Mechanical Harvesting of Selected Vegetables - Feasibility Study

Alan Twomey
Excel Consulting Group

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Horticultural Australia Ltd
Level 1
50 Carrington Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399
E-Mail: horticulture@horticulture.com.au

Project VG05073

Mechanical Harvesting of Selected Vegetables

Industry Scoping Study

Final Report

Author: Alan Twomey
Excel Consulting Group (Qld) Pty Ltd
Ph: (07) 3297 6262 Fax: (07) 3297 6330
e-mail: exclbris@powerup.com.au

Project: VG05073

Project Leader: Alan Twomey

Purpose of Report:

The project was designed to conduct a scoping study that will define the existing mechanical harvesting techniques and practices, adoption of mechanical harvesting in the Australian vegetable supply chain, issues of technology impact on supply chains and barriers to adoption of technology including capital costs and needs for change.

Date: **May 2006**

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Media Summary

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The pressure from the major retailers to have consistent year round supply lines is forcing the creation of super farms and marketing conglomerates capable of dealing in volume quantities.

There are moves by large processors, large food service sectors and some retailers to take their supply away from the domestic market suppliers to offshore supply, taking advantage of either better pricing or more consistent quality.

In order to compete with these directional changes, Growers will need to vastly improve their handling techniques, internal cost structures and negotiating skills. This includes the obvious move to greater mechanization using machinery, robotics, more sophisticated grading and packing equipment, HACCP elements, a reduction in handling and greater on farm processing in order to bring better farm gate returns.

Currently there are two development platforms for mechanical harvesters:

The first and most common is a system that harvests all of the biomass and allows the grading and further processing to be made off-field. Examples of this platform are those being used for broccoli, leeks, onions, lettuce, carrots and potatoes.

The second platform is not widespread but is under serious development. It uses sensing devices to determine fitness for purpose of plants for harvest, sophisticated cutting and in field processing. Examples of this selective harvesting platform are being developed for lettuce and cauliflower.

Crops considered for investment in mechanical harvesting included Asian Vegetables, Celery, Cauliflower, leafy salad, Tomato, Wongbok and Zucchini.

National gains achieved from these crops resulting from recovery of lost export markets and reduced on farm costs were estimated at $60 to 100 million per year.

Costs of establishing agronomic systems, harvester development, materials handling and further mechanization/automation were estimated at $10.5 to 15 million over three to five years for a concerted R&D program. Further assistance may need to be provided for other vegetables that are expanding through minimal processing activities to meet consumer needs.

There is a defined need to extend marketing support for Growers into export markets against international benchmarks for all components of the production, processing and marketing system.

Barriers to adoption of new technologies were considered to be lack of understanding of the need to be internationally competitive, removal of extension support by governments, lack of co-ordination of R&D activities with extension and diffusion forces across the industry sector and the high risk associated with development at a farm level.

Executive Summary

The project was designed to conduct a scoping study that will define the existing mechanical harvesting techniques and practices, adoption of mechanical harvesting in the Australian vegetable supply chain, issues of technology impact on supply chains and barriers to adoption of technology including capital costs and needs for change.

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There are moves by large processors, large food service sectors and some retailers to take their supply away from the domestic market suppliers to offshore supply, taking advantage of either better pricing or more consistent quality.

Consumers are increasingly looking for convenience and time saving products and have adapted shopping habits toward smaller units purchased more frequently.

The most significant consumer needs for fresh vegetables were identified as:

- Consistency in quality.
- Flavour profiling to ensure the product has taste to suit.
- Freshness that can be seen pre and post purchase.
- Shopping stability so that the consumer can expect the same product each time they purchase near the same price break.
- Convenience of product format and size to meet meal needs.

Growth and margin in traditional processed vegetables is low, 2-3% value and 1% in volume and is not seen as an area where consumer demand can be stimulated.

Processors of frozen products have moved toward markets for frozen dinners containing vegetables where growth is significant in both value (30%/year) and volume (25%/year).

Growers, in order to compete with this directional change, will need to vastly improve their handling techniques, internal cost structures and negotiating skills. This includes the obvious move to greater mechanization using machinery, robotics, more sophisticated grading and packing equipment, HACCP elements, a reduction in handling and greater on farm processing in order to bring better farm gate returns.

Adoption of mechanical harvesting has primarily been for mature crops such as peas, beans, potatoes, onions and carrots. Entrepreneurial Growers have invented mechanical harvesters for broccoli, leeks and lettuce while others are currently engaged in development of harvesters for leafy vegetables, celery and cauliflower.

Currently there are two development platforms for mechanical harvesters:

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Recommendations for Future Developments Include:

- Establishment of the total system needs for a given crop and directing funds for R&D and Extension to all components of the system including marketing.

- Conducting R&D for a total system using a model that includes a range of expertise in agronomics, harvester development, materials handling and minimal processing and marketing for each project. It is important for technology adoption that a machinery manufacture and distribution capability is built into each project.

- Increased application of higher technologies in total systems including robotics, ultrasonics, nanotechnology and bionanotechnology to ensure the Industry is at the leading edge of R&D in all system components.

- Increase in extension activities to assist in accelerated industry uptake of system developments based on selected “Champion Growers” in each State who will provide the R&D base for particular crops and leadership in industry development.

- Industry wide development of internationally competitive benchmarks gained from R&D and International Industry Study Tours that include a mix of Growers Machinery Manufacturers/Distributors, Extension and Marketing personnel.

- Changes to the funding processes that allow a wider body of non Grower and Grower opinion and debate in the decision making and allocation of funds.

- Increased support in finance and skill development for Growers and Grower/Processors negotiating with retail and export market decision makers.

- Diversification into new markets where vegetable products and extracts may be used for cosmetics. Nutraceuticals, Cosmeceutical, Pharmaceuticals Functional Food Ingredients and Flavour Enhancers.

Introduction

The project was designed to conduct a scoping study that will define the existing mechanical harvesting techniques and practices, adoption of mechanical harvesting in the Australian vegetable supply chain, issues of technology impact on supply chains and barriers to adoption of technology including capital costs and needs for change.

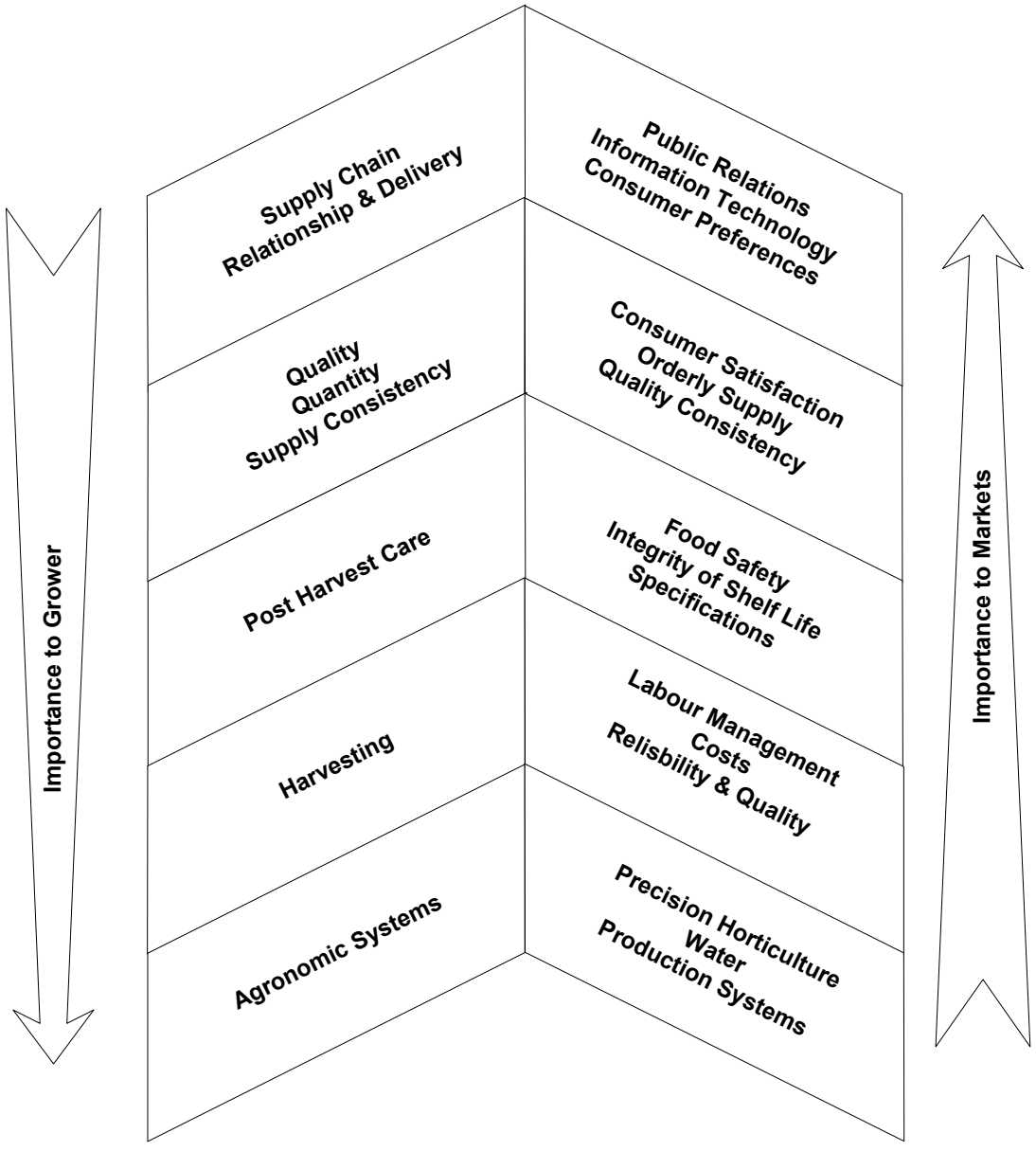
Included in the study are:

- Existing national technologies and adoption/rejection
- International technology developments and adoption/rejection
- Other industry sector technologies that may be adopted
- Barriers to adoption
- “Best bet” crops for adoption of mechanical harvesting
- Impact on total production chain and need to adopt chain process changes
- Direction of research funds to defined opportunities

The output is a review of the current status of mechanical harvesting and definition of the crops that would benefit the greatest from the introduction of mechanical harvesting. In addition it includes a systems analysis for selected crops that would incorporate the impact of mechanical harvesting on agronomic practices, biomass handling, post harvest care, packaging, processing and the use of intelligent films for packaging. This includes capital expenditure and impacts that will require production system changes or adjustments. A number of Industry Issues common to the regions are reported for the purposes of removing barriers to industry technology adoption and strategy formulation for future R&D planning.

Model for Industry Development

The study approach was aimed at ensuring market direction was as important as that of matters that are important to growers. Hence considerable effort was made to contact major retailers, food service entities, processors and vegetable importers. In this part of the study growers were interviewed as individuals and as focus groups to determine the factors pf importance to growers. The major factors for each of the system connecting growers to each market have been summarized in the model diagram below.



The Market Place

Market Trends

There is substantial evidence in industry reports and by anecdotal articles to indicate that the number of growers in the produce markets is declining. Add to this the rationalization of traders in the major fresh markets and the creeping dominance by the major retailers and there is an evident trend to bigger producers, regionally aggregated product and volume handling systems.

The pressure from the major retailers to have consistent year round supply lines is forcing the creation of super farms and marketing conglomerates capable of dealing in volume quantities. This is evident in the establishment of broad-acre farms in South Australia, for the potato market, that are capable of supplying large percentages of the total market requirement. These farms are also heading towards year round supply using a mix of potato varieties and the latest technology in growing. Similarly large leafy salad vegetable growers in Victoria and Queensland are dominating market presence in a growth market. These trends are reshaping the structure of the industry with middle growers being squeezed while larger growers and small Growers producing niche product of high value are expanding.

Further to this are the moves by large processors, large food service sectors and some retailers to take their supply away from the domestic market suppliers to offshore supply, taking advantage of either better pricing or more consistent quality. Recent markets to feel this pressure are the potato growers supplying McDonalds and the broccoli growers in Tasmania. This is less invasive with fresh produce but it is strongly affecting the frozen foods markets.

The key product users outside the retailers are the manufacturing companies such as snack foods, frozen meals and salads. To a greater extent they are now relying on a smaller number of growers or wholesale suppliers on a fixed margin who, under contract, can produce the total requirement for these large volume users. This situation leaves the smaller farmer to contemplate the vagaries of the open markets, the value of organic production or moving to an alternative business. None of these are seen as quality alternatives.

In the processing sector the larger companies are looking to a wider market for supply. Most are offshoots of multinational companies who are now burdened with the global decisions of their parent companies and unable to sponsor the local market. These processors, acting mainly in the frozen foods market category, will bring supplies from virtually anywhere around the world if the price and quality meet standards.

Australia is expected to follow the trends being seen in the US and European markets where fresh fruit & vegetables sales are increasing at quite rapid rates. The following article indicates the trends:

> *As expected, produce imports are highly dependent on U.S. production and seasonal fluctuations. For example, bananas account for more than 22 percent of total fresh fruit consumption and for 60 percent of total fresh fruit imports. Because banana production*

is virtually nonexistent in the United States, imports are not strongly affected by seasonal changes. This contrasts with melon imports, which are the second largest fresh fruit import by volume but highly seasonal. Imports are large in March and April and negligible for July through September. The USDA forecasts that the trend toward increased consumption of fresh fruits and vegetables will continue. Per capita expenditures on fruits and vegetables are expected to have the highest increases among all types of foods through 2020. These increases will be driven by higher incomes, the large number of aging baby boomers, a gradually increasing population, increasing consumption of ethnic foods, and higher levels of education among consumers. Of these factors, higher real income is the most important because consumers can purchase more expensive food products and can pay premiums for desired attributes. (Center for Agricultural and Rural Development (CARD) February 2004)

This situation occurs in many parts of the world and now includes Australia. The key element is usually the cost of labour as the farming methodology and technology application is generally stronger where labour is more expensive. To counter this the moves to reduce the labour cost are creating some innovative growing and harvesting methods, as seen over recent years with grading and part packing on the harvester. Inevitably this makes its way into the marketing mix as the increase in quality from harvesting methods becomes the selling proposition and the rationale for higher prices.

