Horticulture Innovation Australia

Final Report

Global scan for vegetable innovation - Fresh and Minimally Processed

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1. SUMMARY

The Australian vegetable industry aims to increase its vegetables' attractiveness and competitiveness as exports to Asian markets. To achieve this, research into the various types of innovation used within the vegetable industry was conducted to identify new, relevant and commercially viable solutions to assist Australian growers.

A global scan of vegetable innovations – ranging from packaging and value-adding to new products and other initiatives – was conducted from April 2014 to January 2015 as it applied to fresh and minimally processed vegetables. From 40 global innovations identified, a deeper investigation into 10 innovations shortlisted by Horticulture Innovation Australia (HIA) was implemented, to include further profiling and evaluation. Trade interviews with major industry stakeholders such as government officials, trade associations, growers, importers, wholesalers and retailers were conducted in markets where an innovation was first conceptualised and/ or commercially available. These interviews helped shed light on the market innovations, especially with a view to understanding their compatibility with Australian produce and their effectiveness at enhancing Australian exports to Asian markets.

Innovations shortlisted and profiled in this study have high applicability and relevance to Australian growers looking to differentiate themselves from lower-priced, locally grown Asian produce. New infrastructural developments and the modernisation of grocery retailing channels coupled with rising consumer affluence across Asia will create a retail and operations environment more conducive to helping Australian growers benefit from the adoption of select vegetable innovations.

2. KEY WORDS

Geographical: Global
Product category: Fresh and minimally processed vegetables
Innovation types: Shortlisted innovations selected for profiling fall into one of the following categories:

- Packaging refers to the enclosing of products for distribution, storage, sale and use. Innovations may refer to packaging materials, formats or production processes.
- Value-adding refers to economically adding value to a product by changing its current place, time and form characteristics to characteristics more preferred in the marketplace (e.g. mixed salad greens, baby carrots).
- New products refer to commercially proven and market-ready new products that require minimal processing (e.g. banana flour).
- Niche supply opportunities refer to commercial opportunities targeting specific market needs or wants (e.g. hydroponic plants).

3. INTRODUCTION

3.1 BACKGROUND

Globalisation has paved the way for the increased availability, flow and competition of new food suppliers to travel further and deeper into markets. For the Australian vegetable industry to remain attractive in global markets, it is important to identify key innovations to enhance its overall competitiveness. An investigation into vegetable innovations was conducted to identify viable opportunities applicable to the Australian vegetable industry.

Following a tendering process in which Euromonitor International Ltd was successful, Horticulture Innovation Australia (HIA) Ltd contracted Euromonitor International to conduct the necessary market research to identify and evaluate innovations which may be suitable for the Australian vegetable industry.

3.2 OBJECTIVES

Euromonitor undertook this project to fulfil the following research objectives:

- To understand key innovations used around the world to enhance the attractiveness and competitiveness of fresh and minimally processed vegetables
- To identify and profile 10 select innovations which may be best applicable to local growers for the purposes of enhancing and value-adding to Australian produce
- To evaluate how the shortlisted innovations can be exploited in Asian markets.

3.3 REVIEW OF LITERATURE AND OTHER RELATED RESEARCH

Information from various government sources and statistics agencies was incorporated into this report. Online articles, locally sourced publications and trade press were also used during the phase of research analysis. Other related sources consulted encompassed comprehensive market findings derived from trade interviews with major industry stakeholders (including government officials, trade associations, growers, importers, wholesalers and retailers) coupled with extensive store audits. Research fieldwork was conducted between April and December 2014, in country markets where shortlisted innovations were first conceptualised and/ or commercially available, such as the United States, the United Kingdom, Germany, South Korea and China.

3.4 IMPLICATIONS FOR THE INDUSTRY AND LIKELY IMPACT OF THE RESULTS

The research findings will help identify which shortlisted innovations are best suited for use in Asian markets, as well as the challenges which may be associated with their implementation. Innovation profiles serve to provide deeper insights into the mechanics of each innovation and to provide an overall evaluation of usage opportunities for growers.

4. METHODOLOGY

A multi-pronged research approach including desk research and trade interviews with key stakeholders – both upstream and along the vegetable distribution supply chain – was undertaken for the purposes of this study. Research was undertaken by regional and in-country analysts, allowing Euromonitor International to generate a robust set of findings and opportunity evaluations for HIA and Australian growers.

The following methodology was undertaken to accomplish the research objectives set out above for the study.

4.1 DESK RESEARCH

Euromonitor conducted a review of all published information to build up the preliminary background and insights for each innovation type, accessing published and online sources, in English and local languages:

- Euromonitor's own published information on fresh food markets
- Previously published HIA reports
- Published commentary on vegetable innovation trends
- Published commentary on Australian and competing countries' vegetables
- Reviews of locally published sources such as trade press, association reports, government reports, importer websites, etc.

4.2 TRADE INTERVIEWS

Euromonitor conducted semi-structured trade interviews to generate opinions and insights from existing and identified contacts across the vegetable supply chain for each shortlisted innovation. Responses were collected and aggregated to evaluate the overall effectiveness of each innovation in enabling Australian-grown vegetables to become more attractive and competitive in global markets.

Trade interviews were conducted with identified contacts to gain up-to-date and accurate insights in order to create Euromonitor International's analysis addressing HIA's objectives:

- Government officials (2)
- Companies (eg: packaging companies) (15)
- Retailers (4)
- Growers (8)
- Other industry observers and relevant contacts (1)

4.3 ANALYSIS

Euromonitor cross-checked all sources and interpretations and performed an in-depth analysis of all fieldwork output to ensure that its deliverables addressed HIA's immediate objectives and set the stage for longer-term objectives.

An analysis framework with the qualitative measures 'High', 'Low' or 'not applicable' based on overall insights and evidence procured from trade interviews, was used to evaluate the compatibility of each innovation across a range of commodities, the cold chain/ logistics network and the retailing landscape.

- Compatibility to commodities refers to the suitability of the innovation with respect to specific vegetable groups such as leafy, non-leafy and tubular vegetables.
- Compatibility to cold chain/ logistics refers to the capability of existing cold chain/ logistics in the markets considered (i.e. Australia, Developed, Developing) to support the innovation
- Compatibility to retailing landscape refers to the capability of existing retailing landscape (traditional or modern retailing formats) to support the innovation.

The above compatibility was juxtaposed vis-à-vis the domestic Australian market and also other markets in Asia grouped as developed (comprising of markets such as Japan, South Korea, Singapore and Taiwan) and developing (comprised of markets such as India, Malaysia, The Philippines, Thailand and Vietnam etc).

5. OUTPUTS

In accordance with the agreed-upon deliverables of the study, Euromonitor prepared the following outputs as listed below:

- A written report (this report) inclusive of media summary, research background and methodology and relevant research insights pertaining to the study objectives as listed in the previous pages.
- Seven innovation brochures for innovations that presented the best opportunities for growers (included in section 9.2 of this report and also submitted separately in pdf format) to be distributed to growers and relevant stakeholders.

6. EVALUATION

Asia as a geographical region includes diverse country markets and consumer groups. The rapid development of its economic prowess in the past decade has seen the emergence of global heavyweights such as Mainland China, which currently plays a major role in financial markets, manufacturing sectors and global food production. Historically, inter-region vegetable trade between Australia and Asia has been strong. But competition from Asian markets due to the unparalleled rise in agricultural output, high productivity and the wide availability of arable land for vegetable production has reduced the overall attractiveness of Australian produce. However, key characteristics observed across Asia suggest that Australian-grown vegetables can remain competitive and retain their strong value proposition through the selective adoption of innovations detailed within this study.

Stronger supply chains in Asia will support the adoption of innovations

Enhanced infrastructural networks across Asian markets would allow for the strengthened cold chain storage vital in the effective transportation of fresh and minimally processed vegetables. The increased availability of transportation fleets and distribution warehouses with cold storage facilities has reduced food wastage en-route due to temperature fluctuations. The proliferation of modern grocery retailing channels, in both developed and developing Asian economies will continue to strengthen the cold chain. Packaging innovations such as micro-perforation which tend to keep products fresher discussed in this report will benefit from extended cold chain networks in Asia. Therefore, early adoption will enhance Australian vegetable exports before the innovations become a future new industry standard.

Market diversity across Asia will create demand for vegetable innovations

Divergence in socioeconomic demographics across Asia observed from the wide spectrum of consumer lifestyles, attitudes and income levels is expected to drive up demand for various innovations listed in this study. The rise of the new rich in Asia has fostered a burgeoning culture of health consciousness, with more consumers choosing to purchase higher-quality vegetables. Coupled with consumers' general familiarity with quality Australian produce, their sensitivity to price increments as a result of the introduction of new vegetable innovations will be low amongst affluent households. Growing consumer sophistication is evidenced by rising purchases and in-store displays of eco-friendly packaging containers as well as the higher propensity to purchase value-added packaging for one's lifestyle. Demand for on-the-go packaging has gained popularity due to the rapid work pace and extended working hours while shrinking household sizes encourage the uptake of packaging which allows vegetables to be purchased and stored in the same packaging which are intended to extend product freshness. As Asia becomes more integrated with its Western counterparts, its consumer markets are likely to be more receptive towards Western dining habits and vegetable types, with the demand for fresh vegetable snacks as well as salads sold in convenient packing expected to be on the uptrend.

Continuous innovation remains necessary for long-term competitiveness

Intense competition for consumers' wallet across Asian vegetable suppliers has and will continue to reinforce the high-volume, low-margin characteristics of the vegetable industry. Early adoption of new innovations such as microgreens can help differentiate Australian produce, although it is not uncommon for Asian growers to replicate similar practices to enhance their product offerings. For Australian-grown produce to remain relevant, growers may need to continuously adopt new technologies to enhance the superior quality of their vegetables and adopt new innovations for long-term competitiveness.

7. DISCUSSION

The following section of the report, sections 7.1-7.10, discusses the 10 innovations as shortlisted by HIA and AUSVEG. Each innovation is described in detail and is followed by a summary identification of the key benefits the innovation is likely to provide Australian growers and an evaluation of the innovation for its suitability towards various fresh and minimally processed vegetables.

7.1 MICRO-PERFORATIONS

7.1.1 INTRODUCTION

Post-harvest packaging is a vital component in production processes, which is key to protecting the integrity of vegetables for consumption around the world. Micro-perforation technology is adaptable to most commodities and can significantly extend the shelf life of fresh and minimally processed vegetables while reducing wastage incurred both along the supply chain and also while being displayed on retail shelves.

