



Fruit and vegetable consumption and waste in Australia

Recommendations towards a food supply system framework that will deliver healthy food in a sustainable way.

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Abbreviations

ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACF	Australian Conservation Foundation
AFGC	Australian Food and Grocery Council
AICR	American Institute for Cancer Research
AWT	Advanced Waste Treatment or Alternative Waste Technology
CAFO	Confined Animal Feeding Operation
CHD	Coronary Heart Disease
CPRS	Carbon Pollution Reduction Scheme
CSIRO	Australian Commonwealth Scientific and Research Organization
CVD	Cardiovascular Disease
DAFF	Australian Department of Agriculture, Fisheries and Forestry
DALY	Disability Adjusted Life Years
DASH	Dietary Approaches to Stop Hypertension
DEFRA	UK Department of Environment, Food and Rural Affairs
DEWHA	Australian Department of Environment, Water, Heritage and the Arts
DHA	Australian Department of Health and Aging
FAO	United Nations Food and Agriculture Organization
HAL	Horticulture Australia Limited
IFAVA	International Fruit and Vegetable Alliance
MLA	Meat and Livestock Australia
NFF	National Farmers Federation
NWMRS	National Waste Minimisation and Recycling Strategy
OECD	Organisation for Economic Co-operation and Development
RPC	Returnable Plastic Crate
SCECA	Senate Standing Committee on the Environment, Communication and the Arts
TAFE	Technical and Further Education
UN	United Nations
WHO	World Health Organization
WCRF	World Cancer Research Fund
WRAP	Waste and Resources Action Programme



Emily Morgan

In 2007, Emily Morgan was one of fifteen Americans to be granted a Fulbright Postgraduate Scholarship to Australia. A Tufts University postgraduate student and former Mount Holyoke College graduate, Emily carried out her Fulbright research on the relationship between food, health and the environment. This project was completed at VicHealth, under the direction of nutrition promotion and food policy expert Dr Tony Worsley and in collaboration with the School of Exercise and Nutrition Sciences at Deakin University.

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Executive Summary

Food is essential to human existence and healthy, nutritious food is vital for living life to its full potential. What we eat and how we dispose of it not only affects us, but our environment and the people around us.

Internationally, there is growing recognition of the links between food, health and the environment. It is generally accepted that the current levels of expansion and exploitation of our natural resources are not sustainable. Society must adapt to changing conditions and protect and sustain remaining available resources.

Debate and discussion about the food system's intricate relationships with human health and the environment is steadily increasing. In recent years the distance that our food travels, the number of people involved in its safe delivery and the transformations that it undergoes in the process have all multiplied. Once seen as a linear track from farmer to consumer, the food system is now better represented as a series of overlapping circuits, encompassing many participants and processes.

One of the fundamental failures of the current food system is the low consumption / high waste paradigm for fruit and vegetables. Despite their exceptional nutritional qualities and preferential environmental profiles compared to animal-based products, fruit and vegetables are consistently undervalued. Only a small fraction of Australians eat the recommended five serves of vegetables and two serves of fruit per day. At the same time, wastage is high all along the food system, with consumers alone throwing away up to a third of the fresh produce that they purchase.

Drivers for Change

Clear evidence links healthy eating and chronic disease. Diets high in fruit and vegetables protect against cardiovascular disease, Type 2 diabetes and several cancers. They may also help prevent musculoskeletal disorders and dental caries.

The food system and the environment engage in a variety of ways. The food system impacts on the environment through greenhouse gas emissions, water usage and the transformation of ecosystems. On the other hand, the health of the environment plays a pivotal role in determining agricultural productivity and efficiency. Most consumers do have the opportunity to choose foods and eating patterns that have less environmental impact.

The food system is also surrounded by strong ethical debates. Three interrelated fields of ethics – environmental, human and animal – all converge in the food system. The ways in which humans engage with the environment, each other and with animals are subject to considerable debate and controversy.

Improving the Situation

A highly sought-after objective of both the private and public sectors is to secure a more sustainable food system. Achieving sustainability requires a thorough and holistic understanding of the system and its drivers. This report aims to provide government, industry and non-governmental groups with the necessary information to achieve a targeted investment response to turn around the current low consumption / high waste paradigm to meet the current and future challenges facing the Australian fruit and vegetable system.

The future is not bleak. Efforts to target both consumption and waste are already being made with varying results. Research based on the Australian fruit and vegetable system demonstrates that both consumption and waste are affected by a number of issues throughout the system. Therefore, changes to the current paradigm will require a wide range of strategies, with all food system participants fully involved, invested and resourced for advances to be maximised.

Government's role

The role of government is critical. Strong leadership is needed to provide the conditions under which people can both live healthy lives and protect the environment. The Commonwealth Government, in collaboration with the various state and local governments, has a role to play in actively managing the food system. This role includes supporting the private sector to function more efficiently and guiding a cultural shift to increase population-wide appreciation for healthy eating. A whole-of government approach to tackling the low consumption / high waste paradigm must be taken.

Recommendations

Recommendation 1

- **Government and leading institutions must facilitate communication and collaboration between all players in the food supply system.** Communication is a key failure in the system and it cannot be ameliorated without collaboration from all jurisdictions involved in the supply and disposal of food. The current lack of collaboration across the food system has eroded the capacity to manage the supply of fruit and vegetables effectively. Government has a pivotal role to play in knowledge brokering and encouraging and guiding industries to improve their visibility.

Recommendation 2

- **The Commonwealth Government needs to regularly monitor nutrition and waste.** Currently, lack of data inhibits government and others from identifying problems and developing effective solutions. Surveys are essential to monitor the Australian situation and inform and evaluate public health and environmental campaigns. As a matter of urgency, the Commonwealth Government needs to conduct regular national nutrition and waste surveys.

Recommendation 3

- **Government must invest in social marketing campaigns.** Funds must be directed to successful campaigns that provide consistent messages. For example, the Go for 2&5® campaign should be implemented in every state with increased funding and a national anti-waste campaign needs to be developed.

Recommendation 4

- **Government and major institutions can lead by example.** Exemplifying the desired change will inspire other institutions and individuals to adopt more healthful and sustainable practices. Leadership is an essential complement to social marketing campaigns and in this instance could be demonstrated by mandating fruit and vegetable requirements for all food sold and distributed in government agencies and institutions and by implementing composting systems in all of their facilities.

Recommendation 5

- **Local and state governments should support efforts that address localised consumption and waste issues.** Local councils are best suited to address localised barriers to consumption and drivers of wastage. State governments have a role to play in providing councils with information and coordinating the transfer of knowledge across the state. Local and state governments could fund food rescue groups, consider food security in their planning and support programs that divert food waste from landfills.

Recommendation 6

- **Government needs to further encourage all sectors to cut their food waste through regulations and incentives.** Currently, economic incentives are not high enough for the industrial and commercial sectors to divert their wastes from landfill. Landfill levies must be adopted across all jurisdictions, with federal and state governments increasing existing research and development funding for food waste minimisation technologies.

Recommendation 7

- **The Commonwealth Government must create a national waste minimisation strategy.** This type of strategy has not been in place for nearly ten years and without it the states do not have consistent goals. This has resulted in a lack of attention to waste management in many areas and an aging waste management infrastructure which will reach its capacity in the near future. A new strategy would support the states and territories to create consistent goals and to implement strategies to achieve those goals.

Preamble

This report was written by Fulbright Postgraduate Scholar Emily Morgan. Emily was awarded the Scholarship by the Australian-American Fulbright Commission in 2007 to study the relationship between food, health and the environment under the direction of Professor Tony Worsley. Specifically, her Fulbright project examined fruit and vegetable consumption and waste in Australia.

Emily's tenure in Australia was completed in Melbourne at the Victorian Health Promotion Foundation (VicHealth) in affiliation with the School of Exercise and Nutrition Sciences at Deakin University. Her one-year Scholarship commenced in February 2008.

Emily's project included a literature review, face-to-face and telephone interviews with key informants and an online stakeholder survey. This report presents findings from the literature review and interviews. Additional information and the findings from the online stakeholder survey will be reported elsewhere.

Emily would like to acknowledge the generous support of the Australian-American Fulbright Commission, VicHealth and Deakin University. In addition, she would like to thank and recognize the tremendous supervision, guidance and encouragement that she has received from Professor Tony Worsley.

Introduction

*“What you eat is the most political thing you do every day”
– Jeanette Winterson*

Food is one of the most fundamental human needs, and a basic human right (United Nations [UN], 1948). As a result, having a food system is not an option, but what it produces, how it functions and who is involved is the subject of debate.

What we eat not only affects our health, but also has major environmental, ethical and economic implications. In recent years, all four aspects have been gaining increased attention due to changing world circumstances. Populations are increasing, demand for meat is rising in the developing world, land and resources are becoming ever more limited, economic markets are volatile, climate change is altering landscapes and water sources, and the rates of chronic disease are rising. It is clear that we need to rethink what we are eating, as well as how it is produced, distributed, processed, sold, prepared and disposed of (Strategy Unit, 2008).

In April 2005, an international group of academics met at the University of Giessen in Germany to discuss the emerging challenges faced by humankind in the 21st century and the new role nutrition science must take in light of these challenges. The resulting document, the Giessen Declaration, defined a New Nutrition Science, in which nutrition's original concentration on biochemistry is expanded. In this new science, the biological dimension is retained, but it is joined by two other dimensions: social-behavioural and environmental (Beauman et al., 2005).

The Giessen Declaration recognises that the political, economic and social context that existed when the science was born in mid-nineteenth century Europe is no longer relevant. Nutrition was first devised in a time when the focus was on material development and the political expansion of Europe and North America. Living and physical resources were exploited under the general assumption that they were inexhaustible. Now, one hundred and fifty years later, it is clear that this level of exploitation is neither ethical nor sustainable. The focus of nutrition – and all other relevant sciences, for that matter – must shift to one where cultivation, conservation and sustenance are the primary aims. It is imperative that the interconnected goals of personal, population and planetary health be considered concurrently at all times (Beauman et al., 2005).

At about the same time as the New Nutrition Science project was launched, international interest around dietary choices and their impact on health and the environment was beginning to rise. In 2003, the World Health Organization (WHO) released several reports and statements linking diet and chronic disease, especially surrounding the protective effects of diets high in fruits and vegetables (WHO, 2003a; WHO, 2003b; WHO United Nations Food and Agriculture Organization [FAO], 2003). Building from this, the International Fruit and Vegetable Alliance (IFAVA) was formed to encourage and cultivate national efforts to increase fruit and vegetable consumption by providing leadership and developing a global network of members (IFAVA, 2008). Then, in 2006, the FAO released the report *Livestock's Long Shadow: Environmental Issues and Options*, which linked the consumption of diets high in animal products with many of the world's ecological problems (FAO, 2006).

These reports and the debate and discussion that they have generated has built a platform for action and policy-making around food, health and the environment. In July 2008, the Strategy Unit in the UK Cabinet Office released the report *Food Matters: Towards a Strategy for the 21st Century*, an attempt to move the rhetoric to practice. This report reviewed the main trends in food production and consumption in the UK and the implications of those trends on the economy, society and the environment. It took a holistic approach to the food and nutrition system - as promulgated by the New Nutrition Science project. In addition to presenting the current state of affairs, the report outlines objectives for a future food strategy and the means for achieving them. Most importantly, the UK Government agreed to take forward all proposals presented. In the report, the government acknowledges that a healthier, more sustainable diet would need to contain less animal products than those typically eaten today and also presents several strategies for increasing fruit and vegetable consumption (Strategy Unit, 2008).

One of the fundamental failures of the current system is the low consumption / high waste paradigm for fruit and vegetables in developing countries. Despite their exceptional nutritional qualities and preferential environmental profiles compared with animal-based products, fruit and vegetables are consistently undervalued by governments and consumers.

In Australia, there has been no National Food and Nutrition Policy since 1992. In order to develop an updated policy that will set the framework for supplying the population with healthy, nutritious food in an ecologically, socially and culturally sustainable way, we must first understand how the supply system works. In this report we reveal what happens to fruit and vegetables after leaving Australian farm gates and, based on that information, make recommendations for improving the current situation. Emphasis is placed on strategies that increase consumption and decrease wastage of fruit and vegetables. This report focuses specifically on fruit and vegetables due to their role in promoting personal, population and planetary health – the goal of the New Nutrition Science project.

The Australian Food System

“The food industry is affected by a number of macro-trends, partly derived from global sources but also a product of the nature of our consumer base and the ways in which the food retail market has evolved” (Spencer & Kneebone, 2007, p. 17).

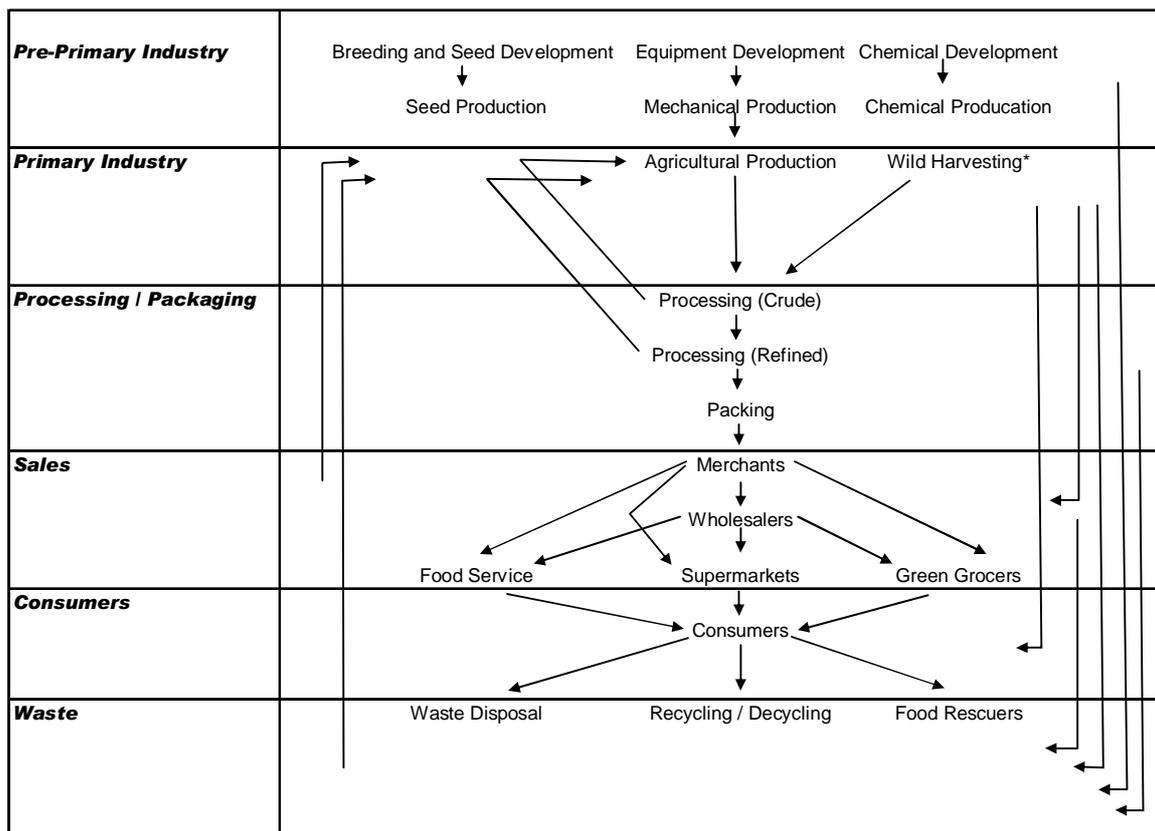
How Do We Conceptualize the Food System?

Traditionally, the flow of food between farm production and household consumption has been represented by the metaphor of a chain. In recent years, this metaphor and its usefulness have been challenged. Critics have pointed out that the linear nature of a chain is too simplistic to capture the dynamic economic, social and environmental context within which the food system functions (Foster et al., 2006).

Sundry systems of ownership, volatile markets, product diversity, varying quality, geography of system participants, global trends, social structures and differing federal, state and local laws and regulations are not represented in this outdated metaphor. In addition, linkages in the system have become more complicated as new roles have been created for intermediaries and consultants in managing commodity chains, developing sources of supply, processing, handling, monitoring and consumer research. The concept of a chain does not provide sufficient flexibility for the inclusion of these system participants (Biles et al., 2007).

Circuits, on the other hand, are cyclical in nature and therefore have no beginning and no end (Foster et al., 2006). A series of circuits, similar to that which formed the foundation of early 17th century clockwork mechanisms, has the flexibility to contain a large network of participants with complex and dynamic relationships. The rotation of each individual circuit influences the whole system and materials are able to leave and re-enter the primary flow of the system at any stage. Conceptualizing the food system in this way re-frames food losses as inputs essential to keep the system flowing, rather than as forms of waste and pollution. Also, the ‘series of circuits’ model brings producers and consumers closer together, thereby enabling consumers to be more aware of the lifecycles of their food and producers to be better informed about consumer demand and concerns. Nevertheless, the metaphor of a chain remains the dominant discourse for referring to the flow of food through the system.

Despite the complexity of the current system, six primary sectors exist, each connected by the transportation sector. As identified in the diagram below, these nodes are pre-primary industry, primary industry, processing / packaging, sales, consumers and waste.



*Wild harvesting has a very limited relationship with pre-primary industry.

Diagram 1: Simplified depiction of the Australian food system

The Sectors of the Food System

The pre-primary industry sector is responsible for providing primary industry with inputs necessary for production. Because of the diverse nature of inputs, from equipment to fertilizer, this sector is not extensively studied as a cohesive unit. Nonetheless, this commercial sector plays a central role in supporting primary industry and therefore the food system as a whole.

Australian primary industry production is valued at \$30.2 billion and employs 309,000 people (Department of Agriculture Fisheries and Forestry [DAFF], 2008). Primary production includes not only cultivation and harvesting, but also initial cleaning and segregation and any other operation that prepares the raw materials for sale as fresh products or to be processed (Higgins et al., 2007). Australia consistently exports substantially (generally two to 5 times) more fresh and chilled fruit and vegetables than it imports. Around 97% of the fresh fruit and vegetables sold in supermarkets is grown in Australia. However, imports of processed fruits and vegetables exceed exports and the difference between imports and exports for this category is growing (DAFF, 2008)

The food processing and packaging (manufacturing) industry is very large and plays a key role in the Australian economy. Food product manufacturing is Australia's largest manufacturing industry and consistently accounts for 18% or more of Australian manufacturing sector employment. The industry is valued at \$71.4 billion (DAFF, 2008). Between 2006 and 2007, employment in food and beverage manufacturing increased by 5% to a total of 191,400 people. However, employment in the fruit and vegetable processing sector fell by 27% to 9275 (DAFF, 2008). This parallels a general decline in the processing side of the Australian vegetable industry (James, 2007).

In 2006-2007, retail turnover in the food and drink sector was \$106.6 billion (DAFF, 2008). The *FoodMap* report, which was commissioned by the DAFF in 2007 to analyse the major food distribution channels, thoroughly examined the sales sector. This sector consists of both retail (grocery, convenience and specialty food stores, such as green grocers) and food service (takeaway food shops, dining out establishments, event/leisure catering and institutional dining). The authors of the *FoodMap* report noted that of total retail turnover in 2005-2006, 52% was represented by the grocery channel alone and 35% was represented by sales through the various food service outlets. The grocery channel is dominated by Coles and Woolworths, who hold collectively up to 78% of the market share of sales (Spencer & Kneebone, 2007).

The waste sector is not normally included in Australian Government reports on the food system. The waste industry is typically comprised of waste management operators who deal with collection, consolidation, sorting, recycling, processing and disposal activities. It is estimated in Australia that waste services sales are approximately \$4.8 billion annually (Senate Standing Committee on the Environment, Communications and the Arts [SCECA], 2008). In June 2003, there were 14,386 people employed by 1092 private and public businesses providing waste management services (Australian Bureau of Statistics [ABS], 2004). While it is certain that only a fraction of these employees are directly engaged in the management of food waste, these figures provide an idea of the overall size of the industry.