Retailers support the investment as they perceive all of the kudos going to them as the final part of the supply chain and they can leverage margins in the process. This is a major industry problem with respect to mechanization as the retailer perception is that reduced farm costs in fact allows the flow on to reduced wholesale prices to theoretically benefit consumers and drive demand. Somehow the industry will need to negotiate margins akin to those achieved by manufacturers and this will require a huge shift in attitude toward price cutting, supply chain management and negotiating skills.

Manufacturers are at this time following the market trends rather than creating them. The generations behind the ‘baby boomer’ have adopted a different approach to vegetable consumption as the availability in the market escalates. Align this with significant exposure to healthy eating advertising and promotion and the markets change regularly and rapidly. The development of the café society has encouraged growth in the level of eating away from the home. This intrinsically alters the shopping habits of the consumer and in turn alters the buying patterns for the retailers.

Vegetables that were once a staple purchase for the household are now increasingly seen in volume in the prepared food sections of the supermarket. Manufacturers have seized upon the movements in consumption to make various vegetables lower in market value and therefore cheaper as an ingredient in their prepared product ranges. A notable example is cauliflower which has diminished as a volume item in the produce sections of the supermarket. While readily available, the volumes have dropped to below half of the volumes of 1995. Cauliflower is still a major component of the frozen mixed vegetable packs and prepared meals ingredients. These trends are reinforced by the dominance of two major players in the frozen vegetable and pre-prepared meals sector. This is illustrated in the Table below:

Frozen Vegetable Market Characteristics:

The Australian Market is dominated by two major suppliers Simplot and McCains who collectively represent 64% market share. In addition to Australian supply these companies import product from New Zealand, Sth East Asia and China. Logan Farm import products from Mexico.

Supermarkets represent 80% of the sales value and volume.

Market value is estimated at $279 million increasing in value by 2.9%/year and volume by 1% per year.

Growth has mainly been in the value added products of stir fried combos but this is now levelling.

Frozen dinners are reducing the market growth rate of frozen vegetables. Frozen dinners that may also incorporate vegetables are the fastest growing category at 51,200,000 units in 2003 having a value of $223,000,000. The annual growth rate has been about 30% in value and 25% in volume.

The market volume is about 85,600 tonnes of frozen product.

Product Segment Share

The products that make up the market value and volume are shown below:

Product	Value %	Volume ,%
Value added	30.2	21.3
Peas	25.4	33.1
Carrot	14.7	15.2
Beans	10.4	11.9
Mixed	6.7	10.3
Others	12.6	8.2
Total	$279,300,000	85,600 tonnes

Corporate Market Share

The major players in the market are:

Player	Value %	Volume %
Simplot	33.7	28.3
McCain	30.3	26.4
Watties	8.8	8.5
Logan Farm	7.2	5.7
House brands/generic	18.6	30.1
Total	$279,300,000	85,600 tonnes

Food Service Frozen Vegetable Market Characteristics

This market is similar in terms of domination to the retail sector. The distribution chain is more complex in that a few major distributors occupy the main parts of food service while a relatively large number of small distributors service regional cities and resort areas.

Simplot and McCain appear to have about equal market share but exact proportions vary with the source.

Products are more varied than for retail. Growth has been relatively flat for the past year. The main stream products are holding market position against the various mixes. This is in contrast to the retail sector. Packaging is much the same as for retail packs and by food service standards are relatively small. It appears that the majors treat the section as a retail extension having a wider product range.

Product, Pricing and Market Share

The major products, pack sizes, packaging, carton size, price and unit price in food service are similar to those used for retail markets. More complex mixes were higher priced than were conventional staple products. For example Edgell's Vegetable Chinoise mix and Vegetable buffet mix wholesaled at $6.36/kg and $3.80/kg respectively while processed carrots, beans and peas tended to be in the range of $1.90 to $2.50/kg.

The market analyses indicated market share for major players was; Simplot at 45%, McCains at 45% and others at 10%. This indicates some difficulty for new players to enter the market. One of the major players indicated that margins were very tight to deliver shareholder expectations and to continue investment in the frozen sector.

International Trends

In the UK there is similar dominance of the retail sector and very few processors. The downward pressure on the farm gate price by retailers is equally pronounced although EU subsidies tend to ameliorate these effects. In Ireland the changes in production of vegetables are following similar lines. This article from the IAFDA indicates where the changes are occurring.

> *During the last five years the vegetable sector has undergone major changes. Growers have become highly specialised in one or two crops and unit area of production has increased. The scarcity of labour has forced many to invest heavily in mechanization with virtually all growers now having a full range of seeders, harvesters, washing and grading machinery. Cold stores are now standard on all vegetable farms. Crops are harvested and pre-cooled prior to entering the marketing chain. The five main vegetables produced, accounting for over 74% of production and 63% of value are carrots, cabbage, cauliflower, broccoli and swedes. Irish production accounts for approximately 70% of the total vegetable market. The balance is imported from countries with a more favourable climate and lower costs of production. The industry is primarily orientated towards the supply of fresh produce through central distribution for the major multiple stores. Production is centred on the main demand areas. Ireland does not export any significant volumes of fresh vegetables due to their bulky nature, perishability and relatively low value. The main production areas are Dublin, Meath, Wexford and Cork.*

New government dietary guidelines recommend that people have at least five servings of fruits and vegetables a day. To assist consumers to meet daily dietary requirements food manufacturers have come out with new products that make eating produce easier than ever. The Good Housekeeping Institute reviewed the following new items recently (Oct.2005)

- *Now you can get microwaved vegetables that don't taste soggy. Birds Eye Steam and Serve veggies (US$2.99) are packaged in a tray with a valve that lets the steam escape like a pressure cooker. It takes about five minutes to cook and the flavour and texture remain intact.*
- *Melissa's Peeled Baby Red Beets ($2.97) are all natural and they're a quick alternative to preparing fresh beets. They have great nutritional value and come ready to eat right out of the vacuum-sealed package.*
- *If you want to boost your broccoli servings, try Fresh Express Broccoli Salad ($3.49 to $3.99). Just pour the pre-washed broccoli into a bowl, then add the bacon, raisins, sunflower seeds and dressing included in the package.*
- *Love pears but hate when they become bruised or squished? Try the Pear Packer ($1). It's a reusable container that protects the fruit from becoming bruised in your bag.*

This article is a good measure of the step change required to create a critical path for success in these markets. While the products mentioned here are from large corporations, in Australia it is possible for the smaller innovative producer to create successful product variations. In essence the grower moves to a new level of vertical integration by growing, harvesting and packing and marketing the product to retailers without any middlemen. To achieve this they must follow the parameters of freshness using quick harvesting methods, quick chilling technology and various forms of packaging to ensure relatively long life for

the product. In the long term vegetables of all types will appear in formats similar to those that are currently used for leafy salad vegetables. In real terms this reduces the volatility normally experienced with fresh vegetable as unit price is determined in much the same way as for shelf stable manufactured products. This provides a level of certainty that assists the decision making processes and consumer value propositions along the entire value chain.

Consumer Trends – Retailers

There are a number of issues in consumer trends that are not always related to price. Some produce shows growth despite the seasonal changes in the value proposition but are severely affected by available volume. Products in the key green vegetables such as zucchini and broccoli will rise heavily in price while the volume and quality suffer. The question here is consistency in supply that has acceptable levels of quality included. If the market conditions were even then most of the primary vegetables would react to a better shelf price. The levels of change would vary from product to product.

In some way all vegetables would respond to consistency, particularly those in the top 20 (commodity) lines. Some products such as iceberg lettuce and broccoli are more reactive. Retailers are currently working price points to maximise sales and are to some extent relinquishing margin to keep sales flowing. This is particularly so with Iceberg lettuce that has dropped from about 40% market share to 27% of leafy salad vegetables.

There are predictable consumer reactions to quality and price from mature vegetables including salads and prepared meals but mainly those that are, to the consumer, time efficient. In all cases some form of consumer related promotion is required to develop the response to farm gate price movements and value propositions. Otherwise consumers will simply see an adjustment based on seasonal value changes. This is supported by a previous HAL study conducted by David McKinna in 2004. In this report McKinna states:

> *"A strong point to emerge from the consumer research pertains to the need for convenience and products which appeal to the time conscious homemaker. Industry marketing on the nutrient value of processed vegetables and engaging the consumer would assist in realising the excellent potential to increase per capita consumption in Australia".*

Growth in specific fresh vegetable sales was found to be related to taste and consistency. There are measurable changes in the market with the cooperative invention of new styles of produce such as baby corn, vine ripened tomatoes, controlled sizes in mushrooms and non-bitter Cos lettuce. There are others but these are the standout products. There is some flexibility in quality as consumers are readers of the seasonality of produce.

Other issues such as branding and range changes alters the growth of the market but the effect on other products in the range has not yet been measured. Effectively the ability to make the produce seem fresh and the creation of impulse by lighting and presentation are seen as the main drivers. Demonstration and sampling have been effective for some products. Interestingly in this area, while the respondents did not include harvesting improvements the produce selected was in most cases subject to such improvements.

The consumer demand on the quality of product is less easy to define. In the supermarkets they are becoming more conscious of quality and are selecting pieces rather than simple purchasing weight. There are clear signs that the purchaser is now looking for meal size purchases and that the home refrigerator crisper is less a pantry and more of a

short-term holding device. This supports the research that shows that shoppers are buying less, more often and that the days and hours of trade have shifted significantly. This appears to be the case more for vegetables than fruit where the purchase weight has remained firm.

There is a fine line between too much and not enough shelf life. Consumers will try pre-packed produce that is 10-12 days life but will steer away from products with 21 days life. “It can’t be fresh if its 21 days old”.

Retailers are taking greater care with the in-store pre-packing of produce. Cabbage, cauliflower, pumpkin, sweet potato etc are increasingly cut to weights that reflect the consumer’s preference for meal size purchases, or within the week usage. There are reduced sales of ‘whole’ pieces. Food safety is also becoming an issue with more consumers concerned about the fact that others have been handling the fresh produce before selecting for purchase. Retailers are aware that this occurs in certain areas more than others and there are consistencies with socio-economic regions. These are significant changes for key products that are to be mechanically harvested as they allow further processing that in turn increases the harvestable marketable biomass with a value adding proposition.

Manufacturers are at this time following the market trends rather than creating them. The generations behind the ‘baby boomer’ have adopted a different approach to vegetable consumption as the availability in the market escalates. Align this with significant exposure to healthy eating advertising and promotion and the markets change regularly and rapidly. The development of the café society has encouraged growth in the level of eating away from the home. This intrinsically alters the shopping habits of the consumer and in turn alters the buying patterns for the Retailer. Some manufacturers such as One Harvest are riding this boom and have dominated market share of the leafy salad sector. Other manufacturers of conventional products have moved to the food service market as the most noticeable growth is in this area, in line with the eating-out trend.

The most significant consumer needs were identified as:

- Consistency in quality.
- Flavour profiling to ensure the product has taste to suit.
- Freshness that can be seen pre and post purchase.
- Shopping stability so that the consumer can expect the same product each time they purchase near the same price break.
- Convenience of product format and size to meet meal needs.

Over riding the development push by the energetic Growers and the trading partnerships that have emerged is the profit push by the major Retailers. In past years, while Retailers have promoted their following of trends in the produce markets, they have been dictating the trends in many ways. Two years ago the idea of pre-pack vegetables was a secondary consideration after the basics of potatoes, onions and carrots in bags. Retail Buyers were hesitant to consider pre-packs as they were not seen as volume alternatives. More recent views have indicated that like pre-pack meats, they are a profit boon for the supermarkets and are to be pushed to the limit, at least for the mainstream items. Today we see carrots, potato, onion, corn, zucchini, mushroom, soup mix, lettuce varieties, parsnip, snow-peas and other produce items in pre-pack trays. The net effect is a growth in per kilogram value with the resulting profit lift for the retailer. (E.g. zucchini is $4.56 per kg loose and $11.20 per kg pre-packed, Nov 2005). This will be the way forward.

Retailers are within their rights to make these margin decisions but in doing so they will begin to dictate the produce lines that are to continue as the preferred next wave items. For the grower this does not mean additional turnover or profit. The volume increases will come from engaging more growers but the margins at farm gate will not be greatly enhanced, unless the Grower is the part of the pre-pack mechanism. This includes the branding options as the Growers' own brand will give greater farm gate margins but the Retailers will push for their own brands, negotiating the price down as far as possible.

The Growers, to compete with this directional change, will need to vastly improve their handling techniques, internal cost structures and negotiating skills. This includes the obvious move to greater mechanization using machinery, robotics, more sophisticated grading and packing equipment, HACCP elements, a reduction in handling and greater on farm processing in order to bring better farm gate returns. The mechanization process if properly applied and accepted by the Retailers will bring a new level of sustainability for the grower as the Retailer will not invest in this type of infrastructure. The balance however is that it is costly and time consuming in its introduction. A particular area singled out for technology change or improvement by Retailers was that of hydrovac and hydro-cooling applications as a universal requirement across the industry. Retailer buying decisions are influenced by these technology usages and they are pushing for introduction to improve consumer acceptance and shelf life.

Influences on Consumers

Consumers are also influenced positively by the high volume of cooking shows on free-to-air and cable TV services. Consumers are learning to use all sorts of vegetables and they are no longer afraid of handling and cooking these produce items. This ease of use education has influenced the retailers who now bombard the consumer with recipe options, promotions and cooking magazines. Once again, the trends are being driven by issues outside the farm but, the farm can ride the back of these trends by introducing technology that ensures consistency.