Table 1 Innovation Summary- Micro-perforated packaging

Type of Innovation	Packaging
Region of innovation origin/usage	Western Europe (UK)
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.1.2 DESCRIPTION

Enhanced modified atmosphere packaging (MAP) solution

Micro-perforations refer to small holes, averaging 5µm-300µm in pore diameter, installed into polymeric films, used in the packaging of fresh and minimally processed vegetables. The technology is categorised under the MAP umbrella of solutions, which aims to enhance and extend the quality and shelf life of fresh produce beyond the primary means of external temperature monitoring and relative humidity control. Micro-perforations or micro-pores can be installed on polymeric films through two main procedures: mechanical puncturing and laser perforation. The former involves the use of a fabricated drum which punctures holes into the polymeric surface as it is being rewound and converted, while the latter uses laser beams to create well-defined holes in the film's surface.

Integrated sensing meets packaging

The benefits of micro-perforation technology are best manifested through online laser technology, compatible with existing fill/ seal systems. Online laser technology systems are typically accompanied by intelligent sensors which determine product respiration rates to optimise perforation diameters and density and still account for the permeability of polymeric film in use.

7.1.3 CURRENT USE AND DEVELOPMENTS

A new and commercially available technology

Micro-perforation technology, both pre-perforated films and micro-perforation systems (mechanical pin, laser-guided) are commercially available today and used in parts of the United Kingdom and Western Europe. Leading UK retailer Marks & Spencer adopted micro-perforation technology for soft fruits in 2014.

7.1.4 KEY BENEFITS

Longer shelf life and extended freshness

Micro-perforations are more effective than macro holes in moderating internal atmospheric conditions such as increased gas permeability and plant respiration while simultaneously slowing down internal atmospheric moisture loss, a common cause of product spoilage. This packaging solution is especially suitable for fresh vegetable produce with high oxygen transmission rates (OTRs). Micro-perforation technology is widely accepted to aid respiration under imperfect storage, transport and retail conditions.

Cost savings for growers and packaging processors

Online laser micro-perforation technology allows growers and processors to react effectively to ever-changing and growing demands for attractive and sophisticated packaging while minimising the inventory of film stock and retaining optimal internal atmospheric conditions for fresh and minimally processed vegetables. Although pre-perforated films do not require additional capital investment, the benefits of increased flexibility of perforation and atmospheric settings are expected to offset initial outlay and switching costs. Users can enjoy economies of scale with the purchase of cheaper, non-perforated films which can be easily customised according to clients' varied needs, whether bulk packaging for transportation or the preparation of other flexible retail formats.

Decreased supply chain costs

Increased product life span due to micro-perforations in film packaging benefits retailers by reducing buffer stock and in-store wastage. Growers and distributors benefit from having greater options in choosing the transportation mode of fresh produce. Growers and distributors alike can elect to transport more products by land and sea rather than by air, bringing down transportation costs in the process. Furthermore, the use of land and sea transportation reduces cold-chain breakage, which occurs more frequently during air freight.

Reach new markets and enhance Australia's reputation

Locally cultivated produce from Australia can now be transported further from its source through micro-perforation packaging solutions. Extended product shelf life and freshness reinforce Australia's association with quality produce, especially in Asian markets, most of which have a positive view of Australian-grown produce.

7.1.5 INNOVATION EVALUATION

Highly compatible with various commodities

Micro-perforation technology is suitable for most vegetable types and is best used for vegetables with high OTRs, such as leafy vegetables along the lines of spinach, chicory and salad leaves. Other suitable commodities include root vegetables such as parsnips, swede and potatoes, brassicas including broccoli and Brussels sprouts, tomatoes, eggplant, asparagus, radishes, mushrooms and leeks.

Ambient storage/ shelving conditions critical

Temperature stability is widely acknowledged as the key prerequisite in the transportation of freshly harvested vegetable produce because vegetable respiration, degradation and susceptibility to microbial infection is dependent on its ambient temperature. Although micro-perforation technology cannot fully defend against extreme temperature fluctuations or replace cold chain logistics, it aids plant respiration more effectively than other packaging options currently available under imperfect storage/ transport conditions. Micro-perforation packaging provides an additional protective layer for fresh vegetable produce, which helps fully exploit and enhance the benefits of existing cold chain support systems.

Minimal pressure on profit margins in the long term

Profit margins for growers are expected to remain stable in the long term even with a short-term cost outlay for the installation/ transition from existing MAP solutions to micro-perforated packaging. Cost savings from the purchase of cheaper, non-perforated polymeric films and increased flexibility to create new products based on client demands and overall economies of scale will drive down manufacturing costs, thus protecting profits in the future. The rate of produce wastage pre-sale will fall with the use of micro-perforation technology, maximising retail inventory for consumer purchases.

The growing modernisation of grocery retailing will boost need

The steady shift of buying habits in Asia from traditional wet markets to organised, modern retailing is expected to lead to the extension and strengthening of temperature-sensitive supply chains. Previously, opportunities to export to developed markets across Asia-Pacific have been, in part, limited by the prevalence of traditional grocery retailing channels which often result in dismantled cold chains and eventual export wastage. The increased participation of distributor-retailer networks both locally and abroad will result in increased demand for packaging solutions such as micro-perforation technology to extend product shelf life and increase overall consumer demand for vegetables.

Sustained consumer preferences for fresh vegetables drive upstream adoption

Although the majority of consumers, especially in Asian markets, still consider loosely sold vegetables to be fresher and of better quality than their packaged counterparts, more are gradually becoming aware of the benefits and superiority of the latter. Retailers who do not want to alienate customers can opt for produce which is bulk-packaged and transported in micro-perforated packaging, which allows for extended product shelf life during transport before being sold loose at stores, thus retaining maximum freshness as best as possible. As micro-perforation technology is best able to support consumer demands for fresh produce, increased upstream adoption by growers, distributors and retailers alike is expected to rise.

7.1.6 INNOVATION COMPATIBILITY

- ✓ Commodities: all commodities
- ✓ Target markets: all markets in Asia

Summary 1 Innovation Compatibility- Micro-perforated packaging

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility	Low compatibility	Not applicable

Image 1 Micro-perforated packaging

Image Credits: A-Roo Company Llc (http://www.a-roo.com/)

7.1.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 2 Sources- micro-perforated packaging

Organisation	Description	Website	Contact
A-Roo Company Llc	Packaging company	http://www.a-roo.com	packaging@a-roo.com
Cooperative Group Ltd	Retailer	http://www.co-operativefood.co.uk/	craig.noonan@co-operative.coop
Marks & Spencer Plc	Retailer	www.marksandspencer.com	n/a
PerfoTec BV	Company providing laser technology for micro-perforation	http://perfotec.com/	info@perfotec.com

7.2 COMPOSTABLE PACKAGING AND LABELS

7.2.1 INTRODUCTION

Compostable packaging is a new, efficient and more effective biodegradable and environmentally friendly packaging which has historically been used to package processed food. The current adoption of compostable packaging for fresh vegetable produce is a welcome move to increase greater use of eco-friendly materials across the landscape of consumer food packaging.

Table 3 Innovation Summary- Compostable packaging and labels

Type of Innovation	Packaging
Region of innovation origin/usage	North America and Europe
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.2.2 DESCRIPTION

Fully decomposable and environmentally beneficial packaging

Compostable packaging – unlike its biodegradable counterpart – is better able to fully decompose and disintegrate into carbon dioxide, water and naturally occurring minerals which do not leave behind residual toxins or pollutants in the earth. Compostable packaging is more effective at self-decomposition than its petroleum-based polymeric cousins due to its molecular composition, which is constructed from plant-based compounds including starch (corn, sugar cane, and bamboo) and cellulose. The raw material is derived from beechwod from the thinning of PEFC (Programme for the Endorsement of Forest Certification) and FSC (Forest Stewardship Council) certified forests. Some compostable packaging and labels are further able to replenish nutrients in landfills upon full disintegration, which marks the new standard in sustainable packaging. Certification of biodegradable/ compostable packaging and labels is made through the Biodegradable Products Institute (BPI), which provides a 'compostable logo' in accordance with the American Society for Testing and Materials (ASTM) Standards specifications D6400 and/ or D6868.

7.2.3 CURRENT USE AND DEVELOPMENTS

Traditionally used in serving ware, growing use in fresh produce packaging

Utensils and serving ware constitute the most prevalent uses of compostable materials today, and those which pioneered the technology. But growing eco-consciousness among consumers has seen widespread use of compostable packaging and labelling, particularly on North American- and European-sourced organic produce.

7.2.4 KEY BENEFITS

Long-term reduction in manufacturing costs

The increased number of compostable packaging suppliers and systems has steadily propelled compostable packaging and labels as viable substitutes for less environmentally friendly polymeric films and trays. Although compostable packaging remains a premium packaging option, it requires less energy and water resources to produce and may result in long-term manufacturing cost savings

which can be passed on to its adopters – growers and packaging converters alike. Increased technological investment into eco-friendly packaging is expected to continually drive down usage costs, making it more attractive to businesses and consumers alike.

Increased resonance with environmentally conscious consumers

Rising retailer interest in compostable packaging as a reaction to consumer preferences may encourage increased upstream adoption in the short and long terms. Compostable packaging is perceived to be the foremost environmentally friendly packaging available to date and it has a sizable and growing consumer base across global markets including those in Asia. Adopters of compostable packaging systems have a ready consumer market best placed to appeal to the eco-sentiment of their consumers. Compostable packaging is especially popular in parts of North America, where some growers have been successful in positioning themselves as the premier supplier within the eco-conscious community after full conversion to said packaging. Leading chained grocery retailer WholeFoods has also encouraged its suppliers to use compostable packaging, from produce packaging to the supply of takeaway utensils.

7.2.5 INNOVATION EVALUATION

Safe and suitable for all vegetable types

Compostable packaging can be used in a wide range of produce types. Improvements in compostable packaging include the creation of an appearance akin to plastic-based packaging while remaining an inert packaging material on contact with fresh produce despite its organic matter composition. Compostable packaging and labels present a safe and viable solution to the storage of multiple vegetable varieties including leafy greens, tubers and various root vegetables.

Minimal conflict with existing distribution and retailing networks

There are no additional logistical requirements within the supply chain to ensure the integrity of fresh vegetable produce distributed via compostable packaging and/ or labelling since it is largely impervious to ambient conditions. It is a widely accepted packaging material exported to both developed and developing markets with minimal disruptions, similar to the situation for loose and polymeric film-packed vegetables.

