 to December 1999)
Evaluation of cauliflower and broccoli varieties. Report number 3 (October 1999 to January 2000)
Evaluation of cauliflower and broccoli varieties. Report number 4 (November 1999 to February 2000)
Evaluation of cauliflower and broccoli varieties. Report number 5 (December 1999 to March 2000)
Evaluation of cauliflower and broccoli varieties. Report number 6 (January 2000 to April 2000)
Evaluation of cauliflower and broccoli varieties. Report number 7 (February 2000 to May 2000)
Evaluation of cauliflower and broccoli varieties. Report number 8 (March 2000 to July 2000)
Evaluation of cauliflower and broccoli varieties. Report number 9 (April 2000 to August 2000)
Evaluation of cauliflower and broccoli varieties. Report number 10 (May 2000 to September 2000)
Evaluation of cauliflower and broccoli varieties. Report number 11 (June 2000 to October 2000)
Evaluation of cauliflower and broccoli varieties. Report number 12 (July 2000 to November 2000)
Evaluation of cauliflower and broccoli varieties. Report number 13 (August 2000 to November 2000)
Evaluation of cauliflower and broccoli varieties. Report number 14 (September 2000 to December 2000)
Evaluation of cauliflower and broccoli varieties. Report number 15 (October 2000 to January 2001)
Evaluation of cauliflower and broccoli varieties. Report number 16 (November 2000 to February 2001)
Evaluation of cauliflower and broccoli varieties. Report number 17 (December 2000 to March 2001)
Evaluation of cauliflower and broccoli varieties. Report number 18 (January 2001 to April 2001)
Evaluation of cauliflower and broccoli varieties. Report number 19 (February 2001 to May 2001)
Evaluation of cauliflower and broccoli varieties. Report number 20 (March 2001 to July 2001)
Evaluation of cauliflower and broccoli varieties. Report number 21 (April 2001 to August 2001)
Evaluation of cauliflower and broccoli varieties. Report number 22 (May 2001 to September 2001)
Evaluation of cauliflower and broccoli varieties. Report number 23 (June 2001 to October 2001)
Evaluation of cauliflower and broccoli varieties. Report number 24 (July 2001 to November 2001)

Evaluation of cauliflower varieties. Report number 25 (August 2001 to November 2001)
Evaluation of cauliflower varieties. Report number 26 (September 2001 to December 2001)
Evaluation of cauliflower varieties. Report number 27 (October 2001 to December 2001)
Evaluation of cauliflower varieties. Report number 28 (November 2001 to January 2002)
Evaluation of cauliflower varieties. Report number 29 (December 2001 to March 2002)
Evaluation of cauliflower varieties. Report number 30 (January 2002 to April 2002)
Evaluation of cauliflower varieties. Report number 31 (February 2002 to May 2002)
Evaluation of cauliflower varieties. Report number 32 (March 2002 to July 2002)
Evaluation of cauliflower varieties. Report number 33 (April 2002 to July 2002)
Evaluation of cauliflower varieties. Report number 34 (May 2002 to September 2002)
Evaluation of cauliflower varieties. Report number 35 (June 2002 to October 2002)
Evaluation of cauliflower varieties. Report number 36 (July 2002 to November 2002)
Evaluation of cauliflower varieties. Report number 37 (August 2002 to December 2002)

10.2.2 Newsletters and Articles

'New cauliflower varieties generate interest'. Good Fruit and Vegetables (2001) **12** (6) pp 5
Ross, P (editor) (2002) Better Brassica - edition 1 (August 2002)
Lancaster, R (editor) (2003) Better Brassica – edition 2 (March 2003)
Lancaster, R and Ross, P. (2002) Incorporation of fertiliser for cauliflower and broccoli crops. Farmnote 31/2002

10.2.3 Field walks

Field walk for cauliflower and broccoli variety evaluation (21 September 1999)
Field walk for cauliflower and broccoli variety evaluation (16 November 1999)
Field walk for cauliflower and broccoli variety evaluation (15 March 2000)
Field walk for cauliflower and broccoli variety evaluation (19 July 2000)
Field walk for cauliflower and broccoli variety evaluation (3 October 2000)
Field walk for cauliflower variety evaluation (22 August 2001)
Field walk for cauliflower variety evaluation (23 April 2002)
Field walk for cauliflower variety evaluation (10 July 2002)
Field walk for cauliflower variety evaluation (2 October 2002)
Field walk for cauliflower variety evaluation (12 November 2002)

10.2.4 Meetings / seminars / workshops

Farm group meeting (Albany), May 2002
Farm group meetings (Manjimup), held every 2 months from 2001
Initial workshop with all industry representatives to determine support for industry plan (26 May 1999 and 31 May 1999)
Industry plan development - workshop 1 (focus group) – 10 November 1999
Industry plan development - workshop 2 – 8 December 1999
Industry plan development - workshop 3 – 3 May 2000
Industry plan update meeting – 31 July 2002

11.0 Recommendations

1 - The export cauliflower industry plan be updated regularly, possibly at five year intervals. It is important the plan is kept up-to-date, to allow response to changing internal and external pressures on the industry, which may mean new actions need to be included in the plan whilst those that are no longer relevant can be removed.

2 - The small neighbouring on-farm groups should continue and where possible, expand to other areas. These groups are a useful mechanism for the transfer of in-depth technology and information which will help to improve the overall profitability of the industry. The focus on the small on-farm groups must remain on production issues which will improve farm profitability, rather than being involved in industry politics.

3 – Support for the on-farm groups is required. The source of the support may be from either private consultants, grower group appointed representatives (e.g. executive officer) or government officers. The support is required to ensure that meetings are held regularly and although brassica technical knowledge by the organiser would be desirable, this is not critical to the functioning of the on-farm groups.

4 - Future research direction should aim to address the objectives in the export cauliflower industry plan, as this would provide a focus for research on current and emerging industry issues.

5 – Variety evaluation is a component of industry competitiveness as the production of varieties desired by the market is necessary. Variety evaluation should be supported in the future, however, strong collaboration between all sectors (seed companies, nurseries, producers, packers and exporters) is required.

6 – Further investigation into reducing the spread of harvest for cauliflower is required to allow the development of mechanical harvesting for export crops. This is essential for Australian export cauliflower producers to remain competitive.