International issues such as BSE, SARS and Bird Flu are also playing a role in the trends for vegetables. Consumers are less interested in imported produce preferring to trust home grown products. Retailers are reacting to this influence and have adopted a high preference for Australian products. These influences also raised the issue of pursuing different and obviously growing markets such as the food service industry. The source of the produce is not so obvious or easy to identify. If the innovations of mechanical harvesting can be focused on this market there are large and profitable turnovers to be gained.

Retailers are taking greater care with the in-store pre-packing of produce. Cabbage, cauliflower, pumpkin, sweet potato etc are all now cut to weights that reflect the consumer's preference for meal size purchases, or within the week usage. There are virtually no 'whole' pieces sales of these products. Food safety is also becoming an issue with more consumers concerned about the fact that others have been handling the fresh produce before selecting for purchase. Retailers are aware that this occurs in certain areas more than others and there are consistencies with socio-economic regions.

Retailers are changing to crate systems to cut out Styrofoam packaging and to minimise the handling before the produce reaches the shelf. This will drive some costs out of the supply chain or at least push them back down the chain to the Growers. There have been some dramatic changes in produce handling seen mostly with fruit such as apples and cherries these are steadily infiltrating vegetables. Recently the move to flow wrap bags reflects this trend for improved food safety and product care in the chain. Much of this influence is the Retailer's ability to display the produce in a good light. Research by the major retailers has identified differing light displays that will enhance the sales of differing styles of produce. Lighting that sells green vegetables may not be the right light for fresh herbs or yellow fruits.

An important consideration is the freshness and health risk. Food Retailers are under greater pressure as the various governments apply greater emphasis on risk free delivery of foods. Eliminating cross contamination by pre-packing produce alleviates the potential for litigation against the Retailer. They will therefore remodel their product offer to ensure that the risk is at its lowest. The fact that this is also a margin growth proposition is seen as a side benefit however generally the cost is borne by the Grower. The major Retailers self insure so the risk is entirely internal.

Consumers are savvy about international competitive forces and are wary of imported products from some countries. Retailers have differing approaches. Some have taken an Australian first approach and will seek out local supply before issuing overseas contracts. In some areas if the local supply is not up to the volumes then supply will be initially from New Zealand and after this the rest of the world is sought. Others have a basic global approach and if the Australian supply is not quality or price efficient they will search overseas for regular supplies. There is some support for import replacement schemes and the retailers will cooperate with Growers/Grower groups that have developed growing and harvesting methods that will create wider supply times and greater consistency in quality. However they want to be involved throughout the development process to ensure the final product is consumer ready and compatible with their systems. This is particularly so with new varieties that are unfamiliar to consumers. It is now reasonably difficult for even a large Grower to penetrate the supply chain of a major Retailer unless they have a unique selling proposition.

Processors

A very good report was prepared for the processing sector by McKinna *et al* (2004) as a HAL initiative. Hence this project has looked more at the emerging forces on processing rather than the historic position of the processing sector. The McKinna report could be considered as the message for a thorough shake up of the processing sector of horticulture as it demonstrated the lack of international competitiveness of the major supply source in Tasmania. In particular the report demonstrated the nearness and competitive advantage of NZ Growers and the developing changes in the international arena. Many aspects of the report have now been demonstrated to be harsh reality. There has been a considerable impact on the Tasmanian sector for products such as broccoli and more recently a wider industry effect as potatoes are imported. While the Australian government has made some effort to reduce the impacts the reality is that international market forces are impacting on the vegetable growers involved with processing and will not go away. Even carrots are poised for importation.

The major Processors have a more international view of raw material supply than does the

Retail sector due to the nature of the products produced. They are generally driven by ingredient cost although some quality issues are involved. Hence in recent times cheap Chinese broccoli has impacted on Tasmanian Growers and will most probably continue to do so. During this study it was disclosed that broccoli and cauliflower florets from China were also entering the frozen chain to food service.

A new breed of processor is emerging in response to market changes particularly those in retail. These have been led by One Harvest who pioneered the production of processed salad vegetables creating, with considerable effort, new segments and products within segments over the past decade. In line with the market trends illustrated above small processors of fresh chilled, dried and frozen products are emerging across the country. The capacity and number of these entities have not yet been identified. They have a capacity to be more flexible and responsive to market trends and are not locked into technologies such as freezing and canning. They appear to be adopting technology at a faster rate than major Processors in order to produce at internationally competitive prices. Many of these products are house branded for major retailers and there is yet to arise a full branding strategy. They save considerable direct marketing costs through the house brand strategy but suffer indirect costs. They may benefit from the premium house brand being developed by a major Retailer.

Marketing Relationships

The relationship between the Grower and the market is not improving despite press to the contrary. The Retailers have shut down access to trading accounts in an effort to force Growers into larger scale individual growing or cooperative groupings dealing with a major wholesaler or directly with buyers. In the meantime they are reducing supply chain cost by reducing the number of accounts that they have to manage.

Due to the recent “crisis” in the supply of processing product in Tasmania there is a real attempt by Processors to engage with the Growers. One Tasmanian Processor has stated: “we do not see China as a long-term supply source. Our aim is to support a local industry sector to become more competitive and in turn allow us to become more competitive”. The effect of the crisis has been a complete review of the total production system and all of those involved along the supply chain. This may lead to a more cohesive and open approach to the Processing supply chain. Interestingly it has promoted the need to accelerate the use of mechanical harvesting processes.

While this may be effective for the Retailer it is of little comfort to the Grower as the innovation they may have achieved is not necessarily going to lead to market success. In research Growers will have to consider the potential loss of investment if the retail doors remain shut. In taking the Retailers advice the Grower, searching out a supplier with an active account, will have to allow for perhaps a 20% increase in cost to the market to cover the middleman commission. This is highly ironic as the same Retailers are pursuing this line to reduce costs in their perception of the supply line. One can assume that the Retailer does not consider profit for the Grower in their equations. This is a major Industry Issue that requires considerable attention.

On the other side of the coin products that have a doorway to the retail markets are given much more promotional activity then ever before. Both major Retailers have quality magazines that promote healthy eating, support in-store product tasting and demonstration, provide recipe leaflet sections to promote the use of produce and will flexible on margin to assist sales success.

Most of this is at the Grower's cost and the Retailer defends his margin vigorously.

With the door partially closed the Grower will find it difficult to promote innovation to the Retailer unless there are greater levels of supporting consultation on how to deal with the retail culture. Many Growers approach the retailers with open hearts only to be rendered defenceless by restriction such as Quality Vendor Management requirements, AQIS accreditations, supply window restrictions and packing and delivery requirements that are unswerving in times of adverse environmental conditions.

Growers will need to push harder to cut cost out of the production process and to produce the styles of products that the Retailer sees as market future. While the Retailers are not truly directing the market trends they do have the capacity to bend the trends into a more suitable retail product. Working with the Retailers on issues such as mechanical harvesting will give the Grower a better doorway to the market. Once on board, Retailers will provide significant assistance as they will see the development of retail friendly outcomes. This is a perfect partnership opportunity but requires considerable skill to make it equitable.

During the research process both the Retailers and the Processors showed considerable interest and some strong knowledge of the mechanical harvesting processes. Retailers were not convinced that the developments that they were aware of would provide any significant improvements in supply chain efficiencies. They were well versed in the cost and scarcity of labour, they were aware of the types of harvesting methods being trialled but they were not yet counting the value at the consumer level. The Processors were more aware on all counts but depending on who was being interviewed, gave less than enthusiastic support for current technologies.

In this case the Growers, who are undertaking the cost of new and innovative harvesting methods, should be apportioning some of their R&D cost to PR and Marketing advice to sell not only the output of the innovation but the innovation itself. This will have far greater reach than the covert development schemes.

Industry Status of Mechanical Harvesting

Existing Technology

Most harvesting equipment currently used is mechanical with few sophisticated controls or sensors. Harvesters tend to be robust and are able to be fixed on farm or at the local workshop. This is in line with the typical pragmatic approach of Growers.

Harvesting technologies are emerging with two different platforms:

The first and most common is a system that harvests all of the biomass and allows the grading and further processing to be made off field. Examples of this platform are those being used for broccoli, leeks, onions, lettuce, carrots and potatoes.

The second platform is not widespread but is under serious development. It uses sensing devices to determine fitness for purpose of plants for harvest, sophisticated cutting and in field processing. Examples of this selective harvesting platform are being developed for lettuce and cauliflower.

Broccoli Harvester – This was developed at Matilda Fresh Foods on the Darling Downs. It is a mechanical harvester that at present has few sophisticated controls. After field trials there has been an indication that the application of a camera and data logger would improve traceability and contribute to the management of the bins of broccoli heads at the time of processing. In WA there are developments in bulk handling for export to Sth East Asian markets in order to reduce packaging and freight costs. There is a move toward selective harvesting for the fresh chilled trade and the remainder of the crop being removed for processing. In Tasmania consideration is being given to a harvester that is more suited to smaller production units and hilly areas. It may include differential harvester capability.

Leek Harvester – Developed by Peter Schreurs & Sons at Craigbourne this harvester is worthy of featuring in the Discovery Channel “Megamachines. It is based on Dutch technology and features 200 horse power of hydraulics. It has proven a considerable saving on labour costs with claims of $500,000/yr. It has considerable scope for further automation as has the processing of the crop. There is a reported alternative operating in WA but this was not defined in this study.

Lettuce Harvesters – The Hortus harvester has been successfully operated at Bacchus Marsh by the Ruffo family. It was imported and used to make lettuce harvesting more worker friendly and allow the company to more effectively compete for labour. It is mechanical in nature and moves the labour from the ground to the platform. It could easily be increased in technical capacity with VIA and robotic technologies.

Another lettuce harvester is being developed at VegeFresh in the Lockyer Valley. The design incorporates a number of sophisticated technologies that allow for either total crop harvest or differential harvest. It is not yet at a commercial state.

Baby Leaf - There are several baby leaf harvesters in operation or under development. This is a rapid growth sector and necessity has driven the need for mechanical harvesting. The existing harvesters have mechanical cutting and materials handling. There is a need for in-field cooling to preserve a very delicate product.

There are other small developments in hydroponic growing and harvesting involving using robots, VIA and ultrasonic cutting.

Hydroponics Leafy Vegetable and Herb Harvester – Under development by Ghost Gully hydroponics this harvester includes robotics and VIA technology. It reduces labour content considerably and contributes to reduced processing labour.

Onion Harvester – The larger growers use an imported USA harvester and some have made adaptations for local use. This harvester has had a dramatic effect on harvesting and transporting costs with data provided that illustrated a reduction from $0.14/kg to $0.026/kg. There are some difficulties with the harvester related to use during wet periods. An important feature of mechanical harvesting is that of agronomic practices and precision of planting. There is considerable scope for GPS use for bed preparation and seeding.

There is further scope for work on onion drying with the potential to use heat pumps. Retail comment was particularly directed at Northern grown onions that tended to be under dried.

One provider of onion harvesters considered that there was room for harvester improvement in areas where onions were grown in long daylight periods. In this instance gains would be made in top and root removal from the softer types of onions.

There is a need for the development of onion harvesters for salad type onions. Such a harvester could be made versatile enough for spring onions, sweet salad onions and soft purple onions.

Potato Harvester – This is not new technology and the general application with small growers is primarily to place the tubers on top of the ground for manual collection. Larger growers are more mechanized. In Sth Australia there are support infrastructure and material handling developments to facilitate materials handling of large quantities of potatoes. There is considerable scope for the use of VIA or laser technologies in grading and sorting. While the industry has accepted the current harvesting practices New Zealand growers have adopted more advanced and economic mechanical harvesting methods. It is suggested that this has made a considerable impact on competitive advantage particularly in the cost effective supply of processing potatoes.

Carrot Harvester – These harvesters are well developed for large scale growing. There are USA harvesters developed by Grimway Farms that include topping in-field. These harvesters are rated at 100 tonne/hour. It would appear that there are considerable gains to be made in the post harvest processing area for carrots. Centre West Exports in WA have an excellent continuous flow hydro-cooler with interactive controls and are steadily moving toward a seamless operation from growing to the customer. A similar professional system has been developed by Lamatinna in Victoria. Generally the harvester capacity exceeds the processing capacity. There tended to be more labour intensive activities in processing despite the availability of off-the-shelf technology. Two Tasmanian plants were considered to be very advanced in processing technology that minimized labour inputs. In Qld, Bunny Bites has increased the value-adding proposition for carrot processing.

Harvesting and material handling vehicles are particularly hard on soil structure through compaction of clay soils. There is a need to further develop harvesters along the lines being adopted in broccoli and use in-field methods similar to those adopted by the grain industry as “controlled traffic farming” (CTF). The advantages of CTF have been promoted in Tasmania by John McPhee of the Dept of Primary Industries, Water & Environment for

carrots as well as use across a range of crops. The savings on land preparation and increases in yields justify a total re-assessment of this technology across horticulture.

Crops and Mechanical Harvesting Status

During an early development of this study some proponents suggested that there should be an “A to Z” of the current status for mechanical harvesting or the potential to mechanical harvest each type of crop. The table below is an attempt to derive a crop status summary. It is still evolving at the time of reporting.