Potential consumer resistance in price-sensitive markets

As the use of compostable materials adds cost to the end product, demand in price-sensitive markets may be lower as consumers turn to cheaper packaging alternatives and/ or prefer to pay the premium for a higher-quality, less environmentally friendly product. Price sensitivity is not restricted to any developed or developing markets, though the former is a more viable option as there are more packaging-conscious consumers in developed markets like North America and Europe. However, consumers increasingly resonate with this type of packaging in mature markets in Asia, including Japan, South Korea and Singapore, where there is an impetus to be more environmentally conscious.

Proper disposal sites required to maximise environmental benefits

To achieve full decomposition, it is required to use proper disposal sites for compostable packaging materials. The United States, one of the world's largest users of compostable packaging, only has 500 commercial composting sites, suggesting a severe gulf between the alleged and actual benefits of compostable packaging. It is unlikely that some developing Asian markets, with a collectively lower eco-friendly consciousness, will make meaningful investment into proper composting sites, thus there may be minimal benefits for exporters to adopt compostable packaging for consumers within this region.

7.2.6 INNOVATION COMPATIBILITY

- ✓ Commodities: all commodities
- ✓ Target markets: Australia and developed Asian markets such as Japan, South Korea and Singapore where consumers where likely to pay a premium for green packaging

Summary 2 Innovation Compatibility- Compostable packaging and labels

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility	Low compatibility	Not applicable

Image 2 Compostable packaging



Image Credits: Verpackungszentrum Graz (http://www.vpz.at/)

7.2.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 4 Sources- compostable packaging

Organisation	Description	Website	Contact
Biodegradable Products Institute	Non-governmental organisation promoting compostable materials	http://www.bpiworld.org/	info@bpiworld.org
Verpackungszentrum Graz	Packaging company	http://www.vpz.at/	b.reichl@vpz.at

7.3 RECYCLED MATERIALS FOR PACKAGING

7.3.1 INTRODUCTION

Post-consumer recycled (PCR) plastic is categorised under the umbrella of commercially available eco-friendly packaging solutions for multiple use across processed and fresh foods. Technological advancements to streamline and increase the dexterity of PCR plastics have generated renewed interest within this innovation.

Table 5 Innovation Summary- Recycled polyethylene terephthalate (PCR-PET) packaging

Type of Innovation	Packaging
Region of innovation origin/usage	Various
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Medium
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.3.2 DESCRIPTION

Fully repurposed post-consumer recycled plastics

Recycled materials for packaging refers to packaging materials which use 100% post-consumer recycled polyethylene terephthalate (PCR-PET) plastics in contrast to virgin plastics, to reduce the disposal of single-use PET products which currently crowd landfills and are a major source of greenhouse gases. Core inputs for 100% recycled PCR-PET include previously used plastic products such as soda bottles separated from solid waste, which are subsequently fed into processing machines to create customised recycled packaging products. Although recycled plastics have received renewed industry interest, the sector remains an undersupplied market due to concerns regarding its overall structural durability and hygiene standards as compared to virgin plastics.

7.3.3 CURRENT USE AND DEVELOPMENT

Well-researched technology but not widely used

PCR-PET technology was first successfully developed and subsequently commercialised in the United States. The high-quality standards imposed on sanitised plastics extracted from waste landfills were critical in allaying market concerns regarding PCR-PET hygiene, a major barrier to commercialisation apart from the high manufacturing costs. In 1994, technology leader Johnson Controls was able to successfully develop and patent the 'Supercycle'- a plastic material made from PCR-PET. The material prepared from a pressurised cleaning process met necessary hygiene standards set by the U.S. FDA. PCR-PET has since been widely accepted by consumers as safe and it is mostly used for ready-to-eat products. Earthbound Organics, in association with Packaging Plus LLC, have pioneered an effort to convince US growers to fully switch to PCR-PET for ready-to-eat salads, distributed in leading retailing chains including WholeFoods and Safeway across the country. Although PCR-PET resin remains less structurally robust than virgin plastics, it is not a major deterrent to its users.

7.3.4 KEY BENEFITS

Growing cost savings for go-green producers

Growers and packaging processers who have partially or fully adopted the use of recycled plastics have reported more cost savings in PCR-PET input material as improvements in manufacturing processes have allowed for reduced consumption of electricity, water and raw materials. Advances in sorting and recycling technology have encouraged the increased availability of recycled resin and the number of viable suppliers, which exerts a downward pressure on material costs and overall manufacturing costs. Although virgin plastics remain the most cost-effective packaging solution, the increased use of PCR-PET is expected to drive down average unit prices making it more cost accessible to growers and packers alike though overall demand is likely to remain a constraint.

Ever-expanding demand for green packaging around the World

The growing base of environmentally conscious consumers has sparked renewed interest in recyclable packaging for everything from consumer durables to food packaging. This has in turn encouraged more growers and packers to increase the consumption of green packaging such as PCR-PET, as its resin is fully compatible with existing packing systems. Although consumer adoption of PCR-PET is mostly limited to ready-to-eat salads and organic vegetables, demand for such packaging may be extended to other packaged vegetables in the future.

7.3.5 INNOVATION EVALUATION

Restricted to premium vegetable offerings

PCR-PET resin is suitable for all vegetable commodities but its relatively prohibitive price when compared to virgin plastic (note: the price difference is unavailable though interviewees contacted during the study commented PCR-PET to be more expensive than virgin plastic) restricts usage to premium vegetable offerings including ready-to-eat products, organic and other more exotic vegetable variants where consumers are accustomed to paying retail premiums. The price floors of PCR-PET packaging significantly limit widespread use and adoption by growers and packers exporting to larger but more price-sensitive Latin American markets, which have similar economic and social dynamics as Asian markets. But the growing presence of specialty and high-end grocery retailers across Asia suggests a greater tolerance for premium products.

Compatible with existing processing systems

PCR-PET resin is a packaging input which is fully compatible with existing packing and sealing systems and does not require additional capital investment for new users. Despite the lower ductility of PCR-PET as compared to virgin plastics, there are minimal differences in the end packaging output, often not noticeable by consumers.

But regulatory requirements pose major barriers

Although PCR-PET is a well-established packaging material, regulatory authorities like the US Food and Drug Administration (FDA) uphold stringent criteria on interested users and manufacturers of PCR-PET resin covering the approved type of plastic inputs to regular inspection tests by FDA staff. Similar restrictions are placed on imported packaged products which utilise PCR-PET, which has dissuaded foreign growers and packers from adopting this innovation.

7.3.6 INNOVATION COMPATIBILITY

- ✓ Commodities: all vegetables; especially organic vegetables for which consumers are likely to pay a premium

- ✓ Target markets: Australia, developed Asian markets such as Japan, South Korea and Singapore where consumers where likely to pay a premium for green packaging

Summary 3 Innovation Compatibility- Recycled polyethylene terephthalate (PCR-PET) packaging

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility | *Low compatibility* | *Not applicable*

Image 3 Recycled polyethylene terephthalate (PCR-PET) packaging

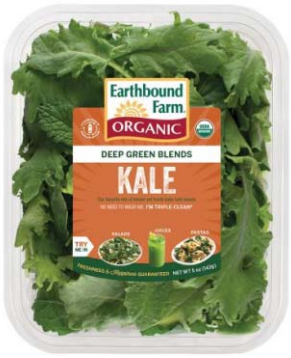


Image Credits: Earthbound Farm's PCR-PET clamshell package (http://www.ebfarm.com/)

7.3.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 6 Sources- Recycled polyethylene terephthalate (PCR-PET) packaging

Organisation	Description	Website	Contact
Clear Lam Packaging Inc	Packaging company	http://www.clearlam.com/	n/a
Earthbound Farm Llc	Grower	http://www.ebfarm.com/	sara.loveday@whitewave.com
PET Power BV	Packaging company	http://www.petpower.eu/	info@petpower.eu

7.4 PEEL-AND-RESEAL LIDDING FILMS

7.4.1 INTRODUCTION

Peel-and-reseal lidding films offer an advanced sealing solution to enhance produce freshness and integrity for in-home consumption. This packaging technology allows for greater integration of the modified atmosphere packaging (MAP) technology which prolongs and protects vegetables from farm to store better than other resealable tops, including rigid plastics and zippers.

Table 7 Innovation Summary- Peal-and-reseal lidding films

Type of Innovation	Packaging
Region of innovation origin/usage	USA
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.4.2 DESCRIPTION

Superior resealing closure

Peel-and-reseal lidding films refer to flexible lid features which can be affixed onto flexible and rigid storage containers to extend the shelf life of packaged fresh produce at home. Peel-and-reseal lids provide super alternatives to zippers, rigid lids, shrink bands and the like, as these closure fixtures can be fully integrated into or applied onto packaging film rolls, which enhances the resealability for home use.

7.4.3 CURRENT USE AND DEVELOPMENT

First pioneered by Clear Lam Packaging Inc., the peel-and-reseal technology is currently used in fresh food packaging, cosmetics, baby care and personal care items. Peel-and-reseal technology is commercially available and is currently offered by leading packaging and technology providers including Flexible Packaging, Print Pak and Bemis, which all provide fully integrated solutions from washing to packing.

7.4.4 KEY BENEFITS

Added manufacturing flexibility

The peel-and-reseal films can be incorporated into a variety of packaging configurations and materials for both wet and dry produce. They can be cut into a myriad of sizes and shapes allowing for maximum flexibility to enhance brand expression and can be readily retrofitted to standard tray sealer packaging lines. Peel-and-reseal technology can also be implemented for 100% recycled polymeric materials, allowing growers and packers with varying levels of eco-consciousness to enjoy greater manufacturing flexibility over their end products.

Able to better extend product shelf life

Unlike existing sealing closures such as preformed rigid lids and band closures which often limit the ability of plant respiration due to their inherent composition, peel-and-reseal lidding films can fully

integrate MAP technology like micro-perforations to allow for increased OTRs for fresh produce from farm gate to retail store. This further reduces food wastage due to the build-up of moisture and nitrogen, which can lead to anaerobic activity and eventual degradation.

Short- and long-term cost savings

Peel-and-reseal lidding technology reduces the necessity for growers, original equipment manufacturers (OEM) and/ or packers to rely on separate and additional preformed plastic lids which, on average, are more costly to manufacture and transport due to the heavier weight of materials involved and required storage space. Unlike rigid lids and band closures, peel-and-reseal lidding films are transported in compact rolls which are lighter and consume less space. With the use of lighter packaging lids and the elimination of additional packaging components growers and packers can enjoy both short- and long-term cost savings through lower packaging spend, transportation bills, trucking space and warehouse storage space.

