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Transfer of postharvest technology for fresh vegetables to exemplar growers

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A report prepared for NZ Vegetable and Potato Grower's Federation

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1 Executive Summary

In 1996, the New Zealand Vegetable and Potato Growers Federation (Vegfed) contracted Crop & Food Research postharvest scientists and technologists to implement an extension programme to upgrade the postharvest technology base of vegetable growers to improve the quality of produce in the market. Financial support was provided by Technology New Zealand.

During the project, Crop & Food Research staff consulted to 34 'exemplar' growers selected by Vegfed, regarding produce handling for 24 major vegetable crops. Each grower, from one of 13 regions throughout New Zealand, was provided with a report at the end of the consultation. Each report contained a summary of the crop studied, observations made during the visits, the results of any specific research projects undertaken, recommendations for modifications to the grower's harvesting, packing or storage procedures and relevant reference material. At the completion of the consultancy in each region, Vegfed arranged a grower seminar in which growers were encouraged to pass on the knowledge they had gained from their participation in the project. These growers were also encouraged to informally discuss the produce handling concepts highlighted in their report with other growers in their region.

Aspects of produce handling which were considered included:

- coolchain management
- precooling options
- weight loss
- humidity control
- physical damage
- sanitation and food safety
- ethylene
- sprouting
- packaging

A range of postharvest technology tools was used to assist the scientists in measuring the influence of each of these factors on produce quality.

Gauging the impact of the project on growers was difficult. However, from interviews with the original three Horowhenua growers who participated in the project, it was clear that the project had influenced their understanding of many of the principles involved in produce handling and that they have implemented changes such as the installation or upgrading of coolstore facilities as a consequence.

The project concept has potential for incorporation into quality activities in other sectors such as packing fresh produce and organic production.

2 Introduction

In 1995, the New Zealand Vegetable and Potato Growers Federation (Vegfed) recognized a serious problem in the presentation and marketing of fresh vegetables. In a consumer survey, they discovered that 25% of consumers were dissatisfied with the freshness and quality of produce available for retail sale. Further investigation revealed that this problem was arising because of inadequate adoption of modern postharvest handling technologies by businesses involved in handling produce.

In 1996, Vegfed contracted Crop & Food Research postharvest scientists and technologists to implement an extension programme to upgrade the technology base of growers to improve the quality of produce in the market. Financial support was provided by Technology New Zealand.

In the project, Vegfed selected up to three growers (described as 'exemplars') in each of 13 regions across the country who grew at least one of the important vegetable crop types. We visited these growers, observing how their overall operations affected the quality of their produce. The growers were introduced to new and existing postharvest technologies and encouraged to adopt or upgrade practices that were appropriate to their operation. The growers were asked to transfer general information gained from participating in the project to other growers, both through 'over–the-fence' discussions and through grower seminars conducted at the end of the consultancy period in that region.

The contract for Technology New Zealand funding for the project expired on 30 April 2000. This report summarises the activities undertaken as part of the project, highlights some of its successes, and assesses the impact of the project on the quality of fresh vegetables which are supplied to consumers by members of Vegfed and the profitability of these growers involved.

3 Summary of activities

The table below summarises the coverage of the project by region and by vegetable type.

Region	Year of visit	Crops studied
Northland	1998	pumpkins, kumara, broccoli
Auckland	1998	glasshouse capsicums, cantaloupes, hydroponic lettuces
Pukekohe	1996/97	potatoes, cabbage, silverbeet
	1999/2000	onions, cauliflower, spinach
Waikato/Bay of Plenty	1997/98	cabbage, cauliflower, broccoli, leeks, outdoor capsicums
Ohakune	1998	carrots, parsnips, Brussels sprouts
Wanganui/Manawatu	2000	lettuces, yams
Gisborne	2000	export rockmelons, beans
Hawkes Bay	1999	broccoli, cauliflower, lettuces
Horowhenua	1996/97	lettuces
Nelson/Marlborough	1998	garlic, celery, lettuces, cauliflower
Canterbury	1998	pumpkins, parsnips, glasshouse capsicums
Otago	1999/2000	Brussels sprouts, gourmet potatoes, silverbeet
Southland	1999/2000	yams, swedes, carrots

We visited a total of 34 growers and consulted on 24 different vegetable crops. Operations visited were generally small to medium-sized family-owned businesses, supplying to local retailers, to supermarket chains and occasionally to auction floors.