Crop	Market Position	R&D Status and Development	Potential Gains	International Position	Priority
Asparagus		Historic harvester used. Scope for in field labour reductions in some areas.	Further gains to be made in packaging and processing. In field grading and sorting to quality requirements could be added.	Not known as yet	
Asian Vegies	Lack of presentation and promotion affects local market. Large Asian markets available if product were more competitive. Market estimated at $140 mill/yr	Generally labour intensive harvesting. Considered a prime target for mechanisation and post harvesting handling technologies.	Considered to be a major growth area if costs were reduced. Presents value adding proposition similar to leafy salad vegetables.	Major growers consider costs need to be halved to compete with Asian producers.	High
Pak Choy		Considerable scope for R&D in total system.	As above	As above.	
Bok Choy		Considerable scope for R&D in total system.	As above	As above	
Baby leaf	Enormous growth rate in food service. Current deficit for market estimated at 450 tonnes per month with farm value of $60,000,000/year. Export markets being accessed in Singapore. High value	Number of mechanical harvesters for field use. Withcott Seedlings have off field harvester. Post harvest handling major area for development. Innovative system being developed by VegeFresh in the	Potential to use in field grading and cooling for post harvest quality. Labour intensive at sorting and grading.	NZ development in baby leaf. Harvester only.	Med

	allows for airfreight. Interest from Middle East.	Lockyer Valley. System combines GPS for precision planting with robotics and VIA technology.			
Beans	Steady market. Flat market in processed products.	Historic developments in bean harvester.	Not likely to be great gains. Gains are in processing labour cost reduction for fresh chilled products.	No new developments detected.	Low
Beetroot	Potential to develop Baby Beet products for consumers as per USA product.	Mechanical harvesting developed. Scope for development in baby beets. Post harvest washing needs with recycled water.	Most interest is in processing. Water driving cleaning back to farm level.	Current methods on large scale growers considered to be at internationally competitive position	Low
Broccoli	Local market generally flat. Retailers consider that new products required. Food service importing frozen Chinese product for consistency of florets. Processors and food service importing from NZ, Mexico and China. Estimated at 3,500 tonne/year. Export market good due in part to window and Mexican drought. China a growing presence in	Mechanical harvester developed at Matilda Fresh Foods under HAL& FIG funding. Advanced system using VIA and robotics being used in processing for fresh chilled and frozen products.	Reports harvest costs reduced from $2000/ha to $500/ha. Costs/kg reduced from $0.23 to $0.13. Increased biomass reduced growing costs from $0.35/kg to $0.20/kg. Further cost reductions under way in using high technology for grading, packing and processing. Work in WA on bulk handling to Asian markets to reduce packaging costs.	Single row harvester developed in France Mostly harvest aids developed in main broccoli countries. USA labour scarcity will drive mechanical harvesting.	Med

	Asia.				
Broccolini	Little grown. Needs promotion as new products. Could be used to stimulate new niche export markets.	Could be harvested with broccoli harvester. Volumes may affect decision.	Similar to broccoli	None detected	Med
Brussels Sprouts	Decreasing market. Needs new varieties that are consumer friendly.				
Cabbage	Market generally flat. Consumer move toward smaller products and ½ cuts. Market for value added pre-prepared products.	Harvester developed in Denmark being promoted in Australia. Reduces hard work and in field handling costs. Could be improved with size grading.	Considerable scope for adoption of existing harvester. Small crop areas may reduce effectiveness. Potential for in field grading using VIA and Robotics.	Adoption of international development most likely.	
Sugarloaf	Popular due to size and flavour. As for cabbage	As for above	As above	As above.	
Capsicum					
Carrot	Market compounding at 2.9% in volume with flat value. Increases from WA Tas & NSW. Smaller carrots preferred. Increased juice market. Asian markets reduced due to Chinese products despite higher quality of local product. Increasing	Harvesters developed. Post harvest costs need to reduce to restore Asian markets.	Considerable scope for post harvest mechanisation. Scope for bulk packaging for some export markets. Agronomic developments have increased production from 36.5 to 41.5 tonnes/ha in 5 years. Further scope for uniformity of size.	Grimway Farms in USA have Harvester to operate at 100 tonnes/h	

	Middle East and European markets.				
Cauliflower	Considered to be a “tired” vegetable on local market. Needs rejuvenation through value adding. Restoration of Asian market if price can be reduced to meet Chinese competition. Very positive in WA. Areas of WA reduced from 27,000 tonnes to 400 tonnes due to loss of exports. Reduced production in other states.	Considerable scope for development in selective multiple harvesting cycles to accommodate range of maturity. Scope for agronomic developments in planting for size and consistency of maturity. Considerable scope for value adding as fresh chilled products.	It is estimated that a combination of mechanical harvesting and higher levels of minimal processing could revive the WA export sector and claw back some 23,000 tonnes of supply lost to China and Vietnam. This has a value range of $18-23 million. A similar value is predicted for the local market as a revived product.	Industry information suggests that a reduction of 50% in farm costs is required to achieve international competitiveness. Increasing concerns for SARS and Bird Flu have contributed to Asian consumer changes in packaging and these will impact on Chinese sourced product over time.	
Celery	Consumer resistance to over sized bunch. Some value adding but not in consumer friendly format. Scope for value adding as per leafy salad vegetables. Export affected by USA quality and varieties in Nth Asian markets.	Considerable scope for development and changes to agronomic practises. Varieties need to suit market needs. In field washing required.	Considered by Growers to be a high priority. Cost reductions and quality improvements would be significant across industry. Need to more closely define consumer needs and product formats.		
Chilli		Historic harvester	Small market. Focus on		

			processing.		
Choko		Unknown quantity			
Cucumber	Changing patterns to Lebanese and continental products. All year demand with salad season peak.	Scope for introduction of melon harvesting technology using ripeness/maturity Bed formation using GPS. Vine openness. Wire system has improved ease of harvest and is set for mechanical operation.	Considerable improvement in economics in areas where labour is short. Need to change a lot of agronomic practises.	None found.	Med
Eggplant					
Eschallot	High value imported as dried product. Not as popular as spring onion.	Could be developed as for onion and spring onion harvesting on a small scale.	Generally small market precludes direct investment in harvesting so an add-on to main stream crops.	None found	Low
Garlic	Local product under pressure from Chinese products. Niche markets have been successful for varieties such as Russian.	Some small harvesters available			Low
Ginger	Relatively static production. Mostly exported. Cheap Asian imports	Mechanical harvesting used but needs further development for in field washing.			Low
Herbs-fresh	Coriander and basil offer market development opportunities in value added packages. Bunches tend to be too large for consumers but OK for food	Diversity of product would require considerable R&D. Leafy vegetable harvester has application in field and hydroponics.	Generally a niche high value market that could be further developed and made cost effective with mechanical harvesting and further processing.	Not Known	Med

	service. Dried herbs increasing as import replacements due to Quality. Very large EU market for frozen product in food service and manufacturing.				
Leek	Steady market. Good export prospects.	As for celery. Needs agronomic developments for crop density and growth format. Harvester being used in WA. Could be upgraded with higher level of technology. Victorian Planter & Harvester very innovative.	Savings in labour about $500,000/year estimated for harvester in Vic. Considerable scope for post harvest processing. Good export potential if costs reduced.	Number of harvesters in Europe.	Med
Lettuce					
Cos and other leafy	Fast growth area estimated at 7.5% per year. Growth in retail, processing and food service supply.	Harvester used at Bacchus Marsh for Cos and other leafy products. Needs further work for labour reduction. Scope for in field processing and use of further mechanisation and automation.	Considerable savings in labour and potential to improve quality of required labour. Economic impact considerable if Hortus harvester made less labour intensive as an evolutionary process. Need to enhance materials handling and processing to meet harvester output. Projected decrease in harvesting costs from $2,800/ha to $1,000/ha.	European harvester used for mechanical harvesting. Scope for improvement in labour efficiency and in field packing.	High

Iceberg	Market share has been declining now at 27% of leafy salad vegetables. Internal competition from packaged products has affected whole head sales. Move to more uniform small heads flow wrapped.	Emerging in-field technology for harvesting and in field flow wrapping. Growing systems need GPS and Laser for beds. Smaller sizes for retail market. Higher level of mechanisation of vacuum cooling may be required to handle harvested material.	Projected decrease in harvesting cost from $3,300 to $1,200/ha. National gain estimated at $65 million/year.	European technology for in field flow wrap	High
Romano	As for above.	As for above			
Hydroponic leafy	Small market share. Compete with field products. Provide niche in retail. Popular in food service. Generally high margin products with little price volatility.	Emerging farm and hydroponic harvesters incorporating VIA and robotics and ultrasonic cutting.	Considerable scope for hydroponic production to reduce water use. Capital intensive.	Israeli technology developed for hydroponics uses VIA and Robots	Med
Mushroom	Retailers are directing size requirements.	Considerable scope for development. Very labour intensive harvesting. Highly automated growing control systems.		Considerable gain could be made for labour saving as this is high input costs. Costs of development estimated to be high.	Med
Onion	Growing imports of red onion. Market generally well serviced. Scope for improved salad onions. Processed	Imported USA technology used. Need for agronomic practises changes in many areas from single to multiple row and varieties for	The defined need in is specialty onions that require softer handling and considerable post harvest care.	USA technology dominates.	Med

	frozen onions limited in sales. Export markets for frozen processed onions especially Japan.	dense growing. Need different type of harvester for soft salad onions and long daylight onions.			
Spring Onion	Growth market particularly in food service. Product influenced by cool chain.	Needs development of specialty harvester for economic production and labour problems. Some agronomic work in Vic for growing bunches being trialled.	Could be integrated with development of other crops such as coriander and basil.	Not known or found.	High
Parsley	Steady use in food service and retail.	Need for a small farm harvester and post harvesting packaging into consumer packs.	Integration with herb harvester required.	None detected.	Med
Parsnip	Consumer resistance to large products. Needs to be more uniformity in length. Scope for further development in value added roast vegetable mixes.	Modified carrot harvester used. General agreement on development and in particular the need for varieties to replace farm stored seeds for shape and quality. Long tail presents a challenge. No top in winter another challenge.	Gains could be considerable if the market is further developed.		Low
Pea	Static market. Dominated by frozen products having little growth. Growth in combined products.	Historic harvesting with little change expected. Prices at farm gate relatively static for past 5 years,	Production could benefit from agronomic practises such as controlled traffic farming.		Low
Pea Sugar snap/snow	Increasing use in salad mixes	Scope for development	Considerable growth	None detected.	Med

	and fresh chilled use for retail and food service. Consumers prefer smaller varieties.	with VIA and robotic pickers. Margin being squeezed. Room for agronomic practices.	supported by leafy vegetable growth and use of pea leaves and pods in mixes.		
Potato	Controversy in processing sector resulting from imports.	Historic harvesters. Considerable scope for post harvest quality assessment and grading.	Potential is in in-field grading and sorting and handling methods. Considerable growth in cool chain and this needs further development at farm level.		Low
Pumpkin	Regarded as a staple consumers have responded to cut products being prepared or partially prepared for instant use. Considerable on farm scope for value adding. Good markets in food service and institutions.	Scope for varietal harvesting based on maturity, shape and colour. Potential to minimize in field labour	Value adding proposition being pursued and providing meal size portions. Very large market. Large Processor market.		Low
Radish		Scope for development as a combined shallow carrot harvester and baby leaf system.	Market relatively constant and seasonal.		Low
Silverbeet	Consumer desire for smaller bunches. Retailers considering wrapping	Considerable scope for development using broccoli, celery and lettuce technologies.	In field harvesting, washing and packaging possible with this crop.	None found.	Med
Spinach	Large	Similar to silver	This could be a		Med

	Japanese export market. Requires correct varieties. Not as popular as Silverbeet in local market.	beet. Not popular due to harvesting problems.	growth processing crop for the future if competitive production methods are developed.		
Sweet corn	Increased value added products have enhanced market. Farm margins considered too low for profitable delivery of value added products at present.	Historic harvesters used. Considerable scope for enhanced technology use in the value chain using robotics, ultrasound, Imaging and packaging equipment.	Gains are in the area of Imaging, cutting and packing using high level technology. Developments currently being undertaken in Lockyer valley. Need to be further developed for automated processing to regain margin.	International use of harvesters. Little advances in high technology for processing.	
Sweet potato	Consumers consider product generally too large and misshapen or broken. Very little value adding. Recent appearance of small varieties in packages with good consumer appeal.	No harvester yet found. There is a mix of reactions to developing a harvester.	Considered gains would be in product quality and these could influence demand. Retailers suggest some grower attitudes need to change re quality issues. Gains to be made in pre-packs.	No harvester yet found.	Med
Tomato	Imported bunched products selling at premium prices. Pressure from imported canned Italian product due to colour and flavour.	Historic harvesters for processing crops. Considerable scope for VIA and robotic pickers for fresh market crops particularly whole bunches.	This is a high gain area for investment in mechanisation of the whole system. The agronomic practises appear to be designed for mechanical harvesting and in field use of VIA.	Processing crop developed in USA over long period. Used with specific varieties.	
Cherry	Value added	Considerable	As above	None as yet	

	packs have stimulated market together with growth in leafy salad vegetables.	scope for small scale harvesters.		found.	
Grape		As above	As above		
Roma	Not competitive as processed product.	As above using in field VIA and robotics. Difficult to mechanical harvest using traditional field harvester.	Benefits in import replacement of about $40 million.	None found. Hand harvested in Italy using cheap imported labour	Med to High
Clusters	Specialty market growth area. Provides consumer with a new quality perception as vine ripened.	As above using VIA and robotics.	Areas where labour is a problem would have substantial benefits. Need for materials handling and post harvest care to meet harvester off take,	None found.	High
Wongbok	Export potential would be enhanced. Need to include baby Wongbok. Most product considered too large for average family. Room to value add.	Considerable scope for in field harvester. Similar to cabbage harvester.	Considered by many to be a growth market both locally and for export if agronomic practises are changed and costs are reduced throughout the system.	Not detected.	High
Zucchini	Steady growth. Value added convenience packs offer advantage to consumers.	Considerable scope for development for multiple pickings over crop using VIA for colour and physical attributes.	Potential is in value adding as indicated in marketing section of this report.	Not detected.	High

Technology Status

Awareness and Understanding

There was general awareness across the grower community of technologies such as robotics and visual imaging but very limited understanding of the potential capability of these technologies in mechanical harvesting. Higher level technologies such as ultrasonics, infra red, modified light visual imaging, radio frequency ID and X-Rays had not been considered. The specialist companies such as Colour Vision were perceived as being only for grading on colour. Historic experiences indicated that the role of higher levels of technology was limited with respect to practical application in unstructured environments. This appeared to be related to the attitude toward more mechanical operations rather than a total distrust in the more sophisticated technologies. Practical issues such as robustness, dust, water and covering of sensors were the main points raised. Most Australian developments relied on local engineering expertise to transform an idea into reality.