7.4.5 INNOVATION EVALUATION

Suitable for most commodities

Peel-and-reseal lidding technology is commercially available and is compatible with most existing MAP packaging solutions for fresh produce, including meats, dairy and vegetables. Due to the highly customisable nature and easy integration of peel-and-reseal lidding technology, it is suitable for the packaging of most types of vegetables as it does not compromise the OTRs of respiring vegetables and it is best able to extend product shelf life and freshness.

Cleaner, safer, value-adding product to retailers for multi-serve portions

Peel-and-reseal lidding films are most advantageous to an expanding pool of value-buying consumers who prefer multiple portions over single-serve products. Retailers, especially warehouse clubs such as US-based Costco, have increased their retail display of peel-and-reseal lid-packaged vegetables as a reactionary supply for their consumers' needs. As said technology allows for the inclusion of tamper-evident features, consumers can be better assured of product safety and integrity. Use of peel-and-reseal lidding technology does not interfere with the structural integrity of a packaged product while still maximising respiration rates, providing fresher and aesthetically appealing vegetables to consumers.

Higher production costs may dissuade growers and packers in the interim

A key hindrance to peel-and-reseal lidding technology is its added production cost – 15%-20% higher than unpackaged produce and 10%-15% more costly than existing rigid lids. Though demand for resealable vegetable containers remains strong, consumers may not yet be fully aware of the superior benefits of peel-and-reseal flexi lids as compared to the rigid alternatives and may thus be less willing to pay the added premium for a disposable container. Additional efforts to convey the benefits of the technology and educate consumers about them need to be undertaken by growers, packers and retailers to increase buyers' price tolerance, which will create a self-perpetuating cycle of higher technology usage and falling production costs.

Expected low demand in Asian markets in the short term

A preference for loosely sold and unpackaged vegetable produce remains prevalent across most Asian markets and is coupled with a general lack of awareness as to how resealable packaging best complements in-home refrigeration to maximise product life span. The high price sensitivity of Asian consumers for fresh produce, due to the presence of locally grown crops, also dissuades consumers from opting for premium packaged vegetables in spite of their aesthetic appeal. Growers and packers may face buyer resistance in Asia in the short term. However, fast-increasing household

income and the rising class of 'new rich' across Asia may create buyer impetus to switch up for more premium products, suggesting potential uptake of peel-and-reseal technology in the long term.

7.4.6 INNOVATION COMPATIBILITY

- ✓ Commodities: leafy vegetables which have high oxygen transmission rates (OTRs)
- ✓ Target markets: Australia and developed countries in Asia

Summary 4 Innovation Compatibility- Peal-and-reseal lidding films

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility | *Low compatibility* | *Not applicable*

Image 4 Peal-and-reseal lidding films

Image Credits: Misionero Vegetable's (http://www.misionero.com/)

7.4.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 8 Sources- Peal-and-reseal lidding films

Organisation	Description	Website	Contact
Clear Lam Packaging Inc	Packaging company	http://www.clearlam.com/	n/a
Bemis Co Inc	Packaging company	http://www.bemis.com/	contactBemis@bemis.com
Misionero Vegetables	Grower	http://www.misionero.com/	contactus@misionero.com

7.5 ETHYLENE SCAVENGERS

7.5.1 INTRODUCTION

Ethylene scavengers serve as counteracting agents to reduce premature ageing and senescence of fresh produce due to the presence of ethylene gas. Though commonly found in silica gel packs within processed foods, raw meats and dairy products, the introduction of ethylene scavengers for vegetable packaging is an economically friendly solution that helps prolong and protect the integrity of fresh and minimally processed vegetables.

Table 9 Innovation Summary- Ethylene scavengers

Type of Innovation	Packaging
Region of innovation origin/usage	Germany
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.5.2 DESCRIPTION

Repurposed technology to slow down senescence

Ethylene scavengers refer to ethylene-absorbing agents that absorb ethylene gas produced by maturing fruit and vegetables, thereby slowing down the ripening and ageing process and delaying the onset of the 'climacteric' stage. Ethylene is a hormone responsible for the ageing process for many different types of fruit and vegetables, and it is released during the climacteric process, which corresponds with increased plant respiration. The onset of the climacteric stage marks the end of the produce's optimal condition and the beginning of senescence – a condition or process of age-related deterioration, making the produce more susceptible to fungal invasion and microbial decay. Traditionally, ethylene scavengers have taken the form of silica gel capsules which are sealed into processed foods including chips and chilled meats to absorb excess moisture and retard bacteria formation within a specified period. The technology has since been applied within the fresh and minimally processed vegetables category, with use designated by commercially available plastic strips, installed onto transportation crates and/ or containers that individually hold fresh produce.

7.5.3 CURRENT USE AND DEVELOPMENT

Well-researched technology but not widely used in fresh vegetable packaging

The commercially available format was pioneered by leading UK retailer Marks & Spencer, which introduced the ethylene scavenger plastic strip in 2012, placing it at the bottom of punnets of strawberries, which reportedly extended in-store display life by up to two days. Despite the low costs of installation, usage of ethylene scavengers for freshly packed vegetables is low due to low overall product awareness across the supply chain. A new scavenger prototype was recently developed, aimed at providing a more cost-effective option for vegetables. Ethylene-scavenging agents are dispersed and glued on the surface of a corrugated board that can be placed beneath bulk crates and/ or display units carrying packaged and/ or unpackaged vegetables, for use both en-route during distribution and on arrival in retail stores. To avoid contamination between ethylene-scavenging agents and fresh produce, the valleys of the corrugated board are covered with a binder

where the dispersed powder/ granules are glued down to prevent spillage. This allows maximum absorption of ambient ethylene gas from the fresh produce.

7.5.4 KEY BENEFITS

Extended product shelf life and reduced food wastage

The creative use of ethylene absorbers on the surface of trays/ crates, without actual contact with vegetable produce is expected to extend the shelf life from farm gate to retailer as the senescence occurs less rapidly. This allows vegetables displayed at warehouses and retailers to retain their colour, flavour and nutrition for the end consumer. Although ethylene scavengers are currently installed in individual packages, it reduces the presence of ethylene gas in the room where the produce is stored, produced by other ethylene-producing produce. The extended shelf life of fresh produce will significantly lower food wastage during both the transportation and storage phases, allowing for cost savings to be enjoyed by multiple players across the supply chain.

Increased export market reach

The use of ethylene scavengers may allow fresh produce to travel further distances in order to reach new export markets. For instance produce with short life spans, including blueberries and strawberries from the United Kingdom, have been able to travel further out and deeper into Asian markets with the aid of ethylene scavengers. This creates new business opportunities for the export of local produce abroad.

7.5.5 INNOVATION EVALUATION

Flexible format allows for multiple applications

Unlike other packaging innovations, ethylene scavengers can be used to regulate internal atmospheric conditions as well as external ambient gas compositions for both packaged and loosely transported and sold vegetables. Ethylene-scavenging agents can be packaged into individual plaster strips and dispersed onto vegetables (with inedible rinds such as butternut squash), with powdered/ granulated formats each catering to varied packaging and storage needs

Easily integrated into existing supply chain infrastructure

Ethylene scavengers can be easily installed in upstream processes including harvesting containers and processing lines to reduce the rate of product decay beginning at the moment of harvest. With less-aged vegetables as core inputs undergoing MAP processes, the overall freshness and integrity of the produce is better retained both transportation, storage and in retail display at stores.

Low implementation costs

Ethylene-scavenging technology has been extensively researched historically and is presently widely used in commercially processed foods. Thus, the wide availability of ethylene-scavenging agent suppliers around the world has created a cost-competitive end product for growers, packers and retailers who wish to adopt this innovation to prolong display shelf life. Current users of ethylene-scavenging technology for packaged vegetables reported low implementation costs, since the technology can be inserted seamlessly within processing and packing lines with minimal staff training required.

Especially suited for vegetable commodities with short life spans

Ethylene scavengers are best used with ethylene-sensitive vegetables including asparagus, broccoli, eggplant, Brussels sprouts, leafy greens and tubular greens such as cucumbers and green beans, as a complementary solution to existing display practices, where these vegetables are not placed within the vicinity of ethylene producing fruits in retail stores.

Need to educate buyers

Despite widespread use and an awareness of ethylene-scavenging packs in processed foods such as meats and dairy products, retailers and consumers may not be familiar with its use for packaged vegetables. Growers and packers will be tasked with the responsibility of educating buyers on the different variations of ethylene-scavenging technology to overcome purchasing inertia both in the short and long term.

7.5.6 INNOVATION COMPATIBILITY

- ✓ Commodities: broccoli, eggplant, Brussels sprouts, leafy greens, cucumbers and green beans
- ✓ Target markets: all countries in Asia to which sea freight is typically carried out

Summary 5 Innovation Compatibility- Ethylene scavengers

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility	Low compatibility	Not applicable

Image 5 Ethylene scavengers

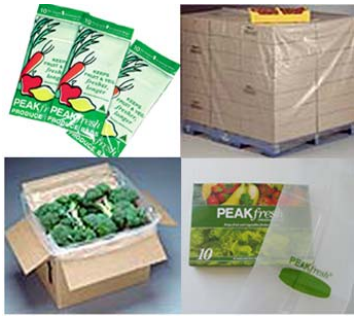


Image Credits:Dry Pak Industries' ethylene-absorbing sachets, filters and film (http://www.drypak.com/)

7.5.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 10 Sources- Ethylene scavengers

Organisation	Description	Website	Contact
Dry Pak Industries Inc	Company manufacturing ethylene absorbing agents	http://www.drypak.com/	info@drypak.com
Sirane Ltd	Company manufacturing ethylene absorbing agents	http://www.sirane.com/	jeremy.haydn-davies@sirane.com

7.6 BIBIMBAP PACKAGING

7.6.1 INTRODUCTION

Bibimbap packaging refers to a culturally inspired packaging visual to host select vegetable variants, providing a convenient ready-to-eat meal for the end-consumer. The packaging has only been successfully implemented for cooked vegetables offered in microwavable meals and it remains in its developmental stage for freshly cut and raw vegetables.

Table 11 Innovation Summary- Bibimbap packaging

Type of Innovation	Packaging
Region of innovation origin/usage	South Korea
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.6.2 DESCRIPTION

Culturally inspired packaging for cut vegetables

Bibimbap is a culturally indigenous and popular traditional dish in South Korea, which has a concentric display of eight different vegetable varieties to be subsequently mixed in with rice and other condiments as part of a full meal. The concept of ready-to-eat cut vegetables, compartmentalised and displayed within a circular plastic tray which resembles the said dish is referred to as Bibimbap packaging.