Road freight is by far the most common means of food transport in Australia. In 2001, 95% of food was transported via road, 4% by rail and 1% by sea. The amount transported by air was negligible. Food and live animals account for about 13.5% of the total weight of road freight carried in a year. The refrigerated road transport sector is currently undergoing consolidation, with larger players merging and acquiring the smaller firms. Rail freight of food and live animals represented between 3% and 5% of the total goods moved excluding grains and sugar in 2001-2003. The current rail infrastructure is not capable of efficiently handling the massive quantity of foodstuffs transported in Australia and therefore is primarily used for moving products which have less critical just-in-time performance, such as grains and sugar. Sea freight and air freight are used for the importing and exporting of foodstuffs, depending on the nature and perishability of the product (Higgins et al., 2007).

In 2007, the Australian Commonwealth Scientific and Research Organization (CSIRO) Food Futures Flagship published the *State of Logistics* report which examined the logistics systems for mangoes, livestock, wine and field crops in Australia. In this report the research team noted, "It is widely recognized that Australia's agriculture and food manufacturers and exporters would increase their competitiveness with a more efficient and cost effective freight transport system" (Higgins et al., 2007, p. 15).

Challenges to Improving the System

Gaining access to quality information is a tremendous challenge when studying the fruit and vegetable supply systems. In the *State of Logistics* report, the authors identified four specific difficulties related to obtaining quality information on the logistics systems of various foodstuffs: gaining access to commercial-in-confidence information; gaining greater industry co-operation in gathering information; obtaining reliable data on quality attributes and obtaining timely data for opportunities in innovation (Higgins et al., 2007).

The challenge of gaining accurate information on the supply system was also noted in the *FoodMap* report. The report highlights specific difficulties that arise when gathering data on fruit and vegetables. It notes that the diverse and disparate nature of the supply

system currently inhibits data aggregation and that, because of the highly perishable nature of fruit and vegetables, the pressure to quickly clear product in markets with many suppliers and/or buyers challenges the adequacy of information transfer between sectors. As a result, the report suggests that certain participants in the system preserve 'gate keeping' roles and hold information, preventing demand signals from reaching suppliers and hindering innovation. For fresh fruit and vegetables in Australia, this role is primarily held by category managers to the major supermarkets (Spencer & Kneebone, 2007).

Major Forces on the Food System

The future of the Australian food supply system is likely to be strongly influenced by a number of major forces. The primary drivers, as outlined by DAFF in the *Australian Food Statistics 2007* report are noted below (DAFF, 2008):

- **Changing global economics:** There is a strong and increasing demand for basic food commodities from developing countries paired with supply constraints resulting from resource competition. Increasing prosperity in developing countries is leading to rising demand for food, especially resource-intensive animal products. At the same time, subsidized production of biofuels in the US, Europe and Brazil is causing food production to compete with fuel production for land.
- **Advancing technologies:** New technologies in the food system usually lead to both better productivity and increased product functionality. The impact of new technologies is dependent on their uptake by food system participants and their acceptance by consumers.
- **Climate variability:** Changing climate patterns as a result of anthropogenic global warming are likely to create relative advantages and disadvantages for various agricultural regions. This leads to increased costs for most production systems and market volatility. Producers are faced with a risk of loss of markets as a result of unreliability of supply.
- **Shifting trade and social policies:** Softening barriers to international trade, such as gradual reductions in tariffs, is leading to increased globalization of food production and retail markets. In addition, closer scrutiny of food producer's budget outlays may lead to reductions in government assistance.
- **Increasing consumer and community demands:** Demand for nutritious foods is growing worldwide and consumers are increasingly interested in food products that promote healthy lifestyles. At the same time, consumers are demanding more assurances on food safety and accountability of environmental impact of food production systems.
- **Peak oil and a carbon-constrained economy:** Not mentioned by DAFF, but also a critical issue to the food supply is that of 'peak oil'. Increases in oil prices create shocks and ripples through the whole economy. As the price of oil rises and fluctuates, food prices will also oscillate and it may become increasingly difficult for participants at the early stages in the supply system (e.g. producers) to make a living (Campbell, 2008).
- **Rising control of retailers:** Also not mentioned in the in the *Australian Food Statistics 2007* report, but highlighted in the *FoodMap* report are the impacts of the application of supply system management strategies by the major Australian retail groups. This vertical control of the market affects the whole food system. Suppliers

- are forced to be more selective in their product specifications and to demand products with better shelf-life performance. This increased pressure makes it increasingly challenging for producers and wholesalers to earn liveable margins. At the same time, food manufacturers struggle to retain relationships with retail customers and grow their businesses in the face of increased supply system costs (Spencer & Kneebone, 2007).

The Role of Government

The choices that individuals make about what they eat, as well as how their food is produced, transported and retailed, are in fact heavily constrained. Government policies, industry decisions and societal inequalities determine the choices that individuals are provided. It is therefore the responsibility of government to provide the conditions under which people can live healthy lives and protect the environment (Nuffield Council on Bioethics, 2007).

For the past 30 years, this has not been the case. Neo-liberal economic policies have resulted in the government assuming a 'hands off' approach. The way that our food moves from through the system has been left to the 'free market' and the private industries have been left responsible for making many decisions that impact on people's ability to lead a healthy life

As outlined in *Public Health: Ethical Issues*, "the concept of stewardship means that liberal states have responsibilities to look after important needs of people both individually and collectively" (Nuffield Council on Bioethics, 2007, p. 25). Stewardship calls on governments to take responsibility for the health and wellbeing of their nations through solid leadership. The Commonwealth Government needs to be more active in managing the food system. Stewardship requires the government to provide vision, set and implement regulations and access and monitor performance. This should not stifle the private sector, but instead promote its more efficient use (Nuffield Council on Bioethics, 2007).

Recommendations

Government and leading institutions must facilitate communication and collaboration between all players in the food supply system. Communication is a key failure in the system and it cannot be ameliorated without collaboration from all jurisdictions involved in the supply and disposal of food. The current lack of collaboration across the food system (and between the various government departments that are responsible for food and nutrition) has eroded the capacity to manage the supply of fruit and vegetables effectively.

- **Knowledge brokering:** Knowledge brokering will help to ensure that the individuals working in the food system have knowledge of the health, environmental, ethical and economic impacts of the various ways that the system supplies the population with food, as well as the major forces influencing the food supply. Increasing knowledge across the system and building capacity in supply chain relationship and information management will help to improve the sustainability of the food system.
- **Sharing data and public good information:** Poor coordination between government, industry and consumers is resulting in market signal failure. Current industry data capture methods and dissemination mechanisms must be reviewed. Government has the power to use incentives and regulations to encourage and guide industries to improve their visibility.

Consumption and Waste in Australia

“Nutritional surveillance means to watch over nutrition in order to make decisions and take actions to improve nutrition in populations. The information obtained through the surveillance system can be used in at least four areas – policy analysis, planning, program management and research. However, in Australia the information currently available is less than adequate for many key questions in these areas”
(Marks, 1991, p. 277).

How Much is Enough?

The Australian Guide to Healthy Eating, a publication of the Commonwealth Department of Health and Aging (DHA), sets out dietary recommendations for the Australian public. While individual requirements differ depending on age, gender, pregnancy or breastfeeding, the Guide recommends adults consume a minimum of 5 serves per day of vegetables and two serves per day of fruit. This number ensures at least 70% of the requirements of protein, vitamins and minerals are met (National Health and Medical Research Council [NHMRC], 2003).

Based on the Guide, serving sizes are as follows:
One serve of vegetables is 75g or:
• ½ cup of cooked vegetables or legumes (beans)
• 1 cup of salad vegetables
• 1 medium potato
One serve of fruit is 150g or:
• 1 medium-sized piece (e.g. apple)
• 2 small pieces (e.g. mandarin)
• 1 cup canned or chopped fruit
• ½ cup 100% fruit juice
• 1 ½ tablespoon dried fruit
This equates to 675g per day.

There has been considerable debate over the last several years about what actually constitutes high and low consumption. Internationally a consensus on ideal intake levels has not been reached and recommendations for fruit and vegetable consumption vary considerably from country to country. For example, in the UK, 5 servings of fruit and vegetables (combined) are recommended daily and potatoes do not count in this tally (Food Standards Agency, 2001). In the US, about 9 serves (4 ½ cups) of fruit and vegetables (combined) are recommended daily for adults, but recommendations vary as they are based on personalized nutrition plans (Department of Health and Human Services and Department of Agriculture, 2005). Furthermore, the size of a serve differs depending on the country, so actual recommendations can be markedly different.

In 2003, a WHO/FAO expert consultation report on diet, nutrition and the prevention of chronic diseases recommended intake of a minimum of 400g of fruit and vegetables per day for the prevention of chronic diseases. This report recommended that tubers, such as potatoes and cassava not be included in fruits and vegetables. Four years later, in 2007, a World Cancer Research Fund / American Institute of Cancer Research (WCRF/AICR) report recommended the consumption of 600g of fruit and non-starchy (i.e. green leafy) vegetables and at least 25g of other plant-based foods, such as nuts, seeds and legumes, daily to protect against cancer (WCRF/AICR, 2007).

In light of these differing recommendations, it is likely that the Australian guideline of 675g (i.e. 7 serves of fruit and vegetables) per day is in excess of actual need. Nonetheless, it is clear that Australians should be striving to consume a diet rich in fruit and vegetables.

Consumption Data

Collecting dietary intake data has consistently been found to be difficult (Field et al., 1998; Michels, Welch, Luben, Bingham, & Day, 2005; Pomerleau, Lock, McKee, & Altmann, 2004). Data on fruit and vegetable consumption is generally collected through self-reported survey sampling, which is, like all types of surveying, prone to bias (Scheaffer, Mendenhall, & Ott, 1990). In addition, the quality and validity of dietary data depends on the ability and willingness of respondents to provide accurate information. One major challenge that exists for health and nutrition professionals is the inconsistent results produced by different survey methods (Pomerleau et al., 2004). This has been especially challenging in Australia, where a National Nutrition Survey of adults has not been conducted since 1995. Researchers and practitioners have been forced to compare data from different surveys that utilized different measurement techniques. Research has shown that when different measurement techniques are employed on self-reported diet assessments, estimates of consumption can vary by as much as 100% (Michels et al., 2005).

International Data

Consumption of fruit and vegetables varies substantially between different regions of the world, amongst different age groups and between the two sexes. Nowhere in the world has consumption of fruit and vegetables been estimated to meet the Australian recommendations for healthy eating. Consumption was found to be highest in European countries where child and adult mortality rates are low. In that region, most groups (examined separately by age and sex) achieved a combined daily consumption level of over 400g (Lock, Pomerleau, Caser, Altmann, & McKee, 2005).

National Nutrition Survey

The most recent National Nutrition Survey in Australia was conducted from February 1995 to March 1996 by the ABS (ABS, 1995). This survey collected data on daily food consumption using the 24-hour recall technique, usual frequency of intake using a Food Frequency Questionnaire, reported food related habits and attitudes and height and weight measurements of 13,800 Australians aged two years and older. Participants came from rural and urban areas in all states and territories.

The Survey found that, on average, persons over 18 years of age consumed 144g of fruit products and 259g of vegetable products per day, for a total of 403g (de Looper & Bhatia, 2001). These quantities were far below the 300g of fruit and 375g of vegetables recommended by the Australian Guide to Healthy Eating (ABS, 1995).

Vegetable and fruit consumption by children was also found to be low. For example, among 5-8 year olds on the day prior to data collection, 40% ate no fruit and 30% ate no vegetables. Furthermore, of the vegetables that were consumed, half were potatoes and 75% of the potatoes were fried or mashed with added fat. In contrast to this, 80% of these children ate foods such as cakes, biscuits and pastries and 60% consumed confectionary (ABS, 1995).

National Children's Nutrition and Physical Activity Survey

Between February and August 2007, data was collected for Kids Eat Kids Play, the National Children's Nutrition and Physical Activity Survey. The survey was funded and carried out by a public-private partnership: DHA, DAFF and the Australian Food and

Grocery Council (AFGC). Each contributed equal funding and data collection and reporting were contracted to the CSIRO and the University of South Australia (DHA, 2008b).

This was the first national survey of children's nutrition since the 1995 survey (and the first national physical activity survey since 1985). Over 4,440 Australian children from all states and territories aged 2 to 16 participated. Dietary data collection involved a face-to-face interview with children and parents during which information on the participating child's food intake was collected using a sophisticated 24-hour recall technique. Another similar recall was conducted on the same informants via telephone 1-3 weeks later (DHA, 2008b).

The survey found that the proportion of children meeting the guidelines for fruit and vegetable intake declined with age. Over 60% of 4-8 year olds consumed adequate amounts of fruit and 22% consumed adequate amounts of vegetables. Of 16 year olds, only 1% met the guidelines for fruit and 5% met the guidelines for vegetables (DHA, 2008a).

National Health Survey

In 2004-2005, the ABS conducted a National Health Survey to obtain benchmarks on a wide range of health issues. Nearly 26,000 people of all ages from all states and territories were included. Unlike the National Nutrition Survey and Kids Eat Kids Play, which asked participants to report their consumption from the previous day, this survey asked participants to estimate their usual consumption levels, using a small number of short answer questions. The data revealed that approximately 90% of the population did not consume the recommended 5 serves of vegetables per day and about 50% did not consume the recommended two serves of fruit per day (ABS, 2006b).

State-based Consumption Data

Several of the Australian States and Territories have gathered their own consumption data for fruits and vegetables. In all cases, this data reinforces the national findings – the Australian population is not meeting the national recommendations for fruit and vegetable consumption (Hands, Parker, Glasson, Brinkman, & Read, 2004; Victorian Department of Human Services, 2006).

For example, in Victoria, the 2006 Population Health Survey found that the only 47% of adults met the recommended daily intake levels for fruit and less than 10% (9.9%) met the recommendations for vegetables. These proportions were both down from those recorded earlier in the decade of 56% and 12%, respectively. Additionally, the Survey found that less than one in ten women (9.9%) and only 5% of males met the guidelines for both fruit and vegetables (Victorian Department of Human Services, 2006). In Western Australia, the 2003 Child and Adolescent Physical Activity and Nutrition Survey (CAPANS) found that on the day of data collection, 45% of children ate no fruit and 30% ate no vegetables. Analogous to findings from the National Nutrition Survey, many of the vegetables that were consumed were potatoes prepared with added fat (wedges, chips or hash browns) and 70% of children ate cereal-based non-core foods, such as cakes, biscuits and pastries on the day of data collection (Hands et al., 2004).

Furthermore, the evidence collected both at the Commonwealth level and at the state level clearly indicates that consumption is not consistent across the population. For adolescents and adults, fruit and vegetable consumption is positively related to income (Kamphuis et al., 2006). Particularly low consumption has also been noted amongst young adult males (between 25 and 34 years of age) (Victorian Department of Human Services, 2006).

Waste Data

Food losses are frequently divided into three broad categories: avoidable food losses, unavoidable food losses and possibly avoidable food losses. Avoidable food losses are comprised of truly edible food items, in contrast to unavoidable food waste, which is comprised of inedible parts of food products, such as egg shells, bones and banana peels. Possibly avoidable food waste represents items that are frequently discarded as inedible, but can actually be eaten by humans. Some examples of possibly avoidable food waste include potato peels and beetroot greens. A product is considered a 'food loss' when it is not consumed by a human, but this does not imply that the food does not stay within the food system or is not fully utilized for another purpose. For example, food which is turned into compost or digested into biogas would be considered a food loss even though it is utilized in another way. Food losses are typically referred to as food waste, but they are not truly wasted unless they are not utilized for another purpose.

The recent Senate report on Australia's waste streams highlighted the lack of reliable, comprehensive and contemporary waste information at the Commonwealth level as a theme throughout its investigation. Although waste audits are done regularly across the country, gaps in geographical coverage occur, the quality and consistency of the data varies between regions and definitions of waste are sometimes conflicting. As a result, comparing the success of waste management schemes between different areas is problematic.

The Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) noted in its submission to the inquiry, for example, that it requires "more robust information to allow it to better understand not only the level and types of waste generated but the implications of this for the environment, the economy and society" (SCECA, 2008, p. 23). Despite the lack of complete Commonwealth waste data, the Senate Committee stressed the sizeable challenge that the increasing generation of waste is placing on the current waste management infrastructure and the need to be proactive as a nation in addressing this issue (SCECA, 2008).

The dearth of data on waste in Australia extends into the food waste arena. Not only is food waste difficult to measure (due to differences in its composition and how it is defined), but the information is spread throughout a large number of diverse firms, many of which hold it in commercial confidence. At many points during this project we found that firms were unwilling to share information on the quantity and type of waste that they generated. However, a submission to the Senate inquiry by the Boomerang Alliance estimated that food waste comprises 15% of the 20 million tonnes of waste that goes to landfill in Australia each year and that the current recycling rate for food waste is extremely low. Only 10% of food waste is recycled and the other 90% is sent to landfill (SCECA, 2008).

Research conducted in the US has looked at food losses along the food supply system prior to reaching the consumer and has found that they vary substantially depending on the type and durability of the crop. Most of these food losses occur through 'walk bys' (explained below), weather, deterioration, neglect and processing (Jones, 2007). While wastage does occur during transportation and storage, it is either on a much smaller scale or goes unnoticed until the food reaches a later stage in the food system. It should be emphasized, however, that poor management of produce as it moves along the supply system can be extremely detrimental to the final product. When the cold chain is not maintained efficiently, the quality of the food products is irreversibly impacted. This results in the delivery of more mature, lower quality produce to the consumer (S. Estrada-Flores, personal communication, August 13, 2008).

On the farm, walk bys occur when a farmer chooses not to harvest a crop in a given year because he or she believes that the costs of the harvesting and transporting the crop to market will be greater than the earnings. This is often an issue in the Northern Territory, where the cost and availability of refrigerated transport is such that some farmers can't afford to get their product to market (S. Estrada-Flores, personal communication, August 13, 2008). Extreme or unusual weather events can also damage a crop at the farm level. For example, in March 2006 Cyclone Larry devastated Australia's banana industry. This single storm ruined 200,000 tonnes of bananas, worth an estimated \$300 million. In addition to the crop loss, the impact of Cyclone Larry on the Australian banana industry left thousands of Queenslanders out of work and caused banana prices to skyrocket (Anonymous, 2006).

As noted above, processing also results in substantial food losses. Rather than terming lost food as 'waste', the processing sector prefers the term 'process by-product'. This discourse shift may seem subtle, but it underlies a fundamental philosophy of waste avoidance throughout the industry. Any inputs that cannot be fully utilized represent a lost profit and, in the case of food waste, may actually represent an additional cost (J. Carter, personal communication, October 2, 2008; M. Klingler, personal communication, July 31, 2008). Nonetheless, in terms of total volume, food processing remains a major area of food losses along the supply chain. Research undertaken by the UK Department of Environment, Food and Rural Affairs (DEFRA) estimated that 33% of total food lost after leaving the farm is lost at the manufacturing level (DEFRA, 2007; Johnson & Parry, 2008).

Supermarket chains and retail industry peak bodies in Australia recommend that stores should not have wastage in excess of 4% of their produce turnover (P. Reilly, personal communication, August 14, 2008). In the UK, research has demonstrated that 13% of total food lost from the food system after the farm gate is lost by supermarkets during retail. This discrepancy between Australia and the UK could be the result of actual differences in wastage between countries or a difference between what the retailing sector aspires to and what actually takes place. Much of the wastage that occurs in food retailing can be attributed to deterioration and neglect (DEFRA, 2007).

Industry experts note that the mechanization of food supply system logistics has supported a general down-skilling of the personnel working in retail outlets. According to these experts, today's retail personnel have less knowledge of the products that they are managing and fewer food handling skills than previous generations of retailers (P. Reilly, personal communication, August 14, 2008).

Food losses in the food service sector (restaurants, pubs, caterers, hospitals, etc) are also frequently attributed to a skill loss in the industry (D. Gibbs, personal communication, November 21, 2008; R. Hooper, personal communication, August 26, 2008). For the past 30 years Australia has had a shortage of trained food service personnel. This shortage prompted the former Department of Education, Training and Youth Affairs to fund a working group to investigate the situation in 2001 (Working Group for the Food Trade Skill Shortages Project, 2001). Chefs note that today rapid training schemes and inexperience in food management and portion control result in food waste. However, they also point out that it is becoming increasingly common for restaurants to use pre-portioned or frozen items to try to combat this waste production (D. Gibbs, personal communication, November 21, 2008).