Types of Technology

It was difficult in some cases to decide if a mechanical harvester was in fact not just a harvesting aid. For example the Hortus lettuce harvester is an excellent machine for harvesting certain types of lettuce. However it does not reduce labour inputs. The driver for adoption in this case was to make the harvesting process more worker friendly, hence the job is easier to perform and labour easier to attract. On the other hand the leek harvester at Peter Schreurs & Sons and the broccoli harvester at Matilda Fresh Foods are dedicated to both reducing labour inputs and making the harvesting process more user friendly and effective.

In the main harvesting technology is mechanical in nature to meet the robustness of the purpose and the attitude and experience base of those involved in the development and use.

High Level Technologies that have been or are being developed or in current use include:

> *Visual Imaging* – Cameras and software are available that allow imaging at 30 million pixels per second. These provide for grading to attributes such as size, shape, colour and contour. These cameras may be used to control the input into robots for picking and placing based on selection of specific attributes. Much of this technology has been in use for some time and continuously improves.
>
> *X-ray imaging* – This is being developed to examine internal structures of vegetables and fruit for defects and insect pests. The output can be connected to robotics and processing devices such as ultrasonic cutters.
>
> *Infra-Red* – Applications of infra red are similar to those for both visible light and X-Ray. The technology may be refined for very specific applications where small differences are important. Nutrient status of crops may be assessed with this technology but needs a lot of variable control in field.
>
> *Laser Imaging* – This is used for a number of functions including grading of carrots, controlling harvester equipment, controlling cutting and processing equipment.

Growers have been using various laser controls for farming but these have not yet entered the harvesting and processing.

Laser Etching – This has been developed for fruit processing where the information on product, Grower, Country of Origin etc may be etched onto the surface of pieces of fruit. It can also have date of pick etc to indicate degree of ripeness or Freshness. No more stickers.

Ultrasonic – Widely used in the Medical and Engineering sectors ultrasonics provide both imaging and cutting potential. Ultra sonic knives have been used across a wide range of food products. These technologies are currently being developed for application in the leafy vegetable sector.

Piezo-Electric – This technology provides for very sensitive measurement and may be used for sensing and feedback control for equipment and robots.

Radio Frequency Identification – This technology has been hailed as the replacement for bar coding and is being used in some retail applications. It has considerable potential for the traceability of product from field to consumer.

Robotics – Robots are being used in the industry for palletizing and product transfer. Recent pricing changes have placed robots such as the SCARA within a position for wider use. These are currently being used for broccoli grading and packing and are under development for sweet corn packing, lettuce harvesting and use with florets of broccoli and cauliflower. They offer the industry cost benefits similar to those experienced in the motor industry. Adoption has been reasonably high in baking and meat processing. Robots have been developed for tractor driving spraying and weeding.

GPS – This is of course widely used in land preparation. It offers other opportunities for freight monitoring and as part of the traceability within a HACCP program. Recent Australian developments for the control of ground preparation have combined GPS with mechanical improvements for increased accuracy and uniformity of growing bed formation.

Nanomaterials – New nano modified composites having corrosion resistance, very light weight and strength greater than steel may be in many processing applications within the next few years. The Australian leader in this field is the University of Southern Qld. Internationally nanotechnology is gaining a place in packaging materials development.

Wireless Controls – Some advanced Growers have adapted/adopted these technologies for monitoring and applying water to fields from an office computer.

Emerging Nano and Nanobiotechnologies – There are technologies emerging for the detection of low levels of bacteria using nano-biology. Carry over nanotechnologies from the narcotics detection industry are in development for sensing insects and residues. This area is considered as having as great an impact on agriculture as the industrial revolution had on civilization.

Limitations in Mechanical Harvesting

Mechanical harvesting brings with it a new set of dynamics with respect to the volume of biomass from a given area and in turn the materials handling challenges. In the case of a typical fresh chilled broccoli crop the biomass will expand by about 40% as the previously uneconomic to harvest crop is taken as well as an increase in the head sizes if further processing is to be done. Decisions have to be made well ahead of time as to where the increased biomass will be directed. In some crops such as leafy salads this is not an issue as the historic methods handled almost all of the biomass.

The challenges of handling the biomass may be:

- Binning from the harvester and internal farm transport
- Cooling if hydrovac is used or in field cooling of baby leaf products and leafy salad vegetables
- Sorting and grading for specific purposes
- Product development if new markets are to be developed
- Product packaging
- New relationship developments with processors and/or retailers

This may result in considerable investment in handling methods and processing infrastructure.

While there may be considerable savings in labour there may be trade offs if the full value of the crop is to be obtained as a mix of products. The most effective method will vary from farm to farm but in general terms the normal rules applying to a specific farm's supply period will be operating. Hence Growers may have to consider a change from the traditional supply chain proposition to a value chain proposition.

R&D Program Review

Horticulture Australia Limited and to a lesser extent the Rural Industries Research and Development Corporation have generally focused R&D strategy on grower defined needs at the expense of being market driven and supply chain oriented. This approach has been very successful in areas such as integrated pest management, efficiency of water use, targeted residue control, new varieties for specific markets and post harvest care. Exceptions to this are the investment R&D programs made in emerging industries and crops such as Asian vegetables.

It has been indicated in this report that those areas considered important to Growers are not necessarily important to Customers. Hence the Grower focus of the R&D Program may have contributed to the steady decline in international competitiveness as well as the lack of coordination in meeting the downward pressures imposed by the dominance of a few major retail Customers. In addition it was found during this study that most Growers were unaware of the relative international competitive position of their part of the industry or where their enterprise was placed as no benchmarks were available or promoted. This is exemplified by the recent turmoil in the processing sector when imports impacted on Growers. It also extends beyond vegetables and into the fruit sector. It highlights the need for good information systems and support in regional extension methods for interpretation and understanding.

Having stated the above there are significant players in sectors of horticulture who have understood the external forces and developed their own strategies to obviate the economic effects and maintain a competitive advantage. Some, such as the larger carrot, leek, leafy vegetables and brassica Growers/Processors stand as innovators who understand competitive forces and through scale of operation and marketing dedication are enjoying a certain level of success. It is the Rapporteur's opinion that had the R&D Program been more directed toward supply chain systems these outstanding successes would have been assisted with higher levels of technology and through this become even more competitive. In turn this would have benefited the wider Grower Community as suppliers to central points. Decreased numbers of very competitive Grower processors would have to some degree resisted the creeping retail downward pricing arrangements.

For a number of what appear to be industry cultural reasons there has been an aversion to directing the R&D Program toward major issues, water being an exception, that have been developing across supply chains. Hence it was universal opinion in the larger Grower/Processors encountered in the study that:

- The R&D Program was oriented toward farm activities
- R&D agencies were becoming more remote from the Growers and State Governments had diminished extension of results by removing field staff.
- Longer term R&D appeared to be science and not industry oriented
- Many scientists were now too remote from the reality of industry needs.
- The entry process to funding encountered peer review that was considered to be less than supportive.
- There was a deliberate farm gate cut off culture that inhibited access to funds for higher risk activities in value-adding and marketing.
- Some Government funding bodies did not support good international market development for a sector due to overzealous imposition of WTO requirements.

- There are difficulties of obtaining grant funds for a more competitive industry sector arising from the guidelines imposition of increasing rather than decreasing the work force to gain efficiencies.

In places where there has not been this level of leadership and business acumen or resources the trend has been toward decimation of Growers. Examples of this have been the WA cauliflower growers, some large broccoli growers, carrot growers and more recently the processing supply Growers of Tasmania.

R&D Providers

Grower opinion about R&D Providers is very mixed with a bias toward questioning the relevance of R&D. This body of opinion exists despite the fact that projects being conducted by the R&D community having been endorsed by the Growers' representatives. There may well be a need for an R&D public relations exercise. There may also be attitudes related to the increasing lack of contact between the R&D community and the Grower community. The Advisory Officers of AUSVEG are attempting to bridge the gap but are a very limited resource in terms of numbers and appear to have no specific direction in this regard although individuals are actively promoting new developments. In this area there may be a need to provide extension method training to the AUSVEG group.

There is no one-stop shop for a supply chain R&D program. This has resulted from the way R&D is managed within State Departments and the focus of Universities on very specific project areas.

Recently there was a stated need for Agricultural Engineers as the research industry is losing this capacity. The major Centre for Engineering in Agriculture, a joint venture of the Qld. Dept of Primary Industries and University of Southern Queensland is considered to be under-resourced and specific project oriented in order to survive. A new breed of engineers/automation technologists having an agricultural portfolio is emerging at the Centre for Autonomous Systems, University of NSW, Precision Agriculture at the University of Sydney and the newly formed Queensland University of Technology Smart Systems Department. These are the R&D providers for new technologies. Commercial entities involved in these new technologies are providing a meaningful connection between the researchers and Grower/Processors who are adopting new technologies within a growing and processing system. In addition across the horticulture sector there are local engineering companies who have assisted in translating a farm borne mechanization idea into a working machine. There is unfortunately a big divide between these developments and the processing sector R&D led by Food Science Australia. Given the increasing trend toward minimal processing by regional processors some integration of these resources is required.

R&D Directions

Processors and Retailers considered that future R&D should include:

Economic analysis of where costs are incurred. By taking all costs including hidden costs and assessing them against the alternatives the Grower will be able to make better business decisions. For many it will be the opportunity to move into more efficient and more cooperative methods including the use of modern technology and harvesting methods.

Items such as GPS-laser farming to reduce soil compaction need to be evaluated against the random vehicle movements in the harvesting process. This cross evaluation will enhance the perception of technology and lift the Grower potential. Effectively the method of harvest determines the hidden costs. Dr Jeff Tillberg, recently retired from Gatton College has widely promoted the features and benefits of traffic controlled farming and consideration needs to be given to matching these principles to horticultural practices.

Replacement of labour in the supply chain is considered to be a priority. Supplies are often held back because the supply of labour is not available. If the efficiencies in mechanical or technological changes to the delivery of produce can be sped up then the ability of Australian Growers to meet local demand will increase quickly. Retailers will support this rationalization as it will enable them to continue quality standards and to improve margins at retail level.

Other technologies should be targeted at the retail customer needs so that there is a reverse flow of information back to the Growers. Currently the total focus is on the supply chain from farm to plate. If the plate does not want the results of this focus then there is a very slow or no communication of this situation back to the Grower. Future changes may then be wasted as the consumer has already rejected the resulting product. Much of the consumer thinking is around free time. If the produce industry can harness the mood the value of their output will increase right along the supply chain.

Pathogen management in the soils is seen as an emerging focus for many growing regions. While the existence of pathogens is not new, the investment by government and growing communities has been low in both R&D and field application. This is now being seen as a hidden cost in producing and will become a major part of the re-evaluation of farm economics. Potatoes were the most used example where the on-harvester sorters are extracting contaminated pieces and dropping them back into the soil where the pathogen levels are increased. This becomes a self generating problem and cost. In WA there is a move to ban the use of unprocessed poultry manure as a means of reducing food borne organisms entering the food chain.

Seed technology is also becoming a regional issue and carries the arguments for and against genetic modification. In areas such as sweet corn the application of seed technology has seen the super sweet corn modified to produce both sugars and starch in balance to give bulk and flavour to suit the market.

Growers had a different perception but all agreed on:

- A focus on labour reduction directed R&D
- Water use and technologies including computerised systems

- The need to have R&D synchronised along the value chain for selected crops as the whole system required development and mechanical harvesting R&D should not stand alone.
- Risk taking by others including funding bodies as individual growers could not sustain development at current margins.
- Multiple harvester capability that can be used for a range of crops particularly in the small high value crops.

Lack of finance tends to determine the level of rotation in crops and paddocks which can ultimately lead to the reduction of quality in the produce. In many cases the move to mechanical harvesting would alleviate some of these symptoms but the finance is not available to fund the cost. In some communities the use of a contracted harvester has changed the pressure on harvesting machinery costs as individuals no longer have money tied up in equipment or leasing charges. Cash flow wise they need to able to pay the contractor but the efficiency is usually greater.

Some emerging Australian industries such as tea and coffee have been more proactive in the development of mechanisation and the vegetable sector may well consider the methods used to achieve efficiencies. Norris and Walsh have demonstrated how R&D can be effective in the coffee sector with respect to differential harvest of berries. In Hawaii drones are used to fly over coffee crops using instrumentation to determine where the ripe beans are located and these are then differentially harvested.

International Developments

Social and Political Pressures

There are significant international pressures operating that will eventually impact on the Australian Horticulture sector. In the USA labour shortage in agriculture has become exacerbated due to the competitiveness with the construction sector and increasing levels of border controls reducing the itinerant Mexican labour source. In real terms the cost of labour that was once a competitive advantage at $US7 to 9/hour is now about $US 9-12/h. This trend was forecast in a paper by Richard Mines of the US Dept of labour in 1999. Mines pointed out that “Mechanical handling of fruit and vegetables in the field has been at a lull for a couple of decades. In 1971 the Agricultural Research Institute had 23 engineers, in 1981 there were 4 and today (1999) only one is left”. This situation appears not to have changed and possibly offers a market for Australian harvesting equipment if it is developed in time.

In the EU there is an increasingly ageing agrarian population and prices of produce are reasonably static. Major retailers are dominating the purchase proposition and Growers are becoming increasingly militant about their returns. Labour is an issue in both quality and quantity. Unlike the US scene the labour entering the EU tends to be directed to cities.