Initial contact with the growers was made by phone, often with a subsequent visit to discuss the project, and to provide an opportunity for the grower to ask questions. On a further visit, the scientists observed the produce handling procedures used by the grower. On many occasions, customised projects

were developed with the grower, to investigate specific aspects of the grower's production system.

Aspects of produce handling which were considered included:

- coolchain management
- precooling options
- weight loss
- humidity control
- physical damage
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- ethylene
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- packaging

Coolchain management is recognized by both Vegfed and Crop & Food Research scientists as a key component in improving the quality of fresh produce and as such, it was a primary focus of the project. On many occasions, we monitored temperatures both on-farm and during transport between the grower's property and the buyer. We were often able to continue this monitoring through to the retail store.

Tools used in measuring the influence of each of these factors included:

- temperature and humidity dataloggers
- digital temperature probes
- whirling psychrometer (humidity)
- digital balance (weight loss)
- small-scale demonstration forced-air cooling unit
- airflow meter
- instrumented recording device (damage)
- camera

Crop & Food Research scientists conducted a number of experiments for growers, either on-farm or at Crop & Food Research's experimental storage facility in Levin and more recently in Palmerston North.

Each grower who participated in the project was provided with a confidential report, summarizing their produce handling procedures, providing them with the results of any monitoring or experiments and recommending any appropriate changes to their handling procedures. Often additional reference material was also provided. Follow-up visits were used to provide an opportunity for growers to give feedback to the scientists and to discuss the report.

Vegfed organized grower seminars in all regions except Gisborne. At these seminars, one or two Crop & Food Research scientists presented the results of the project in that region. They discussed the principles of produce

handling, using illustrations of specific grower's data with their permission. Growers who had participated in the project in that region were invited to contribute to the seminar.

Vegfed commissioned Crop & Food Research to write a report for growers on systems for removing field heat from fresh produce, which is the most direct way in which growers can influence temperatures during transportation of their produce. The report, entitled 'Rapid cooling of fresh vegetables on farm', summarizes the main types of cooling systems that are currently available. It also provides:

- a comparison of the cooling systems
- options for the design of forced-air cooling systems
- rules of thumb for calculating the physical size and refrigeration capacity of a forced-air cooling system that a grower would require
- guidelines on the management of a forced-air cooling system
- references

Copies of this report were provided to a number of growers and further copies are available from the Vegfed office or the authors.

4 Significant observations

For a number of years, Vegfed has been developing a Quality Assurance Programme for the commercial vegetable industry. An increasing number of growers, packhouses and transporters are registering for the 'Approved Supplier' status necessary to belong to the Quality Assurance Programme. Some buyers are already stating that they will not purchase non-QA registered produce. The Vegfed QA Programme Manual includes a Code of Best Practice for growers, with recommendations on produce handling which mirror many of those made to growers during the Exemplar Grower project. The manual also refers to the 'Rapid cooling of fresh vegetables on farm' report mentioned above.

4.1 Marketing of fresh produce

Although this project was aimed at addressing produce handling issues, rapid changes in the way that the fresh vegetable market operated occurred during the project and are ongoing. These changes affected the nature of many of the grower operations that the scientists visited and made many of the issues discussed of even greater relevance than initially thought.

In recent years, there has been a rapid increase in the number of growers selling pre-ordered produce, rather than harvesting and selling via the auction floor or hoping that orders will arrive during the day. Supermarket chains are the largest buyers of vegetables and they are developing 'preferred supplier' relationships with many growers. The expectations of supermarkets in terms of the quality and availability of vegetables provided is increasing. Many

supermarkets are probing produce to ensure it meets their temperature standards. They have rejected some produce on this basis.