Most food losses (over 50%), however, occur at the consumer level (DEFRA, 2007). In the UK, 6.7 million tonnes of food is discarded by consumers each year, compared to 4.1 million tonnes by manufacturers and 1.6 million tonnes by retailers. This equates to consumers throwing away a third of food purchased (DEFRA, 2007; Johnson & Parry, 2008).

Furthermore, their research revealed that most of the food discarded at the consumer level can be eaten: 61% of food wasted is classified as avoidable food losses, 20% as possibly avoidable losses and 19% as unavoidable losses. By cost, 35% of this wasted food is comprised of fruit and vegetables and by weight, 40% is fruit and vegetables. Consumer research by the UK's Waste and Resources Action Programme (WRAP) revealed that most food waste is the result of food being left uneaten on plates, passing its 'best before' or 'use by' date, looking, smelling or tasting bad, or going mouldy. Cooking and preparing too much food was also highlighted as a major cause of wastage (Ventour, 2008).

In 2005, the Australia Institute put a dollar figure on national household food wastage. Its *Wasteful Consumption in Australia* report examined Australia's consumption patterns by identifying the immense quantity of goods and services that are never or hardly ever used. The report found that food accounts for most of this wasteful consumption. It revealed that Australian consumers threw away \$5.3 billion worth of food in 2004, over half of which was fresh food, such as fruit and vegetables. This sum represents over thirteen times the amount donated by Australian households to overseas aid agencies in 2003 (Hamilton, Denniss, & Baker, 2005).

Vignette 1: Mango Wastage

The 2007 CSIRO *State of Logistics* report examined the supply system for the Australian mango industry. Most mangoes in Australia are produced for the domestic market (90%). However, the industry typically suffers very large losses and only a small fraction of the fruit is ever retailed, resulting in considerable lost revenue. There are a variety of reasons that the losses occur along the supply system (also termed value chain because of the value-adding that takes place at each phase), but most can be attributed to losses in quality and shelf-life. Research by the CSIRO team found that the greatest loss in shelf-life occurs in the first 100 hours post-harvest. This time frame typically includes packinghouse operations and transportation to the destination market. If the cold chain is managed with a "best practice" framework, the product can arrive at the market with sufficient time remaining for commercialization. Once the product is purchased by the consumer, its value is closely linked to domestic handling and storage; nevertheless, decisions made during the supply system impact on the remaining shelf-life and value of the product.

The mango industry continually struggles with the high transport and packing costs of the fruit. These costs collectively represent 50% of the grower costs to get fresh product to market and therefore create a major obstacle for the commercialization of mango. Other issues that challenge the mango industry are grower fragmentation, inconsistent cold chain practices, shortages of refrigerated trucks, long distances to markets, lack of skilled labourers and short shelf-life (Higgins et al., 2007).

Recommendations

The Commonwealth Government needs to regularly monitor nutrition and waste.

Currently, lack of data inhibits government and others from identifying problems and developing effective solutions. Surveys are essential to monitor the Australian situation and to inform and evaluate public health and environmental campaigns.

- **Conduct a National Nutrition Survey:** Without a National Nutrition Survey of adults in 13 years, it is impossible to develop informed policies and programs. Regular data collection, using consistent sampling techniques, is necessary for determining changes in consumption over time and the effectiveness of interventions and campaigns.
- **Conduct a National Waste Survey:** Without reliable data on food waste, it is unclear exactly where most food is being wasted. This data is essential to create waste reduction strategies based on sound science. Regular waste audits should collect data on waste disposal all along the food supply system so that each sector (including consumers) can be monitored. Data should be entered into a national waste data system to track changes over time.

Drivers for Change

“The price shocks in global food markets may subside in the coming years, but the underlying issues of increasing scarcity of water and other resources, and of rising demand and climate change, will remain” (Strategy Unit, 2008, p. 34).

The population is not being fed in a healthy, environmentally sustainable or equitable way. All of this is underpinned by an economic system that is changing. The implications of these drivers for change in current food system are significant.

Health and the Link with Fruit and Vegetable Consumption

While debate surrounding the question, “how much is enough?” continues, evidence clearly suggests that a diet high in fruits and vegetables is beneficial for health and wellbeing, especially in the prevention of chronic disease. A chronic disease is a health condition that is long-lasting and recurrent. In Australia and other developed nations, chronic diseases are a major health concern and impact both morbidity and mortality. In 2004-2005, 77% of Australians had at least one long-term health condition (Australian Institute of Health and Welfare [AIHW], 2006b). These health conditions are frequently related to lifestyle choices.

The cost of chronic disease is high for both individuals and the country. In Australia over \$50 billion was spent in 2000-2001 on preventing, diagnosing, treating and managing disease (AIHW, 2006b). However, the current focus of the health system is on treatment; less than 2% of healthcare spending goes to prevention (AIHW, 2008). Health economists generally distinguish between direct costs and indirect costs of poor health. Direct costs include all the expenditures noted above. Indirect costs focus on lost production due to illness and premature death, but also include things such as court costs related to drug abuse. As a result of measurement difficulties, indirect costs are generally not included in cost estimates. However, it is important to note that they can be very high, sometimes even higher than the direct costs (Marks, Pang, Coyne, & Picton, 2001). Chronic disease contributes to the burden of disease through Disability Adjusted Life Years (DALYs). DALYs is a summary measure that combines both fatal and non fatal disease outcomes in the total burden of disease (AIHW, 2006a).

The development of chronic disease is generally a life-long process. Most children and young people up to 24 years of age in Australia are in good health; however, by early adulthood the effects of exposure to risk factors may begin to manifest as the early stages of disease. By middle age, many chronic diseases have already developed (AIHW, 2006b). This disease aetiology may be earlier for many Aboriginal Australians, since their life expectancy is nearly 20 years shorter than non-Aboriginal Australians (Australian Government, 2008). As the Australian population ages and people survive longer with chronic diseases (because of better healthcare and medical technology), there will be an increase in the burden of these diseases on health and wellbeing (AIHW, 2006b).

Yet many chronic diseases are preventable through the modification of a number of risk factors. Several of these risk factors are directly related to diet, including low consumption of fruits and vegetables (AIHW, 2006b). In addition to being a risk factor in its own right, low consumption of fruit and vegetables plays a role in influencing the other diet-related risk factors. High consumption of plant-based foods results in a diet high in dietary fibre and low in energy density, which help to control body weight and lower both blood pressure and cholesterol (WCRF/AICR, 2007).

In 2008, a research team led by Amanda Devine at Edith Cowen University in WA published the report *Vegetables and Fruit for Health and Healing*. In this report, the evidence bases for seven different health areas (primarily chronic diseases) were reviewed in relation to vegetable and fruit consumption: cancer, cardiovascular disease, diabetes, musculoskeletal conditions, Alzheimer's disease, Metabolic Syndrome (Syndrome X) and wound healing (Devine, McFaul, Dick, & Miller, 2008). The following section which considers the evidence linking fruit and vegetable consumption and the prevention of a number of poor health outcomes, draws heavily on this report.

Cancer

The incidence of the most common cancers has increased markedly in Australia in the last 20 years (Devine et al., 2008). Although some cancers have a considerable genetic basis, studies of identical twins have revealed that environmental factors are more closely linked to the causation of most common cancers than genetic factors (Lichtenstein et al., 2000). Approximately 30% of all cancers and 70% of cancers of the gastrointestinal tract are thought to be the result of consuming a diet high in saturated fat and low in vegetables, fruit and whole grains (Belliveau & Gingras, 2007). In addition, increased body weight and the cluster of risk factors that comprise the Metabolic Syndrome are also increased risk factors for some types of cancer (Cowey & Hardy, 2006; Renehan, Tyson, Egger, Heller, & Zwahlen, 2008).

Cancer costs the Australian health system over \$2.7 billion in direct health system costs each year. More than 70% of this is spent on in-patient, out-patient and day care services (ABS, 2006a). In addition, in 2003 cancers were responsible for 19% of all DALY (AIHW, 2006a). It is estimated that low consumption of vegetables (less than 4 serves per day) accounts for 17% of colorectal cancer, 9% of lung cancer, 9% of prostate cancer and 2% of breast cancer in Australia (Marks et al., 2001).

The joint World Cancer Research Fund / American Institute for Cancer Research (WCRF/AICR) report, *Food, Nutrition, Physical Activity and the Prevention of Cancer: a Global Perspective* summarized cancer studies which include cancer and diet prior to 2006. This report was compiled to build on an earlier report that the two institutions had issued in 1997. The earlier report concluded, "Evidence of dietary protection against cancer is strongest and most consistent for diets high in vegetables and fruits ... Other aspects of diet probably or possibly modify the risk of cancers at various sites" (WCRF/AICR, 1997, p. 504).

More recent findings from 2007 showed that it is probable that:

- Green leafy vegetables, fruits and carotenoid containing foods reduce the risk of mouth, pharynx and larynx cancers;
- Green leafy vegetables, fruits and beta-carotene and Vitamin C containing foods reduce the risk of oesophageal cancer; and
- Fruits and carotenoid containing foods reduce the risk of lung cancer.

The research also noted that there was limited evidence that:

- Green leafy vegetables and fruits decrease the risk of nasopharynx cancer and
- Green leafy vegetables, fruits and folate, selenium and Vitamin D containing foods decrease the risk of colon and rectal cancers.

It is important to note that these conclusions are likely to be conservative given the contentious nature of the biomedical research. However, in further support of diets high in fruit and vegetables for disease prevention the report stated "Obesity, type 2 diabetes, coronary heart disease, cancers of some sites and other chronic diseases have been rare or uncommon in those parts of the world where traditional dietary patterns are plant-based" (WCRF/AICR, 2007, p. 192).

The Mediterranean diet, an eating pattern high in fruit and vegetables, has been found to have protective benefits against cancer. A recent prospective study of over 378,000 people found that a Mediterranean diet greatly reduced cancer mortality over a five year period in both men and women. The diet included in this study was comprised of a moderate intake of vegetables, fruit, olive oil, nuts, legumes, cereals, alcohol, fish and dairy products and a low intake of meat and meat products (Mitrou et al., 2007). This finding reinforces the results of previous research on the Mediterranean diet. The Survey in Europe on Nutrition and the Elderly; a Concerted Action (SENECA) study found a positive relationship between consumption of the traditional Mediterranean diet and survival (van Staveren, de Groot, & Haveman-Nies, 2002).

As noted above, in addition to their own innate nutritious attributes, fruit and vegetables are valuable for their role in diluting dietary energy intake and the intake of less healthy alternatives. A diet rich in fruit and vegetables has less room for junk foods and animal products than a diet with limited fruit and vegetable intake. This is particularly important because the 2007 joint WCRF/AICR report identified a 'convincing' aetiological link between red and processed meats and colorectal cancer. The report noted that the evidence to support this finding has strengthened over the past ten years. It also stated that there is limited evidence suggesting that red and processed meats increase the risk of several other cancers (oesophageal, lung, pancreatic, endometrial, stomach and prostate cancer) and that consumption of animal foods that are grilled, barbecued or smoked is linked to the development of stomach cancer (WCRF/AICR, 2007).

Cardiovascular Disease

Cardiovascular disease (CVD) is a group of diseases related to the accumulation of plaque in the arteries of the heart, brain or other organs and impaired blood flow. Associated diseases include stroke and coronary heart disease (CHD). CVD has many risk factors, including several modifiable risk factors, such as high LDL cholesterol, low HDL cholesterol, high blood pressure (hypertension), diabetes, obesity, physical inactivity, cigarette smoking and a diet high in saturated fat and low in fruit, vegetables and whole grains (AIHW, 2005). CVD is the leading cause of death in Australia. In 2003, CVD accounted for 17% of the overall burden of disease and was associated with \$5.5 billion in direct health care costs (AIHW, 2006a).

Fruit and vegetables are especially effective agents in managing blood pressure, due to their richness in potassium, magnesium and fibre (and low sodium content). Excess sodium (salt) intake tends to increase blood pressure, but potassium and magnesium (as well as calcium) work to keep blood pressure levels healthy and possibly reduce elevated levels. Following the Dietary Approaches to Stop Hypertension (DASH) eating plan has been found to lower blood pressure and therefore reduce the risk of developing CVD. This diet emphasizes fruits, vegetables, fat-free and low-fat milk and milk products, whole grains, nuts, fish and poultry (Appel et al., 2003; Appel et al., 1997; Department of Health and Human Services, 2006; Nowson et al., 2004; Nowson et al., 2005).

Research by a Food Science Australia New Zealand (FSANZ) Scientific Advisory Group concluded that there was a consistent relationship between fruit and vegetable intake and CHD morbidity and mortality based on the results of twelve high quality prospective cohort and retrospective case-control studies. As a result of these findings, FSANZ recommended that a high level health claim could be used linking high intake of fruit and vegetables and CHD (FSANZ, 2008).

The literature review on CVD by the team at Edith Cowen University was in accord with this conclusion. For both stroke and CHD, their search identified an inverse relationship between fruit and vegetable consumption and the occurrence of disease. Food items that are usually consumed raw, such as leafy green vegetables and citrus fruit demonstrate

the greatest reduction in risk for stroke. Substances in fruits and vegetables that have been identified as beneficial in preventing CVD are antioxidant vitamins, folate, and various phytochemicals, in addition to fibre, magnesium and potassium (Devine et al., 2008).

Many of the studies associating CVD risk and fruit and vegetable consumption are epidemiological in nature. However, there is strong biological evidence for the mechanism of the various antioxidant and phytosterol components of fruit and vegetables in preventing the build up of plaque in blood vessel walls. Antioxidants disable free radicals, which, if left unabated, cause damage to the body's tissues. Combining this epidemiological and biological evidence leaves little doubt that a diet rich in fruits and vegetables promotes cardiovascular health (Devine et al., 2008).

Diabetes

The term 'diabetes' refers to a set of diseases characterized by high blood glucose levels, resulting from either insufficient or no release of the hormone insulin from the pancreas. There are three types of the disease: Type 1, Type 2 and gestational. Type 2 diabetes is characterized by high blood glucose levels that result from the body's inability to either produce enough insulin or properly utilize the insulin that is produced. This type of diabetes is typically associated with obesity, poor nutrition, physical inactivity and genetic predisposition and can be managed through dietary changes. Type 1 diabetes is believed to be caused by biological interactions as well as exposure to some environmental agents and gestational diabetes has the same risk factors as Type 2. Gestational diabetes usually disappears after the birth of the child but is a marker of increased risk of Type 2 diabetes later in life (Draper, Unwin, Serafino, Somerford, & Price, 2005).

Almost one million Australians now have diabetes and almost 100,000 more cases are diagnosed each year (Draper et al., 2005). Diabetes can shorten life expectancy by up to 15 years. In 2004 in Australia, 11,735 deaths were attributed to diabetes and the disease was listed as an underlying cause for 3,599 more deaths and an associated cause for an additional 8,136 deaths (AIHW, 2006a). Direct costs from the disease to the Australian health care system top \$1.2 billion annually (Draper et al., 2005).

A search of the literature did not determine that a consensus exists on whether high intake of fruit and vegetables is associated with a reduced risk of Type 2 diabetes. However, the decreased risk of obesity associated with a diet high in fruit and vegetables is likely to result in a reduced risk of the disease. Therefore, consumption of fruit and vegetables as a component of a healthy diet can be considered important in reducing the risk of developing Type 2 diabetes (Devine et al., 2008).

Other Conditions

Preliminary data suggests that relationships may exist between fruit and vegetables (or their components) and a number of other health conditions, such as musculoskeletal conditions and dental caries. Findings in these areas are not yet consistent; however, it is likely that they will attract increased interest in the coming years (Devine et al., 2008).

Bone and skeletal disorders such as osteoporosis and arthritis are major contributors to pain and disability for many Australians, particularly older adults (AIHW, 2006a). Osteoporosis is a condition that results from porous bones caused by progressive deterioration of bone tissue. This deterioration is generally gradual in nature and warning signs are often not present until the skeleton is already very fragile. Arthritis is a group of conditions which cause inflammation of the joints, accompanied by stiffness and pain (Devine et al., 2008).

In 2000-2001 musculoskeletal conditions were ranked as the third leading cause of health expenditure, costing the health system \$4.7 billion. However, it is believed that

this number has risen considerably in recent years (Draper et al., 2005). While these conditions are typically non-fatal, the quality of life of sufferers is significantly reduced. In 2000-2001, 25,796 DALY were estimated to be lost as a result of osteoporosis and in 2007, 93,855 DALY were estimated to be lost as a result of arthritis (Access Economics, 2001). While research linking fruit and vegetable consumption and musculoskeletal conditions has had mixed results, evidence strongly suggests a diet high in vegetables and fruits to be beneficial to bone structure and fracture prevention. This is because of the beneficial vitamin constituents (particularly vitamins K and C) and the alkalisating effect of a high fruit and vegetable diet (Devine et al., 2008).

Dental diseases include dental caries and erosion, developmental defects of enamel and periodontal disease. In developed countries, such as Australia, dental diseases account for between 5% and 10% of total health care expenditures. While generally not fatal, dental diseases negatively impact quality of life and are associated with considerable pain and anxiety (WHO/FAO, 2003). Dental health agencies in Australia recommend consumption fruit and vegetables in their raw, steamed, grilled, stewed or tinned forms as part of a healthy diet that promotes good dental health. However, they suggest that juice and sweet, sticky fruits, such as sultanas and other dried fruits, be consumed in limited quantities and only at meal times. This is because the sticky nature and high sugar content of these foods increases one's risk of developing dental caries (Dental Health Services Victoria, 2004).

<i>Summary of the protective health effects of fruit and vegetable consumption</i>
The evidence base for the beneficial qualities on health and wellbeing is strong. However, the benefits cannot be attributed to a single or mix of nutrients or phytochemicals. A review of the literature on vegetable and fruit consumption and disease aetiology revealed the following:
<i>Cancer</i>
<ul style="list-style-type: none"> It is likely that plant-based foods protect against several different types of cancer. Specifically, it is probable that a diet rich in fruit and vegetables reduces the risk of mouth, pharynx, larynx oesophageal and lung cancer and there is limited evidence that it also reduces the risk of nasopharynx, colon and rectal cancers.
<i>Cardiovascular disease</i>
<ul style="list-style-type: none"> There is an inverse relationship between vegetable and fruit consumption and the incidence of CVD. While the evidence base linking consumption and CVD is largely composed of epidemiological data, there is strong biological evidence to support the mechanisms of various antioxidant and phytosterol components of vegetables and fruit in preventing the build up of plaque in blood vessel walls.
<i>Diabetes</i>
<ul style="list-style-type: none"> There is not a consensus on whether or not high intake of vegetables and fruit is associated with a reduced risk of type 2 diabetes; however, the decreased risk of obesity associated with a diet high in vegetables and fruit is likely to result in a decreased risk of the disease.
<i>Musculoskeletal Conditions</i>
<ul style="list-style-type: none"> There is not a consensus on the relationship between high consumption of vegetables and fruit and the risk of musculoskeletal conditions; however, the evidence strongly suggests a diet high in vegetables and fruits to be beneficial to bone structure and fracture prevention.
<i>Dental Caries</i>
<ul style="list-style-type: none"> Frequent consumption of sweet, sticky foods, such as dried fruit and fruit juices can contribute to dental caries; however, consumption of fruit and vegetables, in their whole forms, is encouraged by health professionals to support good dental health.

Environment and Its Relationship with the Food System

In 1998 it was estimated that food consumption patterns in developed countries such as Australia exceeded sustainable levels by at least a factor of four. This is in part because emissions of the major greenhouse gases – carbon dioxide, methane, nitrous oxide and hydrofluorcarbons – are closely associated with food production and consumption (Carlsson-Kanyama, 1998). In addition to this link with global climate change, our food supply system is a significant player in other ecological problems, such as those around water usage and biodiversity conservation. However, evidence indicates that some diets are more harmful than others and most consumers have the ability to choose foods with less negative ecological impact.