Increasingly the EU and the USA have been targeted with respect to the level of agricultural subsidies. In time these are expected to decrease and thus there will be an economic on farm impact affecting a very large number of Growers.

Inevitably these forces are going to drive investment in mechanical harvesting. During this study the developments that were disclosed included:

- Large scale carrot harvesters particularly in the USA having a capacity of about 100 tonnes per hour.
- Onion harvesters suited to hard onions available from the USA.
- Potato harvesters akin to those used in Australia with advanced technology being applied in New Zealand.
- Leek harvesters in the EU that were adapted to smaller farming units.
- Broccoli harvester in France used for single row production.
- Italian “Hortus” lettuce harvester now imported into Australia
- Danish cabbage harvester.

Asian Developments

China has had a devastating competitive effect on some crops. In Japan the USA has suffered market decline in broccoli while China is in the ascendancy. Similarly the Sth East Asian markets for Australian lettuce, celery, carrots and cauliflower have been considerably reduced. These effects are very pronounced in WA. While Australia is considered to be a provider of safe quality produce the cost difference with China needs to be reduced considerably to regain market share at competitive prices. In the longer term there are economic forces at work in China that will contribute to a re-establishment of Australia in Sth East Asia. These include the fast growth of disposable income and the increased trend toward Western Type vegetables and eating habits.

A major limiting factor for the advancement of horticulture in Chinese agriculture is the competition for water between farms, communities and industry. This is expected to contribute to vegetable imports within the next decade.

Parallels to this development have occurred in the past decade when Taiwan was a net exporter of broccoli and celery but today is a net importer of these products. Hence there is a body of opinion that considers Australia will be a supplier to China for supply windows that are seasonally opposite. Developments in mechanical harvesting, scale of operation and increased automation of minimal processing coupled with orderly marketing will accelerate the rate of Australian Growers' position in Asia.

Selected Crops, Harvesting and System Requirements

Rationale for Crop Selection

The criteria for crop selection as candidates for future mechanical harvesting and total system developments were:

- Market trends indicated returns and growth would provide sustainability of the crop.
- Economic analysis indicated that farm gate returns would receive a substantial benefit.
- There was little or no current development in these specific crops
- It was feasible to mechanically harvest the crop
- Quality could be sustained in new processes.
- There was industry sector support for a commercial development
- The outcomes would contribute to international competitiveness

While these were applied to specific crops it must not be assumed that other crops do not need attention. In fact there was not one Grower who had adopted mechanical harvesting encountered in the study so far who had a complete seamless system extending from the soil preparation to the customer. Three were considered to be close.

Selected Crops and Economics

System Requirements

Mechanical harvesting is not a stand alone proposition. The ability to mechanically harvest has systems implication from soil preparation to consumer acceptance. The specific requirements for each of the selected crops are described below. These have been derived from a review of existing practices with growers and researchers and present a systems approach to future R&D in mechanical harvesting. There are further data to be collected to verify the decision process.

Prerequisites for Mechanization were considered to be:

- Precision agriculture: This is a necessity if mechanical harvesting is to be successfully implemented. In some instances it will require considerable changes to agronomic practices and the greater use of technology. Aspects of this include:
- GPS Laser – essential for cultivation and irrigation. New Australian innovations should be promoted across the industry.
- Bed formation – some crops are going to require radical changes to accommodate plant growth format harvester wheels, bin carriers and irrigation. This particularly applies to the broccoli and onion harvesting practices. There are some entrenched attitudes toward changes in this area.
- Irrigation – in some areas fixed irrigation systems pose challenges to levelling, bed formation and planting densities and will need to be accommodated during harvester development. This has been achieved with lettuce and leeks.
- Precision seeding and planting – direct seeding using size enhanced seeds has been very successful however there are some circumstances and some

crops that prevent this being a universal practice. Accurate placement of seeds and seedlings makes the detection and removal of plants by harvesters easier and improves quality of cutting. It also has impacts on plant growth in dense populations.

- Plant Density and Spatial Arrangements – these areas of agronomic practice have a profound effect on harvestability, yield and quality. In broccoli spatial arrangement and density in double row crops may contribute up to 50% differences in between row yield measurements. Many growers use a diamond pattern in lettuce production to offset light effects and competition between plants.
- Pest control – high density planting and changing plant shape pose considerable challenges to conventional IPM methods. Higher density plant populations are generally positive but increase the necessity for accurate population assessment. This needs to be built into any development program.
- Attitude – the values of the past may not be relevant to a mechanical future. The low level of adoption of higher technologies by middle to small Growers may indicate a need for change management if new developments are to be taken up across industry.
- Benchmarking – this relates to the Retailer and Processor comment that Growers need to know their true cost structures. The tendency to see the nearby grower as the enemy instead of looking to World's Best Practice as the point where you must be needs to be changed to ensure that the cost benefits for an individual farm are recognized.

Vegetables Selected for Future Development

Asian Brassica Vegetables

Key Rationale Points:

- Growers and Retailers considered that this was a sustainable crop and the market could be grown if more competitive prices were achieved.
- There was little real data available and this will be studied further. The general opinion was that farm costs could be reduced by about $2,500/ha if mechanical harvesting were used. It would need to include product washing.
- The study revealed no activity in this area but considered existing technology in lettuce harvesting could be adapted.
- Other brassica crops are being harvested mechanically and it is considered that these crops are candidates. However some changes to plant density, row formation and precision planting may be required.
- It was considered that quality could be improved by mechanical harvesting provided the initial cut was precise.
- It was hard to gauge the level of support and this is to be further tested.
- As yet international competitiveness has not been tested.

Agronomic Practices

Considerable R&D is required to establish ideal agronomic practices for a mechanically harvested crop. Some indications may be extrapolated from other brassicas.

Harvesting

Modifications to the imported cabbage or lettuce harvester may be suitable for a harvester. These would need modified infrastructure for materials handling.

Post Harvest Preservation

Time and temperature relationships need to be determined for vacuum cooling.

Processing

There is a value proposition for presenting these vegetables as mixes for Asian style cooking and other stir fry dishes.
Micropore packaging film may contribute to enhanced shelf life.

Marketing

Considerable effort was placed on these products about 5 years ago for export markets. The consensus among Growers is that they are too expensive to produce and handle as an export product. Given a different cost structure this may be a real area to revisit. Significant changes in Asian markets since SARS and Bird Flu have emerged provide an expanding Asian market for packaged products.
Australian retail products could be improved in presentation and as mixes.

Celery

Key Rationale Points:

- Growers and Retailers considered that this was a sustainable crop and the market could be grown if the product were presented in a more consumer friendly manner. The general opinion was that farm costs could be reduced by about $3,000/ha if mechanical harvesting were used. It would need to include product washing.
- The study revealed a lot of interest but no activity in this area. Existing technology in lettuce harvesting may be adapted.
- Changes to varieties grown, plant density, row formation and precision planting may be required.
- It was considered that quality could be improved by mechanical harvesting provided the initial cut was precise and a topping device was included to produce only uniform stem pieces.
- There was considerable enthusiasm toward this development. Retailers were particularly interested in a uniform product having good flavour.
- An exporter indicated that standardized processed and packaged product would be viable in some Asian markets.

Agronomic Practices

Varietal selection is a high priority if consumer expectations are to be met.
Plant density will be important to plant structure and the colour of the stems.
Higher density may reduce dust and grit entering into the bunch structure.
Development of bed structures to accommodate harvesting is required.

Harvesting

Requires similar harvesting principle to broccoli only top is left in field or collected for other product mix.
Potential to wash and pack in-field using flow wrap.
Major issue is removal of dirt/grit at base of stem.

Post Harvest Preservation

Cut product is susceptible to oxidation and hence may need treatment in field prior to wrapping or packing.
Need for cooling requirements to be determined.

Processing

Considerable scope for processed uniform products graded and packaged to meet consumer needs.
Scope for secondary products for use as a supplement in other cooking options.

Marketing

This product provides a proposition similar to that for the consumer packs of coloured and Cos lettuce.
Features and benefits are way beyond the current practice of large bunches and ½ bunches being offered to consumers.

Coriander, Parsley, Spring Onions and Basil

These have been grouped together as some growers saw the potential for a multi purpose harvester that could accommodate these products.

Key Rationale Points:

- Growers, Food Service Sector and Retailers considered that these are a sustainable crops requiring little or no change at the point of sale.
- The general opinion was that farm costs could be reduced by about $3,700/ha if mechanical harvesting were used. It would need to include product washing and bunching capability.
- The study revealed a lot of interest but no activity in this area. Existing technology in lettuce harvesting may be adapted.
- Changes to varieties grown, plant density, row formation and precision planting may be required.

- There was considerable enthusiasm toward this development. Retailers were particularly interested in a uniform product having good flavour and appearance.

Agronomic Practices

Growers are already experimenting with bunch growing techniques that would fit a mechanical harvesting process.
Varieties need to be assessed for density planting as this affects cutting height.

Harvesting

This will require a refined harvester with a custom designed head for each type of crop.
In field packing into bunches is a real option. However consideration should be given to changing the marketing into a weight proposition.

Post Harvest Preservation

These are thermally sensitive crops and require strict protocols for post harvest care.

Processing

There appears to be little gain from further processing activities. Some growers are now providing Basil in 100g packs instead of the traditional bunch and this has resulted in substantial price increases.

Marketing

There are no expectations that the market can be greatly influenced.

Cauliflower

Key Rationale Points:

- Growers and Retailers considered that this was a crop in decline that could be made sustainable through changed agronomic practices, reduced cost structures and if the product were presented in a more consumer friendly manner.
- In WA international competition, particularly from China had reduced export earnings by about $30 million and the regional economy by $75 to $100 million. Victorian Growers reported declining market interest. In the above market assessment the message for pre-packed consumer friendly products strongly related to cauliflower.
- The general opinion was that farm costs could be reduced by about $3,200/ha if mechanical harvesting were used.
- The study revealed a lot of interest but no activity in this area. Existing technology in lettuce and broccoli harvesting may be adapted.
- Changes to varieties grown, plant density, row formation and precision planting may be required.

- It was considered that quality could be improved by mechanical harvesting provided there was selection and grading, initial cut was precise and no damage occurred.

There was considerable enthusiasm toward this development. Retailers were particularly interested in a uniform packaged product having good flavour.

Growers considered that export markets could be reestablished if a better cost structure were achieved. Some considered that the changing market structure in Asia allowed for standardized processed and packaged product selling at a premium.

Agronomic Practices

Current practices would need to be modified for more upright plants using similar practices to those in broccoli.
Varieties need to provide for consumer needs in size, colour and flavour.
Technology for harvesting needs to accommodate leaf cover in summer.
Need for increased uniformity of maturity.

Harvesting

May fit either of the harvesting platforms.
Scope for differential head harvesting using sensors for size, colour and defects coupled with robotic picking and ultrasonic cutting.
Requires special care for damage during handling.

Post Harvest Preservation

Scope for in-field processing and cooling.
Universal application of cooling on farm.

Processing

Needs changes to stimulate demand
Smaller packs in microwaveable format produced on farm
Floreting for mixed products

Marketing

Support for re-establishing export market position
Promotion to establish position across retail markets
Further development by sector to promote health benefits

Leafy Salads and Iceberg Lettuce

Key Rationale Points:

- There has been a marked change in the salad vegetable market in recent years. The company, One Harvest, has tended to dominate the retail sector with a range of fresh cut salads packaged under the major retail brands. Estimates place this market at 26,000,000 units/year with a retail value of about $100,000,000.

- During the past five years these fresh cut packs in retail have increased from 40 to 60% market share while traditional Iceberg lettuce has decreased from 45 to 27% market share. There has been little change in sales of “Fancy” and Cos lettuce that collectively occupy about 10% market share. Overall the segment growth rate is estimated at 4.5%/year and has a current value of $220,000,000. More recently there has been a trend toward mixes of salads provided in separate packs. In addition to the convenience packs the retailers are re-launching the traditional Iceberg, Cos and “Fancy” varieties in new packaged formats that accommodate consumer preferences for size and meet more exacting demands for food safety in that each head is individually wrapped.
- Convenience for consumers and ready to use pre-packaged fresh leafy vegetables is mainly being driven by retailers as a strategy to achieve higher value and margin and reduce waste and labour. It is expected to impact on an increasing product range. This strategy underpins the supply chain proposition being developed in this business plan. The collaborative nature of the project provides a wide range of products that have been accepted in principle by the major retailers. It allows the members of the project to reduce price volatility and increase unit value as a direct supplier into both retail and food service sectors.
- In parallel with the retail developments there has been the rapid growth in the fast food and food service sectors for providing “Healthy Meals”. This has exploded the demand for baby leafy vegetable products and a surge in new products being grown. Not only are there new products but existing products are required in smaller sizes and mixed to reduce the labour costs at the point of sale. This market is now estimated at a value of $22,000,000/year and an annual growth rate of 7.3%.
- The increasing demands for food safety standards has evolved into the individual wrapping of lettuce sold through retail outlets as an unprocessed product. This trend is projected to increase to other vegetables. It imposes a new cost structure on growers in a market where it is hard to recover such costs. A considerable amount of lettuce has previously been packed in field to reduce handling costs. Under the new food safety requirements lettuce will now have to be harvested and taken to a packing shed for trimming, sleeving and packing prior to vacuum cooling.
- Growers, Processors and Retailers considered that this market segment would continue to grow.
- Growers considered that sustainability was dependent on margin recovery as prices were constant over a long period and costs had risen. Increase in scale of operation had been the key to maintaining market position.
- Retailers considered that improvements in agronomic practices, reduced cost structures and lower prices would further stimulate the market.
- The general opinion was that farm costs could be reduced by about $2,200/ha if mechanical harvesting were used. Annual farm gate contribution is estimated near to $20 million. In addition the baby leaf and other leaf are under supplied particularly to food service. Prices for Baby Leaf are expected to decrease as the volume increases. Total industry gain is estimated at $65 million.
- The study revealed a lot of interest and a lot activity in this area.
- Changes to varieties grown, plant density, row formation and precision planting may be required.
- It was considered that quality could be improved by mechanical harvesting provided there was selection and grading, initial cut was precise and no damage occurred.
- There was considerable enthusiasm toward this development. Retailers were particularly interested in flow wrapped uniform product having good appearance.

