

Shelf-life extension of leafy vegetables (PHT/1994/016)

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Collaborating organisations	Queensland Department of Primary Industries and Fisheries (QDPIF), Australia; Agriculture Victoria (now called DPI Victoria), Australia; University of Adelaide (UA), Australia; Hangzhou Institute of Commerce (now called Zhejiang Gongshang University (ZGU)), China; Beijing Vegetable Research Centre (BVRC), China; Zhejiang University (ZU), China
Project leaders	Dr Timothy O'Hare (QDPI), Li Wu (BVRC)
Related projects	-
Principal researchers	Mr Bruce Tomkins (Agriculture Victoria), Dr Andreas Klieber (UA), Prof. Shen Lian-Qing (Hangzhou Institute of Commerce)
Duration of project	1 July 1998 to 30 June 2001, extension 1 July 2001 to 31 December 2002
Total ACIAR funding	\$893,898

Project objectives

- Assessment of existing Chinese handling systems and quantification of existing handling problems for Chinese cabbage, pak choy, broccoli and oriental bunching onions
- Optimisation of environmental conditions to extend shelf life
- Identification of inherent physiological factors limiting shelf life

Although a major part of the project was to identify issues that limit shelf life in the Chinese handling systems, and the development of fundamental knowledge of vegetable physiology controlling senescence, part of the project was aimed at testing potential means of increasing shelf life through novel postharvest treatments or handling systems. It was expected that some of these would be effective and some would not be feasible.

Location of project activities

China

Overview

Project PHT/1994/016 involved working with two groups in different localities with different issues and differing postharvest handling systems for leafy vegetables. Researchers from these groups used postharvest handling system methodology to analyse the existing handling systems and identify limitations and where losses were occurring. Based on this, and on techniques introduced from Australian industry, several improvements in handling chains were achieved, not only in Beijing and Zhejiang provinces but also in surrounding areas and, in some cases, in other major distribution centres that had linkages to industry in the project area.

Although the project concentrated on specific vegetables (i.e. Chinese cabbage, pak choy, bunching onions), many of the improved handling techniques have been transferred to other vegetables, most of which are of higher intrinsic value and constitute up to 80% of total vegetable production. Considering the size of these industries (relative to Australia), there has been considerable monetary benefit.

Apart from direct benefit to industry, benefits also accrued to the research groups, which have received considerable recognition from both government and industry. Project PHT/1994/016 in many ways acted as a catalyst for postharvest research in these provinces, resulting in further research projects in collaboration with government and industry.

Project achievements

Project PHT/1994/016 successfully introduced forced-air cooling and refrigerated transport into the Beijing distribution centre handling systems, which handle 10.75% of vegetables in the Beijing region. In addition, the use of returnable stackable crates (to reduce mechanical injury to vegetables and subsequent rotting) for growers and collectors is now widespread. Moisture loss from leafy vegetables, which causes wilting and weight loss, has been significantly minimised through the use of plastic film liners in the stackable crates that can be wrapped over vegetables.

Losses in stored bunching onions have now been reduced through the introduction of refrigerated storage for 20% of production, while 40% of those still stored using ambient storage conditions now use insulated foam-rubber blankets to minimise freezing injury.

Reduction of mechanical damage of Chinese cabbages that are bulk transported in the Zhejiang region (80–90% of production) has been implemented by a modification of the outer leaf removal procedure. Further mechanical damage and rotting has been reduced for more valuable products (the remaining 10% of the Chinese cabbage industry, pak choy, most other vegetables grown) through the widespread use (in 60–70% of entire vegetable industry) of plastic-mesh bags supported by metal frames.

Reduction of mechanical damage and subsequent rotting in summer has also been implemented in the pak choy industry through the use of controlled moisture loss, with 75–80% of the industry (where workshops were performed) adopting this practice.

Numerous extension workshops have been carried out by BVRC in Beijing, concentrating especially on the four large major distribution centres. Workshops in the Zhejiang region, where distributors tend to be smaller and are often growers themselves, have been directed at growers (including the Nanjing military region) via the local agriculture extension networks.



Plastic film liners used in these stackable crates for bok choy help reduce moisture loss.

The difference the project has made

Adoption of forced-air cooling combined with refrigerated transport by Beijing distribution centres has enabled them to extend the shelf life of produce such that high-quality produce can be presented to consumers through high-quality stores. Consumers pay more for this produce so there is increasing profitability to the distribution centres, which maintain ownership of product in supermarkets until it is sold to the public. The distribution centres pass some of this profit on to growers in the form of an annual bonus. The basis for this is so that the distribution centres remain on good terms with good growers. Similarly, the use of returnable stackable crates and film overwraps has decreased mechanical damage during handling, and moisture loss where wraps are used. This results in both a reduction in loss of saleable weight and an increase in quality. Both these factors increase profit with negligible outlay because the initial cost of the reusable crates is borne by the distribution centres. Increased (gross) profit by the four distribution centres over the last 3 years is estimated at approximately ¥5.3 million (~A\$900,000).

In regard to improved storage of bunching onions, refrigeration has eliminated freezing injury and insulation blankets have reduced freezing losses, which were originally about 40% of stored product. Therefore, more product is available to be sold by growers and collectors, and, as with the stackable crates, the blankets are reusable.



Protective leaves are left on broccoli to help reduce damage during field handling.

In the Zhejiang region growers also tend to be the distributors, so directly accrue benefits where losses have been reduced. Reduced damage to Chinese cabbages transported in bulk, as well as reduced damage to higher value vegetables packaged in plastic-mesh bags supported by metal frames, has led to a direct increase in return to growers in the order of 10–20%. Plastic mesh can be reused and easily repaired by growers. Controlled moisture loss (for pak choy only) reduces leaf turgor, and thus petiole damage and subsequent rotting during packing and handling. This is a relatively simple procedure that costs the grower virtually nothing, and moisture loss can be regained once transported to the marketplace.

Project impacts

Apart from direct impacts on the supply chains in the Beijing and Zhejiang regions, other impacts included flow-on savings to distribution centres and collectors in other main centres (Guangzhou, Shenzhen, Kunming, Shanghai). The reduction in loss has been estimated to be approximately ¥131 million (~A\$21 million) over the last 3 years.

The impact of the project itself on BVRC research staff has been substantial. Closer contact with industry has resulted, and better budgeting and staff/project management skills have secured more projects from the Chinese government (to the value of ¥2.8 million). The BVRC postharvest group has the highest funding of all groups at BVRC. In recognition, BVRC has also had a direct advisory role on vegetable supply during the Beijing Olympics in 2008. The project has been described as a catalyst for the group, with increasing interest from both government and industry. A direct impact of the project was recognition of the potential for fresh-salad and stir-fry packaged fresh-cuts (from the Australian component of the project), resulting in a ¥1.8 million research project. It has been recognised that the direction of research has had to change to areas of growth and potential.

In Zhejiang the project had an accelerating effect on the development of postharvest technology at the Zhejiang Gongshang University (ZGU) and resulted in the development of a postharvest laboratory in a new university (Zhejiang University of Science and Technology). A number of students involved in the project are now employed as lecturers in these two universities. The postharvest handling systems assessment section also developed considerably closer ties with the extension arms of the many countries in which the research results were extended in workshops. The research methodology relating to improved handling practices is still being promoted by these groups.

From: Gordon, J. and Davis, J. (eds) 2007. Adoption of ACIAR project outputs: studies of projects completed in 2002–2003. ACIAR: Canberra.