Climate Change

The evidence in support of anthropogenic climate change is unequivocal. The Earth's atmosphere is warming and human activity is a major cause. The Intergovernmental Panel on Climate Change (IPCC) asserts that there is more than a 95% probability that increases in temperature are primarily driven by human activities that raise the concentration of greenhouse gases in the atmosphere (IPCC, 2007).

In Australia, food production is a significant contributor to greenhouse gas emissions. In 2005, direct emissions from agriculture accounted for 16% of all Australian emissions. Professor Ross Garnaut, the Australian economist commissioned by the Australian Government to examine the impacts of climate change on Australia and recommend policies to improve the situation, estimates that when indirect emissions from energy, transport and waste are included, the contribution of the food system rises to at least 23%. Methane (a much more potent greenhouse gas than carbon dioxide) from ruminant animals accounted for two thirds of these emissions or 11% of Australia's total annual greenhouse gas emissions (Garnaut, 2008). In contrast to this, it is estimated that direct emissions from the vegetable industry account for about 0.7% of Australia's total¹ (O'Halloran, Fisher, & Rab, 2008).

Primary Industries

Internationally, the livestock sector accounts for 9% of anthropogenic emissions of carbon dioxide, mostly through land-use changes such as deforestation. Livestock production is a key factor in deforestation, because woody vegetation is removed to increase space for grazing and producing feed crops. The sector is by far the largest anthropogenic user of land; 26% of the ice-free terrestrial surface of the planet is occupied by grazing and 33% of all arable land is dedicated to feed crop production (FAO, 2006). While land clearing has been regulated to some degree in recent years, assisting Australia in meeting its Kyoto emission abatement targets (Hatfield-Dodds, Carwardine, Dunlop, Graham, & Klein, 2007), the reforestation or revegetation of some pastureland currently used for grazing would present further mitigation opportunities. More information on the Australian meat and livestock industry is presented in Vignette 2.

Agricultural systems can also play an important role in sequestering atmospheric carbon. Green plants remove carbon from the atmosphere through photosynthesis and use it to build biomass in the form of roots, stems and leaves. At the same time, plants release carbon through vegetative respiration, combustion of wood as a fuel, consumption of plants for food and natural decay. Trees, shrubbery and other plants with enduring woody biomass are especially valuable, because they have the ability to retain much of the carbon they sequester over several or many years (Kerckhoffs & Reid, 2007). Farms that are managed to incorporate enduring woody biomass, are best suited to sequester atmospheric carbon in this way.

¹ Caution should be taken when comparing the data on different industries because great variation may exist in underlying assumptions and components included in measurement.

In addition, soil can hold significant amounts of carbon, perhaps two to four times that of vegetation. Like the relationship between carbon held by plants and atmospheric carbon, the relationship between soil carbon and atmospheric carbon is dynamic. The balance of carbon constantly shifts between the atmosphere and the soil through processes such as photosynthesis, transfer of carbon to the soil via roots and decomposing plant matter, biological soil activity and the oxidation of carbon from the soil into the atmosphere (Larsen et al., 2008).

Despite the prominent position of agriculture in the issue of climate change and greenhouse gas emissions, it will not be included in Australia's Carbon Pollution Reduction Scheme (CPRS) before 2015. This exclusion is due to the considerable difficulties in measuring agricultural emissions, the comparatively unsophisticated understanding of those emissions and the huge number of small to medium sized firms involved in agriculture compared with other sectors. Today, Australian governments variously recognize the role of biosequestration and offer landholders a range of incentives (Australian Taxation Office, 2006). However, recognition is still at a rather low level compared with the full potential.

Currently, there is considerable interest within the farming community in exploring opportunities for farmers to be paid for carbon offsets from soil sequestration (Campbell, 2008). The challenges of including soil carbon in climate policy are variability in measuring and monitoring combined with a poor understanding of soil conditions and ecology. A current trial in Western Australia to pay farmers for activities that sequester atmospheric carbon in their soils shows promising results, including increased soil carbon and an associated increase in plant productivity (Larsen et al., 2008). Nonetheless, until the logistics of measuring soil carbon sequestration on a broad scale can be finetuned, it may be that trees remain a more viable option in the near future for carbon offsets for Australian farmers (Campbell, 2008).

Agriculture is only one phase in the food system that contributes to greenhouse gas emissions; prior to primary industry is the pre-primary industry sector, which is responsible for producing the seeds, feed, machinery and chemical inputs that are later used in crop production. This industry utilizes considerable fossil fuels and other natural resource inputs to manufacture its products and in the process emits greenhouse gases. For example, the fabrication of nitrogen fertilizers results in nitrous oxide emissions. To the best of the authors' knowledge, no comprehensive measurement of the extent of greenhouse gas emissions produced by these industries has been made in Australia. However, in October 2008, Horticulture Australia Limited (HAL) estimated pre-farm carbon dioxide emissions of the Australian vegetable industry and found that for vegetable production the pre-primary industry sector emits up to three times as much as the primary industry sector. Their measurement included carbon dioxide emissions due to fertilizer and agrichemical use, fuel production, electrical use for irrigation and electrical use for postharvest use. Of these activities, electrical use for irrigation was by far the largest producer of emissions (O'Halloran et al., 2008).

Distribution and Processing

After leaving the farm, transport, storage and long food distribution chains have been shown to contribute significant energy and greenhouse gas emissions. For the past several years, interest in the concept of food miles (the environmental impact of food freight between farms and consumers) has grown exponentially. In Australia, statistics on food miles are scarce. Data collected in Melbourne found that the total distance travelled by food in a typical Victorian food basket was 70,803 kilometres (km), or twice the circumference of Earth. Of this distance, 21,073 km was via road transportation, which resulted in 11,327 tonnes of carbon dioxide emissions – the equivalent of 2,832 passenger cars driving for one year (Gaballa & Abraham, 2008). Processed food

generally requires more transportation than fresh food, because the various ingredients and pieces of packaging often come from different places (Stoeltje, 2008). When consumers travel to the store, market or restaurant to pick up their food, they are also contributing to the overall food miles of a product. A study commissioned by the UK Government found that car-based shopping emissions can in some cases actually be greater than transport emissions from the distribution system (Foster et al., 2006). This is because commercial vehicles (such as semi-trucks, rail cars and containers ships – but not aeroplanes) are much more energy efficient at moving cargo than passenger cars (Morgan, Renzi, Cook, & Radenovic, 2006).

However, food miles research suggests that the concept cannot be used as a sole indicator of the ecological impact of a food product and should only be considered in the context of other indicators of sustainability (Yakovleva, 2007). A recent study by American engineers Christopher Weber and Scott Matthews found that, although food is transported long distances in general, the greenhouse gas emissions associated with food are dominated by the production phase. Transportation as a whole represents only 11% of lifecycle greenhouse gas emissions (Weber & Matthews, 2008). Furthermore, within the transport sector, a number of other factors beyond distance are critical determinants of energy consumption and greenhouse gas emissions. These include the type of transportation, the transport load factor (how much the unit of conveyance can carry and how full it is) and the type of fuel used (Campbell, 2008). For example, one study found that the energy required to ship one kg of food by aircraft to be 27.74 kJ/km, compared to 0.50 kJ/km for shipping by rail. In addition, in terms of the ecological impact of households' food consumption, there is a growing body of evidence showing that diet composition (meat-centred or plant-based) is more important than how or where food items are produced (Strategy Unit, 2008; Weber & Matthews, 2008).

Cold storage facilities and equipment are essential in maintaining fresh products, such as fruit, vegetables and animal products on their journey to market. This refrigeration requires a constant supply of energy and is continuously contributing to greenhouse gas emissions. Furthermore, refrigerants used in cold storage facilities often have Global Warming Potential and, when they are leaked, they contribute to climate change (Carlsson-Kanyama, 1998).

Food processing and packaging is typically very energy intensive and contributes greatly to greenhouse gas emissions. Processing involves any number of modifications to the whole food product that 'value add' by changing its form in some way. Previously, processed food was considered the opposite of 'fresh food'; however, in recent years this distinction has become blurred as the length of time between harvest and consumption of many foods has been extended and the word 'fresh' has been used to describe an increased number of foods with varying traits (Fordred, 2008). Furthermore, many 'fresh' foods are now processed in some way, such as pre-sliced apples and packaged salad mixes.

Like food processing, packaging helps to ensure food safety, prolong shelf-life, make transport easier and simplify preparation for the consumer, but it negatively impacts on the environment throughout the total course of its lifecycle. Natural resources of all sorts are needed to create packaging products and their production can be incredibly energy intensive. Structural materials in the products generally come from a variety of different sources and must be first produced independently before being assembled together (i.e. a glass jar with a steel lid or a wax-lined cardboard box). The Melbourne study on food miles found that a tin can and milk carton that ended up in the shopping trolley had travelled 17,108 km and 8,035 km respectively (Gaballa & Abraham, 2008). After being utilized to wrap food products, packaging must be either discarded (typically to landfill) or recycled, which continues the lifecycle of the structural materials, but is also an energy intensive process.

Additional greenhouse gas emissions occur as a result of energy use at the food retail and service levels. Cold storage facilities, lighting, temperature maintenance and food preparation equipment are just some of the energy-intensive aspects of these businesses. Many fresh fruit and vegetable products can be stored in ambient conditions for some time without spoilage, but most fresh animal products must be continuously refrigerated or frozen to maintain their safety.

Food Preparation

Storage and preparation in the home, as well as food disposal methods (which are discussed in detail later in this report), also have potential to produce emissions. Three types of storage are generally employed in the home: ambient, refrigerated and frozen storage. Ambient storage has no energy requirements. Refrigerated storage and frozen storage both require electricity and therefore result in greenhouse gas emissions, however the amount of energy required to maintain a refrigerator or freezer can vary greatly depending on the size and efficiency of the unit (Foster et al., 2006).

The energy needs of various food preparation methods also vary significantly. The actual energy usage of particular kitchen appliances depends on their efficiency, the source of energy they require and the preparation techniques utilized (for example, boiling a food in a pot with or without the lid) (Foster et al., 2006). Generally, liquefied petroleum gas (LPG) fuelled appliances are the most energy efficient, followed by gas appliances. Electric appliances have been found to be the least energy efficient (Department of Climate Change, 2008b). Amongst electric appliances, research suggests that hot plates generally use less energy than microwave ovens and microwave ovens use less energy than conventional ovens to cook the same foods to the same degree (Foster et al., 2006).

Food Disposal

The disposal of food is the final area where the food system impacts on climate change. Food losses occur at all levels in the food system and directly impact the environment and climate change in several ways. First, when food is wasted all of the resources and energy that have been expended in the food system up until the point of loss are squandered. Second, food waste is the main source of foul odours and disease vector breeding in municipal solid waste (SCECA, 2008; Tsai, 2008). This causes health and safety concerns for those living, working or spending time near sources or storage areas of waste. Finally, when not aerated and managed properly food waste breaks down to produce methane and hazardous gases (i.e. hydrogen sulphide and ammonia) (Tsai, 2008).

When organic waste (such as food waste, garden organics or other bio-waste) goes to landfill it enters an anaerobic environment. Generally, the material is covered with soil within 24 hours and layered with more waste the next day. With each additional layer of soil and waste, the conditions become increasingly anaerobic. As a result, organic waste in landfill is responsible for nearly all of the waste sector's greenhouse gas emissions, which comprise around 3% of Australia's total emissions (SCECA, 2008).

Conversely, a number of alternatives to sending organic waste, such as food waste, to landfill exist which are either carbon neutral or carbon negative. These include, but are not limited to, converting organic waste to compost, anaerobic digestion, pyrolysis to form biochar and alternative waste treatment. Alternative Waste Technology or Advanced Waste Treatment (AWT) refers to the recovery of resource value from municipal solid waste through a combination of mechanical, biological and in some instances thermal processing. Beyond reducing the greenhouse gas emissions of organic waste breaking down in landfills, AWTs result in the production of useful outputs, such as energy, compost and other recyclables, and stabilize the material to reduce leachate formation (SCECA, 2008).

While the dominant waste model in Australia follows a linear extraction-production-consumption-disposal trajectory, reusing food losses for other purposes follows a modified closed-loop efficiency model. This alternative model helps retain some of the productive capacity of the food within both the environment and economy. Furthermore, keeping food wastes in the food system in this way decreases greenhouse emissions, eliminates landfill contamination and provides an opportunity for the creation of local employment (SCECA, 2008).

Lower Impact Diets

Household level recommendations for lowering the greenhouse gas emissions of one's diet include consuming less animal products, especially red meat from ruminants, and more in-season, fresh, locally produced fruit and vegetables, as well as limiting and better managing wastage (Carlsson-Kanyama, Ekstrom, & Shanahan, 2003; Parry, 2008). While several studies have revealed that none of these recommendations are without caveats, it is clear that dietary changes can have considerable positive impact on the environment (Carlsson-Kanyama et al., 2003). In January 2008, the chair of the IPCC, Rajendra Pachauri, pleaded with the international community to decrease meat consumption as a means of reducing greenhouse gas emissions: "Please eat less meat – meat is a very carbon-intensive commodity – this was something that the IPCC was afraid to say earlier, but now we have said it" (cited in Russell, 2008). Vegetarian diets with equivalent kilojoules to non-vegetarian diets have been shown to require up to 33% less fossil energy (Pimentel & Pimentel, 1996).

However, changing one's eating habits to include less meat does not imply the adoption of a vegetarian or vegan diet. A plant-based diet is an eating pattern that is dominated by minimally processed vegetables, fruits and other plant foods and decreased consumption of animal products, such as meat, eggs and dairy. In comparison to meat-centred diets, plant-based diets contain a larger proportion of a variety of vegetables, fruit, legumes, nuts, seeds and grains (Lea, Crawford, & Worsley, 2006). While vegetarian diets are one form, many plant-based diets actually include some meat. In many cultures meat is seen as a central element of a meal and research has shown that enjoyment of eating meat is the strongest barrier to adopting vegetarian diets (Lea et al., 2006; Lea & Worsley, 2003). Therefore, the inclusion of some meat and animal products in a plant-based diet may enhance its appeal to a larger proportion of the population.

As noted in the 2007 WCRI/AICR report to promote health, diets should also be plant-based:

Maintaining plant-based diets is easily done by planning meals and dishes around plant foods rather than meat and other foods of animal origin... Meat and other animal foods became centrepieces of meals as a result of industrialization, one consequence of which is that meat becomes cheap. As stated above, foods of plant origin are recommended to be the basis of all meals. A healthy plate is one that is at least two thirds full of plant foods; and instead of processed cereals and grains, wholegrain versions are better choices (WRCF/AICR, 2007, p. 381).

The life cycle energy inputs for animal products can vary significantly (Carlsson-Kanyama, 1998). One British study revealed that transitioning from a typical to a vegetarian diet could reduce the ecological footprint of one's diet by 6%. This particular study used cheese to replace much of the meat products, which likely prevented the researchers from seeing a larger drop in the ecological footprint. While cheese is a popular replacement for meat in many lacto-ovo vegetarian diets (those that include both dairy and egg products), it is highly processed and requires considerable energy to produce (Collins & Fairchild, 2007). For this reason, it is important that guidelines for reducing rates of animal product consumption in a plant-based diet identify energy efficient alternatives, such as vegetables, fruit, legumes and whole grains.

Water Usage

Thirty percent of Australia's annual water use is devoted to domestic food production compared to 7% for direct consumption by households (Lenzen & Foran, 2001). In the food system, considerable water is used in agriculture, food processing and packaging, and preparation and cleanup. The amount of water used in each of these activities varies due to the diversity of operations taking place.

For the last decade eastern and south western Australia have been experiencing rainfall deficits and record high temperatures that have severely stressed water supplies. The Commonwealth Bureau of Meteorology predicts that several years of above average rainfall will be necessary to remove the long-term deficits (Bureau of Meteorology, 2008). This prolonged drought has made the impact of water-intensive activities on the environment more salient and pronounced. Australian producers now struggle with water scarcity and increasing water costs that producers in many other nations have not yet experienced.

Embodied or 'virtual' water is the quantity of water required to produce a commodity. In general, livestock and animal products have much higher embodied water content than plant-based products (see Vignette 2 for information on the Australian livestock industry). An animal must consume feed crops, drinking water and service water before it produces a food product. Furthermore, if the animal is slaughtered, very large quantities of water will be used by the abattoir for cleaning purposes (Hoekstra & Chapagain, 2007). In his report for the Australian Conservation Foundation (ACF) on food and farming in Victoria, Andrew Campbell cautions against attributing too much significance to the concept of embodied water. Campbell notes that, like the concept of food miles, embodied water is criticized for its simplification of a complex situation. Specifically, he notes that the concept does not take into account critical factors such as timing, location and type of water. For example, there is no differentiation made between water piped or pumped over large distances or water that falls on rainfed pastures. Even so, embodied water has gained some interest among consumers and may draw attention to various food production methods (Campbell, 2008).

When researchers estimate the total water footprint of a nation, they put special emphasis on the food system. A water footprint is a measure analogous to the 'ecological footprint', but instead of indicating the area needed to sustain people's living, it quantifies the amount of water required to sustain a population. The four main areas that are considered are the volume of all goods consumed, the pattern of consumption (e.g. high versus low meat consumption), the growing conditions (climate) and the water efficiency of the agricultural practices used. Reducing meat consumption on a population-wide level has been suggested as one of the primary means of reducing a nation's water footprint (Hoekstra & Chapagain, 2007).

Vignette 2: The Australian Meat and Livestock Industry

Australia has a very large meat and livestock industry and consequently has one of the highest per capita agricultural emissions in the world. It produces more than 100kg of beef per person per year (compared to a world average of less than 9kg and an OECD average of 22kg) and 29kg of sheep meat per person per year (compared with OECD and world averages of about 2kg and 1kg respectively) (Garnaut, 2008).

Livestock (cattle, sheep, pigs and chickens) is frequently recognized for its high water needs. Internationally, research has asserted that a single 150g hamburger requires approximately 2,400L of water to produce (Hoekstra & Chapagain, 2007). However, Meat and Livestock Australia (MLA) claims that this is an overestimate of actual water requirements. Research by MLA suggests that an animal consumes 100-400L of water to produce 1kg of beef in Australia. They note that actual consumption depends on the environmental conditions and productivity of the farm and that most Australian cattle are raised on rainfed pastures. They point out that if one calculates all of the rain that falls on these pastures then the figure rises exponentially, but that this rain will fall whether or not there are cattle there (Meat and Livestock Australia, 2008). It is likely that the actual water needs of the livestock industry are higher than that suggested by MLA, but below the international average. This is because the MLA figure does not include water used to grow food for the animals and service them before and after slaughter.

Internationally, livestock's primary threats to biodiversity arise from its detrimental impact on the primary resource sectors: climate, air and water pollution, land degradation and deforestation. Internationally, 23 of the 35 global hotspots of biodiversity loss are reported to be affected by livestock production (FAO, 2006). Internationally, much cropland is utilized for livestock production indirectly by producing feed crops. In Australia, this is less of an issue, because most Australian cattle and sheep consume the majority of their calories grazing, rather than being fed grain crops (C. McDowell, personal communication, August 22, 2008). The Australian industry is probably unique in many respects, especially regarding water use, but it is unlikely to prove substantially more environmentally sustainable than the global meat and livestock industry.

Although most beef and sheep meat is produced for export (Spencer & Kneebone, 2007), in comparison to other nations, apparent meat consumption in Australia is very high, with ABS reporting that the average Australian consumes approximately 304g per day. It is possible that this figure underestimates actual consumption, as it does not include seafood or processed meats (ABS 2000 cited in Larsen, Ryan, & Abraham, 2008). Current global adult average meat consumption is 100g per day per person, but there is an order of magnitude difference between high consuming and low consuming populations. In high income countries, the average is about 200-250g per day and in low income countries it is between 25g and 50g per day. A paper by McMichael et al. (2007) published in the *Lancet* advocated for an international contraction and convergence policy to address the health, energy and environmental impacts of meat consumption. Recognizing that East Asian demand for meat is rising, the team of international researchers recommended a working global target of 90g per day, with no more than 50g per day coming from red meat from ruminant animals to stabilize greenhouse gas emissions and increase emissions equity.