- Growers considered that export markets could be re-established if a better cost structure were achieved.

Agronomic Practices

Genetics of varieties suitable for harvesting through international connections
Uniformity of growth at point of harvest
Precision planting as seeds or seedlings
Controlled watering to point of harvest
Multiple cuts for some varieties

Harvesting

Further development of existing technology to remove labour
Emerging new technologies to reduce labour and increase harvesting precision
In field flow wrapping of some types particularly Iceberg
In field cooling of leafy types
Visual imaging, robotics and ultrasonic technologies applicable.

Post Harvest Preservation

In-field cooling
Universal adoption of vacuum cooling or ice water systems
Use of micropore technology for shelf life preservation

Processing

Generally well developed
Increased emphasis on food safety as consumer packs with longer shelf life are developed
Cool chain integrity needs to extend to consumer.

Marketing

Little to be done as it is such an active market.

Tomato Single and Clusters

Key Rationale Points:

- Growers and Retailers considered that this crop continued to grow through product innovation. Consumers consider that the flavour has been bred out of the ordinary tomato. Vine ripened tomatoes have stimulated demand as has new types such as the Grape Tomato.
- In Qld international competition, particularly from China for Asian markets had reduced export earnings.
- Imports of Italian canned products are estimated at $40 million/year and the Roma type of tomato imported requires a soft mechanical harvesting regime to prevent deterioration.
- In the above market assessment the message for consumer friendly products with lots of flavour indicates where the future of tomatoes lies.
- The general opinion was that farm costs could be reduced by about $3,200/ha if Mechanical harvesting needs to be further assessed with respect to cost

reductions in labour. Current agronomic practices are favourable for mechanical picking and grading in the field. The type of harvester would have to be different to those used for traditional field processing crop harvesting.

- The study revealed a lot of interest but no activity in this area.
- Changes to varieties grown for flavour, plant density, row formation and precision planting and ripening practices may be required.
- It was considered that quality could be improved by mechanical harvesting provided there was selection and grading and no damage occurred.
- There was considerable enthusiasm toward this development. Retailers were particularly interested in a uniform packaged product having good flavour supplied year round.
- Growers considered that some export markets could be further developed if a better cost structure were achieved.

Agronomic Practices

Flavoured varieties that can meet consumer preferences are required.
Leaf removal near to harvest may be required.
Varieties that place fruit to the outside of the plant would facilitate harvesting
Row spacing may need to be assessed.

Harvesting

This crop is ideal for the more sophisticated harvesting technologies including visual imaging, robotic picking, in field grading and bulk handling.
Cluster harvesting fits the same picture but will require different handling techniques.
Considerable development work is required.

Post Harvest Preservation

Generally regarded as a robust crop due to plant breeding.
Increased industry cooling capacity required and better control at the retail end.

Processing

Processing tomato harvesters have been used for a long time. The varieties allow for more consistent ripening and the skin thickness makes the fruit more robust. There are considerable imports of Italian canned tomatoes.
This was not considered a Grower priority.

Marketing

Need to promote flavour properties when established.

Wongbok

Key Rationale Points:

- Growers and Retailers considered that this crop needed a lot of work to increase consumer acceptance, particularly in size and presentation.
- In Qld international competition, particularly from China had reduced export earnings particularly to Taiwan. Drought also played a part.

- In the above market assessment the message for consumer friendly products in meal size portions is the message to be heard. Market could increase as stir fry mix.
- The general opinion was that farm costs could be reduced by about $2,100/ha with Mechanical Harvesting.
- Current agronomic practices are favourable for picking and grading in the field and adaptation of the cabbage harvester seems to be a proposition.
- The study revealed a lot of interest but no activity in this area.
- Changes to varieties grown for size and flavour, plant density, row formation and precision planting may be required.
- It was considered that quality could be improved by mechanical harvesting provided there was in-field selection and grading and no damage occurred.
- Retailers were particularly interested in a uniform packaged product having good flavour, economy of size and supplied year round.
- Growers considered that export markets could be reestablished if a better cost structure were achieved and it rained more often.

Agronomic Practices

Considerable effort required on planting density and final product size.
Nutrition may be important in flavour and needs to be assessed.
Climatic conditions need to be better defined for varieties available.

Harvesting

Proposed that the cabbage harvester be adapted for application.
Increase harvester technology for in field grading on size.
May be possible to assess flavour based on odour.

Post Harvest Preservation

Universal cooling required.

Processing

Oxidative changes for processed product need to be managed.
Opportunity for micropore technology in packaging
Possible to value add into stir fry mixes

Marketing

Considered to be undermarketed at present due to need for consumer education.
Size and flavour need to be considered for the value proposition
Product range opportunity exists akin to broccoli and leafy vegetable products

Zucchini

Key Rationale Points:

- Growers and Retailers considered that this crop could be increased in value and volume if the value propositions were able to be more consistent and a little lower in price.

- Increased consumer acceptance, particularly in size, consistency over the year and presentation.
- In the above market assessment the message for consumer friendly products in meal size portions is the message to be heard. Value creation is possible with minimal processing.
- Market could increase if better co-promoted with leafy salad vegetables.
- The general opinion was that farm costs could be reduced by about $4,100/ha with Mechanical Harvesting as it is labour intensive. (Seems high and needs closer scrutiny.)
- Current agronomic practices are favourable for picking and grading in the field for some varieties that are more erect in growing habit. Ideal colour for sensing and mechanically picking at exact stage of maturity. Requires extra sensitivity to preserve the soft skin.
- The study revealed some interest but no activity in this area.
- Changes to varieties grown for size and flavour, plant density, row formation and precision planting may be required.
- Retailers were particularly interested in a uniform packaged product having good flavour, economy of size and supplied year round.

Agronomic Practices

Needs varieties and growing methods aligned with harvesting requirements or vice versa.
May lead to growing structures similar to those used for tomatoes.
Uniformity of size and days to maturity needs to be examined for a range of growing and seasonal conditions.

Harvesting

Suitable for sophisticated harvest technologies for size, defects and colour in field.
Extreme care required for handling during picking and placing.

Post Harvest Preservation

Dehydration a problem with most products hence needs cooling and protection.
Stem bleeding can be a problem.

Processing

High potential for value adding and higher returns
Oxidative processes need controlling

Packaging in micorpore technology ideal
Cool chain control required even in retail point of sale

Marketing

Good value adding prospects for promotion
Co-promotion with leafy salads and stir fry mixes
Processed products readily consumer accepted.

Industry Costs for System Development

Development costs across the Industry will be substantial if a total systems approach is taken toward the development and implementation of the proposed areas of mechanical harvesting as is indicated above. In addition most Growers would financially benefit from further investment in all crops if International competitive position were to be reached. At the current margins the level of investment is beyond the middle grower and small growers who are not specialized in higher value crops. Compounding this is that there is no one-stop shop for technology assistance or a guide as to what is World's Best Practice in any one crop. Some of the advanced and larger Growers have adopted International Benchmarking while the majority appear to more likely to use very local benchmarks.

Provisional estimates based on actual costs for total system development provided by larger growers indicate that for each crop an expenditure of about $3.0 to $5.0 million per crop would be required over a three to five year period. This value has been derived from Industry sources that have been through a similar development process. It includes agronomics, harvester development, materials handling systems, mechanized/automated minimal processing, logistics systems and marketing. This cost estimate includes system development in at least two regions to assist in understanding natural variation and providing examples for diffusion and direct extension across the industry sector.

Industry benchmarks that may be used to determine relative position for productivity could include the values below. The benchmarks are based on marketable biomass having specific quality requirements rather than total production that could be achieved. The estimated industry values have been made from data provided by high producing Growers and extrapolation across an industry sector. In the case of cauliflowers the value relates to regain of export markets and for tomatoes the decreased imports resulting from increased competitiveness to produce particular varieties and harvest bunches.

Crop	Harvester Platform	Benchmark Yield Range kg/ha	% Harvesting Cost reduction targets	Estimated Potential Industry value gain
Asian brassicas	Non selective	Depends on type	70 to 78	$5,000,000
Broccoli fresh chilled market	Non selective	15,000 to 20,000	65 to 75	$6,000,000
Broccoli processing market	Non selective	19,500 to 24,000	68 to 75	$4,000,000
Celery	Non selective	48,000 to 52,000	55 to 65	$5,000,000
Cauliflower	Selective	40,000 to 45,000	50 to 70	$30,000,000
Leafy salad/iceberg	Selective	20,000 to 27,500	55 to 65	$24,000,000
Tomato Roma and Bunches	Selective	Depends on type	45 to 55	$20,000,000

Future Markets Resulting from Mechanical Harvesting

Mechanical harvesting has the potential to create new avenues for Growers to market produce or processed produce outside of the traditional Fresh and Processed vegetable markets. The capacity to produce large quantities of biomass at a low cost provides an energy efficient method for phytochemical production as plant extracts.

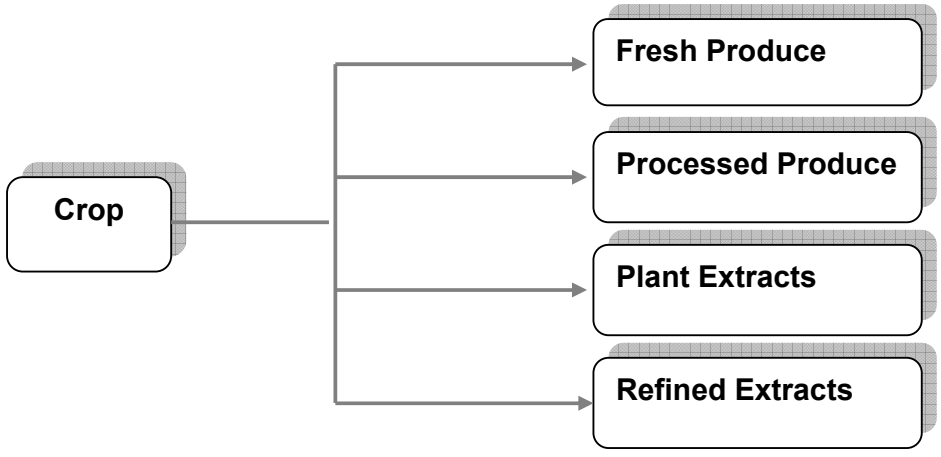
As an example there is an interesting emerging market segment within an overall market loosely defined as fruit and vegetable extracts. This has an estimated value of €819.9 million in the European and US fruit and vegetable extracts and powders market. It is a growth sector estimated to grow 4.5 per cent annually, to reach €1.07 billion by 2009." (NutraIngredients, 6 Sept 2005).

In parallel with this is the growth of nutraceuticals and functional food ingredients of plant origin. Nutraceuticals of plant origin used in the developed world are estimated at $2.3 billion/year. Some 25% of pharmaceuticals derive from plant chemicals or variations of these. Cosmetics and cosmeceutical markets are increasingly using plant extracts as ingredients within this US$ 30 billion market.
The new era in horticulture will be where plants supply lifestyle and well being products outside of the traditional functions of food to which we are accustomed.

For example:

- Carrots may be developed within the health supplement range for beta carotene and other bioflavanoids
- Broccoli will become the source of anti cancer and anti ulcer drugs
- Tomatoes will be used for lycopene extraction to prevent prostate cancer and degenerative diseases
- Peppers will supply the oleoresins and flavours for hamburgers
- Plants will supply the components for biodegradable plastics
- Plants will be developed to supply antibiotics and even antibodies for disease control
- Plants will be grown as the sources of natural pesticides contributing to the principles of integrated pest management through selectivity of action

Growers will become value chain members for a number of industry sectors and break dependence upon the supply chain for fresh and processed vegetable sectors. These are illustrated in the diagram below.



The Future Mechanized Farm

The future farm will be a multifunctional production unit employing considerable technology and technological skills. The total system will be run on data collected along the entire supply/value chain for a number of industry sectors. Harvesting will be completely automated and the field platform will be segregating crop products for a number of end uses in a number of market segments. Information systems will operate from data inputs on climate, soil moisture, crop nutrient status during growth and harvesting information and data provided from precision agriculture systems.

The primary market may well continue as the supply of fresh vegetables but products will leave the farm in convenience formats for consumers. There will be reduced oversupply situations as biomass will now have a number of processing options. Even the secondary biomass such as broccoli leaves may be further processed for extraction of plant chemicals such as sulphorophanes. The Vital Vegetables project is a forerunner of the type of vegetables we will see in the future.

Conclusions

It was concluded that:

Retailers were driving the agenda with respect to farm gate returns and as part of their process were reducing the number of suppliers to gain efficiency of delivery and all year supply capability.

Processors were locked into mature markets with low growth and margin and only through new levels of convenience were they able to increase the growth rate. Hence Processors were under pressure to compete using imported vegetables rather than local sources that lacked competitive pricing.

Consumers were looking for convenience, freshness and consistency of quality and price over the year.

Loss of export markets had occurred as a result of declining competitive position for some crops and the emergence of low cost Chinese product in Asia.

Growers were generally unaware of the cost structure required to make them internationally competitive. The competitor was seen as other local or regional Growers rather than international suppliers.

Growers were aware of automation technologies but had not related the use of these to horticulture.

Leading Growers had developed mechanical harvesters and achieved considerable cost reductions through labour saving. There was virtually no diffusion of these technologies across the industry.

Imported mechanical harvesters were used in a range of crops that tended to be in more mature markets such as onions, carrots and potatoes and hence the gains had already been made.