In Auckland, the market is rather different from markets in the rest of New Zealand. Here, independent retailers have a majority share of the retail vegetable market, but this situation may change rapidly.

A few growers that we visited marketed their reputation for the supply of locally-grown produce, harvesting only one or two hours before supplying directly to the retailer.

A number of the growers that we visited appeared to be reassessing their participation in the vegetable industry. They saw that vegetable growing was becoming less profitable because the prices they received were static while their production and compliance costs were increasing. Often they were concerned that none of their children were interested in vegetable growing the their business would be hard to sell.

4.2 *Harvesting and packing procedures*

Most produce was harvested during the morning, graded and packed into vegetable crates, palletized and either sent straight to market or held on-farm for a few hours. Some growers harvested into bulk bins, avoiding the additional cost of crate hire charges.

Very few growers owned or had access to cooling facilities that were capable of cooling produce below 10°C within 5 hours. Consequently, a vast majority of produce was stored on the grower's property at temperatures well above those which are optimum for their storage.

Growers varied in their understanding of the influence of handling damage on fresh produce, particularly the fact that bruising, crushing or abrasion damage may not be visible until after the produce has left the grower's property. We were able to demonstrate this in a number of storage experiments. Issues which we noted in reports to growers included:

- overloading of crates (crushed produce)
- rough handling of crates (bruising damage)
- excessive time in washers (abrasion and bruising damage)
- pallet loads of produce collapsing (bruising, crushing, hygiene)
- field bins falling off tractor forks (bruising, crushing, hygiene)
- large drops on grading lines (bruising damage)

On several occasions, we used an Instrumented Recording Device (IRD) to evaluate the potential for impact damage to fresh produce being harvested or packed. An IRD is a 65 mm diameter sphere which contains three accelerometers which measure the magnitude and direction of impacts to which it is subjected. Previous overseas and New Zealand-based research has identified 'damage boundaries' for a range of produce which are useful in analysing output from the IRD.

We used the instrument on potato, tomato, carrot and parsnip packing lines and identified high damage potential areas in a rotary washer, drops between

sections of a potato grader and during size grading of carrots. We made recommendations for modifications to these lines to each of the growers involved, including reducing the time that produce spent in a rotary washer, removing or modifying drops on packing lines and the use of high-density foam to cushion impacts.

Wilting can occur in produce after as little as 3% weight loss. We measured weight loss as high as 7% in a matter of only a few hours. Effective coolchain management and covering produce with wet sacking or equivalent during and after harvest will reduce weight loss significantly.

Many on-farm chillers were either refrigerated shipping containers or converted supermarket chillers with small evaporators, which generally result in inadequate cooling and low humidity. Low humidity can cause excessive weight loss, which can be reduced by covering the produce or upgrading the chiller with a larger refrigeration system.

Sanitation and food safety are becoming important components in the production and marketing of fresh produce. Supermarkets are developing Hazard Analysis Critical Control Point (HACCP) procedures, which will require suppliers to have supporting procedures in place as well. The main areas of on-farm concern were:

- the collection of soil from the field on the bottom of crates, which may then be transferred to fresh vegetables
- the quality of wash water on grading and packing lines

We provided advice to a number of growers on improving their sanitation procedures, including avoiding placing crates on wet soil, washing the soil from crates after harvest, daily or twice daily replacement of wash water and the addition of sanitizers to wash water and its monitoring. Several growers were referred to suppliers of commercial sanitizers.

We considered that ethylene was not generally a problem on-farm. However. we did advise a number of growers to remove rotting produce from storage areas, particularly chillers, and to avoid running vehicle engines in confined spaces where produce was kept.

Sprouting can be a problem in tubers (potatoes, yams and kumara) as well as some other crops such as onions. In general, temperature management can limit sprouting when storage periods are relatively short.

We provided some advice on packaging options, such as shrink wrap plastics for capsicums.