There is undoubtedly room for increasing the ecological efficiency of livestock production and may even be a case for greater public assistance because of public good consideration. However, as in the energy sector, there is also scope for better demand management. It is likely that worldwide livestock production will need to contract in the future as the need to use arable land for crop production will rise. However, this does not mean that the industry will disappear, rather, as noted by Richard Lowe, Chief Executive of the UK Meat and Livestock Commission, livestock production "will be a smaller industry but producing higher quality, welfare friendly and environmentally friendly products" (Lowe, 2007, p. 12). Livestock numbers will decline, but the value of meat will increase.

Biodiversity Conservation and Ecosystem Health

The intensification and extensification of agriculture in the second half of the 20th century resulted in damage to the biodiversity of the Australian countryside and waterways. Biodiversity is essential to maintain ecosystem health and the services that healthy ecosystems provide. Sustainable food production, in turn, is dependent on those services, such as stabilization of the watertable and pollination. A 2004 report by the Victorian Department of Sustainability and Environment outlined the farming practices that have the most significant impacts on biodiversity in the state. These include unregulated grazing, monoculture cropping, conversion from native habitat to cropping, inadequate buffering between cropping, waterways and remnant native habitat and incremental deforestation (Wilson, Ford, & Lavis, 2004).

It is important to draw the distinction between historic and current land use changes and impact. In the short time since European occupation of Australia, very rapid land use change has occurred. Indigenous ecosystems have been replaced with agricultural ecosystems, thereby reducing the viability of many indigenous species, ecosystems and habitats. The impact of these historic land use changes have become widely recognized in recent years and actions are being taken to address ecosystem decline. Today incremental land use changes continue, but generally not to the extent that previously occurred (Crosthwaite, Callaghan, Farmar-Bowers, Hollier, & Straker, 2004).

Some of the impacts of farming practices are unique to the livestock industry, but many are indicative of cropping systems (Wilson et al., 2004). To minimize negative impact, it is critical that all agricultural systems are managed under a plan that emphasizes landcare and environmental stewardship.

Biodiversity in our oceans, rivers streams and lakes is another area of ecological concern. Currently, 76% of global fish stocks are fully exploited or over exploited. This is largely a result of fisheries failing to implement and enforce measures that would protect the sustainability of marine ecosystems. Most fisheries' management regimes focus simply on responding to consumer demand and market pressures, rather than on developing business models that will allow ecosystems to recover and flourish (Allsopp, Page, Johnston, & Santillo, 2007). Commercial fishing also tends to involve 'bycatch', or the catching of non-targeted species. Sometimes these additional fish and animals are kept, but frequently they are dumped into the sea once they are already dead or dying (Larsen et al., 2008). While no Australian fisheries are classified as 'overfished', at least 20% of the fish species that are currently fished in Australia are and it is highly likely that some imported fish come from depleted stocks (Larcombe & McLoughlin, 2007).

Aquaculture (fish farming) is rapidly growing as a source of fish and is frequently appraised for its potential to alleviate pressure on wild fish stocks. However, aquaculture can also have significant negative ecological impacts. Fish excrement, chemicals, antibiotics and vaccines from farming operations can cause water pollution that can impact on biodiversity on the surrounding ecosystem. In addition, damage can occur when non-native fish escape from the cages and invade ecosystems. Negative impact from aquaculture can be minimized by managing fish numbers, reducing excess feeding, using high quality fish food, carefully designing culture systems, utilizing biofiltration systems and collecting solids (Larsen et al., 2008).

Globally, the meat and fishing industries are considered leading players in biodiversity loss, since they are major drivers of climate change, deforestation, land degradation, pollution, sedimentation of coastal areas, over fishing, and introduction of alien species into ecosystems (FAO, 2006). For these reasons, supplementing some dietary meat with plant products has the potential to help preserve or restore local and global biodiversity. But in this plant-for-meat substitution, consumers must take heed of issues such as seasonality, cropping systems, level of processing and food miles to maximize the benefit.

Ethics and the Food System

An ethical food system is one in which production, distribution and retail are carried out in an environmentally sustainable manner, fair prices reflect the true costs of food, the welfare of animals is protected and every member of the population has consistent access to a variety of healthy, safe foods. In Australia and around the world, this is not the case. Throughout the development of the modern food system, three interrelated streams of ethics have been ignored to varying degrees: environmental ethics, animal ethics and human ethics.

Environmental Ethics

Environmental ethics relates to the moral relationship between human beings and the environment. The concept was first championed by American writer Aldo Leopold in *A Sand County Almanac* in an essay entitled 'The Land Ethic'. Leopold wrote,

All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. His instincts prompt him to compete for his place in that community, but his ethics prompt him also to co-operate (perhaps in order that there may be a place to compete for). The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land (Leopold, 1948, pp. 203-204).

Leopold's argument, which has been repeated and refined by environmentalists for the last half century, can be summarized by saying that biodiversity has an intrinsic worth and does not exist solely for human pleasure and taking.

As evidenced by the above section on the environment, we know that, to a large extent, gains in agricultural productivity have been at the expense of biodiversity and the environment. Consequently, environmental ethics have been eroded as water resources, soils and natural habitats have been undervalued and unsustainably exploited and polluted. This exploitation and pollution has traditionally been viewed as an externality to the food supply system and has therefore not been reflected in the market value of food (Strategy Unit, 2008), notwithstanding many farmers adopting a stewardship ethic.

Human Ethics

The term human ethics is used here to refer to the broader concepts of human rights and social justice. According to the Universal Declaration of Human Rights, "All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood" (United Nations, 1948). This first Article in the Declaration sets the foundation for all societal workings and processes, including a fair food system that provides all people with safe and healthy food while providing those engaged with the system an adequate income. However, the current food system does not achieve this.

Today, the top 10% of Australian farms generate more than 50% of gross agricultural production and the bottom 50% of farms generate less than 10% (Barr, 2005). As a result, most farmers are losing money most years. Those who remain in farming and are not amongst the top earners are subject to rising indebtedness, and consequently, increased health risks and stress levels, such as depression and suicide (Drought Policy Review Expert Social Panel, 2008). These poor states of mental health and wellbeing have negative social repercussions that extend beyond the immediate family and permeate rural communities. Like the strain of pollution and environmental and animal exploitation, these social impacts are not currently accounted for in the cost of food (Campbell, 2008).

Rural communities play a critical role in the management of the Australian countryside. In fact, farmers manage 60% of the Australian landmass (Department of Climate Change, 2008a). Across Australia, these communities have been working to repair and manage the landscape through both coordinated and individual efforts. Many thousands of rural residents have become active stewards of the land through the hugely successful Landcare Movement (Youl et al., 2006).

Vignette 3: The Landcare Movement

It is now widely recognized that the European-based farming practices that were first employed in Australia in the 18th century were not suited for the landscape and have caused considerable degradation. In the 20th century, governments and ecologists began to develop programs aimed at repairing the damage that these farming practices have inflicted upon the environment. These included programs focused on soil conservation, weed and pest control and reforestation. Building on these early programs (and momentum created by recent ecological debates, such as that over Franklin Dam in Tasmania), the Landcare Movement took off. Beginning in Victoria in the 1980's as a partnership between the state government and local groups of landholders, Landcare developed with all of the hallmarks of a highly autonomous, multi-disciplinary, community-based program (Youl, Marriott, & Nabben, 2006).

In a rare instance of unity, the Australian Conservation Foundation and the National Farmers Federation joined forces to lobby then Prime Minister Bob Hawke to fund a national Landcare program. Their proposal was well-received and in 1989 the Commonwealth Government committed \$360 million to the 'Decade of Landcare'. Today over 4000 community groups have mobilized around the country to improve farmland, rehabilitate waterways, restore wildlife habitats and engage in a number of other recovery projects. Landcare Australia acts as the peak body for the groups and Landcare efforts are supported by a mix of public and private funds (Youl et al., 2006). Over the years, the Landcare model has been criticised as government over-reliance on voluntarism (Toyne & Farley, 2000) and landscape degradation continues in Australia; however, the movement has demonstrated the importance of community organisation and action to sustainable development. While little more than a third of farmers are members of Landcare groups (and even fewer are active), studies show that members are much more likely to take up best management practices (Curtis & De Lacy, 1994).

The prosperity of rural communities is not the only link between human ethics and food. Food security has been defined by the Victorian Health Promotion Foundation (VicHealth) as "the state in which all persons obtain a nutritionally adequate, culturally acceptable, safe food regularly through local non-emergency sources" (VicHealth, 2007, p. 1). When people are financially stressed, food choices often become discretionary. People on lower incomes are more likely to consume lower amounts of plant-based foods, such as fruit and vegetables and higher quantities of cheaper energy-dense foods that are high in fat and sugar. Research on food insecurity has demonstrated that energy dense foods are often seen as being more affordable, accessible, filling and acceptable to family members (Drewnowski & Spector, 2004).

People on lower incomes are more likely to have trouble feeding themselves (VicHealth, 2007). It is estimated that increased environmental degradation as a result of climate change will lead to rising levels of human displacement (A McMichael, Woodruff, & Hales, 2006). Food insecurity is likely to rise if these predictions come to fruition and climate refugees, fleeing areas that are especially hard hit by continued climate changes, come to Australia in search of more stability around food.

Another form of food security that is sometimes discussed in relation to increased consumption of local, unprocessed, lower-impact diets (with implied high fruit and vegetable consumption) is national food security. This type of food security refers to sufficient domestic food production to feed the Australian population. The contention is that dependence on other nations to supply Australians with healthy food could leave many in food insecurity should international relations fail or global food stocks become further depleted. This argument is based on the assumption that Australia has the capacity to produce enough food to support its population if lower-impact diets are adopted.

Despite research indicating lower fruit and vegetable consumption among those on lower incomes (Drewnowski & Spector, 2004), the fewer value-adding processes that a food product goes through, the cheaper the cost (by weight). A study in Cardiff, Wales found that consumption of a vegetarian diet cost 15% less than consumption of the average, non-vegetarian diet (even though the vegetarian diet included large amounts of expensive cheese) (Collins & Fairchild, 2007). Additionally, when fresh fruit and vegetable procurement is local - such as through farmers markets or community supported agriculture - economic benefits flow back into the community. Surveys of community supported agriculture members in the USA have found that the majority increased their consumption of produce after joining (Oberholtzer, 2004; Perez, Allen, & Brown, 2003). This being said, recent Australian research has revealed that the costs of healthy foods (including fruit and vegetables) have risen slightly more than unhealthy foods relative to inflation, so the margin of savings between produce and less healthy alternatives is narrower today than fifteen years ago (Burns, 2008).

With a very large number of Australian farms currently involved in animal production, recommending reduced consumption of animal products, even as a way for consumers to save money, protect their health and lessen the environmental impact of their diet, is problematic. The challenge will be in ethically managing the transition from unsustainable to sustainable food systems. Like the wild landscapes and ecosystems that for millennia fed our hunter-gatherer ancestors, these sustainable food systems will be dominated by a range of plants that invariably outnumber the animals which feed upon them. As British biologist and writer Colin Tudge wrote, "If farming is to be sustainable, then whatever form it takes it must conform to the logistics of biology: a huge output of plants; a much smaller output of livestock" (Tudge, 2005, p. 717). This transition will require careful planning and collaboration between all members of the supply system, from primary producers to health professionals. It is critical that it be done in a way that enables, encourages and engages the agricultural sector, while concurrently improving the prosperity of rural communities.

Animal Ethics

Animal ethics (embodying both animal welfare and animal rights) is another issue with which the food system grapples. Consumers are becoming increasingly concerned with the credence attributes of food. Credence attributes refer to quality dimensions of food that cannot be ascertained before or after purchase. For example, consumers generally cannot ascertain how an animal was raised, fed, or slaughtered from the way that a meat product looks, smells, tastes or feels. However, in some cases, quality labels can provide consumers a means of inferring these characteristics (Grunert, 2005).

Two Australian studies on the benefits and barriers to adopting vegetarian and plant-based diets found that 30-36% of respondents believed that adopting these types of eating patterns would help improve overall animal welfare (Lea et al., 2006; Lea & Worsley, 2003). In addition, concentrated animal feeding operations (CAFO), also known as factory farms, are considered especially inhumane and major sources of noise, foul odours and pollution (Sustainable Table, 2008). As mentioned earlier, most cattle and

sheep in Australia are not produced in this way; however, the pig and chicken meat sectors remain under scrutiny regarding animal welfare for their stocking densities (Scott, 2008).

Food production systems impact on local fauna. All cropping and animal producing operations transform the landscape and most displace wildlife. Degradation as a result of farming was most dramatic following European colonisation, but has slowed in recent years. Local Landcare groups in many communities are currently working to bring species back into the landscape, but there is still much to be done (Youl et al., 2006). Loss of habitat as a result of primary production can be minimized if considered in the strategic plan for the operation and planned for appropriately (C. Watts, personal communication, May 14, 2008).

Economics and the Future of the Food System

Economics is a major driver of change and, as leaders in the field are now stressing, proceeding with 'business as usual' is not an option (Campbell, 2008; Royal Institute of International Affairs, 2008). With shifting weather patterns attributed to climate change, coupled with the impending carbon trading scheme and peak oil, the current system will soon be economically inefficient. In the future, externalities will be internalized (albeit to what degree and by what method and at what cost is still unclear) and the food system will be forced to respond accordingly, if it has not already prepared to do so.

Agriculture is an important part of the economy and the life-blood of rural Australia. However, as outlined previously, the major drivers to the food supply are complex and varied. Currently, Australian agriculture is strongly export-oriented: over the past five years, agriculture has accounted for 35% of Australia's merchandise exports (Department of Climate Change, 2008a). This means that the Australian agricultural economy is especially sensitive to changes in world markets.

In May 2008 the Royal Institute in International Affairs in the UK published a briefing paper titled *Thinking about the Future of Food*. In this paper, the independent British think tank put forth four possible global food supply scenarios for the future. These scenarios are:

- 'Just a Blip', where the present high food prices only last temporarily and then return to cheaper levels;
- 'Food Inflation', where food prices continue to rise for a decade or more;
- 'Into a New Era', where today's food system has reached its limits and must change; and
- 'Food and Crisis', where a major world food crisis develops.

The 'Just a Blip' scenario is recognized as being the least credible and least likely. Conversely, 'Into a New Era' is seen as the most transformational and holding the most promise (Royal Institute of International Affairs, 2008).

As nations around the world begin to grasp the reality that the global food supply has begun to dramatically change in some form, they will seriously grapple with ways to make their own food systems more ethical and sustainable. Australia has the potential to be a world leader in this area. Efforts are already being taken domestically to address a number of food supply issues, including the current low consumption/high waste paradigm for fruit and vegetables.

Current Efforts to Change the Paradigm

“The evidence suggests that there is much more to be done to address the public health and environmental issues arising from food consumption, and a need to do so in a joined-up way” (Strategy Unit, 2008, p. 4).

Efforts to Increase Fruit and Vegetable Consumption

International

Internationally, IFAVA serves as the peak body for organizations involved in the management and execution of campaigns to promote fruit and vegetable consumption. IFAVA mission is “to encourage and foster efforts to increase consumption of fruit and vegetables globally for better health by supporting national initiatives, promoting efficiencies, facilitating collaboration on shared aims and providing global leadership. All of which is based on sound science” (IFAVA, 2008). Currently, over 30 different countries have organized national campaigns. Research has demonstrated that use of a consistent slogan (promoting 5-a-Day) in the US, New Zealand and several European countries increased awareness of the need to eat more fruit and vegetables (Miller, Pollard, Hendrie, & Rowley, 2007).

‘Go for 2 and 5[®]’ Campaign

The Go for 2&5[®] social marketing campaign is the Australian program represented in IFAVA (IFAVA, 2008). The campaign was originally developed by the Western Australian Department of Health in March 2002 and later adopted by Commonwealth, state and territory health jurisdictions (with the exception of Victoria) as part of a national approach to increase fruit and vegetable consumption (Pollard et al., 2007). The campaign is a collaborative effort between all levels of government and the private sector, represented by Horticulture Australia Limited (Department of Health, 2008).

The multi-approach strategy includes a website (www.gofor2and5.com), mass media advertising, public relations events, publications, and school and community activities (Pollard et al., 2007). The primary target group of the campaign is meal preparers and grocery buyers aged 25-54, especially those with young children. The secondary target groups are influencers (e.g. health professionals), providers (e.g. growers and those working in the supply system), educators and stakeholders, such as government bureaucrats. Since Australian adults have expressed that they believe that they already eat enough fruit and vegetables and/or find it hard to eat the recommended serves, the strategy of the campaign is to demonstrate to the target audiences that they are not eating enough and that it is easy to increase intake (Devine et al., 2008).

Evidence from Western Australia and Queensland shows that implementation of the campaign increases both awareness of the recommended servings of fruit and vegetables and actual consumption. It has been estimated that an investment of approximately \$1 million per year for up to three years of the campaign achieves average increases in consumption of fruit and vegetables of half to one serve per day across a state (Miller et al., 2007).

In Western Australia, fruit and vegetable consumption increased by 0.8 servings per person per day (0.2 servings of fruit and 0.6 servings of vegetables, or 75g) over the three year intervention period. The campaign was found to have the most profound impact on male low consumers of fruit and vegetables (Pollard et al., 2007). In

Queensland, an evaluation completed halfway through Phase one of a four year campaign revealed an increase of 0.4 servings per person per day (0.1 servings of fruit and 0.3 servings of vegetables). It is anticipated that the results of this campaign will continue to improve as the campaign completes Phase one and progresses into Phase 2 (Gellweiler, 2006).

‘Go for Your Life’

In Victoria, healthy eating is predominantly coordinated through the ‘Go for your life’ initiative, which is funded by the Victorian Government. The most recent aspect of this that is targeted at fruit and vegetable consumption is the ‘Just Add Fruit and Veg’ communications campaign. This campaign has four stages, each focusing on a particular meal or snack and predominantly uses tip cars and posters (available in most fruit and vegetable retailers and independent supermarkets throughout the state) to show easy ways to include fruit and vegetables in each meal. The project received approximately \$450,000 worth of funding over a fifteen month period and includes evaluation (Heart Foundation, 2008).

Kids-‘Go for your life’, the program within the initiative aimed at children, promotes healthy eating and physical activity in early childhood centres and primary schools. Six messages are promulgated by the program to promote behaviour change: Tap into Water Everyday; Plant Fruit and Veg in Your Lunchbox; Limit Occasionally Foods; Move, Play and Go; Turnoff, Switch to Play; and Stride and Ride. Of these messages, ‘Plant Fruit and Veg in Your Lunchbox’ and ‘Limit Occasionally Foods’ include the promotion of fruit and vegetable consumption, but fruit and vegetables are not the specific focus of the overall program. Home Economics Victoria runs the school-based Fruit + Veg partnering program in the initiative, which includes workshops that have a particular focus on ‘up-skilling’ teachers and parents to more effectively support the use and consumption of fruits and vegetables in schools (Hill, 2008). Kids-‘Go for your life’ was launched in early 2007 with three years of funding. In 2007-2008 the program received approximately \$1 million for implementation and evaluation, but funding varies from year to year (State Government of Victoria, 2008).

Other Efforts

Several additional, smaller efforts have been undertaken across the country with the aim of increasing fruit and vegetable consumption. These initiatives approach the issue from a variety of different angles (reducing rates of obesity, improving animal welfare, decreasing greenhouse gas emissions from the food system, etc...). Many are civil society led and funding and scope vary.

Three distinct types of intervention and influence exist - those that target government, those aimed at communities and those directed at individuals. Some efforts attempt to address all three levels. In terms of fruit and vegetable consumption, efforts targeting government seek to eliminate structural obstacles to achieving adequate consumption. These structural barriers are those which communities or individuals could not overcome on their own. See Vignette 4 on the Food for All program for this type of initiative.