Mechanical Harvesting offers solutions to the sourcing of quality labour and removes many of the costs of labour. Overall reductions would vary with the type of crop and collectively would deliver between $60 and $100 million/year to farm gate returns from labour cost reductions and increased production of marketable products.

Mechanical harvesting is not a stand alone proposition as the agronomic practices, harvesting, materials handling, minimal processing, supply logistics and marketing activities need to be treated as a complete system and R&D applied to every component of the system.

Research and Development has generally been project oriented with emphasis on farm production and not system focused to achieve reduced costs, higher productivity and net market returns.

Future R&D aimed at creating international competitiveness should be assessed by a broader based process having full chain expertise to ensure all parts of the supply system are included and coordinated.

Future R&D in mechanical harvesting should be conducted by consortia having a range of expertise to address the needs of a total system rather than individual projects within a system.

Extension capacity has been reduced as government services have been withdrawn and this important role may need to be expanded by AUSVEG.

International benchmarking studies should become a regular feature for Growers, Equipment Suppliers and Manufacturers, extension and marketing persons. These studies need to provide quantifiable targets for productivity and qualitative information on trends in various marketplaces.

Growers and Grower/Processors need to have increased skills in marketing and negotiation in order to keep the gains of increasing mechanization and automation at the farm gate and not allow them to be usurped by retailers and multi national processors.

Potential emerging markets in plant extracts for use as ingredients in polymers, functional foods, cosmetics, cosmeceuticals, nutraceuticals and pharmaceuticals provide mechanisms for Growers to reduce dependency on traditional fresh and processed vegetable sectors.

Recommendations

Recommendations For Future Developments Are:

Establishment of the total system needs for a given crop and directing funds for R&D and Extension to all components of the system including marketing.

Conducting R&D for a total system using a model that includes a range of expertise in agronomics, harvester development, materials handling and minimal processing logistics and marketing for each project. It is important for technology adoption that a machinery manufacture and distribution capability is built into each project.

Increased application of higher technologies in total systems including robotics, ultrasonics, nanotechnology and bionanotechnology to ensure the Industry is at the leading edge of R&D in all system components. These may be longer term research strategies as part of a continuous improvement process.

Increase in extension activities to assist in accelerated industry uptake of system developments based on selected “Champion Growers” in each State who will provide the R&D base for particular crops and leadership in industry development.

Industry wide development of internationally competitive benchmarks gained from R&D and International Industry Study Tours that include a mix of Growers Machinery Manufacturers/Distributors, Extension and Marketing personnel.

Changes to the funding processes that allow a wider body of non-Grower and Grower opinion and debate in the decision making and allocation of funds.

Increased support in finance and skill development for Growers and Grower/Processors negotiating with retail and export market decision makers.

Creation of an Industry Futures Group that will provide long term direction in both traditional and non traditional markets for increasing Grower profitability and improved life style.

Industry Issues

Key Issue Area: Economics

Issue 1: Investment and Risk

There was a general consensus that the level of investment and the risk profile for developing mechanical harvesting was too high for individual growers. Some growers had participated in trials with “Inventors” and were aware of the problems and the skills required for achieving outcomes. While there were pioneers of new harvesting technologies these were mostly advanced forms of harvest aids that made the job easier without significant reductions in costs. There were some exceptional cases where necessity had driven the development process. The harvester at Withcott Seedlings is one such example of necessity being a development driver. Similar drivers of change were apparent in leeks, large scale broccoli and carrot production.

Critical Success Factors

To overcome these limitations a collective approach as provided by HAL funding together with commercial participation for a specific industry sector is required to reduce individual risk and bring a wider expertise base to the project.
For technology adoption across the industry sector the licensing of technology to commercial producers of harvesters or co-development with such entities is critical to early adoption.
Partnering between HAL and Technology Suppliers could assist the development process.

Issue 2: Infrastructure

There appears to be sufficient R&D infrastructure available in the private sector and government for the development of mechanical harvesters and supply of research science to facilitate development. There is a need to focus these resources on industry needs and provide assistance in the co-ordination of industry focussed R&D. There is no one stop R&D facility.

Industry feedback on the application of these resources indicated a lack of understanding of both the infrastructure capabilities and the available enabling technologies. These points are coupled with a wide view that the researchers are not in touch with the industry needs and are slow to deliver results. This is a perception as some parts of the R&D community are definitely focussed on economic farm gate outcomes.

Critical Success Factors

R&D Community needs to develop positive marketing campaign to growers on features and benefits and become more commercial in the delivery of R&D.
Co-ordination of activity is somewhat restricted by State boundaries and needs managing

Issue 3: Farm Returns

The rationale for mechanical harvesting was defined as the need to obviate the difficulties associated with the seasonal rural labour force and overcome the economic pressures that have steadily decreased margins as major retailers control the supply chain.

Specific areas of workforce difficulties include:

- Seasonal nature of work requires training each season
- Workforce tends to be itinerant and not always reliable
- Workforce costs have increased 15 to 20% over the past 5 years
- Workforce quality has to be improved to meet market requirements
- Competition for workers requires changes to way work is done

Farm gate returns have decreased as the supply chain has placed pressure on competitive position including the direct imports of vegetables. Imports of vegetables now represent about 40% of the frozen vegetable sector. This has an estimated value of $200 Million. Other imports are into the food service sector for broccoli and cauliflower florets and the manufacturing sector for broccoli and potato products. There is a general lack of awareness of international benchmarks for production costs except for those who are serious exporters and particularly exporters who have lost markets to developing countries. The recent spate of imports has raised awareness of international competition but there is a lack of quantification of international competitive position. However the competitor is mainly perceived to be other Australian growers who “cut prices”.

The general opinion is that for most crops there is little room to move in reducing growing costs and that harvesting and scale of operation are the only factors that can now be influenced. There is some evidence that in crops such as broccoli the economics of growing are positively affected by increased marketable biomass. Thus the cost per kilogram for growing is spread over a larger volume and hence is reduced.

Critical Success Factors

Agronomic practices need to have a greater focus on harvestable, marketable quality biomass production when being developed as part of a total system.

Defined labour inputs need to be reduced not just for cost reasons but also for competitiveness of labour supply and quality and reliability factors.

Awareness of international competitive position should form part of the Industry Development Program.

Issue 4: Role of Government

In some areas such as Tasmania and Werribee, Government policy may need to be reassessed with respect to land use and the economic size of viable farm units. Werribee growers are impacted by a so called “green wedge” that has been impacted by encroaching urbanisation and government policy that prevents subdivision and thus the movement of growers to more viable areas.

There is a widespread lack of appreciation of government funding and grants available for assisting growers to expand processing and introduce higher levels of technology. This also extends to those advising growers. Generally the process of accessing grant funds is time consuming and requires skilled inputs for grant applications to be professional and competitive.

A condition of most grants is that of increasing employment. Given the above situation regarding rural labour the application of various guidelines should be reviewed with respect to farm labour increases as the main intent should be to increase more skilled positions while decreasing the overall labour content of processes.

Growers and Processors expressed the view that the creeping impost of the regulatory environment and paperwork was becoming a major cost component. One processor had costed this at an equivalent to $70/tonne of product processed across a range of produce processed.

Critical Success Factors

Peak Industry Bodies should assist growers who are impacted by local and regional government policies that impact on farm viability.
Growers need a higher level of awareness of external funds that could be accessed for expansion or introduction of higher levels of technology.
Governments need to change policies toward rural employment with respect to grant applications.
Review of regulatory costs imposed on small businesses as is extolled in both Commonwealth and State policies.

Issue 5: Scale of Operation

Production trends appear to be steadily moving toward larger growers gaining economies of scale for more specific crops and smaller growers who are specialising in higher value crops with further processing increasing returns. This trend has a profound effect on the type of agronomics employed, the scale of the harvester required and the support infrastructure.

Many smaller growers and multiple crop growers indicated the need to have flexibility built into mechanical harvesters to prevent over capitalisation. The need was defined as a base platform to which could be added multiple harvesting heads. Specific crops that would benefit from these machines would be spring onions, parsley, coriander and other herbs.

Critical Success Factors

Focus on mechanical harvesting and agronomic practices that are relevant to the type of crop and size of the production unit.

Develop facilitation mechanisms to allow non viable units to exit the industry as was done with the regulated Dairy and Sugar Industry sectors.

Issue 6: Water

The primary issue is water. Australian growers are being held back in competition with offshore growers because the infrastructure and bureaucratic restrictions on water use stop them from having sustainable cropping methods. In the closest competing market, New Zealand, Growers have large water resources which have been harnessed for electricity generation giving the Grower greater ability to manage their growing seasons.
This and the size of entities is one of the reasons that Australian Growers have recently lost contracts for 50,000 tonnes of potato to New Zealand. Other issues include financial support for investment in farm infrastructure. This has several levels of effect on the ability to produce. Most contracts are for a 12 month period making it difficult for a Grower to convince a lending body that they can produce a sustainable business plan.

There is continuing application of recycled city water but generally there is a lack of will on the part of State Governments to promote this source and assist in Infrastructure development. There is a strong Commonwealth commitment toward water schemes and considerable Grant funding is available under the Smart Water Program.

Critical Success Factors

Lobbying of State Governments with a substantiated Industry Plan would provide a platform for wider use of recycled water.
Promotion of increased water storage capacity both on and off farm with incentives to adopt these practices unencumbered by the effects of the environmental lobby.

Issue 7: Funding Decisions

At some point in time Industry will have to face a difficult decision process whereby assistance is provided at a higher level to the leaders of a particular industry sector. This has a lot of implications with respect to the existing funding processes and the levelling influences that result from peers evaluating the funding proposals. Interestingly only one Grower promoting mechanical harvesting had accessed HAL funding for a large scale development project. A General view was that the process was too difficult to access. There seemed no specific support for this view.

Critical Success Factors

Funding has to be applied to total system development within a competent existing Grower infrastructure despite any competitive advantage provided using expanded VC type funding that is more accessible. In conjunction with this is the necessity to expand extension activities.

Key Issue Area: Social

Issue 1: Regional Culture

There are marked differences between areas visited with respect to culture, beliefs, values and expectations. The spectrum from complete negativity with respect to the competitive position of Australian growers to complete optimism was experienced. Most of the larger growers involved in export, despite considerable set backs (particularly in Sth East Asia) were optimistic about the future. Growers who were closely linked to the retail supply chain tended to be more optimistic than those who were not. Almost all growers considered the major retailers had markedly influenced farm gate returns for the worse as prices were relatively constant and costs had increased. Other factors were quality requirements and individual packaging without increased returns.

It was considered that the internalising of these economic problems was related to historic and embedded aspects of culture and in turn these contributed to much of the negativity. An outcome of this appeared to be a lack of understanding of market forces and the need to benchmark to national and international standards. It would be fair to say that inter and intra regional competition was considered more important than importation of products despite the recent publicity to the contrary.

Issue 2: Leadership

Within the most progressive Growers encountered there was considerable leadership directed internally to enhance competitive position and inspire confidence. This is seen as a major driver for the adoption or development of new technologies and attitudes toward marketing. Examples were encountered in broccoli, leafy salad vegetables, carrots, leeks and other salad vegetables. It appears that the executive of AUSVEG are providing a degree of leadership with respect to Industry Issues.

Critical Success Factors

Increase Industry participation in the Rural Leadership Program.

Key Issue Area: Environmental Systems

Issue 1 Environmental Standards

Generally the Industry is well advanced in Environmental Issues. HAL has provided considerable leadership in managing the “Pathways to EMS in Industry Program” and AUSVEG has made a significant contribution toward industry adoption. The concern expressed by Growers related more to the bureaucratic processes they faced at Local and State Government levels. These processes created uncertainty in decision making and were very time consuming.

Issue 2 Agronomic Factors

Climatic Diversity was highlighted as an issue with respect to any R&D program in mechanical harvesting. It was also a factor to be considered in relation to regional cropping density and IPM recommendations. Examples given were in broccoli grown on the Darling Downs may require different inputs to those of Tasmania and carrots in WA vs growing in Vic.

Key Issue Area: Industry Capability

Issue 1: Quality Assurance

The cost of compliance and time wasted is an issue with Grower/Processors who supply a number of customers each of whom has differing quality system requirements. A further imposition is that of AQIS with respect to exports. In particular there is criticism of the individual variation of AQIS inspectors and the limited access to higher authority to challenge decisions. AQIS certified exporters who carried out their own phytosanitary work were generally less critical. However they did express the view that Australian Grower/Exporters had to meet much higher standards from within Australia than did Asian producers. For example China shipped broccoli in boxes using re-used PET bottles as the source of ice or chilled water.

Critical Success Factors

Customer acceptance of a standard QA system and the results of third party audits across the industry.

Standardisation of AQIS requirements and application of standards.

Increasing AQIS awareness of the competitive environment and disparity in standards across Asia.

Issue 2: Business Structures

A feature of the David McKinna report was the conclusion "*that it is unrealistic to expect growers (either individually or as a consortium) to undertake a major processing project producing consumer ready, packaged, branded products in a processing operation which will compete head on with major multi-nationals which dominate the industry".* To obviate such a collision the minimal processors of vegetable products have carved out their market shares and are growing in volume through their own production capacity and establishment of Grower networks. It is a realism that this business model will be the way forward with other Growers being forced to remain in a dwindling central market system.

The issue of capability derives from the funding requirements for both growth and the R&D for innovative least cost technologies. This is an area where a systems approach that includes these key players is necessary for future funding.

Critical Success Factors

Increased R&D into minimal processing technology to increase capacity that will be required by expanded mechanical harvesting.

Bibliography

A considerable number of web sites and farming publications were examined in this study. Further reading may assist persons wishing to adopt the recommendations or use the content of this report and selected reports for this purpose are indicated in the list below.

- Adding Value: the critical factors for farming. Authors: Richard Stayner and Brendan Doyle. RIRDC Publication 04/047
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- The World Cosmetics and Toiletries Market: Strategy 2000. Euromonitor PLC

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