7.6.3 CURRENT USE AND DEVELOPMENT

Varying OTRs of cut vegetables pose barrier to commercialisation

Instant Bibimbap packaging for freshly cut vegetables remains in a developmental stage due to complications arising from the varying maturity rates of the packaged produce. Previous packaging trays and lids were unable to balance the various OTRs of fresh-cut produce which resulted in discolouration unsuitable for commercial production. Other techniques to package ingredients separately within the same plastic tray were rejected due to the loss of visual similarities to the

traditional Bibimbap dish. Interest in Bibimbap packaging remains strong within the cooked foods/ ready-to-eat meals category, where leading packaging manufacturers have developed stronger packaging materials for microwavable Bibimbap meals.

7.6.4 KEY BENEFITS

Building stronger consumer affinity through cultural exports

The concentric Bibimbap packaging is iconic of Korean culture which strongly appeals to persons of Korean ethnicity both within the Korean peninsula and markets with high concentration of Korean migrants. The strong cultural ties within the ethnic Korean community around the world provide a core consumer base for local retailers who offer cultural food exports. Thus, demand for growers and packers of indigenous Korean vegetables and/ or vegetables used within traditional Korean foods will remain largely stable in future.

7.6.5 INNOVATION EVALUATION

Use for salad mixes

The Bibimbap packaging could be customised and used to prepare a variety of salad mixes with fresh leaves, cherry tomatoes, cut asparagus or other ingredients which require minimal processing or preparation. Such a product can be sold as a ready to consume product which is accompanied by dips or salad mixes. That said, the senescence rate of the various ingredients contained in the mix will have to be considered to ensure that products do not ripen ahead of others.

Short life span poses major hindrance

One of the largest hindrances to the commercialisation of Bibimbap packaging is the irregular ageing of packaged vegetables including lettuce, baby leaves and red cabbage – core ingredients of the traditional dish which tend to have shorter life spans. The limited shelf life has also forced manufacturers to source from domestic producers rather than foreign imports due to the closer proximity of domestic farms to those consumer markets.

High distrust of imports to South Korea

Recent scandals involving contaminated fresh food imports from mainland China into South Korea have forced stricter and longer customs clearance processes, which reduce the optimal en-route storage for imported fresh vegetables.

High latent demand potential due to k-wave culture

Despite the current input and packaging challenges of this innovation, there may be a high latent demand for culturally inspired Bibimbap packaging due to the proliferation of the Korean wave (K-wave) which has swept across the world, especially in Asian markets. The continuously rising demand for Korean-related consumables ranging from foods to electronic products to automotive equipment suggests a sustainable favourable disposition by consumers and retailers towards commercially viable Bibimbap packaging for freshly cut vegetables.

7.6.6 INNOVATION COMPATIBILITY

- ✓ Commodities: Commodities which can packed together and have similar rates of senescence
- ✓ Target markets: South Korea, other Asian markets such as Singapore where salad mixes are gaining in prominence

Summary 6 Innovation Compatibility- Bibimbap packaging

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility	Low compatibility	Not applicable

7.6.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 12 Sources- Bibimbap packaging

Organisation	Description	Website	Contact
National Institute of Horticultural and Herbal Science, Vegetable Research Division, South Korea	Government agency promoting the innovation	http://nihhs.go.kr/	nihhs@korea.kr

7.7 QR CODES ON VEGETABLE PACKAGING

7.7.1 INTRODUCTION

Quick response (QR) codes for vegetables were implemented in 2000 but have since risen in popularity due to the spate of contaminated fresh and processed food from key supply markets including China and Japan. Although QR codes remain in use largely by other food and non-food retailers for various promotional means, the use of QR codes in mainland China has shifted towards food traceability to assure consumers of food safety.

Table 13 Innovation Summary- QR Codes on vegetable packaging

Type of Innovation	Packaging
Region of innovation origin/usage	Japan
Status of Innovation	Commercially available
Ease of implementation*	Medium
Estimated cost of implementation*	Medium
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.7.2 DESCRIPTION

Technological apps to empower consumers

QR codes are advanced two-dimensional informational barcodes which have significantly higher data storage space than conventional barcodes. QR codes for vegetables can be printed on various packaging surfaces or located on retailing display shelves to provide information such as product origin, safety, etc. to consumers via mobile apps on smartphones to assist in informed pre-purchase decision-making.

7.7.3 CURRENT USE AND DEVELOPMENT

Effective platform for origin tracking and food safety

QR codes were initially developed for non-food promotional codes to attract shoppers to various retail stores and they have since been used extensively within the grocery channel. Food traceability and origin has become a major health concern in light of growing food trade around the world. Fresh and processed food exports from major Asian markets like China and Japan have come under global scrutiny due to suspected and actual bacterial contamination, which has resulted in major food scares across the globe and particularly in Asia. QR codes installed on fresh and packaged vegetable packaging provide a signal of quality assurance as consumers can easily obtain information about the products before purchase.

7.7.4 KEY BENEFITS

Bridging the gap between growers and buyers

QR codes create a new communication channel between growers and end consumers. Information stored in the QR codes pertaining to the grower and origin of produce provides consumers with insights into upstream processes which help build trust. Although this is of greater concern to exports from mainland China, Australian growers can still utilise this innovation to better reach out to consumers overseas for branding and marketing purposes.

Low costs of installation

Average operational and installation costs of QR codes onto packaging films and labels are low as the technology is well-developed and easily sourced around the world. Growers and retailers would need to either purchase in-house QR code generating software or engage a third-party supplier to develop the necessary codes and information to be stored, all of which incur significantly lower costs than traditional marketing campaigns.

7.7.5 INNOVATION EVALUATION

Well suited for most vegetable types

QR codes can be applied to a wide variety of leafy, non-leafy and tubular vegetables but are most commonly found on packaged items, e.g. those packaged with polymeric films, shrink bands etc., than on items sold loosely and directly. Within the modern grocery retailing channel, QR codes for loosely displayed vegetables can be prominently found on item display shelves and crates for consumers. The variety of installation option enables QR codes to be a dynamic value-added driver that boosts consumer vegetable purchases.

Use of QR codes is not as prevalent despite high smartphone penetration globally

The benefits arising from QR codes remain contingent on consumer willingness to access and explore the produce's origin. Despite the high penetration and use of smartphones around the world, the use of smart devices for fresh food shopping and reviews remains low on the average

consumer's agenda. Within Mainland China leading retailer Carrefour continues to invest in in-store billboards and banners to communicate the source of product farm origins to its consumers despite the high ownership of smartphones (83%, 2013). The additional click required for QR codes reduces the attractiveness of the innovation amongst growers since it is not a major factor influencing consumer behaviour. The fact that QR codes are compactly printed on packaging films increases the likelihood they will be overlooked, thus offsetting the stated benefits.

Growing consumer health consciousness may lead to increased QR code usage

Increased consumer-led scrutiny of fresh produce hygiene in affected markets such as China and Japan has seen greater use of QR codes to determine the integrity of the grower and its distributors as part of various user-generated safety procedures. Outside of affected markets, QR codes are commonly associated with premium, organic vegetables where consumers utilise QR codes to research nutritional information and home recipes. Australian growers looking to increase exports should consider installing QR codes on packaging surfaces to enjoy the dual benefits offered by the innovation.

7.7.6 INNOVATION COMPATIBILITY

- ✓ Commodities: all types of vegetables
- ✓ Target markets: China and Japan where concerns of food origins are particularly relevant

Summary 7 Innovation Compatibility- QR Codes on vegetable packaging

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility | *Low compatibility* | *Not applicable*

Image 7 QR Codes on vegetable packaging

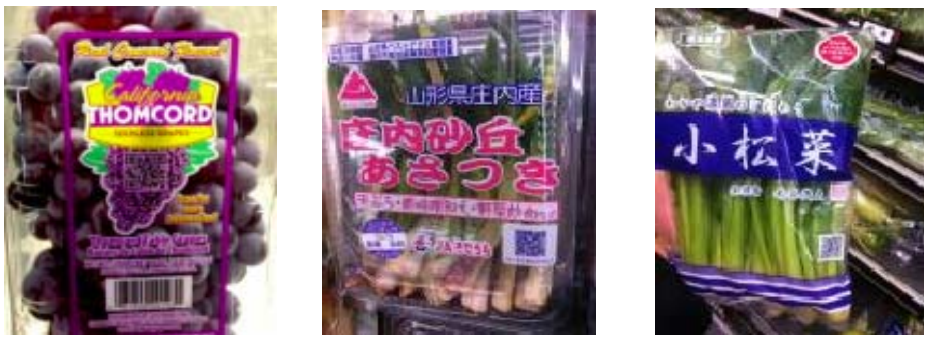


Image Credits: Far left: California Thomcord Grapes (http://www.wegrowgrapes.com/), Middle: Shonai Sakyu Chives ((Euromonitor store checks), Left: Wakya Nojo Japanese Spinach (Euromonitor store checks)

7.7.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 14 Sources- QR Codes on vegetable packaging

Organisation	Description	Website	Contact
Tenacious System Inc	Company offering food traceability solutions	http://www.farmsoft.com/	sales@tenacious-systems.com
Total Produce Plc	Grower	http://www.topfruit.com/	top@totalproduce.com
Taylor Farms	Grower	http://www.taylorfarms.com/	n/a
Yotta Mark	Company offering food traceability solutions	http://www.harvestmark.com/	sales@harvestmark.com

7.8 LIVING SALADS

7.8.1 INTRODUCTION

Living salads provide consumers who demand better and healthier ingredients with the opportunity to enjoy the 'freshest' possible vegetables from retail stores as the produce has not been severed from its roots unlike other packaged or loosely sold vegetables.

Table 15 Innovation Summary- Living salads

Type of Innovation	New product
Region of innovation origin/usage	UK, USA
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.8.2 DESCRIPTION

Home harvested salads

Living salads are trays/ pots of growing baby salad leaves which are ready to be freshly harvested at home and are picked only prior to consumption. Living salads are said to be 'crunchier, juicer and more flavoursome' as compared to ready-packed salads or salads assembled from scratch from whole vegetables. The average life duration of a pot of living salad is up to 10 days, requiring minimal daily watering.

7.8.3 CURRENT USE AND DEVELOPMENT

Commercially available but challenging to export

UK-based Home Harvest Living Salads was the first to commercialise the innovation in 2005 and currently holds the trademark of the term 'Living Salads', producing the product for distribution in select UK supermarkets. Living salads are typically locally grown and sourced for domestic markets due to regulatory restrictions on the export of soil matter. The short life span of various vegetable species also limits export opportunities to overseas markets due to time and distance constraints. It remains a relatively new product innovation in its developmental stage. Growing conditions within the tray/ pot require close monitoring to prevent crowding by certain varieties of leaves. In addition, new systems such as specially equipped greenhouses have to be installed at grower farms to cater to the reduced plot size and depth for vegetable cultivation. Living salads remain a labour- and capital-intensive product and they are not a fully scalable process at present.