Vignette 4: Food for All Program

The Food for All program is a VicHealth initiative aimed at combating food insecurity in Victoria. The program is carried out in collaboration with local Governments in areas of socioeconomic disadvantage around the state. Each of the eight councils funded through Food for All have a designated project officer who works to increase the council's offering of practical and sustainable ways to increase access to a variety of nutritious foods. This includes identifying barriers in particular in relation to systems, infrastructures and policies. These have been implemented by increasing awareness within Councils and encouraging units within councils to consider the impact of their activities on access to food and to work together to overcome barriers.

Food for All project officers work closely with councils and residents to design resources and programs that will be appropriate and useful for the local populations. Activities have varied from designing 'Welcome Kits' for newly arrived immigrants that help familiarize them with available fresh fruit and vegetables and safe food practices in their native languages to coordinating supermarket transport for the elderly and homebound.

VicHealth also works to promote food security by supporting capacity building and knowledge transfer between research and practice. The organisation continually seeks new ways to partner with communities, Government and businesses to raise awareness and seek solutions to food security (VicHealth, 2008).

Many efforts target both communities and individuals concurrently. Examples of these types of efforts are common in school settings. For example, the Fruit +Veg program coordinated by Home Economics Victoria mentioned above. Another scheme utilizing school settings to promote fruit and vegetable consumption is outlined in Vignette 5.

Vignette 5: Healthy Kids School Canteen Association

In New South Wales, the state Government developed the Fresh Tastes @ School NSW Healthy School Canteen Strategy and the Healthy Kids School Canteen Association (SCA) has been supporting schools to adopt it. This Strategy came into effect in 2005 and is mandatory for all NSW Government schools and strongly supported by the Catholic and independent education sectors. It helps schools determine healthier foods that should be available for sale in their canteens. Foods are divided into red, amber and green categories to determine how frequently they should appear on the canteen menu.

The Healthy Kids SCA, a not-for-profit, non-governmental organisation, is based in Sydney. In addition to coordinating the Fresh Tastes Strategy, it also engages in a number of other activities to promote healthy eating. The organisation works to promote the provision of healthy foods at school, influence food choices within families and communities and encourage the celebration of food and eating together. They help canteens run more efficiently and effectively, all the while serving more healthful food. In addition, they help coordinate programs such as Fruit 'n' Veg Week across NSW (Healthy Kids SCA, 2008).

An example of an individual focused effort to increase consumption of fruit and vegetables is the WhyVeg.com campaign run by Animals Australia, one of Australia's leading animal protection organisations. The focus of this campaign is increasing vegetarianism as a way of promoting animal rights, improving human health and reducing greenhouse gas emissions (Animals Australia, 2008).

Efforts to Minimize and Better Manage Food Waste

In Australia, state jurisdictions are responsible for waste management policy, but significant duties are undertaken by local councils. At the Commonwealth level, an updated strategy for minimizing waste does not exist at present. In 1992, the National Waste Minimisation and Recycling Strategy (NWMRS), which includes a target of reducing the amount of waste per capita going to landfill by 50% by 2000, was adopted. But since 2000, no new targets have been established. It should be noted that because the states have the constitutional powers to legislate and implement national strategies, the Commonwealth Government is limited in what it can do to minimize waste. In the absence of federal leadership, the states and territories have developed diverse waste management policies and infrastructure that give rise to differing legislation, rules, targets and definitions between jurisdictions. In March 2008, the Australian Senate Environment, Communications and Arts Committee began an inquiry on the management of Australia's waste streams with particular emphasis on trends in waste production, existing strategies to reduce, reuse or recycle waste and potential new strategies that could be employed (SCECA, 2008).

In efforts to move towards more sustainable waste management, the governments of New South Wales, Victoria, the Australian Capital Territory, South Australia and Western Australia have all adopted zero waste or substantial waste minimisation goals. To aid in the realization of each of these targets, each is underpinned by specific timelines and a set of strategies for achieving them. To date, the Northern Territory, Queensland and Tasmania have not set minimisation targets (SCECA, 2008).

In each of the states and territories with specific waste reduction goals, landfill levies are used as an incentive for waste generators to change their behaviour (A. Johnson, personal communication, October 2, 2008). In their report, the Senate committee investigating waste management recommended the hypothecation² of landfill levies. The committee supported their investment into waste management infrastructure and initiatives that encourage the avoidance, reuse, recycling and recovery of energy from waste. Currently, hypothecation rates vary between states with the highest rate in Victoria where 100% of the levy funds are used for environmental protection and to encourage sustainable resource use and best practice waste management. In South Australia, the landfill levy was doubled in 2007 and the increased amount (i.e. 50% of the new total) was hypothecated to Zero Waste South Australia. The purpose of this group is to build partnerships, advocate and create incentives that will help the state achieve its waste minimisation goals (SCECA, 2008).

Minimizing Food Losses along the Supply System

Because losses occur at all levels in the food system, strategies for loss reduction and more ecologically sustainable utilization of losses can be undertaken by each sector. Primary producers, like all others in the food supply system have a vested interest in decreasing food losses to, among other things, increase their earnings. To cut wastage, some farmers have sought alternative ways to distribute their excess or imperfect products. These alternative options include retailing at farmer's markets and donating 'seconds' fruit to local schools (B. Bales, personal communication, August 21, 2008). It has been suggested that if farmers received a higher income from their supply contracts with supermarkets and wholesalers, they would be better equipped financially to get more of their product to market. As demonstrated in Vignette 1 on the mango industry, coordinating and funding best practice storage and transportation can be a

² Hypothecation refers to the dedication of a tax to a specific purpose or cause. In this cause the term is used to describe the dedication of a tax on waste to landfill to fund waste minimisation programs.

significant challenge. Higher incomes would ensure that farmers have the resources to get their products to market and thereby minimize wastage (J. Potter, personal communication, November 13, 2008).

Some health professionals and food security advocates promote and campaign for the adoption of a graded produce system to bring more fruit and vegetables, irrespective of their size and shape, into the market. In its submission to the Australian Competition and Consumer Commission (ACCC), VicHealth encouraged the adoption of a fruit and vegetable grading scheme by supermarkets (Harper, 2008). The submission notes,

Due to water shortages and diminishing affordability, it will be essential that supermarkets review their standards in order to provide consumers with a choice of quality gradings and price ranges. This approach will also be good for growers and the environment by reducing food waste (Harper, 2008, p. 2).

Returnable Plastic Crate (RPC) machinery is one technology that has been credited in decreasing wastage in transport and distribution, but not without debate. The RPC enables fresh produce to be loaded on the farm directly into crates that are effectively 'shelf-ready' for the supermarket. This helps minimize handling and as a result saves time, thereby increasing freshness; however, the usage of RPCs places an additional cost on the growers who must rent the crates from the supermarkets and pack them according to the retailers' specified protocol (S. Estrada-Flores, personal communication, August 13, 2008). It has been suggested that RPC technology could actually increase wastage in the long term by decreasing point-of-sale management of produce (P. Reilly, personal communication, August 14, 2008).

Some industry experts believe that the export market has huge potential to improve quality standards pertaining to how food is handled and managed postharvest, thereby decreasing wastage. When the standards are improved for exports, the quality of the domestic supply also improves because all sectors in the system work to meet the new, elevated standards (S. Estrada-Flores, personal communication, August 13, 2008). However, this approach to decreasing waste is contested by localization advocates, who believe that it would result in more fruit and vegetables being rejected from the market and therefore higher wastage. They also question the sustainability of increasing exports, especially pertaining to lengthened transport and storage systems (J. Potter, personal communication, November 13, 2008).

The food manufacturing sector is eager to improve its overall environmental performance, which includes minimizing waste. According to the AFGC, between 2003 and 2005, the food manufacturing industry as a whole substantially reduced its environmental impact. Per kilogram of finished product, the AFGC claim that the industry has reduced greenhouse gas emissions by 29%, cut water use by 21% and minimized energy use by 14% (AFGC, 2005).

In its *Environment Report 2005*, the peak body for food manufacturers notes, "Minimising waste production is a central part of reducing cost and improving efficiency in the industry" (AFGC, 2005, p. 20). When pricing of more effective and efficient technology is favourable, food manufacturers eagerly adopt it (J. Carter, personal communication, October 2, 2008; M. Klingler, personal communication, July 31, 2008). One example of this is shown in Vignette 6 (on the next page)..

Vignette 6: Golden Circle

Golden Circle is one of Australia's largest fruit and vegetable processors. The company manufactures over 500 products, including a large array of shelf stable fruit and vegetables (in cans and jars), beverages and baby food. Golden Circle is committed to reducing food waste and operating in an environmentally sustainable manner. It is involved in efforts to both reduce overall waste and to better manage the remaining waste.

The company has worked to adopt technology that will minimize food waste. One example of this is a set of highly efficient juice pressers. Golden Circle uses these pressers to press fruit that isn't suitable for direct canning, thereby extracting large quantities of high quality juice. By doing this, the company is able to decrease wastage and increase earnings.

Most of the Golden Circle's solid organic waste comes from canning. This waste (approximately 9000 tonnes each year) is sold to regional livestock producers as cattle feed and because the products are being kept within the food system, they are constantly tested for pesticide residue and other contaminants. Fruit and vegetable solids that are extracted from waste water (approximately 6000 tonnes) are sent to a commercial compost producer and sludge from the waste water treatment plant (approximately 4000 tonnes) is sent to regional strawberry farmers as a soil conditioner. The company currently sends 8% of its waste generated to landfill and is working to improve its recycling rate and extract further value from existing waste streams (J. Carter, personal communication, October 2, 2008).

In October 2008, Heinz Australia offered to purchase Golden Circle. This offer is subject to shareholder and regulatory approval (Golden Circle, 2008). Heinz Australia also has a history of working to improve the sustainability of their operations. Between 2000 and 2008 Heinz Australia worked to coordinate a ten fold reduction of solid waste to landfill at their Echuca baby food processing plant (L. Gilmore, personal communication, October 27, 2008).

Another way that food losses are being minimized along the supply system is through food rescue agencies. These organizations recognize the potential to feed the hungry through the distribution of food that would otherwise be lost from the food system and collect and deliver it to individuals who are experiencing food insecurity. Ian Carson, Chairman of SecondBite, a Victorian food rescue group, notes on the organization's website, "There is no shortage of people in need or food to feed them, only the delivery model and infrastructure to service the need" (SecondBite, 2008). These agencies do not buy or sell the food that they collect, but instead receive it from a range of donors and then redistribute it. Some groups distribute raw food products and others engage in preparation of the products before distribution (see Vignette 7). Currently these agencies are funded by private donations and do not receive consistent government support. Despite their considerable efforts in the area, these agencies note that at their current funding levels, they are unable to meet the demand for redistribution (M. Godinho, personal communication, June 19, 2008).

Vignette 7: FareShare

FareShare, a food rescue group based in Melbourne, has been operating since 2001. The not-for-profit organization receives food from a variety of donors, such as wholesalers, catering companies and food outlets, and turns it into meals that can then be given away to the hungry and homeless in Victoria.

Some items, such as sealed fruit juices and breakfast cereals, can be directly sent to charities. But what makes FareShare unique is that it goes beyond this direct redistribution role. The organization's dedicated staff and volunteers transform the raw, prepared, or partially prepared donated food into meals. These meals are then delivered to over 100 different community groups and charities around Melbourne. In 2007 they rescued 280 tonnes of food (FareShare, 2008).

Better Managing Food Losses along the Supply System

Utilizing gas capture technology is one technique employed by landfills to reduce their emissions. A landfill can halve its emissions from 1,100 tonnes of carbon dioxide equivalent emissions to just over 500 tonnes by switching from a best practice cap with no capture to 70% capture. It is estimated that, in Australia, 26% of methane emissions from landfills are now either flared or used to generate renewable electricity. However, sending organic waste, such as food waste, to landfill, even with very high levels of gas capture, is twice as greenhouse intensive as the best AWT (SCECA, 2008).

As noted above, organic waste, such as food waste, can be composted into fertiliser and soil conditioner. According to DEWHA, modern farming practices have depleted soil carbon levels from 3% to less than 1%. Applying recycled organic matter not only supports agricultural systems by replenishing organic carbon levels, but can provide an over 25% water savings, a reduction in run-off which results in soil erosion and pollution of waterways and an enhancement in plant health. This boosts agricultural production while saving growers money that they would otherwise be spending on chemical fertilizers (SCECA, 2008).

For many farmers, synthetic fertilizers are the alternative to compost. Approximately 50% of fertilizer used annually in Australia is imported. In the past year, the cost of high nitrogen phosphate fertilizer has nearly tripled from \$600 to \$1700. However, large scale composting is still challenged by unfavourable price signals; for organic waste, landfill disposal continues to be more cost-effective than composting. Transportation costs are a major barrier for composting. According to a submission to the enquiry by Zero Waste Australia, there are 680,000 tonnes of Australian Standard certified compost stockpiled in Sydney that don't have a market primarily due to transportation costs (SCECA, 2008).

Manufacturers must balance the financial benefits of more ecologically sustainable disposal methods with the cost of sending wastes to landfill. The choice of disposal method is influenced by a variety of factors. These include local and state regulations and levies, local alternatives to landfill, cost of each disposal method, distance to various disposal facilities and human resources of the company. The most common disposal method of industrial fruit and vegetable wastes is as stockfeed for local farmers, for which the farmers typically pay the company. After this, most industries are sending a portion of their wastes to be processed into fertilizers or other soil conditioners. The remaining process by-product is generally sent to landfill. Vignette 8 highlights one company that is working to minimize food waste to landfill. Several food manufacturers are engaged in research on the extraction of chemical compounds from plant-based process by-products to be used in other foods, but extraction is not currently a dominant strategy for minimizing losses in Australia (J. Carter, personal communication, October 2, 2008; L. Gilmore, personal communication, October 27, 2008).

Vignette 8: Wilbur Ellis Company

Wilbur Ellis Company is an international company that markets industrial and agricultural products, including animal feeds and pet food. In Australia, the Wilbur Ellis Feed Division is based in Queensland but collaborates with a number of primary producers and food manufacturers around the country. In addition to working with farmers to market grains and grasses produced directly as animal feeds, the company works with manufacturers to help them better manage their process by-products. To Wilbur Ellis, left over food products are not waste; these products are the life-blood of the Feed Division and hold a considerable amount of value.

In Australia, Wilbur Ellis does not actually make animal feeds or pet foods; instead, the company consults with food manufacturers to find markets for downstream products. Wilbur Ellis recognizes that food losses represent substantial lost revenue for the manufacturing sector and can create environmental issues. Therefore, they work with the sector to find ways to better manage the losses (C. McDowell, personal communication, August 22, 2008).

The food service sector, including restaurants, takeaway establishments, pubs and caterers can save money and resources by managing their waste under a best practice framework. Sustainability Victoria, the Victorian statutory body responsible for encouraging sustainable resource use, has devised a 'Waste Wise Catering Toolkit' to help the food service sector become aware of the benefits of carefully managing and minimizing their waste. The Toolkit is designed for catering managers, supervisors, chefs, and staff trainers. It helps identify where waste is produced in the operation, provides ideas for reducing, reusing and recycling and guides the business through the development of an action plan. The Toolkit is freely available on the organization website (Sustainability Victoria, 2008).

Vignette 9: BiobiN Technologies Pty Limited

The BiobiN is an in-vessel composting system developed in South Australia. The BiobiN system provides for an alternative to landfill for food and other organic wastes generated from a range of facilities. Each BiobiN unit has a built-in aeration system and has the capacity to hold up to 9 cubic metres of material. Its unique design makes it easy to use in a variety of settings and provides for the control of leachates, odours and nuisance pests and vermin. When full or at the end of each 2 – 3 week cycle, the BiobiN is collected and end material composting completed at a commercial composting facility and replaced.

To date, the vessel has been successfully utilized at a variety of sites including supermarkets, universities, shopping centres, mining sites, convention centres, restaurants and festivals. The technology offers an opportunity for businesses and other groups to better manage their food waste in an easy, cost-effective manner (A. Grant, personal communication, September 30, 2008).

Whilst AWT can result in substantial diversion from landfill and decrease in greenhouse gas emissions, the economic incentive is not high enough for the industrial and commercial sectors. The waste management industry argues that economic incentives are needed to encourage substantial investment in AWT facilities in Australia. According to the Senate Waste Inquiry, the Australian waste infrastructure requires an investment of approximately \$4 billion in order to meet the various state government waste reduction and recycling targets. This funding is necessary to build both commercial and industrial material recovery facilities and AWT. The inquiry notes, "without a substantial paradigm shift to resource recovery, and away from disposal, coupled with significant investment in

infrastructure such as AWT, jurisdictions are unlikely to achieve their diversion from landfill targets” (SCECA, 2008, p. 75).

Minimizing Food Losses at the Consumer Level

In Australia, no major food waste minimisation campaigns exist at the consumer level; in fact, very few of these campaigns exist anywhere. The most prominent food waste minimisation effort in the world is undertaken by WRAP in the UK. This campaign, called *Love Food, Hate Waste* is presented online and provides consumers with targeted information on why food waste matters and how to shop more wisely, better manage food stocks, cook appropriate sized portions and reuse leftovers. A specific emphasis is placed on saving both time and money while reducing waste. The campaign also strongly encourages website visitors to share their own experiences and suggestions.

Better Managing Food Losses at the Consumer Level

As mentioned previously, waste management schemes and models vary by jurisdiction. In Australia, certain councils have a strong commitment to developing and implementing modified closed-loop efficiency models to reduce the amount of waste going to landfill. In the Senate report, the New South Wales Port Stephens Council was highlighted for its efforts in composting approximately 81% of its domestic waste, thereby diverting it from landfill (SCECA, 2008). Throughout the course of this project we also heard evidence of many council areas across New South Wales, Victoria and South Australia that are working with residents to divide organic waste out and collect it separately. For example, ZeroWaste South Australia is working to develop diversion systems in collaboration with 10 local councils (Zero Waste South Australia, 2008) and the Groundswell Project in New South Wales is collaborating with three different councils on a project with a similar aim (Zero Waste Australia, 2008).

In addition, last year, the Department of Environment and Conservation New South Wales published the report *Co-Collection of Domestic Food Waste and Garden Organics: the Australian Experience*, summarizing the outcomes of source separated collection services (Department of Environment and Conservation, 2007). This report found that while overseas data indicates an average food diversion of two kg per household per week, most Australian trials report diversion in volume and percentage terms, making a direct comparison difficult. Councils that did present diversion by mass had between a 1.2kg and 2.4kg average diversion per household per week.

The report also presented the following lessons learned for those jurisdictions considering implementing their own diversion program:

Containers

- The provision of kitchen containers increases diversion rates and participation and is most efficient if done on a ‘by request’ basis
- Customer satisfaction increases with vented kitchen containers and compostable liner bags
- Lining containers with paper bags, newspaper or wrapping scraps can also be effective, as long as the processor can effectively deal with the chosen lining
- 240L mobile garbage bins appear to be most effective for collection

Frequency of Collection

- Weekly combined organics services provide the highest diversion, participation and customer satisfaction rates
- When weekly collection is not feasible, fortnightly services (such as those provided for recycling) appear successful
- Reducing residuals service may be met with initial resistance from residents, but this resistance can be overcome with incentives

Contamination and Processing

- Contamination appears to be minimized when the collection contractor is responsible for meeting contamination levels and ample education is provided
- In Australia, indoor, covered or in vessel composting would be necessary to comply with governmental licensing requirements

Education and Promotion

- A well funded educational and promotional campaign has been essential in all trials

Implementation

- It is recommended that councils conduct a trial testing a variety of configurations before implementation of a new service

Taiwan poses one international example of progressive food waste management. In Taiwan, government has worked with citizens over the last 8 years to transform food losses into agricultural resources. With the rapid development of the island in the 1980s-1990s and a number of environmental pollution scandals, local authorities realized the need to responsibly manage municipal solid waste. As a result, considerable emphasis has gone into recovery, recycling and upgrading of food waste (and other biodegradable wastes) for the purpose of developing useful products. Between 2005 and 2006, Taiwan saw a 22% increase in food waste diversion from landfill. Between 2003 and 2006, 75-83% of total diverted food waste went to swine-raising, with the majority of the remainder used to produce compost. However, in recognition of the strain placed on the environment by intensive animal production, efforts are currently underway to cut the quantity of food waste going to the swine industry and redirect it to composting (Tsai, 2008).