4.3 *Transport to market*

Most growers transported their vegetables from their properties to a produce distribution center using commercial transporters. Most transporters provided curtainsider trucks, with an increasing number of these being refrigerated. Other growers delivered their own produce either to a produce distribution centre or directly to the retailer. Few growers owned curtainsider trucks, with some of them covering their loads with tarpaulins instead, but others use no cover at all. Generally, this was for short-haul delivery of 30 minutes or less.

Monitoring during the project showed that even refrigerated curtainsiders cannot be expected to reduce the temperature of produce. Clearly, removal of field heat before transport to market is the best option for retaining shelf-life and quality.

4.4 Buyers and retailers

We spoke to a number of buyers and retailers of fresh produce during the project. Support for the project varied. When asked about the value to a grower of providing precooled produce, the answer was generally 'We will continue to buy from that grower if they precool it.' Some independent retailers were very cost-driven and saw the cooling of produce as unnecessary.

Some growers had established relationships with brokers, buyers and retailers who were interested in the results of the monitoring and who were planning to upgrade their coolstore facilities. Other buyers and retailers seemed either intimidated or unconcerned. One retailer held the grower's lettuce in the full sun for nearly an hour, then said 'You should have been here yesterday when it was 40°C. You could see the produce wilting'.

5 How did the project influence the growers?

To gauge changes that growers may have made to their operations since their involvement in the project, in early 2000 Crop & Food Research scientists visited the same three growers in the Horowhenua, initially visited in 1996/97. All three growers had at least a basic understanding of the principles of produce handling and their operations reflected this. However, their participation in the project provided them with:

- quick access to more detailed postharvest information and
- relatively simple experiments which demonstrated how ungrading their produce handling procedures could improve their business

Two growers considered that the project had convinced them of the value of investing in improved coolchain management. One of these growers owned a small chiller before the project. He has since invested approximately $100,000 in new coolroom space. This new facility is already at capacity and the grower is considering further expansion. He is selling to a number of buyers who will only purchase pre-cooled produce. He has also implemented a range of other practices such as regular checks of produce temperatures with a digital probe and the use of wet capillary matting to cover his harvested produce, as a result of recommendations in his report.

Before his involvement in the project, the second grower had no cooling facility. He considered such an investment too expensive. Since then, he has built a large cooler for leafy greens and brassicas and considers that he could not run his business without it. He is now able to store brassicas on-farm for

up to five days, with little loss of quality. He also supplies to a buyer who purchases only precooled produce.

The third grower has also built a new chiller with a larger capacity than his existing one. He considers that he was moving along the path of improved coolchain management, regardless of the project, but that his buyers are more aware of its importance, as a consequence of the project.

Monitoring undertaken during the return visit showed that all three growers were achieving temperatures between 3 and 10°C in less than five hours, compared to between 5 and 18°C three years previously. The most impressive improvement is for the grower who did not previously have a chiller. The volume of produce grown and sold by all three growers has increased significantly.

6 Future work

This project adopted the concept of consulting with 'exemplar' growers as a means of delivering technology transfer. Its success lay in facilitating a change in the mindset of growers involved in the project and others who were influenced by attending the regional seminars, speaking to a participating grower reading articles in 'Commercial Grower' or other means.

This demonstrates that the exemplar concept is useful where the aim is to expand an industry's understanding and adoption of established principles through one-on-one discussions and relatively simple measurement of the impact of its adoption.

We believe that Vegfed could expand the use of this concept beyond the handling of fresh vegetables, with equal success. Two examples are:

- supplying produce to the expanding organic market is limited by the production knowledge of interested growers. The 'exemplar' concept could easily be adopted to deliver this knowledge to those growers
- during the Postharvest Exemplar grower project, Crop & Food Research demonstrated the occurrence of physical damage to potatoes during grading and packing. We used the Instrumented Sphere to measure the size of impacts on a limited number of packing lines. The exemplar concept could be used to extend this work to a larger number of packhouses.