7.8.4 KEY BENEFITS

Steady demand for fresher greens will drive up sales

Potential growers of livings salads can tap into a stable consumer base that is willing and able to pay a premium for freshly grown vegetables. The growing pool of consumers keen to try out new organic and vegan diets is expected to constitute the future ad hoc demand for living salads as it is also widely perceived to be a superior alternative to processed and pre-packaged salads. Other key consumer trends such as rising demand for non-chemically treated/ chemical-free salads will fuel interest in 'home-grown' and 'home-harvested' vegetable plots, which may fuel nascent demand for new products such as living salads. Other potential buyers for living salads include foodservice operators who have similarly high standards of food quality and/ or may utilise living salads as part of the theatrical flair to enhance their customers' dining experience.

7.8.5 INNOVATION EVALUATION

Limited varieties are suitable for living salads

A small range of baby leaves, lettuce, red chard and select other vegetable commodities is suitable to be grown in a confined tray/ pot due to the differing nutritional and cultivation needs. Vegetable species within the same plot must be carefully selected to reduce risks of nutritional cannibalisation, overgrowth or crowding. Additional buyer demands for a visually appealing living salad plot will restrict the available list and combination of commodity types, which is further compounded by the seasonality of certain vegetable types.

High labour- and capital-intensive product

Growers will need to invest in new greenhouse facilities including heating capabilities, ultraviolet (UV) lighting and hydroponic float systems to allow for the year-round production of living salads. Experiments to develop the optimal nutritional soil mix need to be conducted regularly to reduce 'crop failure' while moisture is best fed daily through capillary matting, which imposes additional costs on growers.

Difficult to achieve volume consistency

Given the multiple links and inputs required to achieve a successful harvest, growers face the challenge of achieving and maintaining volume consistency that satisfies both supply and demand. Given the niche nature of this product consumer demand may fluctuate throughout the year, causing supply bottlenecks or supply shocks, while minor kinks or delays in production are likely to result in crop failure and food wastage. Although living salads can be transported in ambient conditions, they are susceptible to spoilage if exposed to extremely hot or cold temperatures. The

loss of soil moisture, exposure to ambient micro-bacterial influences and chilling spoilage are amongst the most common causes of wastage experienced by living salad growers, which damage the integrity of the living salad product.

Premium price of living salads limits available clientele

The available consumer markets which favour living salads remain small due to the premium pricing of the product. Consumer appetites for premium-priced vegetables have not grown proportionally with rising personal disposable income, especially in Asian markets, due to the prevalence of competitively priced vegetables – both imported and locally produced. As salad consumption habits remain foreign in most parts of Asia and the preference for out-of-home dining remains steady, consumer willingness to pay higher premiums for living salads is projected to remain low.

7.8.6 INNOVATION COMPATIBILITY

- ✓ Commodities: baby leaves, rockets, lettuce, water cress and red chard
- ✓ Target markets: Australia, developed markets such as Japan and Singapore in Asia

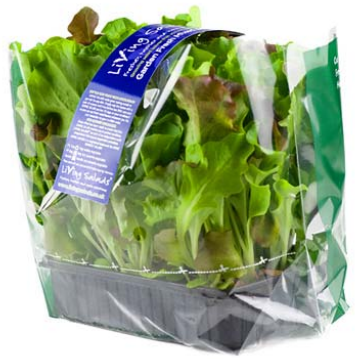
Summary 8 Innovation Compatibility- Living salads

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility	Low compatibility	Not applicable

Image 8 Living salads



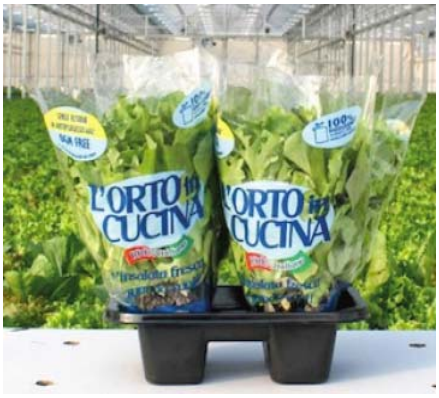


Image Credits: Home Harvest Salads (http://www.livingsalads.co.uk/), Societa Agriccola Sempre Fresco Srl (http://www.ortoincucina.com/)

7.8.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 16 Sources- Living salads

Organisation	Description	Website	Contact
Home Harvest Salads Ltd	Grower	http://www.livingsalads.co.uk/	info@livingsalads.co.uk
Societa Agriccola Sempre Fresco Srl	Grower	http://www.ortoincucina.com	info@ortoincucina.com

7.9 FRESH VEGETABLE SNACK PACKS

7.9.1 INTRODUCTION

Snack-pack formats for fresh vegetables have been commercially successful in recent times due to advances in sealing and modified atmosphere packaging (MAP), which retains and protects the integrity of the packaged fresh produce.

Table 17 Innovation Summary- Fresh vegetable snack packs

Type of Innovation	Value addition
Region of innovation origin/usage	Various
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.9.2 DESCRIPTION

Single-serve packed vegetables

Fresh vegetable snack packs refer to pre-packaged, single-portion vegetables (and fruits) targeted at children and time-pressed consumers who require convenience and easy-to-eat healthy snacks compatible with their lifestyles. Demand for snack-packed vegetables arises from multiple sources, including consumer-driven preferences for healthier snack options to governmental health policies intended to combat rising obesity rates and promote the importance of better nutrition and balanced meals.

7.9.3 CURRENT USE AND DEVELOPMENT

Widely used product with high consumer familiarity

Single-serve packs are a well-developed and commercially available retail format for fresh, cut and dried vegetables (and fruit) and food items including biscuits, dairy dips and processed meats. Snack packs have also been marketed as a diet-management format, leveraging on dietary beliefs that six smaller snacks are more beneficial than three large meals a day. The wide variety of foods and accompanying condiments compatible with single-serve snack packs and widespread consumer and retailer familiarity suggests continuous uptake of this product. In recent times, consumer demand for single-serve freshly cut vegetables (and fruit) has been on the rise with improvements in packaging allowing for a more visually appealing end product which is perceived to be a viable source of daily nutrition.

7.9.4 KEY BENEFITS

Snacking culture gaining fast traction across global consumer markets

The proliferation of snacking can largely be attributed to the globalisation of American food culture and the increasing pace of average urban households. Consumers today have a more favourable disposition towards snacks due to the advent of healthy snacks such as crunchy baby carrots in contrast to their historical association with high-calorie junk food. The faster pace of life amongst workers creates additional impetus for consumers to choose snack packs containing freshly cut vegetables (and fruit) since each pack may contain the equivalent of the recommended daily nutritional intake, creating time savings for home meal preparation. Although snacks remain weak substitutes for full meals, their potential as meal replacements should not be underestimated. Growers of vegetables suitable for snack packs are expected to be in high demand as snacking culture becomes more prevalent across markets.

New snack-pack solutions created specifically for vegetable types

To leverage on the growing demand for grab-and-go convenience packs, packaging manufacturers have begun to develop specialised solutions for the vegetable snack category. The ‘Snap Apart Multipack’ solution won a finalist spot at the prestigious 2014 Produce Marketing Association (PMA) Impact Awards for Excellence in Packaging, which can be easily produced on horizontal form-fill-seal machines and is also compatible for use in its preformed shape on fill-seal machines. The integration of controlled atmosphere technology coupled with hermetically sealed lidding films which do not require high heat for sealing provides a MAP solution to enhance product quality and freshness more effectively than existing solutions. The advent of packaging innovations and manufacturers’ interest in creating integrated MAP solutions for fresh produce suggests long-term potential for growers to continue producing for this food segment.

7.9.5 INNOVATION EVALUATION

Not all vegetables are suitable for snack-pack solutions

Vegetables which are commonly perceived as viable snacks often exclude leafy vegetables and select starch-based tubular variants such as potatoes and yams as the former is commonly associated with full-salad meals while the latter is not typically consumed in its raw/ uncooked form. Although there have been efforts from growers and retailers alike to increase the variety of vegetables available in snack packs, consumers still gravitate towards familiar variants such as baby carrots, cucumbers and cherry tomatoes. Growers who produce other vegetable types may need to work more closely with retailers to innovate and market attractive solutions if they are keen to latch onto the vegetable snack-pack trend.

Additional investment into new processes required

Depending on the vegetable type, snack-pack processing and packing centres may require additional investment in washing, cutting and drying facilities to ensure that inputs are suitable for snack packaging. Added costs can also arise from the installation of fill-form-seal machines and/ or higher-cost preformed snack-pack containers, which translate into higher wholesale and retail prices at stores. To ensure that packaged produce retains its intended integrity, MAP technology including the alteration of the internal gas atmosphere and moisture control in packaging may be required, which will drive up total investment in snack-pack technology. Given the ready-to-eat format of snack packs, there may be additional quality-control requirements for hygiene and proper handling, which increase the overall cost of production for snack-packed fresh vegetables.

7.9.6 INNOVATION COMPATIBILITY

- ✓ Commodities: baby carrots, cucumbers, cherry tomatoes
- ✓ Target markets: Australia and other developed markets such as Japan and Singapore where healthy snacks are very popular

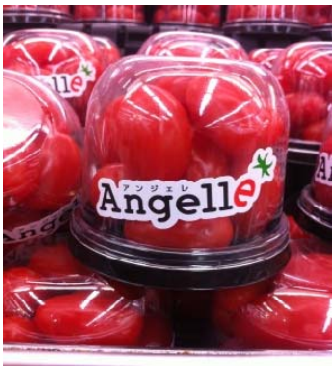
Summary 9 Innovation Compatibility- Fresh vegetable snack packs

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility | *Low compatibility* | *Not applicable*

Image 9 Fresh vegetable snack packs



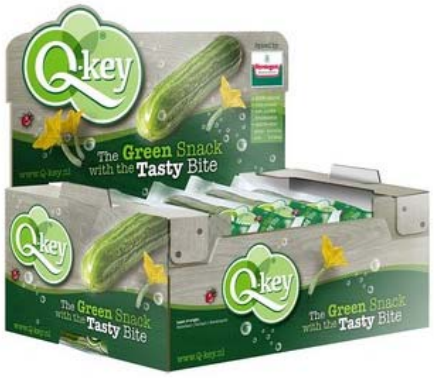


Image Credits: Left: Angelle Cherry Tomatoes(Euromonitor store checks), Right: Q-Key Cucumber Snack (http://www.q-key.nl/)

7.9.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 18 Sources- Fresh vegetable snack packs

Organisation	Description	Website	Contact
NatureSweet Ltd	Grower	http://naturesweet.com/	info@naturesweet.com
RJW Versteegen Nursery	Grower	http://www.q-key.nl/	r.versteegen70@gmail.com
WM Bolthouse Farms Inc	Grower	http://www.babycarrots.com/	http://www.babycarrots.com/

7.10 MICROGREENS

7.10.1 INTRODUCTION

Microgreens refers to a niche product demanded primarily by high-end foodservice owners to enhance the visual appeal and upscale dining experience for their well-heeled clientele.