Whole-of-System Approaches to Improving the Food System

Concern is growing worldwide about the aforementioned trends in the evolution of modern food systems. In response to these concerns, policy attention is being paid to the food system. In some cases, this attention focuses on the whole food system, thereby attempting to address several key issues (for example, the low consumption-high waste paradigm for fruit and vegetables) under one comprehensive policy umbrella. Arguably the most progressive of these policy development schemes are occurring in the UK and Scandinavia, but in three Australian states, whole-of-system approaches are also being examined.

In the UK, the recent approach to re-examine the food system has been four-fold and was outlined in the *Food Matters* report.

- The aims of this report are: to review the main trends in food production and consumption in the UK; to analyse the implications of those trends for the economy, society and the environment; to assess the robustness of the current policy framework for food; and to determine what the objectives of future food strategy should be and the measures needed to achieve them (Strategy Unit, 2008, p. iii).
- Government leadership in the project has been central, with firm commitment from the Prime Minister. In addition, the project has been developed by and is deeply grounded in a wide range of agencies and industries (Strategy Unit, 2008).

In several Scandinavian nations, including Norway, Finland and Sweden, integrated agriculture, food and health policies have been in place for some time. In Norway, a Nutrition and Food Policy was first established in 1975, when the government aimed to cut the proportion of fat in the food supply in an effort to combat the nation's high

incidence of CVD. This goal was achieved in 1991. From the onset the agricultural community has eagerly been included in attempts to develop effective national food policy (Tyrchniewicz & McDonald, 2007).

In Finland, the government has worked for the last 35 years with several sectors to improve diets. Reacting to data in the early 1970s that indicated that Finland had the highest CVD mortality rate in the world, the government and health agencies worked with the food industry to alter the food supply and systematically roll out clear dietary guidelines for all meals served in government institutions (schools, eldercare centres, armed forces, etc...). As a result, mortality from CVD more than halved as the Finns doubled their vegetable intake in a single decade and cut the proportion of saturated fats in total fat consumption (Tyrchniewicz & McDonald, 2007).

In Sweden, both the Agriculture and Environment ministries are working to cut energy use and meet national health targets. Sweden is working to halve its resource use by 2021, and one approach that it is taking is to reduce greenhouse gas emissions along the entire food supply system. Since the 1990s, the government has been working to integrate agriculture, food and health policies in response to heavy criticism of monoculture production systems (Tyrchniewicz & McDonald, 2007).

In Australia, efforts are being undertaken in South Australia, Victoria and Western Australia to examine the whole food supply system and develop a framework for improvement. In South Australia, the Thinker in Residence program was developed by the State Premier's office to bring world-leading thinkers to the state to assist with the strategic development and promotion of South Australia. The 2008 Thinker was Andrew Fearne, a world-recognized leader in the management of food supply systems.

Fearne's activities included developing capability to enable changed practice amongst all sectors in the supply system in developing competitive products, provide advice on strengthening training and education-industry links and to make recommendations to building stronger linkages between health, environment, agriculture, education, retailers and consumers. His residency brought together several government departments, private industries, food industry groups, universities and others (Government of South Australia, 2008).

In Victoria, the ACF received private funding to conduct a comprehensive review of the Victorian food supply chain and develop a strategy for improving its sustainability. As part of this project the organisation produced a scoping paper on current trends, policy directions and key obstacles to progress. Throughout the entire project, ACF has called upon experts from all sectors in the food supply system, bureaucrats and other key stakeholders to draw upon their expertise and ensure a breadth of ideas. At the completion of the project, ACF will produce a detailed strategy for step-change toward a more sustainable and healthy system that it will present to the Victorian Premier (Watts, 2008).

To bring focus to the Western Australian food system, the State Premier allocated the responsibility for food industry development to the Minister of Agriculture and Food in February 2006. To complement this new responsibility, the Department of Agriculture was renamed the Department of Agriculture and Food two months later. The Department is now responsible for production, marketing and consumption issues around food and has begun work in the development of a comprehensive food strategy with the assistance of a government-wide working group.

In February 2008, the Department released a discussion paper for comment on the Food Strategy WA and outlined the eight interconnected components it sees as central in supply system development in the upcoming years. These components are health,

sustainability, business and investment, market, innovation, safety and quality, careers and skills and regional areas. The Department is hoping to release the Strategy before the end of 2008 (Western Australia Department of Agriculture and Food, 2008). Despite the efforts taking place in South Australia, Victoria and Western Australia, the Australian governments remain fragmented in their efforts to improve the food system and to link food, health and the environment. Key informants in this project continually mentioned a lack of coordination around the food system as a (perhaps the) big barrier to increasing consumption and decreasing waste. Interest and investment from senior bureaucrats in multiple departments across each level of government is essential to design and implement a comprehensive farming, food and nutrition strategy that will move Australia from where it is to where it ought to be.

Recommendations

Government must invest in social marketing campaigns. These campaigns play a crucial role in educating the public and changing behaviours. Funds should be directed to successful campaigns that provide consistent messages.

- **Implement the Go for 2&5® campaign:** This successful campaign will be most effective if implemented in every state (including Victoria) with increased funding. The Commonwealth Government has the power to raise the marketing levy on fruit and vegetables and match the levy increase with public funds. This levy increase and the corresponding matching increase can then be used to double promotional funding. All funding must be long-term and underpinned by evaluation.
- **Develop a national anti-waste campaign:** This will ensure that increases in consumption are matched by decreases in food waste, thereby improving the sustainability of the food system. This campaign could investigate food waste patterns among Australians and develop strategies to overcome barriers to decreasing wastage. This campaign could be funded by hypothecated landfill levies.

Government and major institutions can lead by example. Exemplifying the desired change will demonstrate and inspire other institutions and individuals to adopt more healthful and sustainable practices. This leadership is an essential complement to social marketing campaigns.

- **Mandate fruit and vegetable requirements:** Setting rigorous minimum health requirements for all food sold and distributed in government agencies and institutions (such as schools, hospitals, government offices, etc...) will have a positive impact on the people that eat in those settings. This will not only directly assist the population in attaining the recommended two serves of fruit and five serves of vegetables per day, but will show a variety of ways that fruit and vegetables can be prepared.
- **Implement settings-based composting:** Providing composting systems in each of these settings and encouraging their usage will directly help to manage food waste and will assist in increasing public acceptance of and interest in composting and best practice management of food waste.

Local and state governments should support efforts that address localised consumption and waste issues. Local councils are best suited to address localised barriers to consumption or drivers of wastage. State governments have a role to play in providing councils with information and coordinating the transfer of knowledge across the state.

- **Fund food rescue groups:** Organisations that collect and redistribute unsold food play a role in both increasing consumption of fruit and vegetables and decreasing wastage. Local and state governments should strategically fund and evaluate these groups to ensure that Australia's hungry and homeless are able to access nutritious food and unsold food is not sent to landfill.
- **Address barriers to adequate consumption:** Structural and community-level barriers to fruit and vegetable consumption can be significant. Local councils should consider food security and the sustainability of various food procurement systems in their planning.
- **Support food waste diversion:** With food waste highest at the consumer level, councils have the ability to divert tremendous amounts of waste from landfill by implementing diversion programs. These programs create local jobs and can also result in the production of compost that can be purchased by local farmers and gardeners.

Government needs to further encourage all sectors to cut their food waste through regulations and incentives. Currently, economic incentives are not high enough for the industrial and commercial sectors to divert their wastes from landfill. However, government has the ability to make waste minimisation the best economic option for industry.

- **Landfill levies:** Currently the usage of levies is inconsistent around the country and large producers of waste have an incentive to work in states without levies. Landfill levies should be adopted across all jurisdictions to encourage waste producers to invest in alternatives to landfill.
- **Increase R&D funding for new technologies:** To balance the adoption of landfill levies, the federal and state governments should increase available funding for innovation and research and development into new technologies for food waste minimisation. If increased funding was available, industries would have a further incentive to invest in research.

The Commonwealth Government must create a national waste minimisation strategy. This type of strategy has not been in place for nearly ten years and without it the states do not have consistent goals. This has resulted in a lack of attention to waste management in many areas and an aging waste management infrastructure which will reach its capacity in the near future. A new strategy would support the states and territories to create consistent goals and to implement strategies to achieve those goals.

Conclusion

“Our attitudes, values, personal aspirations and sense of self-efficacy are important determinants of behaviour. We know that in many cases policy that seeks to influence the development of attitudes and social norms will be more effective in encouraging positive behaviour than using incentives, legislation or regulation alone”
(Knott, Muers, & Aldridge, 2008, p. 10).

Culture Change

When questioned both about why people don't eat enough fruit and vegetables and how consumption can be increased, many interviewees for this project noted that the current culture was insensitive to fruit and vegetables, consistently undervaluing them. It was evident in the responses that achieving adequate fruit and vegetable consumption is not considered a priority in many Australian homes. The current culture was noted as a barrier and a 'culture shift' was put forth by many as the underlying thing that must be done for consumption to increase population-wide.

In January 2008 the Cabinet Office of the UK Government released the report *Achieving Culture Change: A Policy Framework*. In this report, the Cabinet office outlined the relationship between culture change and behaviour change and approaches to developing culture change policy. It noted that attitudes, values, aspirations and self-efficacy (collectively known as cultural capital) are developed by our immediate environment and wider society-wide influences, such as the economy, technology and media. By understanding the environmental influences in which cultural capital is formed, how it evolves over time and how it influences behaviour, policymakers will be able to construct more effective policies (Knott et al., 2008).

The UK report promulgates a three step approach to designing culture change policy. The first step is to identify the target populations. Because different populations respond to policy interventions differently, this will allow the policy makers to tailor their policies to the target group. The second step is to examine the path to the particular behaviour for each of the target populations. The third and final step is to access appropriate policy interventions based on the behavioural path of each target population (Knott et al., 2008).

Effective culture change policy will translate into actual behavioural changes through a four-pronged method: enable, encourage, engage, and exemplify. Individuals should be enabled to change their behaviour through removing barriers, putting support services in place and developing skills. Individuals can then be encouraged by awards and financial incentives for the desired behaviour and legislation and regulation discouraging undesirable behaviour. Engaging with individuals includes working with people and creating space for debate and dialogue as well as using social marketing techniques to promote new or adaptive forms of behaviour. Finally, exemplifying can be achieved through consistent messages and ensuring that prominent and well-respected figures lead by example (Knott et al., 2008).

All of the recommendations put forward in this report on fruit and vegetable consumption and waste in Australia support a culture change and endeavour to follow the four-pronged method promulgated in the *Achieving Culture Change* report. A whole-of-government approach to doing this is presented and government is called upon to enable, encourage, engage, and exemplify more sustainable behaviours.

To better understand the Australian situation, so that effective culture change policy can be designed, implemented and maintained, this report recommends that Australia regularly conduct a National Nutrition Survey and a National Waste Survey. It is deplorable that health and nutrition professionals must work with out-of-date or inconsistent data when they are designing programs and policies. It is not possible for efforts to be effective unless they are built upon sound science, which cannot currently be done. Similarly, with no National Waste Survey, the amount of waste generated in Australia is unknown and there is little impetus to work towards a more sustainable system.

Improving communication and collaboration across government and along the food system, enables and encourages the various departments and industries to work more effectively. Building capacity at all stages in the system and ensuring that public good information is accessible will result in improved supply and demand signals. Similar recommendations have also been made by DAFF and the CSIRO Food Futures Flagship (Higgins et al., 2007; Spencer & Kneebone, 2007).

Industry could also be encouraged by the development of a national waste minimisation strategy. With a national strategy in place, state governments would have a consistent framework to build from. They would also be driven stronger to address their waste management issues.

Supporting localised approaches, such as funding food rescue groups, considering food security in council planning and supporting food waste diversion programs will also help to enable change. Localised approaches work to remove barriers, establish support services, develop skills and improve the local economy. These approaches are especially important for engaging the population and promoting local debate and dialogue.

Social marketing also plays an important role in engaging the population. Implementing the Go for 2&5® campaign and an anti-waste campaign nationally will help to promote new and modified forms of behaviour. The development of the Go for 2&5® campaign closely followed the three-step approach to designing culture change policy outlined in the *Achieving Culture Change* report. The creators identified a target population (meal preparers and grocery buyers, especially those with young children), studied that population and designed a program that is effective at achieving behaviour change. However, with an extremely small budget in comparison to the budgets of the major food manufacturers the impact of the campaign is consistently trumped by better funded competitors. Long term implementation at higher funding levels will be essential for optimized outcomes.

At the same time, no large-scale campaign exists in Australia to decrease food losses and the development of one will require considerable public engagement. While this campaign could surely learn from the UK *Love Food, Hate Waste* campaign, it needs to be distinctly Australian and designed to target a particular audience. Research by WRAP revealed that most people do not know the quantity of food that they waste (Ventour, 2008). British research on the sustainable consumption of food found that once consumers are made aware of the quantity of wasted and the economic and environmental implications of this wastage, they identify it as a priority for behaviour change (Owen, Seaman, & Prince, 2007).

Finally, government has a significant role to play in exemplifying desired behaviour and leading by example. Consistent and confident government leadership - similar to the leadership that UK Prime Minister Gordon Brown's government is demonstrating through the *Food Matters* project - is pivotal. By mandating fruit and vegetable requirements in food sold and distributed at all government-managed settings and providing complimentary composting facilities, government is sending a strong signal that it values fruit and vegetable consumption and is committed to decreasing food wastage.

The time is now right for Government action. In the recent *Green Light Report* from Sustainability Victoria, environmental and health concerns were mentioned first and third as the most important issues requiring Government attention. As citizens Australians are ready for a change, but as consumers they need support. The Commonwealth Government is best positioned to offer this guidance by enabling and encouraging the population to eat more fruit and vegetables, engaging the public in creatively implementing more sustainable consumption habits, and by exemplifying healthy eating and sustainable behaviours in its own internal operations. To complement this culture change, the Government must support the various industries responsible for supplying food in developing new ways to utilize fruit and vegetables and minimize and better manage their wastes.

Summary of Recommendations

Recommendation 1

- **Government and leading institutions must facilitate communication and collaboration between all players in the food supply system.**
Communication is a key failure in the system and it cannot be ameliorated without collaboration from all jurisdictions involved in the supply and disposal of food. The current lack of collaboration across the food system has eroded the capacity to manage the supply of fruit and vegetables effectively. Government has a pivotal role to play in knowledge brokering and encouraging and guiding industries to improve their visibility.

Recommendation 2

- **The Commonwealth Government needs to regularly monitor nutrition and waste.**
Currently, lack of data inhibits government and others from identifying problems and developing effective solutions. Surveys are essential to monitor the Australian situation and inform and evaluate public health and environmental campaigns. As a matter of urgency, the Commonwealth Government needs to conduct regular national nutrition and waste surveys.

Recommendation 3

- **Government must invest in social marketing campaigns.**
Funds must be directed to successful campaigns that provide consistent messages. For example, the Go for 2&5® campaign should be implemented in every state with increased funding and a national anti-waste campaign needs to be developed.

Recommendation 4

- **Government and major institutions can lead by example.**
Exemplifying the desired change will inspire other institutions and individuals to adopt more healthful and sustainable practices. Leadership is an essential compliment to social marketing campaigns and in this instance could be demonstrated by mandating fruit and vegetable requirements for all food sold and distributed in government agencies and institutions and implementing composting systems in all of their facilities.

Recommendation 5

- **Local and state governments should support efforts that address localised consumption and waste issues.**

Local councils are best suited to address localised barriers to consumption and drivers of wastage. State governments have a role to play in providing councils with information and coordinating the transfer of knowledge across the state. Local and state governments could fund food rescue groups, consider food security in their planning and support programs that divert food waste from landfills.

Recommendation 6

- **Government needs to further encourage all sectors to cut their food waste through regulations and incentives.**

Currently, economic incentives are not high enough for the industrial and commercial sectors to divert their wastes from landfill. Landfill levies must be adopted across all jurisdictions, with federal and state governments increasing existing research and development funding for food waste minimisation technologies.

Recommendation 7

- **The Commonwealth Government must create a national waste minimisation strategy.**

This type of strategy has not been in place for nearly ten years and without it the states do not have consistent goals. This has resulted in a lack of attention to waste management in many areas and an aging waste management infrastructure which will reach its capacity in the near future. A new strategy would support the states and territories to create consistent goals and to implement strategies to achieve those goals.

References

- Access Economics. (2001). *The burden of brittle bones: Costing osteoporosis in Australia*. Canberra: Osteoporosis Australia.
- Allsopp, M., Page, R., Johnston, P., & Santillo, D. (2007). *Oceans in peril: Protecting marine biodiversity* (No. 174): WorldWatch Institute.
- Animals Australia. (2008). WhyVeg.com. Retrieved November 21, 2008, from <http://whyveg.com/>
- Anonymous. (2006, March 20). Cyclone Devastates Australia's Banana Crop. *Sydney Morning Herald*.
- Appel, L., Champagne, C., Harsha, D., Cooper, L., Obarzanek, E., Elmer, P., et al. (2003). Effects of comprehensive lifestyle modification on blood pressure control: Main results of the PREMIER clinical trial. *Journal of the American Medical Association*, 289(2083-93).
- Appel, L., Moore, T., Obarzanek, E., Vollmer, W., Svetkey, L., Sacks, F., et al. (1997). A clinical trial of the effects of dietary patterns on blood pressure. *New England Journal of Medicine*, 336(16), 1117-1124.
- Australian Bureau of Statistics. (1995). *National nutrition survey: Foods eaten, Australia 1995* (No. ABS 4804.0). Canberra: Australian Government.
- Australian Bureau of Statistics. (2004). *Waste management services, Australia, 2002-03* (No. ABS 8698.0). Canberra: Australian Government.
- Australian Bureau of Statistics. (2006a). *Cancer in Australia: A snapshot, 2004-05* (No. ABS 4822.0). Canberra: Australian Government.
- Australian Bureau of Statistics. (2006b). *National health survey: Summary of results, 2004-2005* (No. ABS 4364.0). Canberra: Australian Government.
- Australian Food and Grocery Council. (2005). *Environment report 2005*. Canberra: AFGC.
- Australian Government. (2008). Australia 2020 Summit: Long-term Health Strategy. Retrieved April 11, 2008, from <http://www.australia2020.gov.au/topics/health.cfm>
- Australian Institute of Health and Welfare. (2005). *Living dangerously: Australians with multiple risk factors for cardiovascular disease* (No. AIHW AUS 57). Canberra: Australian Government.
- Australian Institute of Health and Welfare. (2006a). *Australia's health 2006* (No. AIHW AUS 73). Canberra: Australian Government.
- Australian Institute of Health and Welfare. (2006b). *Chronic diseases and associated risk factors in Australia* (No. AIHW PHE 81). Canberra: Australian Government.
- Australian Institute of Health and Welfare. (2008). *Public health expenditure in Australia 2006-2007* (No. AIHW HWE 41). Canberra: Australian Government.
- Australian Taxation Office. (2006). Information for Primary Producers 2005-2006. Retrieved September 4, 2008, from <http://www.ato.gov.au/businesses/content.asp?doc=/content/66037.htm&page=10&H10>
- Barr, N. (2005). *Australia's farmers: Past, present and future*. Canberra: Land and Water Australia.
- Beauman, C., Cannon, G., Elmadfa, I., Glasauer, P., Hoffmann, I., Keller, M., et al. (2005). The Giessen Declaration. *Public Health Nutrition*, 8(6A), 117-120.
- Belliveau, R., & Gingras, D. (2007). Role of nutrition in preventing cancer. *Canadian Family Physician*, 53, 1905-1911.
- Biles, J., Brehm, K., Enrico, A., Kiendl, C., Morgan, E., Teachout, A., et al. (2007). Globalization of food retailing and transformation of supply networks: Consequences for small-scale agricultural producers in southeastern Mexico. *Journal of Latin American Geography*, 6(2).
- Bureau of Meteorology. (2008). Drought Statement: A Dry Autumn and Winter over Most of Australia. Retrieved September 4, 2008, from <http://www.bom.gov.au/climate/drought/drought.shtml>
- Burns, C. (2008, October, 15). The Rising Cost of Healthy Foods. *ABC News Online*.
- Campbell, A. (2008). *Paddock to plate: Food, farming and Victoria's progress to sustainability*. Melbourne: Australian Conservation Foundation.

- Carlsson-Kanyama, A. (1998). Climate change and dietary choices - how can emissions of greenhouse gases from food consumption be reduced? *Food Policy*, 23(3/4), 277-293.
- Carlsson-Kanyama, A., Ekstrom, M., & Shanahan, H. (2003). Food and life cycle energy inputs: Consequences of diet and ways to increase efficiency. *Ecological Economics*, 44, 293-307.
- Collins, A., & Fairchild, R. (2007). Sustainable food consumption at a sub-national level: An ecological footprint, nutritional and economic analysis. *Journal of Environmental Policy and Planning*, 9(1), 5-30.
- Cowey, S., & Hardy, R. (2006). The metabolic syndrome: A high-risk state for cancer? *American Journal of Pathology*, 169, 1505-1522.
- Crosthwaite, J., Callaghan, J., Farmar-Bowers, Q., Hollier, C., & Straker, A. (2004). *Drivers of land use change: Driver research phase one*. Melbourne: Victorian Department of Sustainability and Environment.
- Curtis, A., & De Lacy, T. (1994). Landcare in Australia: Does it make a difference? *Journal of Environmental Management*, 46(2), 119-137.
- de Looper, M., & Bhatia, K. (2001). *Australian health trends 2001* (No. AIHW PHE 24). Canberra: Australian Institute of Health and Welfare.
- Dental Health Services Victoria. (2004). *Teeth - oral health information for maternal and child health nurses*. Melbourne: DHSV.
- Department of Agriculture Fisheries and Forestry. (2008). *Australian food statistics 2007*. Canberra: Australian Government.
- Department of Climate Change. (2008a). Australia's Agriculture - Impacts of Climate Change. Retrieved November 21, 2008, from <http://www.climatechange.gov.au/impacts/agriculture.html>
- Department of Climate Change. (2008b). *Australia's national greenhouse accounts: National inventory by economic sector 2006*. Canberra: Australian Government.
- Department of Environment and Conservation. (2007). *Co-collection of domestic food waste and garden organics: The Australian experience*. Sydney: New South Wales Government.
- Department of Environment Food and Rural Affairs. (2007). *Report of the food industry sustainability strategy champion's group on waste*. London: UK Government.
- Department of Health. (2008). Go for 2&5. Retrieved October 1, 2008, from <http://www.gofor2and5.com.au/>
- Department of Health and Aging. (2008a). *2007 Australian national children's nutrition and physical activity survey fact sheet - key findings*. Canberra: Australian Government.
- Department of Health and Aging. (2008b). *2007 Australian national children's nutrition and physical activity survey fact sheet - survey methodology*. Canberra: Australian Government.
- Department of Health and Human Services. (2006). *Your guide to lowering your blood pressure with DASH* (No. NIH 06-4082). Washington, DC: US Government.
- Department of Health and Human Services and Department of Agriculture. (2005). *Dietary guidelines for Americans, 2005*. Washington, DC: US Government
- Devine, A., McFaul, S., Dick, I., & Miller, M. (2008). *Vegetables and fruit for health and healing*. Perth: Edith Cowan University.
- Draper, G., Unwin, E., Serafino, S., Somerford, P., & Price, S. (2005). *Health measures 2005: A report on the health of the people of Western Australia*. Perth: Department of Health WA.
- Drewnowski, A., & Spector, S. (2004). Poverty and obesity: The role of energy density and energy costs. *American Journal of Clinical Nutrition*, 79, 6-16.
- Drought Policy Review Expert Social Panel. (2008). *Assessment of the social impacts of drought and related government and non-government social support services: Issues paper*. Canberra: DAFF.
- FareShare. (2008). FareShare. Retrieved July 1, 2008, from www.fareshare.org.au
- Field, A., Colditz, G., Fox, M., Byers, T., Serdula, M., Bosch, R., et al. (1998). Comparison of 4 questionnaires for assessment of fruit and vegetable intake. *American Journal of Public Health*, 88(8), 1216-1218.
- Food Standards Agency. (2001). *The balance of good health: Information for educators and communicators*. Middlesex: UK Government.

- Food Standards Australia New Zealand. (2008). Proposal P293 - Nutrition, Health and Related Claims. Retrieved November 27, 2008, from <http://www.foodstandards.gov.au/standardsdevelopment/proposals/proposalp293nutritionhealthandrelatedclaims/index.cfm>
- Fordred, C. (2008, May). Is 'Fresh' Always Best? *EcoLibrium*.
- Foster, C., Green, K., Bleda, M., Dewick, P., Evans, B., Flynn, A., et al. (2006). *Environmental impacts of food production and consumption: A report to the Department for Environment, Food and Rural Affairs*. London: DEFRA.
- Gaballa, S., & Abraham, A. (2008). *Food miles in Australia: A preliminary study of Melbourne, Victoria*. Melbourne: Centre for Education and Research in Environmental Strategies.
- Garnaut, R. (2008). *The Garnaut climate change review*. Canberra: Department of Climate Change.
- Gellweiler, K. (2006). *Go for 2&5 fruit and vegetable campaign results - phase 1*. Brisbane: Queensland Health.
- Golden Circle. (2008). Proposal for Heinz to Acquire Golden Circle Limited. Retrieved November 24, 2008, from <http://www.nsva.com.au/ftp/news/021720721.PDF>
- Government of South Australia. (2008). Adelaide Thinkers in Residence. Retrieved November 5, 2008, from <http://www.thinkers.sa.gov.au/home.html>
- Grunert, K. (2005, January 31). *Current issues in consumer food quality perception*. Paper presented at the Consumer and Market Demands Network Workshop, Edmonton.
- Hamilton, C., Denniss, R., & Baker, D. (2005). *Wasteful consumption in Australia* (No. Discussion Paper Number 77). Canberra: The Australia Institute.
- Hands, B., Parker, H., Glasson, C., Brinkman, S., & Read, H. (2004). *Physical activity and nutrition levels in Western Australian children and adolescents*. Perth: Western Australian Government.
- Harper, T. (2008). *Submission to the ACCC inquiry into the competitiveness of retail prices for standard groceries*. Melbourne: VicHealth.
- Hatfield-Dodds, S., Carwardine, J., Dunlop, M., Graham, P., & Klein, C. (2007). *Rural Australia providing climate solutions*. Canberra: CSIRO Sustainable Ecosystems.
- Healthy Kids School Canteen Association. (2008). Healthy School Canteens. Retrieved November 21, 2008, from <http://www.schoolcanteens.org.au/healthy-school-canteens>
- Heart Foundation. (2008). Campaigns: Just Add Fruit and Veg. Retrieved November 30, 2008, from http://www.heartfoundation.org.au/Get_Involved/What%27s_On/Victoria/Campaigns.htm
- Higgins, A., Estrada-Flores, S., Singh, G., Ton, T., Dunstall, S., Archer, A., et al. (2007). *State of logistics: Final report*. Sydney: CSIRO Food Futures Flagship.
- Hill, J. (2008). Fruit and Veg Program 2008. Retrieved November 26, 2008, from www.kidsgoforyourlife.org.au/downloads/HealthProfessionals/whatsnew/Healthprofessforum_2008v2.pdf
- Hoekstra, A., & Chapagain, A. (2007). Water footprints of nations: Water use by people as a function of their consumption pattern. *Water Resource Management*, 21, 35-48.
- IFAVA. (2008). About us: IFAVA mission statement and purpose. Retrieved September 11, 2008, from http://www.ifava.org/about_pages.asp?id=2100
- Intergovernmental Panel on Climate Change. (2007). *Fourth assessment report*. Geneva: IPCC.
- International Fruit and Vegetables Alliance. (2008). About Us: IFAVA Mission Statement and Purpose. Retrieved September 11, 2008, from http://www.ifava.org/about_pages.asp?id=2100
- James, I. (2007). *Economic outlook - trade challenges*. Paper presented at the Vegetable Industry Conference 2007.
- Johnson, D., & Parry, A. (2008). *Helping consumers reduce fruit and vegetable waste: Interm report*. Banbury, United Kingdom: Waste and Resources Action Programme.
- Jones, T. (2007). Using contemporary archaeology and applied anthropology to understand food loss in the American food system.

- Kamphuis, C., Giskes, K., de Bruijin, G., Wendel-Vos, W., Brug, J., & van Lenthe, F. (2006). Environmental determinants of fruit and vegetable consumption among adults: A systemic review. *British Journal of Nutrition*, *96*, 620-635.
- Kerckhoffs, L. H. J., & Reid, J. B. (2007). *Carbon sequestration in the standing biomass of orchard crops in New Zealand*. Hastings, New Zealand: New Zealand Institute for Crop and Food Research Ltd.,
- Knott, D., Muers, S., & Aldridge, S. (2008). *Achieving culture change: A policy framework*. London: UK Cabinet Office.
- Larcombe, J., & McLoughlin, K. (2007). *Status of fish stocks managed by the Australian Government*. Canberra: DAFF and Bureau of Rural Sciences.
- Larsen, K., Ryan, C., & Abraham, A. (2008). *Sustainable and secure food systems for Victoria: What do we know? What do we need to know?* (No. 1). Melbourne: University of Melbourne.
- Lea, E., Crawford, D., & Worsley, T. (2006). Public views of the benefits and barriers to the consumption of a plant-based diet. *European Journal of Clinical Nutrition*, *60*, 828-837.
- Lea, E., & Worsley, A. (2003). Benefits and barriers to consumption of a vegetarian diet in Australia. *Public Health Nutrition*, *6*(5), 505-511.
- Lenzen, M., & Foran, B. (2001). An input-output analysis of Australian water usage. *Water Policy*, *3*(4), 321-340.
- Leopold, A. (1948). *A Sand County almanac*. New York: Oxford University Press.
- Lichtenstein, P., Holm, N., Verkasalo, P., Iliadou, A., Kaprio, J., Koskenvuo, M., et al. (2000). Environmental and heritable factors in the causation of cancer - analyses of cohorts of twins from Sweden, Denmark, and Finland. *New England Journal of Medicine*, *343*, 78-85.
- Lock, K., Pomerleau, J., Causer, L., Altmann, D., & McKee, M. (2005). The global burden of disease attributable to low consumption of fruit and vegetables: Implications for the global strategy on diet. *Bulletin of the World Health Organization*, *83*(2), 100-108.
- Lowe, R. (2007, Winter). How Should We Farm Animals in 2050? *Food Ethics*.
- Marks, G. (1991). Nutritional surveillance in Australia: A case of groping in the dark? *Australian Journal of Public Health*, *15*(4), 277-280.
- Marks, G., Pang, G., Coyne, T., & Picton, P. (2001). *Cancer costs in Australia - the potential impact of dietary change*. Canberra.
- McMichael, A., Powles, J., Butler, C., & Uauy, R. (2007). Food, livestock production, energy, climate change and health. *Lancet*, *370*(9594), 1253 - 1263.
- McMichael, A., Woodruff, R., & Hales, S. (2006). Climate change and human health: Present and future risks. *Lancet*, *367*, 859-869.
- Meat and Livestock Australia. (2008). *Cattle and the environment*. North Sydney: MLA.
- Michels, K., Welch, A., Luben, R., Bingham, S., & Day, N. (2005). Measurement of fruit and vegetable consumption with diet questionnaires and implications for analysis and interpretation. *American Journal of Epidemiology*, *161*(10), 987-994.
- Miller, M., Pollard, C., Hendrie, D., & Rowley, C. (2007). *The case for enhanced investment in Go for 2&5 in South Australia*. Adelaide: Department of Health and Primary Industries and Resources South Australia.
- Mitrou, P., Kipnis, V., Thiebaut, A., Reedy, J., Subar, A., Wirfalt, E., et al. (2007). Mediterranean dietary pattern and prediction of all-cause mortality in a US population: Results from the NIH-AARP Diet and Health Study. *Archives of Internal Medicine*, *167*, 2164-2168.
- Morgan, D., Renzi, S., Cook, R., & Radenovic, H. (2006). *Seattle food system enhancement project: Greenhouse gas emissions study*. Seattle: University of Washington, Program on the Environment.
- National Health and Medical Research Council. (2003). *Dietary guidelines for Australian adults*. Canberra: Australian Government.
- Nowson, C., Worsley, A., Margerison, C., Joma, M., Frame, A., Torres, S., et al. (2004). Blood pressure response to dietary modification in free-living individuals. *Journal of Nutrition*, *134*, 2322-2329.

- Nowson, C., Worsley, A., Margerison, C., Joma, M., Godfrey, S., & Booth, A. (2005). Blood pressure change with weight loss is affected by diet type in men. *American Journal of Clinical Nutrition*, 81(5), 983-989.
- Nuffield Council on Bioethics. (2007). *Public health: Ethical issues*. Cambridge: Nuffield Foundation.
- O'Halloran, N., Fisher, P., & Rab, A. (2008). *Preliminary estimation of the carbon footprint of the Australian vegetable industry*. Sydney: Horticulture Australia Limited.
- Oberholtzer, L. (2004). *Community supported agriculture in the Mid-Atlantic region: Results from a shareholder survey and farmer interviews*. Stevensville, MD: Small Farm Success Project.
- Owen, L., Seaman, H., & Prince, S. (2007). *Public understanding of sustainable consumption of food*. London: DEFRA.
- Parry, A. (2008). What is Being Wasted and Why - Priorities to Address. Retrieved October 15, 2008, from http://www.wrap.org.uk/downloads/Andrew_Parry_-_Insights_to_WRAPs_food_waste_research.06174102.5933.pdf
- Perez, J., Allen, P., & Brown, M. (2003). *Community supported agriculture on the central coast: The CSA member experience*. Santa Cruz: University of California.
- Pimentel, D., & Pimentel, M. (1996). *Food energy and society*. Nowak, CO: Colorado University Press.
- Pollard, C., Miller, M., Daly, A., Crouchley, K., O'Donoghue, K., Lang, A., et al. (2007). Increasing fruit and vegetable consumption: Success of the Western Australian Go for 2&5 campaign. *Public Health Nutrition*, 11(3), 314-320.
- Pomerleau, J., Lock, K., McKee, M., & Altmann, D. (2004). The challenge of measuring global fruit and vegetable intake. *Journal of Nutrition*, 134, 1175-1180.
- Renehan, A., Tyson, M., Egger, M., Heller, R., & Zwahlen, M. (2008). Body-mass index and incidence of cancer: A systematic review and meta-analysis of prospective observational studies. *Lancet*, 371, 569-578.
- Royal Institute of International Affairs. (2008). *Thinking about the future of food: The Chatham House food supply scenarios*. London: RIIA.
- Russell, G. (2008, April). Confounders: The CSIRO and the Total Wellbeing Diet. *The Monthly*.
- Scheaffer, R., Mendenhall, W., & Ott, L. (1990). *Elementary survey sampling* (4th ed.). Boston: KWS-Kent Publishing Company.
- Scott, P. (2008). *Meat being competitive: Competitiveness of Australia's intensive livestock industry*. Canberra: Australian Bureau of Agricultural and Resource Economics.
- SecondBite. (2008). SecondBite. Retrieved October 18, 2008, from <http://www.secondbite.org/>
- Senate Standing Committee on Environment Communications and the Arts. (2008). *Management of australia's waste streams (including consideration of the Drink Container Recycling Bill 2008)*. Canberra: Senate Printing Unit.
- Spencer, S., & Kneebone, M. (2007). *FoodMap: A comparative analysis of Australian food distribution channels*. Canberra: Department of Agriculture, Fisheries and Forestry.
- State Government of Victoria. (2008). Information for professionals: Kids - 'Go for your life'. Retrieved November 30, 2008, from http://www.goforyourlife.vic.gov.au/hav/articles.nsf/pracpages/Kids_Go_for_your_life?Open
- Stoeltje, G. (2008). *Follow that french fry: Food miles and roadway damage*. Austin: Texas Department of Transportation and Government and Public Affairs Division.
- Strategy Unit. (2008). *Food matters: Towards a strategy for the 21st century*. London: UK Cabinet Office.
- Sustainability Victoria. (2008). Waste Wise Catering Toolkit. Retrieved November 6, 2008, from http://www.resourcesmart.vic.gov.au/for_businesses/waste_2211.html
- Sustainable Table. (2008). The Issues: Factory Farming. Retrieved November 19, 2008, from <http://www.sustainabletable.org/issues/factoryfarming/>
- Toyne, P., & Farley, R. (2000). *The decade of Landcare: Looking backward - looking forward*. Canberra: The Australia Institute.
- Tsai, W. (2008). Management considerations and environmental benefit analysis for turning food garbage into agricultural resources. *Bioresource Technology*, 99, 5309-5316.

- Tudge, C. (2005). Feeding people is easy: But we have to re-think the world from first principles. *Public Health Nutrition*, 8(6A), 716-723.
- Tyrchniewicz, E., & McDonald, B. (2007). *Finding common ground: Food for a healthy population and a healthy agri-food sector*. Ottawa: Canadian Agri-food Policy Institute.
- United Nations. (1948). *Universal declaration of human rights*. Geneva: UN.
- United Nations Food and Agriculture Organization. (2006). *Livestock's long shadow: Environmental issues and options*. Rome: FAO.
- van Staveren, W., de Groot, L., & Haveman-Nies, A. (2002). The SENECA study: Potentials and problems in relating diet to survival over 10 years. *Public Health Nutrition*, 5(6A), 901-905.
- Ventour, L. (2008). *The food we waste*. London: Waste and Resources Action Programme.
- Victorian Department of Human Services. (2006). *Victorian population health survey 2006*. Melbourne: Victorian Government.
- Victorian Health Promotion Foundation. (2007). *Food security fact sheet*. Melbourne: VicHealth.
- Victorian Health Promotion Foundation. (2008). Food for All Program. Retrieved November 15, 2008, from www.vichealth.vic.gov.au/foodforall/
- Watts, C. (2008). *The future food and farm project: Project outline for prospective consultants*. Melbourne: Australian Conservation Foundation.
- Weber, C., & Matthews, S. (2008). Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science and Technology*, 42(10), 3508-3513.
- Western Australia Department of Agriculture and Food. (2008). Food Strategy WA. Retrieved November 5, 2008, from <http://www.agric.wa.gov.au/content/foods/Fstrat/index.htm#1>
- Wilson, J., Ford, J., & Lavis, T. (2004). *Driver research phase background report 1: Land use impacts on native biodiversity*. Melbourne: Victorian Department of Sustainability and Environment.
- Working Group for the Food Trade Skill Shortages Project. (2001). *A recipe for change: The future of commercial cookery in Australia*. Canberra: Australian Government.
- World Cancer Research Fund / American Institute for Cancer Research. (1997). *Food, nutrition and the prevention of cancer: A global perspective*. Washington, DC: AICR.
- World Cancer Research Fund / American Institute for Cancer Research. (2007). *Food, nutrition, physical activity, and the prevention of cancer: A global perspective*. Washington DC: AICR.
- World Health Organization. (2003a). *Fruit, vegetables and NCD disease prevention*. Geneva: WHO.
- World Health Organization. (2003b). *The world health report 2003: Shaping the future*. Geneva: WHO.
- World Health Organization, & United Nations Food and Agriculture Organization. (2003). *Diet, nutrition and the prevention of chronic diseases: Report of a joint WHO/FAO expert consultation* (No. WHO 916). Geneva: WHO/FAO.
- Yakovleva, N. (2007). Measuring the sustainability of the food supply chain: A case study of the UK. *Journal of Environmental Policy and Planning*, 9(1), 75-100.
- Youl, R., Marriott, S., & Nabben, T. (2006). *Landcare in Australia: Founded on local action*. Melbourne: SILC and Rob Youl Consulting.
- Zero Waste Australia. (2008). Groundswell. Retrieved October 2, 2008, from www.zerowasteaustralia.org/australia/nsw/groundswell
- Zero Waste South Australia. (2008). Food Waste Pilot. Retrieved November 15, 2008, from www.zerowaste.sa.gov.au/foodwaste_invitation.php



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March 2009