Table 19 Innovation Summary- Microgreens

Type of Innovation	Niche supply opportunity
Region of innovation origin/usage	Various
Status of Innovation	Commercially available
Ease of implementation*	High
Estimated cost of implementation*	Low
Potential value from implementation*	High

**Note that that the above metrics were subjectively rated by Euromonitor International*

7.10.2 DESCRIPTION

Vegetable confetti used in gourmet meals

Microgreens refers to tiny leafy vegetables grown for gourmet meals which were popularised in the United States as early as the 1980s. Renewed interest in the innovation arose with the rise of molecular gastronomy and experiential fine dining, supported by the ascent of the new rich around the world. The greens are harvested as seedlings averaging 1-1.5 inches in length and are typically sold for use in salads and garnishes for foodservice clients. Almost all leafy vegetable species can be harvested as microgreens, although crop selection is often based on seedling colour, texture, flavour and overall market demand.

7.10.3 CURRENT USE AND DEVELOPMENT

Foodservice clients are the main buyers of microgreens

Demand for microgreens remains limited to commercial foodservice clients due to the perception that they are fresher and more flavourful. Microgreens can also be sold in cultivated pots and harvested/ cut as required. Most microgreens are packed and distributed in rigid plastic clamshell containers and/ or plastic trays which add additional transportation weight and other related costs. Although demand for microgreens is largely dependent on seasonal fine dining culinary trends, commonly grown varieties such as arugula, beets, basil, chard, chervil, cress, fennel, kale, mustard and sorrel are often featured year-round. Advancements in microgreens cultivation are few due to the niche nature of the industry and inertia by existing growers to improve on current processes.

7.10.4 KEY BENEFITS

Few restrictions on vegetables suited for microgreens cultivation

As microgreens refers to the seedling state in a vegetable's growth cycle, most – if not all – vegetable varieties, whether leafy, tubular or otherwise, can be harvested to meet this demand. This suggests new market demand avenues for growers of popular vegetable types used in fine dining, which command a high premium amongst buyers due to the high labour and capital intensity required for a successful harvest.

7.10.5 INNOVATION EVALUATION

Additional and costly installation facilities required

The fragility of seedling-stage vegetables requires specialised facilities to reduce environmental stress for a successful harvest. Greenhouses, high tunnels, shaded structures and other indoor growing rooms are typical cultivation spaces for microgreens, which may require computerised systems that regulate watering frequency and temperatures. As young greens are highly susceptible to microbial infection, specially formulated soil/ growing pod mixes are employed to enhance plant health and resilience to pests. Interested growers should consider the economic investment required to produce microgreens along with the risks of crop failure due to the delicate nature of this produce.

Lack of regulations for microgreens could dilute produce quality

There are few industry regulations that pertain to microgreens due to their niche supply nature. With fewer standardised procedures and quality controls in the undersupplied market, clients are often reliant on the harvest quality of their suppliers. This has led to growing concerns by foodservice owners and growers surrounding the potential risks of decline in microgreens product quality and prestige as inexperienced growers, both local and overseas, could flood the market with poor-quality produce. Although fewer regulations may reduce overall barriers to entry, the dilution in produce quality will hurt long-term industry prospects.

Limited export opportunities

Microgreens can be a challenge to sell or export due to their delicate nature and sensitivity to environmental stress. Changes in ambient temperature during any phase of production and distribution – from the growth and harvest to transportation from farm to kitchen – could adversely influence the produce and compromise its overall appearance and taste. Export opportunities to new markets are limited due to the presence of multiple touch points which would lead to damage and food wastage. At present, the majority of microgreens are grown domestically for local businesses.

7.10.6 INNOVATION COMPATIBILITY

- ✓ Commodities: Leafy vegetables and leafs of vegetables such as carrots
- ✓ Target markets: Australia

Summary 10 Innovation Compatibility- Microgreens

Extent of innovation compatibility with respect to…	Target markets		
	Australia	Asia (Developed)	Asia (Developing)
Range of commodities			
Cold chain/logistics			
Retailing landscape			

Legend:

High compatibility | *Low compatibility* | *Not applicable*

Image 10 Microgreens

Image Credits: Company source (confidential)

7.10.7 NEXT STEPS

The following table provides a non-exhaustive list of organisations that are aware of the innovation or have implemented the innovation. While in some instances, names of specific individuals cannot be listed due to confidentiality reasons, the organisation's email addresses or email addresses of media contacts (where available) have been provided as a first step to initiate communication for consultation purposes.

Table 20 Sources- Microgreens

Organisation	Description	Website	Contact
Fresh Origins Llc	Grower	http://www.freshorigins.com/	n/a
Lucky Leaf Gardens	Grower	http://www.luckyleafgardens.com/	kate@luckyleafgardens.com

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9. APPENDIX

9.1 INNOVATIONS MASTER LIST

In the initial stage of the study 40 global innovations were identified by Euromonitor International as potential innovations which to be considered by Australian growers. These innovations were identified through a combination of desk research in both English and local languages and from internal discussions conducted with Euromonitor International's industry and country research analysts.

From this list of 40 innovations, 10 innovations were shortlisted by HIA and AUSVEG based on internal discussions. Detailed innovation profiles have been drawn up for these 10 innovations in the pages preceding while all the innovations identified in the preliminary stage of the project are listed for reference below.

No.	Innovation	Description
1	Active packaging – e.g. humidity controls	Active packaging is defined as 'packaging in which subsidiary constituents have been deliberately included in or on either the packaging material or the package headspace to enhance the performance of the package system'. Along with the incorporation of additives into a flexible packaging film, active packaging also employs moisture absorbers, temperature control packaging, preservative releasers, oxygen scavengers and carbon dioxide absorbers.
2	Modified atmosphere packaging (MAP) innovations	MAP is a way of extending the shelf life of fresh food products. The technology substitutes the atmospheric air inside a package with a protective gas mix. The gas in the packaging helps ensure that the product stays fresh for as long as possible. Both high- and low-oxygen systems are used in MAP. In high-oxygen MAP, 60%-80% of the gas is oxygen and the remainder is carbon dioxide. In low-oxygen MAP, the oxygen is reduced to significantly less than 1% and replaced with carbon dioxide and nitrogen. The application of high-oxygen MAP is a new approach for the retailing of freshly prepared produce items and is capable of overcoming the many inherent shortcomings of current industry-standard air packaging or low-oxygen MAP.
3	Micro-perforations: modified moisture packaging (MMP)	This technology involves installing smaller perforation holes into packaging. The new hole design is 'scientifically proven' to extend the life of the product by 'efficiently' controlling the amount of moisture.
4	Edible and soluble films	Edible films and coatings enhance the quality of food products by extending their shelf life and improving food safety by protecting them from chemical, biological and other threats as well as physical deterioration.

5	Intelligent packaging – e.g.: temperature indicators	Intelligent packaging can be defined as 'packaging that contains an external or internal indicator to provide information about aspects of the history of the package and/ or quality of the food'. Intelligent packaging involves a 'smart' material that is capable of detecting a change in its environment through any combination of indicators, sensors and processors. Upon the detection of a change, an automatic response takes place. It is an extension of the communication function of traditional packaging and communicates information to the consumer based on its ability to sense, detect or record external or internal changes in the product's environment.
6	Controlled release packaging	A technology by which active compounds such as antimicrobials and antioxidants are incorporated into a package and then released to the food in a controlled manner to retard microbial growth or lipid oxidation for shelf-life extension. When appropriate, this innovative technology may be combined with traditional technologies such as modified atmosphere packaging to achieve the desired benefits.
7	Biodegradable/ compostable packaging and labels	An alternative to pulp and EPS products with compostable packaging nets from beechwood cellulose. The compostable packaging nets are produced from modal cellulose fibre and are environmentally friendly both in production and in waste disposal. The raw material is derived from beechwood from the thinning of PEFC (Programme for the Endorsement of Forest Certification) and FSC (Forest Stewardship Council) certified forests.
8	Supply chain transparency/ traceability	It was proposed in a 2008 academic paper that a system of 'gapless traceability' be adopted for ready-to-eat (RTE) vegetables as 'traditional traceability is not enough'. This system can provide the complete history of a product, from seed to shelf, including treatments and biological detections.
9	Laser labelling	The laser labelling technique marks the surface of a fruit or vegetable, permanently using de-pigmentation without damaging the product itself.
10	Intelligent labels	Electronic intelligent labels that indicate whether certain temperatures have been exceeded.
11	Colour-coded labels	Coloured labels used to inform consumers of the different varieties of food or to visually indicate which would be the healthiest options for purchase.
12	Shipping Container Ozonation System	This is a patented active atmosphere technology that enhances the atmosphere inside a refrigerated container with an active form of oxygen (ozone) to control moulds, yeasts, ethylene, salmonella, E. coli, listeria and other contaminants, both in the air and on surfaces.
13	C-Pak reclosable package	C-Pak is an innovative, proprietary, reclosable package system specifically manufactured to maintain freshness and to optimise

		marketability. This system includes high-speed tray sealing solutions combined with an innovative reclosable packaging method. It is characterised by a lower shelf film seal flange and an inside closing interference-style lid.
14	Leak-proof packaging	This packaging – plastic PET with a special clasp – is opened by removing a special 'clip' and it also is resealable.
15	Recycled material for packaging	This is synonymous with green packaging with one such use being of 100% post-consumer recycled polyethylene terephthalate (PCR PET) plastic.
16	Peel-and-reseal lidding film technology	Clear Lam Company's new peel-and-reseal lidding film designed to replace rigid lids and shrink bands.
17	Microwavable packs	Vegetables which are pre-packed in microwavable containers or wrapping for easy cooking and consumption.
18	UV-C radiation	This process uses low doses of ultraviolet light to stimulate natural plant defences (a process known as hormesis). The effect of low-dose UV-C treatment is not restricted to the surface of the treated commodities (e.g. germicidal effect), but is also manifested through the plant tissues. Sodium hypochlorite (NaClO) is typically used in the fresh-cut vegetable industry for disinfection, but certain problems with the process warrant alternative sanitation treatments. Subjecting vegetables to minimal UV-C radiation has been found to keep them fresh longer.
19	Mobile pre-cool unit	This is a modern and sustainable solution to the quick refreezing of temperature-sensitive fresh produce, developed by BG Door International. The technology arose from the need to quickly cool fresh produce such as soft fruit and lettuce.
20	Solar conduction dryer	This 2013 winner of Dell's Social Innovation Challenge is a dehydrator of fruits and vegetables powered by solar conduction.
21	VACC-TEK	This system developed by Danish company Frigortek is able to solve one of the problems that arises when storing onions, namely the need to drain huge amounts of water within a short time span during the onion harvest.
22	Ethylene scavengers – ethylene-absorbing packaging	These agents are used in specially produced ethylene-absorbent corrugated cardboard to absorb the ethylene gas produced by the natural ripening process of fruit and vegetables.
23	Adding mint oil to potatoes to prevent germination	To prevent germination in potatoes and minimise the treatment of the product with chemicals this process involves the fumigation of potatoes with mint oil instead.
24	Heat-shocking	This process extends the life of fresh-cut vegetables without the use of chemicals or irradiation.

25	Living salad	Living salads are sold in tray, pots or containers with all their roots attached and are ready to consume at any time. Once bought, they can be stored at home in a cool and bright place for up to a week.
26	Living lettuce displays	Living lettuce displays allow shoppers to freshly pick their own head of Salanova lettuce – without leaving the store.
27	Microgreens	Microgreens are a tiny form of young edible greens produced from vegetable, herb or other plants.
28	Vegetable vending machines	Pre-packed vegetables or vegetable meals sold in vending machines.
29	Fresh vegetable snack packs	This refers to on-the-go packs of vegetable snacks, sometimes provided with an accompanying dip or dressing.
30	Freeze-dried vegetable snack mix	A minimally processed vegetable snack with no additives.
31	Kale chip kit	Ready-to-bake kale chips, capitalising on the consumer trend of baking kale leaves as a healthier snack option.
32	Vegetable crumbs	Wheat-free and gluten-free vegetable crumbs which are used as a substitute for bread crumbs.
33	Dried vegetable soup	A dehydrated vegetable soup mix.
34	Vegetable purée	Puréed vegetables that come in jars or plastic pouches.
35	Stuffed vegetables	Meat- or cheese-stuffed peppers and other vegetables.
36	100% pure vegetable juice	Bottled vegetable juice made from less conventional vegetables, such as greens, beets, etc.
37	Grilled/ stir-fried/ roasted vegetable kits	A pack of fresh mixed vegetables for grilling or stir-frying purposes. May come with a stir-fry sauce.
38	Salad kits	Pre-packed salad leaves and vegetables that come with extras such as croutons, salad dressing, bread or cheese.
38	'Bibimbap' packaging	This container has eight compartments for eight different kinds of vegetables designed to maximise the colour and freshness of the respective vegetables.
39	QR codes on vegetable packaging	Quick response (QR) codes on packages that allow consumers access to a variety of information relating to the vegetable.
40	Recipe website with vegetable delivery	A recipe website allows its readers to order fresh vegetables based on their selected recipes.

9.2 INNOVATION BROCHURES

Micro-perforations

Micro-perforations
Packaging Innovations

Horticulture Innovation Australia

What is it and how does it work?

- Advanced modified atmosphere packaging technology to extend product shelf life
- Micro-perforation pore diameters range from 5µm-300µm
- Installed via mechanical puncture or laser-cutting technology on polymeric films
- Best used with integrated sensing technology to determine respiration rates to optimise perforation diameters and maximise oxygen transmission rates
- Commercially available with technology compatible with existing packing lines

Why should you use it?

Meet demand for packaged greens | Extend freshness and shelf life | Expand into new markets | Long-term cost savings

What are some other benefits?

- Highly compatible with most vegetable types, especially leafy greens
- Aids vegetable respiration under imperfect storage/ transport conditions
- Slows down product maturity, senescence and incidence of microbial growth/ damage
- Lowers wastage along the supply chain and on retail shelves
- Supports Australia's association with product freshness and nutritional value

Left: Micro-perforated packaging
Image credits: A-Roo Company LLC (website)

For more information on this innovation and other publications, please visit www.ausveg.com.au/infoveg.
This project has been funded by Horticulture Innovation Australia Limited using the vegetable industry R&D levy and funds from the Australian government.

Compostable packaging

Compostable Packaging
Packaging Innovation

Horticulture Innovation Australia

What is it and how does it work?

- Packaging and labels are made from plant-based compounds including starch (corn, sugar cane, bamboo) and cellulose
- Fully decomposes into carbon dioxide, water and naturally occurring minerals
- Some constituents are further able to replenish nutrients to landfills upon full disintegration
- Certified through the Biodegradable Products Institute, which provides a 'compostable logo'

Why should you use it?

Uses less energy and water in production | Long-term savings | Biodegradable and environmentally friendly

What are some other benefits?

- Safe and suitable for all types of vegetables
- Widely accepted material used in developing and emerging markets alike
- Consumers increasingly relate to environmentally friendly packaging in Japan, South Korea and Singapore
- No additional logistics are required as the packaging is largely impervious to ambient conditions

Far left: Biodegradable net tube packs
Middle: Biodegradable plastic bags
Left: Biodegradable bulk packs
Image credits: Verpackungszentrum Graz (website)

For more information on this innovation and other publications, please visit www.ausveg.com.au/infoveg.
This project has been funded by Horticulture Innovation Australia Limited using the vegetable industry R&D levy and funds from the Australian government.

PCR-PET packaging

PCR-PET Packaging
Packaging Innovation

Horticulture Innovation Australia

What is it and how does it work?

- Uses 100% post-consumer recycled polyethylene terephthalate (PCR-PET) plastics
- Used plastic products including soda bottles are processed to create customised recycled packaging
- Technology exists to ensure that the plastics used meet the necessary hygiene standards for food products
- Successfully developed and subsequently commercialised in the United States

Why should you use it?

Lower consumption of electricity, water and raw materials | Compatible with existing processing systems | Environmentally friendly

What are some other benefits?

- Cost savings with PCR-PET as input material due to improvements in manufacturing processes
- Resin is fully compatible with existing packing systems, which sidesteps need for changes in packing systems
- Lower barriers to entry as consumers already familiar with packaging
- Addresses consumer demand for green packaging arising in developed Asian markets

Far left: Earthbound Farm's PCR-PET clamshell package
Image credit: Earthbound Farm (website)

For more information on this innovation and other publications, please visit www.ausveg.com.au/infoveg.
This project has been funded by Horticulture Innovation Australia Limited using the vegetable industry R&D levy and funds from the Australian government.

Peal and reseal Lidding

Peel-and-reseal Lidding Film
Packaging Innovation

Horticulture Innovation Australia

What is it and how does it work?

- Flexible films can be affixed to flexible and rigid storage containers
- Fully integrated into or applied onto packaging film rolls
- Packaging innovation which allows for greater integration of modified atmosphere packaging (MAP) technology

Why should you use it?

Suitable for most vegetables | Savings in transport and warehousing costs | Cleaner, safer, value-added product for consumers

What are some other benefits?

- Ease of implementation – commercially available technology offered by leading packaging and technology providers
- Can be implemented on 100% recycled polymeric materials – appeals to green consumers
- Flexibility – can be cut to varying sizes allowing retrofitting to enhance brand image
- Can integrate MAP technology, which reduces food wastage due to build-up of moisture and nitrogen

Left: Misionero Vegetable's green leaves in clamshell packaging with a peel-and-reseal film
Image credit: Misionero Vegetable (website)

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Ethylene scavengers

Ethylene Scavengers
Packaging Innovation

Horticulture Innovation Australia

What are they and how do they work?

- Agents that absorb ethylene gas produced by maturing vegetables, thus slowing down the ripening process
- Delays the onset of 'climacteric' stage and the beginning of senescence
- Commercially available as plastic strips, installed onto crates or containers holding the fresh produce
- A new prototype of corrugated boxes which have in-built ethylene absorbers is being developed

Why should you use them?

Suitable for products with limited shelf life

Allow fresh produce to travel further distances

Extend freshness and shelf life

What are some other benefits?

- Extend product shelf life and reduce wastage
- Can be used to regulate ethylene gas composition for both packaged and loose vegetables
- Can be easily installed in harvesting containers and processing lines to reduce rate of product decay
- Low implementation costs due to the wide availability of suppliers

Left: Dry Pak Industries' ethylene-absorbing sachets, filters and film
Image credit: Dry Pak Industries (website)

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QR Codes on vegetable packaging

QR Codes for Vegetables
Packaging Innovation

Horticulture Innovation Australia

What are they and how do they work?

- Quick response (QR) codes are advanced, two-dimensional informational barcodes
- QR codes can be printed on various packaging surfaces or located on retailer display shelves
- Scanning QR codes reveals information on a product's origin, farming practices, etc., providing food traceability and assuring consumers of food safety

Why should you use them?

Suitable for most vegetables

Well-developed and easily sourced technology

Effective social media marketing tool

What are some other benefits?

- Bridge gap between growers and consumers and help to build trust
- Effective tool for creating brand awareness and for marketing purposes
- Increasing use of QR codes for food traceability more prevalent in target markets such as Mainland China and Japan
- Lower cost compared to traditional advertising and marketing campaigns

Far left: California Thomcord Grapes
Image credit: Farmers Fresh Fruit Co (website)

Middle: Shonai Sakyu Chives
Image credit: Euromonitor store checks

Left: Wakya Nojo Japanese Spinach
Image credit: Euromonitor store checks

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Vegetable snack packs

Vegetable Snack Packs
Value-added Innovation

Horticulture Innovation Australia

What are they and how do they work?

- Snack-pack formats for fresh vegetables retain and protect the integrity of fresh produce
- Pre-packaged, single-portion vegetables (cut or snack-sized) sold in convenient packaging suitable for on-the-go consumption
- Sold either as standalone product or accompanied by a dip or seasoning

Why should you use them?

Can be used for a variety of vegetables

Increasing consumer demand for healthy snacks

More profitable than bulk sales

What are some other benefits?

- Minimal additional processing and technology involved
- Specialised solutions from packaging manufacturers likely in response to growing consumer demand
- Widely used product with high consumer familiarity
- Ability to jump ahead of the curve and ride growing consumer demand for healthy snacking

Far left: Angelle Cherry Tomatoes
Image credit: Euromonitor store checks

Left: Q-Key Cucumber Snack
Image credit: Q-Key

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